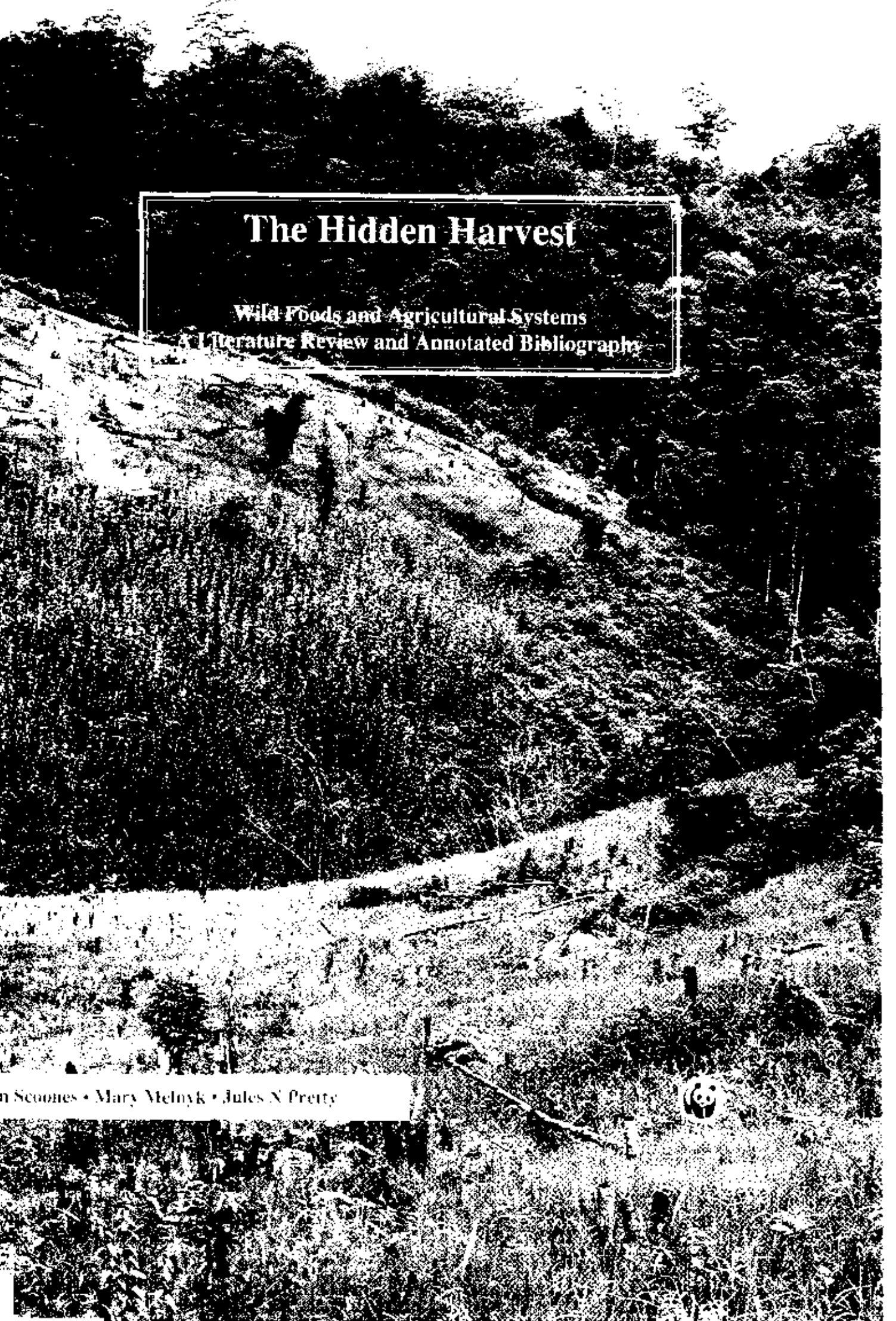

The Hidden Harvest

Wild Foods and Agricultural Systems
A Literature Review and Annotated Bibliography

n Scoones • Mary Melnyk • Jules N Pretty

THE HIDDEN HARVEST:

WILD FOODS AND AGRICULTURAL SYSTEMS

A LITERATURE REVIEW AND ANNOTATED BIBLIOGRAPHY

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- Front Cover: Forest margin and swidden cultivation, Northern Thailand - Jules Pretty
- Upper Back Cover: Bird hunters, Northern Thailand - Jules Pretty
- Lower back cover: Cassia senna collectors, Khartoum Province, Sudan - Jules Pretty

FOREWORD

This literature review and annotated bibliography of close to one thousand references relating to wild foods is the first phase of a research project entitled *The Hidden Harvest*. It is a three year programme of research support and institutional collaboration designed to assess the role of wild foods in agricultural systems. The programme is being coordinated by the Sustainable Agriculture Programme of IIED, London.

The research involves a close collaboration between IIED and partner institutions in Africa and Asia engaged in the analysis of biological diversity, agricultural production and local livelihood strategies. The five phases of the programme are:

- this annotated bibliography with extended essays;
- research into the role of wild foods in agricultural systems;
- the adaptation and blending of participatory methods with techniques for valuation of natural and environmental resources to assess the economic value of wild foods, and the training of collaborating researchers in their use;
- the publication of research findings and materials that present new perspectives on the linkages between agricultural production, biological diversity and household food security;
- the convening of workshops and conferences both to strengthen the network of collaborators and inform policy options and incentives that relate to the role of wild food in agricultural systems.

The annotated bibliography and series of methodological papers on valuation techniques and participatory rural appraisal methods have been funded by the *Swedish International Development Authority* and the WWF, *World Wide Fund for Nature* (formerly known as the World Wildlife Fund), Biological Diversity, Conservation Policy Division, WWF International. The Programme gratefully acknowledges their support.

The compilation of this bibliography would not have been possible without the generous assitance of colleagues around the world who have shared their research materials and pointed us towards sources of reference material. The Overseas Development Institute library, Kew library and the CAB data base at the Oxford Forestry Institute have been particularly helpful in locating sources. We would like to thank colleagues at IIED, notably Deviani Vyas, for assisting with the editing process. Tanya Yudelman also helped with the development of the database and compiled the indices.

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INTRODUCTION TO THE REVIEW AND BIBLIOGRAPHY

This bibliography is not intended to be a comprehensive review. The 971 reference entries represent only a fraction of the available literature collected together for this review. Those selected are intended to provide an indication of the range of research carried out on wild foods in agricultural systems, highlighting key themes of policy interest. The bibliography and review is therefore not intended to be an exhaustive listing of available literature.

The bibliography is organised into a number of different thematic sections. The brief literature reviews found at the beginning of each section point the reader to major issues in the literature and areas where questions remain unanswered. Extensive referencing refers to numbered entries in the bibliography. Cross-referencing is made to other sections where relevant material can be found. Following the overview essays, a series of references relevant to that theme can be found. These are ordered alphabetically according to author. At the end of the bibliography are three indices. Numbered indexing is by geographical areas, by ethnic groups and by themes.

There are a total of 11 overlapping themes that make up the bibliography. The first section provides a broad overview of the role of *wild foods in agricultural systems*, noting how hunting and gathering is an important component of sustainable livelihoods in many areas. The next section concentrates on the literature on *swidden agriculture and foraging in forest areas*. The third section focuses on wild food use in *pastoral systems*, largely drawing on literature from Africa. The following section takes *wildlife utilisation* as the theme, examining the importance of bush meat as food and the need to ensure wildlife use by local people. The sections on wild foods and *food security* emphasise the importance of wild foods in times of food scarcity. The next section examines the *nutritional significance* of wild foods in diets. The following section highlights the importance of common property areas as sources for the collection of plants and hunting of animals. It also explores the *tenure and institutional* implications of wild food use under increasing land pressure. The section on *differentiated use* demonstrates the importance of wild foods to particular groups in society, notably the poor, women and children. The value of wild foods to people is taken up as the theme in the section on *economic valuation* of wild foods. Here methodological issues of

valuation are explored, together with the question of appropriate incentives for wild resource management. The importance of conserving the world's genetic *biodiversity* is emphasised in the following section. This highlights the importance of wild genetic resources in sustaining agricultural production and the potentials for in situ conservation of biodiversity by farmers. The final section contains references, largely country or region specific inventories, of the range of *non-timber forest products* found in different agroecosystems.

The literature reviews highlight a number of key issues of relevance to agriculture and forestry policy:

- Conventional agriculture and forestry research has concentrated on 'major crops', with little attention being paid to the range of other products harvested in agricultural and forest areas;

- Wild foods are important in the whole range of agricultural systems, in all parts of the world. Wild food use is not the exclusive preserve of 'hunting and gathering' societies;

- Wild foods may be particularly important during certain seasons of the year and during major stress periods, such as in droughts;

- Wild foods are especially significant for women, children and the poor;

- Wild foods are often collected from common property resource areas; securing access to such resources is important for sustaining the livelihoods of the poor;

- The sustainable management of wild resources requires local management and control over the resource, and so there is a need for investment in local institutional capacities;

- Wild products have significant economic value, and this needs to be taken account of in agriculture and forestry planning;

- Wild genetic resources are key for the future of agricultural production, and so conservation and management of such resources on farm and by farmers will help to ensure the maintenance of biodiversity.

The literature reviews have, however, highlighted several significant gaps. Many studies have been simply inventories, listing a range of species harvested. But how do wild foods fit into people's livelihood system? How important are wild foods, relative to other sources of food or income? Who is dependent on them and when? What are the implications of changing patterns of land-use and land tenure? What is the economic value of wild foods to local people? What policy incentives need to support the management of wild resources?

This bibiliography and literature review is part of a wider project on the role of wild foods in agricultural systems being coordinated by the Sustainable Agriculture Programme of the International Institute for Environment and Development (IIED) that will attempt to fill some of these gaps in our present understanding. Future work on this project will involve the development of participatory research approaches for the local level valuation of wild foods and for the examination of wild resource management in incentives. This will be carried out through a series of case studies together with collaborators in South Asia and Africa.

For more information on this, and other work of the Sustainable Agriculture Programme, please contact: The Director, Sustainable Agriculture Programme, IIED, 3 Endsleigh Street, London WC1 HODD.

Chapter One

Wild Foods in Agricultural Systems

Baobab and Acacia trees with millet, Senegal
Photo: Jules Pretty

1. WILD FOODS IN AGRICULTURAL SYSTEMS

Throughout the world agriculture is the site of a great diversity of managed and collected plant and animal foods. Conventional agricultural research and extension, by focussing only on the main food crops, chiefly cereals, roots and domesticated livestock, has long ignored the range of other plants and animals that also make up agricultural systems.

Studies of this diversity and attendant complexity are demonstrating the importance of understanding the full range of products harvested. For instance, in the apparently maize dominated agricultural system of Bungoma in Kenya, people consume at least 100 different species of vegetables and fruits drawn from 70 genera and belonging to 35 families (88; 729). Similarly, the agropastoral Tswana, in Botswana, use 126 plant species and 100 animal species as sources of food (261). Similar patterns are shown in SE Asia (179; 132; 152; 188), Himalayan areas (160), central America (682), Latin America (2; 3; 126), northern Europe (866; 867) and elsewhere in Africa (47-49; 82; 273; 400a; 493; 494; 770).

Studies of settled agriculture worldwide, whether in semi-arid, temperate or humid settings, on the plains or in mountain areas, show that hunting and gathering remains an important component of the livelihoods of agricultural peoples. There is no progressive evolutionary trend of 'development' from hunter-gatherer to small-scale settled agriculture and livestock keeping to intensive agricultural systems. Livelihood strategies in all social, economic and ecological settings encompass a wide range of activities. These include the exploitation of a hidden harvest of wild food sources. As the references in this section show, diversification of livelihood strategies, combining agricultural sources of food and income with that derived from wild resources, is particularly important for the poorest households, and for women and children (48; 49; 608-630).

Agroecological Change

As agroecosystems change, through expansion of cultivated area or changes in cropping

patterns, so the availability of wild foods alters. As woodlands are cleared, new edible weeds and pests linked with agricultural lands appear as other foods more associated with the woodland ecology disappear (170; 171 for southern Zimbabwe). The simplification of agroecosystems, such as in the conversion of forest areas to cattle pastures in Brazil and the intensification of small-scale agriculture through Green Revolution technologies worldwide, has the greatest impact on the poor, as key sources of food are lost (76).

Although the greatest diversity of wild foods are found in multi-layered, complex agroforestry systems and home gardens, wild foods are still important in apparently simple, monoculture systems. For instance, canals feeding extensive rice areas are habitats for fish, frogs and plants associated with excess irrigation water (4; 69; 152). Similarly, other forms of intensive agriculture may harbour particular pests such as rats, mice and locusts, which may be eaten. Intensification of agriculture, with increased use of pesticides and fertilisers, may have a negative effect on the wild food crop by killing off the potential foods 'pests' or 'weeds'. However fertiliser inputs may increase the prevelance of certain species (152).

Wild foods are not only associated with undisturbed systems that replicate the ecological diversity of the uncleared forest, they are also found in degraded sites. Sometimes disturbance increases the diversity of wild products (173). For instance, in Kenya and Tanzania, the greatest prevalence of wild vegetables was found in gullies caused by erosion on farmland (90; 173). Pathways, roadsides, home sites and field edges are also potential sites for wild products; sites which otherwise might be considered valueless. Areas that are logged within forests may become the site for mushroom fruiting (861).

More often, the diversity of wild foods declines during the conversion of complex woodland to simplified cropped land. For instance, in three Tanzanian villages there is a correlation between the diversity of edible plants being eaten and the degree of deforestation (400a). Similarly, twenty years of agricultural change in Kenya have had a major impact on Mbeere wild food collection and use strategies, causing them to use fewer wild food sources, because of reduced access to bush land as a result of land privatisation (28-30; 137).

As agricultural systems change there are new pressures on wild food resources. One response

is actively to domesticate the wild foods. Vegetables and fruit trees, formerly harvested in the forest or grazing areas, are increasingly protected or planted (1). In north-west Uganda valuable weeds in the diet of farmers have started to be cultivated within the home compounds (156; 729 for western Kenya). Similarly bush-fallow systems may be transformed by enrichment planting (108), such as the planting of fruit trees in fruit-poor Acacia fallow areas (39).

Agroforestry Systems

Farmers have always incorporated trees into farming systems. An increased interest in agroforestry during the past decades has resulted in a more thorough documentation of agroforestry practices from Africa (1; 24; 56; 89; 105; 114; 138; 139), home gardens in SE Asia (40; 62; 102-104; 116; 151a; 151b; 168), kitchen gardens in the West Indies (27) and agroforestry systems in Latin America (2; 3; 9; 53; 58; 99; 117-119). The complexity and diversity of many managed agroforestry systems is immense (23).

The inclusion of trees as a component of the agricultural system increases the structural complexity of the field environment, provides a degree of complementarity in seasonal and interannual production patterns with annual crops and changes the labour commitments to an area of land. Retaining trees on farm land during clearance for agriculture or subsequent planting of trees produces a range of ecological habitats and seasonal niches ideal for wild food production.

During the selective clearing of land for agriculture, farmers usually retain particular tree species. These are often fruit trees, the providers of seasonally important wild foods. In Zimbabwe, clearing of Julbernadia globiflora dominated miombo woodland reduced canopy cover from 52% to 8%. But the canopy cover of fruit trees was only reduced from 7% to 1%. Some favoured fruit tree species, notably Diospyros mespilliformis, Strychnos cocculoides and Azanza garkeana, showed no reduction in cover when forested areas and cultivated areas were compared. Depsite widespread deforestation for land clearance in one site, patterns of fruit use in two agricultural areas were similar because trees had been

selectively retained in cleared fields during woodland clearance (36).

In other settings, trees within farming systems have been enriched by planting. The complex multi-storey home garden systems found in Indonesia (104), Mexico (7), Tanzania (63), Kenya (110), tropical America (165) and elsewhere (56; 65; 101; 102) are examples of intensively managed multi-species systems. Within such gardens wild foods can be found occupying a diversity of ecological niches.

Wild fruit trees may be collected from forest areas and planted in agricultural land to enrich on-farm tree species. This has been recorded in many instances (89; 126; 132). The fruit producing potential of wild cultivars can also be upgraded by simple grafting and breeding techniques (115).

Home Gardens

Complex home gardens have been described in West Sumatra (104) and Java (102; 151a) in Indonesia. Here a range of annual and perennial crops are grown together, complementing the main rice crop derived from other fields. In Java, home gardens containing 500 species are found within a single village (102). There are several different types of garden, including the intensively managed home garden, the village/forest gardens and the forest fringe gardens. The importance of wild foods increases in gardens towards the forest fringe; these gardens resemble more closely the ecological conditions of the forest itself. In Western Sumatra a range wild foods including 22 fruits, 8 vegetables and spices and 3 fern species are protected and harvested in different garden types, while in migrant communities' gardens in Mexico some 338 species are found (7). Home gardens are also important as a site for experimentation with new varieties, domestication attempts and evaluation of different cropping rotations and patterns (128; 188; 243).

Weeds as Food

Trees are not the only component of the agricultural system that are potential sources of food. Along with the major crops planted by the farmer, a range of plant material can be found in agricultural fields that represent potential food (25; 70; 90; 111-113; 175; 703b). These wild foods (vegetables, tubers, grasses) may be potential competitors with the major crop, but whether they are weeds depends on the observer. To many agronomists anything but the major crop itself is regarded as a weed, and so the monocrop ideal (or at most, simple intercropping) is preached by agricultural extension workers throughout the world. Yet many plants deemed 'weeds' may have a variety of uses to local people. To a woman attempting to find cheap and nutritious ingredients for relish, the wild food resource found in agricultural lands may be critical.

Many studies document the importance of wild vegetables in local diets; many of these are available from farmlands. A particularly extensive set of literature exists for east and southern Africa (eg. 79; 86; 135; 143 for Zambia; 111-113 for Swaziland; 171; 172 for Zimbabwe; 98, 139 for Kenya; 90 for Tanzania; 50; 148; 149 for southern Sudan; 96 for Zaire). Most studies note that it is women who are primarily engaged in the collection and management of wild vegetables in Africa (139). Similar findings are reported from elsewhere (876 for Assam; 152, 153 for SE Asia; 528 for Mexico).

Plants collected from fields may be either managed or simply left to grow. Four categories of weed have been identified in southern Sudan: self-sown species, wild species whose seeds are collected and scattered in the fields, those collected as they appear and those eaten only when under severe food shortage (148; 149).

Pests as Food

Arable lands also attract certain pest species. Rodents tend to be at a higher density in fields compared to surrounding areas (51). The abundance of rodent species thus often changes with agricultural clearance (eg. 57 for the New Guinea Highlands). Rodents of various sorts are an important source of food in agricultural communities (317; 747). In Zimbabwe, roasted mice fetch a high premium as a snack food at beer parties (172). The African giant rat

Cricctomys gambiani) is also important in southern Nigeria (382; 286). Changes in bushmeat availablity have occurred as a result of land clearance in West Africa with increasing rodent hunting possibilities, eg. of the grasscutter rodent, Thyrononmys swinderianus (292).

Insects also represent an important dietary component in many agricultural societies (21; 54; 140; 547). Such insects may also be crop pests, but their role as supplementary food is well documented. For instance, termites are an important fat and protein supplement across southern Africa (97; 109; 172) and in southern Sudan (148; 149). Caterpillars (eg. Gonimbrasia belina - the mopane worm) are also widely eaten and marketed (26; 106). In Zambia there is a wide range of edible insects in the diet (159). This has a seasonal dimension. The importance of caterpillars may rise to 40% of relish items in the period November to January (159). Locust or cricket swarms can also provide important additions to local diets (45; 100; 155).

Hunting and Gathering

There are few groups who can sustain livelihoods solely on the basis of hunting and gathering from wild resources (19). Most 'hunting and gathering' communities have some food inputs from arable agriculture or livestock, either from their own plots (48; 49; 65) or through trade and exchange with farming communities (55; 212; 236).

Hunting and gathering is dependent on a diverse source of products that can offset seasonal and interannual variability in wild food production (11; 49; 67; 174). Alternatively a highly reliable and plentiful food source must be available. For instance, the !Kung San rely on mongongo (Ricinodendron rautenenii) as their major food source, with two to three days' supply gathered at any one time (20; 93; 94; 154; 415). Together with the hunting of a variety of wild animals and the collection of a range of wild plants, this is a highly labour and energy efficient survival strategy for the harsh environment of the Kalahari (92-94; 415). Similarly, in the past, Australian aborigines were able to collect a day's food from the bush in two to four hours (259; 260). In the Fertile Crescent of the Middle East, highly nutritious wild wheat and barley provided food for people before the origins of agriculture some 10,000

years ago (134; 263; 279b, 264). With such an abundance of wild produce, the alternative investment of land, labour and capital into the domestication of plants and animals with settled agriculture and livestock keeping appears to make little sense.

Patterns of Use: Seasonality, Regulation and Sustainability Issues

Wild foods in agricultural systems often fit a particular seasonal niche. They may provide green vegetables early in the rainy season, or can be dried and stored for the dry season. They may also provide counter-seasonal food with fruit bearing in the dry season when little else is available. Wild foods may be particulary important in years when harvests fail (49; 170; 400a-d; 484; see 374-452).

Wild foods may only be available occasionally. For instance, insect outbreaks may only be sporadic (or cyclical) or mushroom fruiting dependent on particular (rare) conditions. Diets changed rapidly in a Sudanese village following locust swarms (45), and in Kenyan agricultural areas after rat outbreaks (157). However when such events do occur, as in extensive mushroom fruiting, labour may be diverted away from normal agricultural activities to collection and marketing (121 for southern Zaire; 123 for Zambia; 861 for northern Thailand; 146 for north India).

Collection and consumption of wild foods is often differentiated between socio-economic groups and gender (see 608-630). Women are primarlily engaged in wild food management and harvesting, particularly of green vegetables (90; 113). Wild foods are also important nutritional supplements for children (139; 623 for Kenyan case material; 617 for forest edge communities in Sierra Leone; 125 for central Indian tribal areas). These may be eaten as snack foods or as main meals. The importance of wild foods is greatest amongst poorer households, where main field crops are often insufficient to provide food for the family for the whole year. In a dry miombo area of Zimbabwe poor households use fruits as the alternative to grain for a quarter of all dry season meals (172).

The use of wild products may be regulated by local rules and institutions (see 569-607). Large fruit trees in farmland are often protected (170 for Zimbabwe; 129 for West Africa)

by local communities. Rights over wild products may change as land is cleared for agriculture. In Zimbabwe, fruit trees retained on farm plots effectively become individually owned by farmers during the cropping season, although they may revert to common property in the dry season (but still are protected from cutting by community rules). In other settings all products are privatised by the process of conversion of land to agriculture, reducing the access of those without control over land. Recently, Malawian farmers have sold the rights to the collection of wild resources to Mozambican refugees (171).

Few studies, however, have addressed the degree of dependency on these food sources or their economic value as part of agroecosystems and peoples' livelihoods (see 631-702b). As a consequence, it is difficult to assess the impact of patterns of land-use and land tenure change on different groups of people.

The sustainability of wild food use has also received relatively little attention in the literature. Sustainable harvesting levels for different plant and animal populations remain largely unknown. A number of studies report that wild foods are diminishing with the clearance of forest areas (eg. 152 for NE Thailand; 90; 400a for Tanzania) or the heavy harvesting of wild animals (108; 284; 353). The consequences of agricultural intensification on wild food production are also poorly studied (152).

Unlike large game animals (342), small animals, especially rodents, may be heavily harvested without affecting the viability of the population (170; 353). They are also less susceptible to changes in agricultural land-use and agronomic practice. Indeed rodent populations increase with arable land expansion (292). The same applies to weedy plant species which quickly regenerate following collection and can survive in ephemeral environments on field edges or degraded lands (170; 172; 628). This is in contrast to many fruit tree species which are less resilient to agroecological change, as they may take many years to regrow to maturity.

The study of wild foods in agricultural systems requires an interdisciplinary approach that can examine the role of wild foods in the context of local peoples' livelihoods. This requires posing many questions:

- Where are wild foods collected?
- Who owns the resource?
- Who collects and uses wild foods?
- How important are wild foods as food or as income sources to farming households?
- What are their value to local people?
- How is the availability of wild foods changing?
- Are present harvesting practices sustainable?
- What policy frameworks and incentives are appropriate to encourage the sustainable management of wild resources?

These, and many other questions, are beginning to be answered by the literature. The following sections take a number of these questions and explore the way these themes have been developed in existing publications.

CHAPTER 1: WILD FOODS IN AGRICULTURAL SYSTEMS

1. Adegbehin, J.O. and Igboanugo, A.B.I. (1990). Agroforestry practices in Nigeria. *Agroforestry Systems, 10(1), 1-22.*

> Pressures on common woodland resources means that the development of on farm tree resources is imperative. Shifting cultivation systems with long fallows are no longer able to support farmers in Nigeria; there is a need to explore methods of intensification through agroforestry. Experiences of homestead gardens, taungya, alley farming and scattered tree methods are reviewed.

2. Alcorn, J.B. (1981). Huastec noncrop resource management. *Human Ecology, 9, 395-417.*

> Huastec plant management involves both the manipulation of individual plants and the manipulation of the whole vegetation community. This involves attention to both crop and non-crop plants. The result is a range of anthropogenic vegetation zones in the Mexican rain forest.

3. Alcorn, J.B. (1984). Development policy, forests and peasant farms: Reflections on Haustec-managed forest contribution to commercial and resource conservation. *Economic Botany, 38(4), 389-406.*

> This paper begins with a discussion of development policies in the tropics which promote export crops and timber extraction. It suggests that agricultural development in the tropics which provides income and food to rural communities can proceed while conserving species diversity. A model for such development is given through a description of the Huastec managed forest plots know as "*te'lom*" meaning a "group of trees". It can be derived from swidden fallow lands or may be permanent plots and contains introduced species as well as those from primary and secondary forests. Over 300 useful species can be found within the plots, 81 of which are food producing. Coffee is also grown for sale. In addition to supplying daily food, construction materials, and medicines, the "*te'lom* " acts as a buffer when crops fail or markets for produce fluctuate. Trees within the "*te'lom*" are either protected, or transplanted, while those considered not useful are removed. In order to apply such a system which complements agricultural production, investigations into the types of plants utilized, their management, market demands for products, and possible inputs into the systems are recommended.

4. Ali, A.B. (1989). Ecological principles of the rice-cum-fish farming system. In: Huisman, E.A. and Zonneveld, N. (eds.) *Aquacultural Research in Asia: Management Techniques and Nutrition.* Proceedings of the Asian seminar on aquaculture organized by IFS, Malang, Indonesia, 14-18 November 1988.

> In rice-cum-fish farming, wild fish are trapped and subsequently grown in the rice fields. The most abundant and economically important fish species cultured were Trichogaster pectoralis, a herbivore, Clarias macrocephalus, an omnivore, and Channa striatus, a carnivore. The results are discussed in relation to new management methods to complement the cropping system.

5. Allan, W. (1965). The *African Husbandman.* Oliver & Boyd, London.

> This is a classic text based on work carried out in Zambia from the 1940s, under the auspices of the Rhodes Livingstone Institute. The book argues that local knowledge about natural resource management

needs to be taken seriously. Although somewhat dated, it remains a good sourcebook.

6. Allen, M.S. (1985). The rain forest of Northeast Luzon and Agta foragers. In: P.B. Griffin (ed.), *The Agta of NE Luzon: Recent Studies*, University of San Carlos, Cebu City, Philippines.

7. Alvarez-Buylla Roces, M.A., Lazos Chavero, E., and Garcia-Barrios, J.R. (1989). Homegardens of a humid tropical region in South east Mexico: An example of an agroforestry cropping system in a recently established community. *Agroforestry Systems, 8, 133-156.*

This study examines the homegardens of a migrant rural community. The homegardens, maintained by 97% of the families, supplement cattle and agricultural production. Fruits, vegetable, fuelwood and medicinals, both wild and cultivated, are collected from them. Children were the main consumers of fruit. Within the gardens, 338 species were found, along with pigs, dogs and chickens. A list of 62 wild plant species and their uses is given. Fruits eaten by children are distinguished. The home gardens were begun by clearing and burning the forest area. Seedlings of useful wild trees were protected, while bananas and coconuts were planted. The area around the homestead is divided into three zones: the yard, which is a cleared area in front of house; the home garden containing species needing special protection, medicinals and ornamentals; and the orchard with multi-purpose trees and shrubs. Some gardens were stratified into different layers. The complexity and the diversity of the gardens is proportional to the amount of labour available within the household. Information on gardens and species is actively exchanged between families, particularly as most are new to the area. Families also brought with them crops such as coffee from their former homesteads. They learnt about the ecology of the new area as they allow a certain "weed", Melampodium divaricatum, to grow around tomatoes for protection from winds and the maintenance of humidity. Many "weeds" are also foraged by pigs and chickens. Wild species such as Inga are also allowed to remain in pastures. As only 12% of the original forest cover remains in the area, these wild species are important in the conservation of species and their germplasm.

The production and consumption of garden produce is quantified for eight families representing four different economic classes. The family with the smallest amount of land and no cattle had the greatest number of fruit tree species in its homegarden. It also produced and consumed the most fruits. The family with the largest land holding and greatest amount of cattle, also had a complex an d large garden, however, it consumed fewer fruits, sold none and allowed much of the production to fall to the ground to feed animals. Families with intermediate land holdings sold more fruit than they consumed. The garden then is most important for the subsistence of farmers with little land and who hire themselves for wage labour. Annual incomes from garden produce varied from US$0 - US$6,525 (1981) for these families.

8. Anderson, A.B. and Posey, D.A. (1989). Management of tropical scrub savanna by the Gorotire Kayapo of Brazil. *Advances in Economic Botany, 7, 159-173.*

9. Anderson, A.B., Gely, A., Strudwick, J., Sobel, G.L. and Pinto, M.G.C. (1985). Umsistema agroflorestal na varzea do estuario a mazonico (Ilha das Oncas, Municipio de Barcarena, Estado do Para). *Acta Amazonica, Suplemento, 15(1-2);195-224.*

This paper describes the agroforestry systems of a non-indigenous Brazilian family. They live within the Amazon estuary and harvest various native and exotic species from a house garden, managed floodplain forest and unmanaged floodplain forest. Within the managed area, some vines, shrubs and trees are cut. The unmanaged area contains economically important species such as the acai palm (Euterpe oleracea) and rubber (Hevea brasiliensis). Altogether these three zones provide fish, game,

fruits, medicines, household items and oilseeds; not only for home consumption, but also for sale. With the cash, the family is then able to buy other staple goods. This study shows that given the proper conditions, mainly market access, a living can be made from forest gathering.

10. APU (Agricultural Planning Unit) (1987). *Resource Appraisal and Development Study of Selected Areas of N.E. Darfur.* ODA/Democratic Republic of Sudan.

This consultancy report provides an overview of agricultural and natural resource management strategies in NE Darfur. It reflects on the various survival strategies employed in this highly variable, dry environment. These include the extensive use of wild foods, especially during drought. Lists of wild foods are given, together with local and botanical names. The drought of 1984-5 and the experience of declining rainfall over a long period has prompted a review of development approaches in the area. This report suggests some avenues for the Agricultural Planning Unit to pursue.

11. Bailey, R.C. and Peacock, N.R. (1988). Efe Pygmies of northeast Zaire: Subsistence strategies in the Ituri forest. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 88-117, Clarendon Press, Oxford.

12. Balee, W. (1989). The culture of Amazonian forests. *Advances in Economic Botany, 7;1-21.*

This article debates adaptationist theories of cultural ecology which portray societies as adapting to and being limited by their natural environments. The author presents evidence illustrating that at least 11.8% of terra firme forest in the Brazilian Amazon is of anthropogenic origin.

13. Balee, W. and Gely, A. (1989). Managed forest succession in Amazonia: The Ka'apor case. *Advances in Economic Botany, 7;129-158.*

14. Barnard, A. (1984). *The Perception and Utilization of Morama and Other Food Plants by the Nharo of Western Botswana.* Occasional Papers, 4, Centre for African Studies, University of Edinburgh.

This paper describes the Nharo people, their ethnobotany and environment, plant types found by soil conditions and plant communities, gathering practices and taboos, plant classification, use and distribution, and cultivation practices. The Nharo make a distinction between foods introduced from outside and those traditionally the product of foraging in the field. Only the former are perceived as properly suitable for cultivation.

15. Baxter, P.T.W. and Butt, A. (1953). *The Azande and Related Peoples of the Anglo-Egyptian Sudan and Belgian Congo.* International African Institute, London.

16. Bean, L.J. and Lawton, H. (1976). Some explanations for the rise of cultural complexity in native California with comments on proto-agriculture and agriculture. In: Bean, L.J. and Blackburn T. (eds.) *Native Californians: A Theoretical Perspective*, pp19-48. Bullena Press, Ramona, California.

This chapter discusses a range of wild resource management practices in California. Burning by Diegueno Indians to manage grass seed yields, the pruning of mesquite by the Cahuilla to improve bean yields and the management of wild game birds are all discussed. The use of fire management tools is seen as key. The Indians had well demarcated fields of valued wild plants. The authors argue that the abundance of California's food resources plus the range of extractive techniques developed by local

populations meant that it was unnecessary to develop an agricultural mode in the area during the last century and earlier.

17. Beckerman, S. (1977). The use of palms by the Bari Indians of the Maracaibo Basin. *Principes, 21(4), 143-154.*

This article describes several genera of palms useful to the Bari Indians on the border of Venezuela and Colombia. Euterpe, Oenoc arpus and Jessenia all yield fruits. Jessenia fruit is particularly important as it is often collected to substitute for low returns from hunting and fishing. Its mesocarp is estimated to have a 70% crude fibre, 18% fat and 8% protein by dry weight. A family usually collects 4 kgs of this palm, the edible portions of which have a similar protein content to five eggs. Also, Jessenia palms are intentionally cut and the logs left lying on the ground in order to promote the growth of the edible larvae of Rhynchophorus palmarum within them.

18. Beckerman, S. (1983). Optimal foraging group size for a human population: The case of Bari fishing. *American Zoologist, 23, 283-290.*

The Bari, located on the border of Colombia and Venezuela, are swidden cultivators who obtain 75% of their meat from fish and 25% from game. This article analyses the labour inputs and yields of fishing. It discusses a model of how yields may be optimised and labour requirements reduced through group cooperation.

19. Bicchierri, M. (1972). *Hunters and Gatherers Today: Socioeconomic Study of Eleven Such Cultures in the Twentieth Century*. Holt, Rhinehart and Winston, New York.

20. Biesele, M., Bousquet, J. and Stanford, G. (1979). A Kalahari food staple: Ricinodendron rautanenii. In: J.R. Goodin and D.K. Northington (eds.), *Arid Land Plant Resources: Proceedings of the International Arid Lands Conference on Plant Resources*, pp. 341-3 56, ICASALS, Lubbock, Texas.

21. Bodenheimer, F.S. (1951). *Insects as Human Food: A Chapter in the Ecology of Man.* Dr. W. Junk, The Hague.

22. Bohrer, V.L. (1970). Ethnobotanical aspects of a Hohokam village in southern Arizona. *American Antiquity, 35, 413-430.*

A historical study of Hohokam agriculture documents how the agricultural system combined maize and bean staples with other wild foods. Sahuaro, Opuntia seeds and mesquite supplemented agricultural products, especially when crops failed. Hohokam cultivated fields "*would probably be more accurately ... depicted as a thin carpet of selected weeds*".

23. Boster, J. (1983). A comparison of the diversity of Jivaroan gardens with that of the tropical forest. *Human Ecology, 11, 47-68.*

Garden transects were used to measure the diversity of intercropped species and of local manioc varieties. The gardens have much lower species diversities than surrounding forest, even though crop composition reflects the age, topography and soil type of the swidden.

24. Bradley, P. (1991). *Woodfuel, Women and Woodlots. Vol I. The Foundations of a Woodfuel Development Strategy for East Africa.* MacMillan, London.

This book documents the experience of the Kenya Woodfuel Development project based in Kisii, Kakamega and Murang'a. The book presents some of the information collected by the project on indigenous agroforestry practices, the management of woody biomass, household characteristics and management practices. The book also presents details of the varied research methods employed by the project.

25. Brandao, M. and Zurlo, M.A. (1988). Weeds in human nutrition. *Informe Agropecuario, 13, 14-17.*

The suitability of 47 wild plants for use in human nutrition, the parts of the plant (mainly leaves) suitable for use and culinary purposes are discussed.

26. Brandon, H. (1987). Food that crawls. *International Wildlife, March/April 1987.*

27. Brierley, J.S. (1985). West Indian kitchen gardens: A historical perspective with current insights from Grenada. *Food and Nutrition Bulletin, 7(3), 52-60.*

28. Brokensha, D. and Riley, B.W. (1978). *Mbeere Wild Foods*. Paper prepared for the symposium, "Woman the Gatherer". 77th Annual Meeting, American Anthropological Association, 15 November 1978, Los Angeles, California.

29. Brokensha, D. and Riley, B.W. (1980). Mbeere knowledge of their vegetation and its relevance for development: A case study from Kenya. In: D.W. Brokensha, D.M. Warren and O. Werner, *Indigenous Knowledge Systems and Development*, pp. 113-129, University Press of America, Lanham, Maryland, USA.

30. Brokensha, D. and Riley, B. (1986). Changes in uses of plants in Mbeere, Kenya. *Journal of Arid Environments, 11, 75-80.*

31. Bronson, B. (1966). Roots and subsistence of the ancient Maya. *Southwestern Journal of Anthropology, 22, 251-279.*

32. Browder, J. (ed.) (1989). *Fragile Lands in Latin America: The Search for Sustainable Uses.* Westview Press, Boulder, Colorado.

33. Brush, S.B. (1977). *Mountain, Field, and Family: The Economy and Human Ecology of an Andean Valley.* University of Pennsylvania Press, Philadelphia, USA.

34. Brush, S. (1979). An anthropological appraisal of Latin American farming systems. *Studies in Third World Societies, 7, 107-116.*

Topics centre on the Amazon with papers on traditional agricultural systems and rubber tapping.

35. Budelman, A. and Zander, P.M. (1990). Land use by immigrant Baoule farmers in the Tai region, southwest Cote d'Ivoire. *Agroforestry Systems, 11(2), 101-124.*

36. Campbell, B.M. (1987). The use of wild fruits in Zimbabwe. *Economic Botany, 41(3), 375-385.*

The availability and use of wild fruit trees in Zimbabwe was investigated. An area of high population density undergoing deforestation is compared to two areas with lower population densities and greater amounts of climax woodland. It was found that the presence of wild fruit trees in the area of high population did not decline proportionately with total covered woodland. For three of the most favoured fruit trees their contribution to woody cover increased from 0.5% in climax to 5% in cultivated fields. These trees were protected during land clearing as local people recognized their nutritional value. The data illustrates that the fruits are gathered the most during times of seasonal hunger preceding the harvest, rather than when they are in greatest supply. Primary school children collected the fruits the most in order to eat them; followed by young women who would sell them in the market. Trees were chosen mainly for taste rather than ease of collection and the most favoured species differed according to each area.

37. Campbell, J.G. (1987). Socio-economic factors in traditional forest use and management: Preliminary results from a study of community forest management in Nepal. *Banko Janakari, 1(4), 45-54.*

38. Chernela, J.M. (1989). Managing rivers of hunger: the Tukano of Brazil. *Advances in Economic Botany, 7, 159-173.*

39. Chidumayo, E.N. (1988). Integration and role of planted trees in a bush-fallow cultivation system in central Zambia. *Agroforestry Systems, 7, 63-76.*

The purpose of natural fallow in bush-fallow cultivation systems is to improve soil fertility following a phase of cultivation and to provide useful forest products, including livestock feed. When natural fallow fails to serve these purposes, it can be supplemented or replaced by planted trees. This paper describes the development and function of Acacia fallow in the Soli tribal land of central Zambia, and examines the supplementary role of planted trees. The species making up this Acacia fallow are suitable for regeneration of soil fertility and production of fodder. However, Acacia fallow is poor in edible wild fruits and durable construction wood. The scarcity of fruits in the study area has been *compensated for by widespread planting of exotic fruit trees; some 90% of households have fruit trees.*

40. Christanty, L. and Ruchiyat, Y. (1985). *Homegarden Source Book. Volume 2: Socio-cultural, Economic and Nutritional Aspects.* Institute of Ecology, Padjadjaran University, Bandung, Indonesia.

41. Colfer, C.J.P. (1983). Change and indigenous agroforestry in East Kalimantan. *Borneo Research Bulletin, 15(1), 3-21 and 15(2), 70-87.*

This paper describes a traditional and a commercialized Kerayan village in East Kalimantan. The commercialized village had resettled leaving the traditional village to a more lowland site. In the first part differences in the ecology and technology of the two areas are described. A table of "Access to Selected Forest Products" such as rattan, bamboo, pineapple is given. Edible ferns were reported to be more abundant in the traditional village. A possible decline in wild food use in the resettled village is only incidentally mentioned in a footnote. There is no indication of whether this is due to a decline in actual time spent harvesting, a diminished supply or differing ecologies. Part II describes production with a brief mention of some wild ferns, fruit trees, boars and deer harvested by the traditional village. A diagram illustrates where (secondary or primary forest) these are collected.

42. Colfer, C.J.P., Gill, D.W. and Agus, F. (1988). An indigenous agricultural model from West Sumatra: A source of scientific insight. *Agricultural Systems, 26, 191-209.*

The land-use systems and the income sources for the Minangkabau of West Sumatra are described.

Forest products collected from regenerating forests, as well as the ones providing income are listed in tables. Recommendations for development include an "improved agroforestry system" and the promotion of crop diversity in fields.

43. Colfer, C.J.P., Evensen, C., Evensen, S., Agus, F., Gill, D., Wade, A. and Chapman, B. (1985). *Transmigrants' Gardens: A Neglected Research Opportunity*. Proceedings Centre for Soil Research Annual Technical Meetings, Bogor, Indonesia.

This report is a preliminary survey of the potentials which transmigrants' gardens have for improving nutrition and income. The survey was a part of a larger project (Tropsoils) on soil management. Eighty families from four villages were interviewed about agricultural production and income and twelve gardens were visited and mapped. In order to ascertain whether further development of home gardens should be promoted the survey investigated what percentage of agricultural production, consumption and income are obtained from rice fields and from gardens. The garden provided 28-60% of all agricultural produce and 46-80% was consumed by the households. Of total income, both field and garden production earned households 10-46% of their income. The study noted that the gardens of transmigrants were less diverse than the traditional gardens of Java, not all the available space was used. This was due to concern with other sources of income, not enough labour or the presence of pigs. It was recommended that women play a greater role in the project as they are responsible for the care of gardens and feeding their families. Also further nutritional studies would ascertain which important nutrients were derived from garden products.

44. Colson, E. (1951). The plateau Tonga of Northern Rhodesia. In: E. Colson and M. Gluckman (eds.), *Seven Tribes of British Central Africa*, Oxford University Press, Oxford.

45. Corkhill, N.L. (1954). Seasonal dietary change in a Sudan desert community. *Journal of Tropical Medicine and Hygiene, 57, 257-269.*

46. Corlin, C., de Kartzow, A., Nilsson, G., Olsson, H., and Interforest A.B. (1989). *FTP in Vietnam: Base-line and Diagnosis Study, Socioeconomic Part, Technical Part.* Working Paper 100, Forests, Trees and People, FAO, SIDA, Swedish University of Agricultural Sciences, International Rural Development Centre, Uppsala.

This socio-economic study of two Vietnamese villages of rice cultivators reveals no great dependence on forest products. This may be related to the scarcity of natural forest. Homegardens and agroforestry plantations are however present. Fruit trees, bamboo, vegetables, medicinal plants and cash crops (tea, peanuts) are grown in home gardens. Those families with large home gardens were able to sell produce. 75% of gardens contained fish ponds providing a readily available protein source.

47. Cunningham, B.A. (1988). Collection of wild plant foods in Tembe Thonga society: a guide to Iron Age gathering activities? *Annals of Natal Museum, 29(2), 433-446.*

This paper discusses wild plant use by the Tembe Thonga agro-pastoralists today in relation to what may have been gathered during the Iron age. The reliance on these plants during times of drought and low supplies of agricultural products is mentioned along with the types of nutrients certain species provide. An extensive table of 106 species is given complete with month collected, location found and plant part eaten. The author suggests that Iron Age farmers may have affected vegetation in the area through their management of these products.

48. Davies, A. G. and Richards, P. (1991). *Rain Forest in Mende Life: Resources and Subsistence Strategies in Rural Communitites around the Gola North Forest Reserve (Sierra Leone).* A Report to the Economic and Social Committee on Overseas Research (ESCOR),

UK Overseas Development Administration, UK.

This is a summary of findings from an eighteen month study of communities near the Gola Forest Reserve, Sierra Leone. The objectives included identifying non-agricultural forest products, *documenting their uses and surveying the frequency of use.* Surveys covered building materials, household items, foods and medicines collected from forest, fallow, farm, swamp or plantation. Of the foods, 14% were hunted or collected from the forest; 25% from fallow land; 8% from plantations; 19% from farm, swamp or garden; 21% from streams and rivers; with the final 13% bought or given. As these data illustrate that many products are collected from fallow lands and multi-purpose plantations, these areas deserve further research attention. Information on these surveys is contained in several databases.

49. Dei, G.J.S., Sedgley, M. and Gardner, J.A. (1989). Hunting and gathering in a Ghanaian rain forest community. *Ecology of Food and Nutrition, 22, 225-243.*

The paper examines the nature, contribution, and impact of the exploitation of forest resources on a rural hunter-gathering and farming community in Ghana. Data were collected in 1982/83 to examine the adaptive responses of the peasant farmers to the seasonal food supply cycle, as well as to the national economic crisis of the early 1980s. Detailed studies were used to collect data on hunting and gathering in the small town of Ayirebi, southeastern Ghana. All households are involved in farming, but also hunt or trap to a certain extent. While hunting is predominantly a male occupation, a few women engage in trapping by fencing individual farm plots and setting traps. Gathering of forest products is mainly done by women and youth of both sexes. Estimates of the amount of bush animal protein consumed in domestic households, using scales to weigh game for meal preparation, indicate that every household adult consumes at least 250g of bush meat per week. Together with other animal products such as crabs, snails and oil palm grubs, bush animal protein constitutes an important *substitute for fish and beef in the household diet. The proportion* of food supply provided by the bush rises in the lean pre-harvest season (16%), and is higher for low income households.

50. Deisons, J. (1986). Trees, plants and a rural community in Southern Sudan. *Unasylva, 154, 32-43.*

51. Delaney, M.J. and Kansiimeruhanga, W.D.K. (1970). Observations on the ecology of rodents from a small arable plot near Kampala, Uganda. *African Review of Zoology and Botany, 81, 418-425.*

52. Denevan, W. M. (1971). Campa subsistence in the Gran Pajonal, Eastern Peru. *Geographical Review, 61, 496-518.*

53. Denevan, W.M. and Padoch, C. (1987). Introduction: The Bora Agroforestry Project. In: W.M. Denevan and C. Padoch (eds.) *Swidden-Fallow Agroforestry in the Peruvian Amazon. Advances in Economic Botany, 5, 1-7* The New York Botanical Garden, New York.

54. Dufour, D.L. (1987). Insects as food: A case study from the Northwest Amazon. *American Anthropologist, 89, 383-397.*

Over 20 species of insects are collected by the Tukanoan Amerindians of Colombia. Data is presented on the dietary intake of these species as compared to fish and game. Beetle larvae (genus Rhynchophorus), ants (genus Atta), termites (genus Syntermes) and caterpillars (families Nocutidae and Saturnjidae) are the most commonly consumed. They are most abundant during the rainy season when they can contribute between 12% and 26% of the crude protein from animal sources for men and

women respectively. Beetle larvae contain 24.3g of protein per 100g, while termites contain 58.9g per 100g as compared to 43.4g per 100g for smoked river fish (Hoplias malabaricus and Aequidens latifrons) and 75.4g for smoked tapir (Tapirella spp). Their energy values varied from 425 to 661 kcal per 100g. Smoked beetle larvae had the highest value of 661 kcal per 100g, followed by ants (Atta sexdens) with 628 kcal per 100g. The energy values for smoked river fish and smoked tapir are 312 kcal and 516 kcal per 100g respectively.

Overall the proximate composition of ants, beetle larvae and caterpillars are similar to goose liver, pork sausage and beef liver, respectively. These insects are eaten not only when seasonally abundant, but also when game and fish are in short supply. Women did not have the same access to game and fish as men and so often consumed more insects. On 5 of the 40 days studied, insects were the only source of animal food for women. This situation did not occur for men. The harvesting of these insects is also described. For example, after the felling of palms for fruit, the Tukanoa often return to harvest weevil larvae growing in the decaying trees. In conclusion the author stresses the importance of insects in contributing to dietary diversity and daily consumption needs.

55. Dunn, F.L. (1975). *Rainforest Collectors and Traders, A Study of Resource Utilization in Modern and Ancient Malaya*. Monographs of the Malaysian Branch Royal Asiatic Society, 5, Kuala Lumpur.

56. Dupriez, H., de Leener, P. and de Leener, P. (1987). *African Gardens and Orchards*. Terres et Vie, Nivelles, Belgium.

Home gardens and orchards are important sources of food, beverages and condiments in most African farming systems and the authors set out to explain, as simply as possible, how to make the best use of crops in this context. The treatment is very comprehensive, covering dietary requirements, food preparation and cooking as well as planting and growing. Examples are drawn from savanna and forest regions and countries as wide apart as Senegal and Burundi.

57. Dwyer, P.D. (1978). Rats, pigs, and men: Disturbance and diversity in the New Guinea Highlands. *Australian Journal of Ecology, 3, 213-232.*

58. Escalante, E.E. (1985). Promising agroforestry systems in Venezuela. *Agroforestry Systems, 3, 209-221.*

Two agroforestry systems in Venezuela are described. One is the intercropping of fruit and timber species with coffee. Above the coffee, three layers of varying heights composed of fruit and timber trees are distinguished. It is mainly smallholders who practice this system in which fruits, timber and fuelwood are produced for their own consumption or sale. The silvopastoral systems of the Venezuelan savanna (Llanos) region is the second to be described. The indigenous tree species provide leaves, fruit and flowers of a high protein content for livestock. Crude and digestible protein values are listed for several species. For example, the leaves of Capparis odoratissima have a crude protein value of 24.5%. These species are particularly important in arid and semi-arid areas where there is little pasture. Many species, however, are not regenerating as seedlings are cut during pasture maintenance.

59. Evenson, S. (1986). Farmer practice and production study: characterization of home gardens in Aur Jaya (Sitiung Ve). *Tropsoils Field Research Brief, September 1986, No. 32.*

The composition of transmigrants' home gardens in West Sumatra is detailed with comparisons of traditional Javanese gardens. Transmigrants were given 0.25 hectares for a home garden and one hectare of upland for a field. They had been in the area for only 3.5 years. Upon arrival, they planted staple crops within their home gardens for the first two years along with fruit trees and coffee, allowing for a succession of products. A total of 46 different species were found in the eight family

gardens studied. The greatest number of species planted per farmer, however, was 28. A traditional home garden can contain as many as 50-60 species. The author found few vegetables, particularly greens, in the transmigrants' gardens. This lack of vegetables and the tendency to sell much of what is grown undermines the nutritional well-being of the transmigrants. However, it is noted that most of the fruit is not sold, but eaten by children.

60. FAO (1984). Land, food and people. Based on the FAO/UNFPA/IIASA report: *Potential Population Supporting Capacities of Lands in the Developing World.* FAO, Rome, Italy.

A static 'carrying capacity' argument that assumes that population levels in rural areas of the Third World are solely determined by crop/livestock production (plus some trade). Additional factors such as migration, urban subsidy and wild resources are barely considered.

61. Faulkingham, R.H. (1977). Ecological constraints and subsistence strategies: The impact of drought in a Hausa Village, a case study from Niger. In: D. Dalby, R.J. Harrison-Church, and F. Bezzaz (eds.), *Drought in Africa*, 2, African Environment Special Report No. 6, International African Institute, London.

62. Fernandes, E. and Nair. P. (1986). Evaluation of the structure and function of tropical homegardens. *Agricultural Systems, 21, 1-14.*

63. Fernandes, E.C.M., Oktingati, A. and Maghembe, J. (1984). The Chagga homegardens: A multi-storied agroforestry cropping system on Mt. Kilimanjaro (Northern Tanzania). *Agroforestry Systems, 2, 73-86.*

This article describes the composition and structure of Chagga home gardens. The management of banana and coffee are emphasized as they are the most important crops. The Chagga live on Mt. Kilimanjaro, an area of fertile, volcanic soils. Over the last century, they have developed a complex and diverse agroforestry system in home gardens. These gardens are in addition to cultivating and raising livestock (chickens, pigs). At the time the article was written the population density equalled 500 people per square kilometre. Staples, fruits, vegetables, fuelwood, fodder and medicinals are produced in the gardens. A list of 43 species and their uses is given; however, over 100 have been inventoried. The home gardens are composed of about six layers, beginning with ground cover of grasses, food crops and fodder and proceeding upwards through stories of coffee, medicinal plants, bananas, fruit, fodder, fuel and timber trees.

There is no more land available on Mt. Kilimanjaro for further home gardens. Many people have moved to urban areas or to nearby Mt. Meru. Mainly older people tend the gardens and the danger exists that much of their knowledge of the management of species will be lost. With growing populations, it will be necessary to improve the productivity of the gardens. It is recommended that extension agents provide assistance aimed at the whole, integrated system rather than individual crops. Further recommendations include introduction of nitrogen fixing species, new crop varieties, and fertilizers. Research is needed on optimal crop, spatial and temporal arrangements.

64. Frechione, J., Poscy, D.A. and Da Silva, L.F. (1989). The perception of ecological zones and natural resources in the Brazilian Amazon: An ethnoecology of Lake Coari. *Advances in Economic Botany, 7, 260-282.*

65. Fujisaka, S., Sajise, P. and del Castillo, R. (1986). *Man, Agriculture and the Tropical Forest: Change and Development in the Philippine Uplands*. Winrock International Institute for Agricultural Development, Bangkok, Thailand.

66. Gliessman, S.R., Garcia E., R. and Amadora, M. (1981). The ecological basis for the application of traditional agricultural technology in the management of tropical agro-ecosystems. *Agro-Ecosystems, 7,173-185.*

67. Gould, R. (1976). Ecology and adaptive response among the Tolowa Indians of North West California. In: Bean, L.J. and Blackburn, T. (eds.) *Native California: A Theoretical Perspective,* pp49-78. Bullena Press, Ramona, California

The range of Tolowa food procurement strategies are discussed. These include large sea mammals (eg. sea lions, seals and sea otters), marine shellfish (eg. sea mussels, scallops, clams), acorns (from various oak tree species), andromus fish (eg. salmon), waterfowl (ducks, geese, cormorants etc.) and surf fish (eg. smelt). These are complemented with a range of harvested land mammals, berries, edible plants and ocean fish. These major food sources provide a seasonally complementary diet. For instance, large sea mammals are harvested in July-August, the time of the poisonous period for marine shellfish and before the acorn harvest. The production levels of these resources, especially salmon, smelt and acorns, vary dramatically between years. But the diversity of food sources creates a degree of security in food provisioning.

68. Gould, R.A. (1985). 'Now let's invent agriculture': a critical review of concepts of complexity among hunter-gatherers. In: *Prehistoric Hunter-Gatherers.* pp. 427-434. Academic Press, London.

The paper argues for fewer ethnocentric assumptions in discussions on the origins of agriculture. Rather than simplistic 'just so' stories on invention of agricultural practice, the author argues for more empirical detail on the dynamics of change in hunting and gathering societies.

69. Grandstaff, S.W. (1986). Trees in paddy fields in Northeast Thailand. In: G. Marten (ed.), *Traditional Agriculture in Southeast Asia*, Westview Press, Boulder, Colorado.

70. Grivetti, L.E. (1987). Bush foods and edible weeds of agriculture: Perspectives on dietary use of wild plants in Africa, their role in maintaining human nutritional status and implications for agricultural development. In: R. Akhtar (ed.), *Health and Disease in Tropical Africa: Geographical and Medical Viewpoints,* pp. 51-81, Harwood, London.

71. Grivetti, L, Frentzel, C.J., Ginsberg, K., Howell, K, and Ogle, B.M. (1980). *Agricultural Development: Present and Potential Role of Edible Wild Plants. Part 2: Sub-Saharan Africa.* USAID, Washington, D.C.

72. Guha, R. (1989). *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalayas.* Oxford University Press, Oxford and New Delhi.

73. Gupta, A.K. (ed.) (1991). Ramanathan's forest agriculture. *Honey Bee, 2(1), 10-11.*

This is a brief description of an agroforestry design of Thiru C.R. Ramanathan in which 1500 trees can be grown on a single acre. These species provide food, fodder, fibre and medicinals and are said to provide more benefits than staple crop production. A total of five acres of trees are recommended. The first three years require investments such as fertilizer, watering and growth of live fences costing Rs.3,000-6,000 per acre. After five years of growth when fruiting begins very little care is needed.

74. Guy, R. (1972). The honey hunters of southern Africa. *Bee World, 53, 159-166.*

75. Hannover, J.W. (1988). Feasibility study on small-farm production of gums, resins, exudates and other non-wood products. *Multipurpose Tree Species Network Research Series, 4*, Winrock International.

76. Hecht, S.B. (1982). Agroforestry in the Amazon basin: Practice, theory and limits of a promising land use. In: Hecht, S.B. (ed .), *Amazonia: Agriculture and Land Use Research,* pp. 331-371, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

77. Heizer, R (1955). Primitive man as an ecological factor. *Kroeber Anthropological Society Papers, 13, 1-31.*

The paper reports on the careful management of wild resources, particularly amongst the North American Indians. The paper documents the management techniques employed to regulate game hunting among many tribes of native American Indians. The Hopi of Arizona, for example, when hunting wild sheep always leave at least one male and one female *"so as to make more sheep for the next hunting"*. A wide range of uses of different wild plants are also recorded.

78. Henry, D., LeRoi-Gourhan, A. and Davis, S. (1981). The excavation of Hayonim Terrace: an examination of terminal pleistoceine climatic and adaptive changes. *Journal of Archeological Science, 8, 33-58.*

The Natufian groups who inhabited the Palestinian mediterranean areas around *10,000BC* to *8,500BC* had to adapt their livelihood strategies in the face of climatic change. This involved extending their areas of habitation and the range of foods collected and hunted. The paper provides a listing of the range of products hunted according to archeological evidence. For between 1500 and 2000 years these groups were collecting wild cereals, but with the onset of drier and cooler conditions they had to change to agricultural production and the cultivation of cereals.

79. Holden, S. (1983). *A Survey of Vegetable Production and Marketing on the Central Plateau in Northern Province, Zambia.* Occasional Paper, Agricultural University of Norway, As, Norway.

80. Hong, E. (1987). *Natives of Sarawak: Survival in Borneo's Vanishing Forest.* Institut Masyarakat, Pulau Pinang, Malaysia.

81. Hunink, R.B.M. and Stoffers, J.W. (1984). *Mixed and Forest Gardens on Central Java: An Analysis of Socio-economic Factors Influencing the Choice Between Different Types of Land Use.* Department of Developing Countries, University of Utrecht, Utrecht, Netherlands.

82. Huybens, E. and Tollens, E.F. (1989). Rice production in the rainforest in Zaire: an analysis of the smallholder traditional farming system in Yalibwa Upper-Zaire. *Agricultural Systems, 31, 291-303.*

During the period May 1974 to May 1975, on-farm and off-farm labour use, earnings, expenditure and harvest yields were recorded twice a week for 20 households in Yalibwa, in the Upper-Zaire Region of Zaire. On the basis of these data, a study was made of the productive factors in the smallholder farming system and their relation to agricultural output in this rainforest area. Although the major cash crop is rice, game and, to a lesser extent, fish and wild fruit, are also important cash products.

83. Irvine, D. (1989). Succession management and resource distribution in an Amazonian

rainforest. *Advances in Economic Botany, 7, 223-237.*

84. Janzen, D.H. (1973). Tropical agroecosystems. *Science, 182, 1212-1219.*

This paper is an overview of tropical agriculture which raises many issues such as the growth of cash crops for export and difficulties of farming on marginal lands in the tropics.

85. Jardim, M.A.G. and Anderson, A.B. (1987). Management of native populations of the acai palm in the Amazon estuary. Preliminary results. *Boletim de Pesquisa Florestal, 15, 1-18.*

In a trial near Belem, Para, Brazil, indigenous practices for management of the multipurpose palm, Euterpe oleracea, (selective thinning of competing tree species and within palm clumps) concentrated fruit production on a smaller number of stems, facilitating simultaneous harvesting of fruit and palm hearts.

86. Johannson, E. (1989). Cultivated, semi-cultivated and wild vegetables used in Zambia. A pilot investigation for the regional SADCC genebank programme. *IRDC working paper, 119.* Swedish University of Agricultural Sciences, Uppsala.

87. Johnson, A. (1989). How the Machiguenga manage resources: Conservation exploitation of nature. *Advances in Economic Botany, 7, 159-173.*

88. Juma, C. (1989). *Biological Diversity and Innovation: Conserving and Utilizing Genetic Resources in Kenya.* African Centre for Technology Studies, Nairobi, Kenya.

This book's main goal is to discuss the policies and institutions needed to conserve genetic resources in Kenya. Included within the book are the general results from an extensive ethnobotanical survey of 1200 households covering 60% of the Bungoma District in western Kenya. The villagers use about 100 different species of fruits and vegetables which are listed in tables. It was found that 47% of the households routinely collected plants from the wild and 49% maintained wild species within their farms. As forested areas decreased, villagers were attempting to domesticate certain species. Because Kenya has strict laws which forbids the gathering of forest products, many of these species targetted for domestication were obtained from neighbouring Ugandan forests. Women were most knowledgeable about vegetables, while children made more use of wild fruits. On the whole knowledge of wild resources was declining among the young. The case is put for the importance of maintaining genetic diversity as a means of ensuring food security.

89. Kerkhof, P. (1990). *Agroforestry in Africa: A Survey of Project Experience.* Panos Institute, London.

This publication aims at sharing lessons from agroforestry project experience in Africa. It presents a survey of 21 projects in 11 countries throughout Africa. Farming of trees within the agricultural environment is increasingly being recognised as an important component of livelihood systems. The provision of wild products (fruits, honey, nuts, beers, wines, wood products etc.) from trees are important components of local diets and income generation strategies. Ensuring that appropriate institutional support, participatory project planning and technical design based on local priorities is key to the success of both government and NGO initiatives. The report is divided into three parts. Part I gives a summary of the overall lessons that have emerged to date. Part II documents information from the 21 projects, grouped into five broad categories. Part III draws on these project profiles to illustrate and discuss a number of key elements in the design and running of agroforestry related projects.

90. Kingamkono, R. and Lindstrom, J. (1990). *Forests and Fields: The Role of Livestock and Collected Food Products in Food Production and Security Systems: The Case of Babati District, Tanzania.* Preliminary Research Report prepared for Forest, Trees and People Project: A project under Community Forestry Section, Ministry of Land, Natural Resources and Tourism, Tanzania Food and Nutrition Centre, July 1990.

This study looks at the role of livestock, wild and cultivated foods in agro-pastoral households. The field sites were two villages, one near a forest reserve and the other in an area undergoing deforestation and erosion. The field study was conducted by interviews and direct observation. Data is presented for species collected, their frequency of use, the nutritional status of men, women and children, and seasonal variations. Additional topics discussed include: the importance of variety in household food security and collection according to location, availability, gender and age. Of the wild foods, emphasis is placed on green leafy vegetables and fruits.

91a. Labelle, R., Majisu, L. and Munyua, H. (1988). *Agroforestry Literature: A Selected Bibliography.* International Council for Research in Agroforestry, Nairobi, Kenya.

91b. Kyle, R. (1987). Rodents under the carving knife. *New Scientist, 25 June 1987, 58-61.*

This paper provides an accessible overview of the use of rodents for food across the world. Capybara meat production is compared with beef production in Venezuela and studies show that capybara meat production has a 50% advantage. A table provides nutritional comparisons of wild meats from rodents and beef or vegetable protein sources. Rats have a nutritional score equivalent to beef or mutton. The conflict between rodent populations and agriculture is discussed and the potential for captive production of rodent meat. Trials at the University of Ibadan, Nigeria show that a group of 25 female grasscutters and five males could potentially yield nearly 400kg of carcass meat per year.

92. Lee, R.B. (1969). !Kung bushman subsistence: An input-output analysis. In: Vayda, A.P., (ed.), *Environment and Cultural Behaviour,* pp. 47-49, Natural History Press, Garden City, New Jersey, U.S.A.

93. Lee, R.B. (1979). *The !Kung San. Men, Women and Work in a Foraging Society.* Cambridge University Press, Cambridge.

This seminal work reviews the productivity of the !Kung San of southern Africa. Productivity is very high in terms of labour input, but consists of two components: gathering which furnishes a reliable basis diet, and hunting which is riskier and less rewarding in calorie and protein terms, but is valued for the quality and variety of food it provides. Contrary to orthodox views of hunter-gatherers, this shows that their average working week is only 2.3 days per adult. Each day consists of about 6 hours. Their average intake of calories is 2355 per adult, derived from Mongongo nuts (58%), meat (30%) and wild vegetable plants (12%). They make use of 84 species of edible palnts and 54 of edible animals. The results presented are different from those reported in earlier papers and articles.

94. Lee, R.B. and de Vore, I. (1976). *Kalahari Hunter-Gatherers: Studies of the !Kung San and Their Neighbors.* Harvard University Press, Cambridge, Massachusetts.

95. Lewis, H. (1972). The role of fire in the domestication of plants and animals in SW Asia: a hypothesis. *Man, 7, 195-222.*

This paper synthesises archaeological, ecological and cultural information on the management of wild plants and animals, and their domestication. The hypothesis that time employed by people, has played

a significant role in the emergence of agriculture is discussed.

96. Malaisse, F. and Parent, G. (1985). Edible wild vegetable products in the Zambezian woodland area: a nutritional and ecological approach. *Ecology of Food and Nutrition, 18, 43-82.*

The composition of 184 edible wild vegetable products from a Zambezian woodland area of southern Zaire is given.

97. Malaret, L. and Nguru, F.N. (1986). An ethno-ecological study of the interactions between termites and small-holder farmers in Kenya. In: *International Conference on Tropical Entomology,* 31 August-5 September. ICIPE, Nairobi.

98. Maundu, P. (1987). The importance of gathered fruits and medicinal plants in Kakuyuni and Kathama Areas of Machakos. In: K.K. Wachiira (ed.), *Women's Use of Off-Farm and Boundary Lands: Agroforestry Potentials,* pp. 56-60, Final Report, ICRAF, Nairobi, Kenya.

This analysis recognizes that the value of gathered plants differs depending upon the user group. Overall, they are more important to the poor than the rich. Women consider vegetables most important, but children think fruits are. Men prefer fibre and medicinal plants. Despite these individual preferences, the collection of wild products benefits the whole community, as they are inexpensive, sometimes close at hand and a ready source of medicines. Many people believe that traditional medicines are more successful in curing illnesses than modern medicines. Important medicinal plants are conserved; however, some have disappeared due to overexploitation. Wild fruits are particularly important to families with no fruit trees on their farms and/or those who cannot afford to buy them. Children collect and eat fruits the most with the example given of children who will have fruits for lunch when they spend the day herding. They are also eaten during times of famine. Two species of fruits (Tamarindus indica and Ximenia caffra) are sold in markets. Others are becoming rare. The consumption of wild vegetables is more seasonal than fruits but is also more important. They appear during the rainy season and provide an inexpensive food source during a time when food supplies are decreasing. Commelina sp. is the most popular wild vegetable.

99. May, P.H., Anderson, A.B., Frazao, J.M.F. and Balick, M.J. (1985). Babassu palm in the agroforestry systems in Brazil's Mid-North Region. *Agroforestry Systems, 3(39), 275-295.*

An average of 34.8% of a household's total income, including non-cash income flows, is earned by babassu kernel gathering and processing in the study area in NE Brazil.

100. McCrae, A.W.R. (1982). Characteristics of swarming in the African edible bush-cricket Ruspolia differens (Serville) (Orthopteran, Tettigonioidea). *Journal of East Africa Natural History Society and National Museum, 178, 1-5.*

101. Mergen, F. (1987). Research opportunities to improve the production of homegardens. *Agroforestry Systems, 5, 57-67.*

This is a general review article of home garden studies. Descriptions are given of the systems of Java, Thailand (forest village) , Tanzania (Chagga), West Africa (compound farms), Brazil (Kayapo), Papua New Guinea, Nepal (hill farms), and Chile. The author recommends areas for research such as the coordination of indigenous knowledge with that of ecologists and geneticists.

102. Michon, G. (1983). Village forest gardens in West Java. In: P. Huxley (ed.), *Plant Research and Agroforestry,* Chapter 2, p13-24 ICRAF, Nairobi.

In this chapter, home gardens are presented as a sustainable method of agroforestry which has been in practice for centuries. Their spatial structure is similar to natural forests and within a single village over 500 species can be cultivated. This system can support a population density of 1,000 people per square kilometre. Three types of gardens are distinguished in West Java: the home garden in which crops are most intensively managed; the village-forest-gardens which contain fewer plant species, but taller trees; and gardens located on village fringes and dominated by certain species such as papaya.

A multi-storied structure characterizes these gardens. The first layer consists of vegetables, herbs and medicinals less than 1.5 m in height. The next layer continues to 5 m with cassava, banana, papaya and ornamentals. The higher layers up to for home gardens and 35 m contain trees of varying heights: guava, coffee, cacao, mango, sugar palm and bamboo. Only a few wild species, remnants of primary forest, may be found in gardens far from villages. Within this spatial structure, light and humidity vary as within natural forests. The resulting diversity in physical conditions promotes a wide variety of species with differing grow the requirements. The vegetation minimizes soil erosion from rain and the complex root structures from the diversity of species takes up nutrients from different soil levels. Data is presented on the amounts of products sold and consumed. Vegetables were mainly for home consumption while fruits were often sold. The amount of time spent in caring for a home garden was given as 13% of total time for men and 17% for women.

103. Michon, G., Bompard, J., Hecketsweiler, P. and Ducatillion, C. (1983). Tropical forest architectural analysis as applied to agroforests in the humid tropics: the example of traditional village-agroforests in West Java. *Agroforestry Systems, 1(2), 118-129.*

104. Michon, G., Mary, F. and Bompard, J. (1986). Multistoried agroforestry garden system in West Sumatra, Indonesia. *Agroforestry Systems, 4(4), 315-338.*

This article not only describes the species and structure of the agroforestry garden system in West Sumatra, but also discusses its relevance for rural development. Most agroforestry gardeners are permanent rice cultivators. Of the villages studied, it was found that the land area under tree gardens was inversely proportional to the area of rice fields. From these gardens, households are able to obtain fruits, vegetables, construction materials, spices and fuelwood for their own needs as well as for sale.

The tree gardens form a buffer zone between the villages and the government forest reserves. Their area can range from 50-88% of agricultural land within a village. Both annual (egg plant, maize, beans and cucumber) and tree crops are planted. The six tree crops cultivated are: durian (Durio zibethinus); Pterospermum javanicum, a construction wood grown in association with durian; Toona sinensis, construction wood and shade tree for coffee and nutmeg; cinnamon (Cinnamomum burmani); nutmeg (Myristica fragans); and coffee (Coffeea canephora). These species are of different heights; therefore, occupying different layers to form a multi-storied structure. Schematic diagrams of the two most common tree gardens, durian + wood species + nutmeg/cinnamon and coffee + wood species are given. Many vegetables (egg plant, maize) and fruits (banana, papaya) are also planted in rice fields.

In addition to the above species which are directly planted, there are a range of wild species which are protected and harvested. A list is given of these "non-cultivated but useful" species along with where they are found (primary forest, secondary growth or gardens) and their secondary uses. They include 20 species for construction wood, 22 fruits, 8 vegetables and spices, and 3 fern species.

The farmers work with the natural dynamics of a forest ecosystem for the maintenance of their gardens. They retain species which a re soil improvers. Wild fauna in the area pollinate flowers and disperse seeds. With the exception of durian and nutmeg, spontaneous germination of seedlings is relied

upon for the propagation of useful species. Many pioneer species, such as Toona species, appear in gaps left by trees having fallen in storms or of old age. Seedlings may then be transplanted to more desirable locations; for example near decaying trees for fertilization. Ordinarily, the only trees which are cut are cinnamon for its bark and timber species.

Durian is an exceptional tree species with multiple uses. It is a shade tree for coffee, nutmeg and cinnamon. The pericarp of the fruit is used as a fertilizer for coffee. When it no longer yields, it is used for fuelwood. Its fruits are consumed more than rice. Its harvesting has priority over rice; however, the maintenance and collection of garden produce ordinarily does not interfere with the agricultural cycle. Approximately 90% of durian fruits are sold, from which villages can earn US$17,500 to $165,500 (1985). The authors estimate that a hectare of garden produces US$365 to US$5,000 (1985) and that the sale of agroforestry products has a value of US$49 to $93(1985) per family. These amounts are an underestimate, as the value of wild plants is not taken into account.

In addition to providing food, income and soil cover, to these agroforestry systems provide an in situ gene bank for both wild and cultivated species. One reason for the success of this system is the communal control of land and trees with individuals responsible for the care of gardens. They are allowed to harvest and sell what they have planted; however, other species are available to the whole community. Households have security of tenure and directly benefit from their investments of time and labour in their gardens.

105. Munyua, H., Bondole, B.M., and Majisu, L. (1989). *Agroforestry Literature: A Selected Bibliography on Subsaharan Africa.* International Council for Research in Agroforestry, Nairobi, Kenya.

106. Ndlovu, Sifanele (1991). Amacimbi extinction threat causes concern among villagers. *The Sunday News, March 3, 1991,* Bulawayo, Zimbabwe.

This newspaper article illustrates the importance of the mnopare worm amacimbi, a food with a high protein content. Villagers of the Bulilimamangwe District were concerned that outsiders were coming into the area over-collecting the caterpillar and destroying its breeding habitat. The local development association put forward the proposal that there be specific sites, and times for collection to prevent further over-harvesting. This group's spokesman, Cde Zenzo Nkobi, summed up the situation by stating: *"The rate at which they are being collected without any regard to the environment that produces them means that very soon we will be needing a 'save macimbi' campaign similar to the one for rhinos"*.

107. Ninez, V.K. (1984). *Household Gardens: Theoretical Considerations on an Old Survival Strategy.* Potatoes in Food Systems Research Series, Report No. 1, International Potato Center, Lima, Peru.

108. Nwoboshi, L.C. (1987). Regeneration success of natural management, enrichment planting and plantations in West Africa. In: J. Vincent and F. Mergen (eds.), *Natural Management of Tropical Moist Forests: Silviculture and Management Prospects of Sustained Utilization,* Yale University, New Haven, Connecticut, USA.

109. Nymapfene, K.W. (1986). The use of termite mounds in Zimbabwe peasant agriculture. *Tropical Agriculture (Trinidad), 63(2), 1 91-192.*

Termitaria are important sources of soil with high clay fractions and high plant nutrient contents. Termite mounds are often spread on farmers' fields in conjunction with manure. Higher fertility and improved soil structure results; this is especially important in the nutrient deficient granitic sand soils

of the communal areas. Termite mounds also represent important micro-habitats for tree species. Within fields, small patches of woodland associated with termitaria may be retained; these are often sites of fruit trees, such as Berchemia discolor. Termites themselves are also an important source of supplementary food for local populations. Great efforts are expended to extract termites for consumption.

110. Oduol, P.A. (1986). The Shamba system: an indigenous system of food production from forest areas in Kenya. *Agroforestry Systems, 4, 365-373.*

This paper describes the Shamba system in Kenya in which agricultural crops are allowed to grow with tree seedlings for two years. The tree crops are usually plantation species; for example, Eucalyptus, Acacia and Pines. The farmers are able to feed themselves and to sell their produce for profit. Tables of the amounts of maize, potatoes, beans and cabbages produced are given as well as returns per hectare.

111. Ogle, B.M. and Grivetti, L.E. (1985). Legacy of the chameleon: Edible wild plants in the Kingdom of Swaziland, Southern, Africa. A cultural, ecological, nutritional study. Part I-Introduction, objectives, methods, Swazi Culture, landscape and diet. *Ecology of Food and Nutrition, 16, 193-208.*

This paper is the first of four which together investigate the availability, collection, consumption and mineral composition of wild plants in Swaziland. Formal and informal interviews were conducted with adults and children. Villagers interviewed were mainly subsistence agriculturalists growing maize. Cattle were also raised. In addition to maize, a side dish of a relish or stew of fish, meat, vegetables or legumes are also consumed at meals. Green leafy relishes may be derived from cultivated or wild vegetables. Caterpillars and termites can also be added to relishes. Grasshoppers and locusts are usually eaten by children. Non-traditional and packaged foods, such as wheat bread and soft drinks, are also consumed. Between meals, people snack upon fruits. Part I also describes the major ecological zones of the study area: Highveld, Middleveld, Lowveld, and Lubombo. Most agricultural fields are located within the Middleveld. Bidens pilosa, Commelinacea spp. and Sonchus oleraceus are considered weed species and are commonly found in fields, fallow fields, pasture and along paths. Past botanical and nutritional research in the area is reviewed.

112. Ogle, B.M. and Grivetti, L.E. (1985). Legacy of the chameleon: edible wild plants in the Kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study. Part II- Demographics, species availability and dietary use, analysis by ecological zone. *Ecology of Food and Nutrition, 17, 1-30.*

This paper details the results of interviews on the recognition and consumption of edible wild plants in Swaziland with data from four ecological zones. In addition to growing maize and raising livestock, fruit trees were grown by 71% of households and vegetables by 41%. Food is widely purchased, yet all those interviewed collected wild vegetables and 21% hunted or fished. Adults identified an average number of 48.7 wild plants with an average of 38.9 consumed yearly and 17.9 frequently. Children recognized 39.3 wild plants and consumed 34.4 yearly and 14.4 frequently. A total of 110 fruit trees were named, 50 of which were eaten more often by children than by adults. Half of the adults reported eating wild leaves at least twice a week when they are available. The most frequently consumed leaf, Bidens pilosa/B. bipinnata, is also a weed of agriculture. It is eaten frequently by 70.6% of adults. Mushrooms, bulbs and flowers are also collected. Tables present these data on availability and consumption. Consumption of wild plants in the spring and summer alternates with cultivated plants in the autumn and winter. An appendix lists over 200 wild plants along with their seasonal availability. Of the adults surveyed, 39% stated that wild plants contributed more to diets than cultivars, 37% relied upon more cultivars, and 18% believed there to be a balance between the two. Although several species can be found in all four ecological zones of Swaziland, regional specificities

exist and are presented in tables. Throughout all four areas, species have become rare or extinct. The greatest perceived loss occurred in the area with the greatest agricultural expansion.

113. Ogle, B.M. and Grivetti, L.E. (1985). Legacy of the chameleon: Edible wild plants in the Kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study. Part III- cultural and ecological analysis. *Ecology of Food and Nutrition, 17; 31-40.*

114. Okafor, J.C. and Fernandes, E.C.M. (1987). Compound farms of south-eastern Nigeria: A predominant agroforestry homegarden system with crops and small livestock. *Agroforestry Systems, 5(2), 153-168.*

Compound farms are a homegarden type agroforestry system involving the deliberate management of multipurpose trees and shrubs in mutlistored association with agricultural crops and livestock. In addition to the immediate production benefits of a diversified system, compound farms are the site for in situ conservation of tree species that are disappearing due to extensive clearance of forest lands in southeast Nigeria.

115. Okafor, J.C. (1985). Selection and improvement of indigenous tropical fruit trees: problems and prospects. *Journal of Tropical Forest Resources, 1, 87-95.*

Traditional sources of fruits, nuts, spices, condiments, leafy vegetables, edible oil, and beverages, indigenous wild fruit trees play significant roles in improving food problems. In comparison with staple arable food crops, such species have been little studied. This paper presents an account of work done in Nigeria during the past decade on indigenous West African fruit trees, and covers their potential for selection and improvement, constraints on use and development, and work on propagation techniques.

116. Olofson, H. (1983). Indigenous agroforestry systems. *Philippine Quarterly of Culture and Society, 11, 149-174.*

117. Padoch, C. (1983). Agricultural practices of the Kerayan Lun Dayeh. *Borneo Research Bulletin, 15(1), 33-37.*

118. Padoch, C. and De Jong, W. (1991). The house gardens of Santa Rosa: diversity and variability in an Amazonian agricultural system. *Economic Botany, 45(2), 166-175.*

This study presents an example of house gardens in Peru which rival those in Southeast Asia and Africa for species diversity. From 21 homegardens, a total of 168 species were identified and listed in the article. The number of species within an individual garden varied from 18 to 74. The managers of these gardens are non-tribal, river dwelling people known as Riberenos. The plants are utilised for food, medicines, construction materials and as ornamentals. The size of the gardens, their composition and spatial arrangement all vary according to the goals of individual households. The garden areas may be located on the sites of old swidden-fallows. In addition to trees remaining from these sites, young seedlings may arise spontaneously or are planted by the Riberenos. Useful species are protected while others may be removed. As many previously described most home garden systems occur in areas of high population density, this example in Peru indicates that similar complex and diverse systems can occur in areas of low densities, but to date they have not been thoroughly investigated.

119. Padoch, C. and Vayda, A. (1983). Patterns of resources use and human settlement in tropical forests. In: F. Golley (ed.), *Tropical Rain Forest Ecosystems: Structure and Function,* pp. 127-142, Elsevier, Netherlands.

120. Paolisso, M.J. (1985). Subsistence and coffee cultivation among the Irapa-Yukpa of Venezuela: a cultural ecological investigation. *Dissertation Abstracts International, A Humanities and Social Sciences, 46, 1016.* Dissertation, University of California, Los Angeles.

This research investigates the economics and ecology of the Irapa-Yukpa Indians of western Venezuela. These Amerindians grow coffee as a complement to subsistence agriculture and wild food procurement. The involvement of the Irapa-Yukpa in coffee cultivation affects environmental, socioeconomic and dietary changes. The thesis describes both the community-level changes due to the incorporation of once autonomous communities into regional economies and the cultural institutions (economic, political, social) that locally implement state development policy.

121. Parent, G. and Thoen, D. (1977). Food value of edible mushrooms from Upper Shaba Region. *Economic Botany, 31, 436-445.*

122. Parker, E. (1989). A neglected human resource in Amazonia: The amazon caboclo. *Advances in Economic Botany, 7, 249-259.*

123. Pegler, D.N. and Pierce, G.D. (1981). The edible mushrooms of Zambia. *Kew Bulletin, 35, 475-491.*

124. Persoon, G. (1988). Modified hunting and gathering: The Kubu and the outside world (South Sumatra). In: *12th International Congress of Anthropological and Ethnological Science*, Zagreb, 24-31 July 1988, Leiden.

125a. Pingle, U. (1988). Central Indian tribal societies under stress of modern socio-economic pressures: Strategies to face the challenge. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 405-417, Clarendon Press, Oxford.

This chapter investigates the effects of in-migration, encroachment of tribal lands and participation in the cash economy on two tribal groups, the Raj Gonds and the Koyas of central India. They are compared with the more traditional Maria Gonds for agricultural production, food consumption and indebtedness. As production of cash crops, mainly cotton, by the Raj Gonds increased, they reduced the amount of land under grain cultivation. Their indebtedness also increased. The Koyas had been involved in the cash economy for a longer period of time. Many were landless and those with farms were often in debt. Indebtedness was not a problem for the Maria Gonds and they were able to have a store of surplus grains. Nutritionally, 82% of the Maria Gonds households were able to meet 90% or more of their energy requirements; however, only 58% of the Raj Gonds and 33% of the Koyas were able to meet theirs. The Maria Gonds are still able to collect many wild fruits, mushrooms and vegetables, but due to extensive deforestation, the Raj Gonds and Koyas are not able to collect such products. A strategy recommended to avoid further deterioration of these tribal societies include the issue of land titles to tribal peoples.

125b. Pingle U. (1991). Greening of Central Indian Wastelands. Presented at the International Symposium Food and Nutrition in the Tropical Forest: Biocultural Interactions and Applications to Development, 10-13 September 1991, UNESCO, Paris.

Fifty percent of India's wastelands lie in the central states. Reforestation with useful fruit trees, particularly mangoes, was be gun there in 1970 by NGOs, the government and the people. Since then, over 100,000 people have benefitted from the project. The project is a significant source of employment and has raised land values from zero to Rs 25,000 per acre (equivalent to the price of rice

paddy land). Families can earn from Rs. 1,000 to Rs. 4,000 per acre from the sale of fruit. Nutritionally, children of families in orchard areas, experienced less protein-energy malnutrition and vitamin A deficiency than those living in non-orchard areas. Mangoes are rich in B-carotene, a *precursor of vitamin* A. *Although they may be eaten only during a short season, the body is able to* store vitamin A in the liver for use throughout the year. In one mango growing area, vitamin A deficiency decreased from 42% in 1985 to 21% in 1990. Educational programmes have been developed which explain the relationship between foods and health and encourage fruit trees in home gardens.

126. Posey, D. (1982). Keepers of the Forest. *Garden, 6(1), 18-24.*

127. Prance, G.T. (1973). The mycological diet of the Yanomam Indians. *Mycologia, 65(1), 248-250.*

128. Pretty, J. (1991). Farmers' extension practice and technology adaptation: agricultural revolution in 17-19th century Britain. *Agriculture and Human Values, 8, 132-148.*

During the British agricultural revolution, crop and livestock production increased 3-4 fold as innovative technologies and techniques developed by farmers were extended to other farmers through tours, farmer groups, open days, and publications, and then adapted to local conditions by rigorous experimentation. These technologies maximized the use of on-farm resources at a when there was no government ministry of agriculture, no research stations, and no extension institutions. But at the same time as this revolution in on-farm resource use, agriculture also expanded into uncultivated lands, increasing aggregate production but destroying common property resources and so threatening the livelihoods of the poor.

The promotion of extensification by government through enclosure acts of parliament destroyed the common property resources that were essential buffers against adversity for those relying on the provisions of fuel, fodder, food, and employment opportunities. During the agricultural revolution their value was barely recognised. They were called wastes, and represented to many a symbol of backwardness or underdevelopment. Board of Agriculture reporters said common property resources were *"the trifling fruits of overstocked and ill-kept lands"*. But after enclosure poor farmers had to destock as fodder sources beyond their farms were no longer available and hay prices rose; and many farmers, given small plots of land in *lieu* of grazing rights, sold them to larger landowners, and *"the money was drank at the ale house"* (Arthur Young). Generally those people living in diverse landscapes fared better than those in the monocropped cereal lands. Of the arable lands, William Cobbett said there were *"no hedges, no ditches, no commons, no grassy lanes ... and the wretched labourer has not a stick of wood, and has not place for a pig or cow to graze. What a difference there is between the faces you see here, and the round, red faces that you see in the wealds and forests"*.

129. Pullan, R. (1974). Farmed parkland in West Africa. *Savanna, 3(2), 119-151.*

130. Pullan, R. (1974). Farmed parkland in Zambia. *Zambian Geographical Association Magazine, 26.*

131. Raintree, J.B. and Warner, K. (1986). Agroforestry pathways for the intensification of shifting cultivation. *Agroforestry Systems, 4, 39-54.*

This paper views swidden cultivation as an indigenous agroforestry system. However, as populations increase there is a need to intensify such systems. Suggestions for intensification such as taungya, enriched fallows, alley cropping and tree crop systems are given. Fallows may either be enriched for economic species or for species which will aid regeneration and soil fertility. Drawing from existing literature the author notes that in areas increasing population densities, tree growing is intensified,

particularly in home gardens.

132. Rambo, A.T. and Sajise, P.E. (1984). *An Introduction to Human Ecology Research on Agricultural Systems in Southeast Asia.* University of the Philippines at Los Banos, Laguna, Philippines.

This book introduces human ecology as the study of the interactions between humans and the ecosystems in which they live. The firs two parts contain chapters which define and explain various aspects of tropical agroecosystems from the biological and physical (energy flows, population dynamics, plant succession and soils) to the cultural and economic. The final part is composed of five case studies from Peninsular Malaysia, Thailand, Java and the Philippines illustrate the interactions between the bio-physical and socioeconomic features of agroecosystems.

133. Rankin, J.M. (1985). Forestry in the Brazilian Amazon. In: G.T. Prance and T.E. Lovejoy (eds.), *Amazonia.* Key Environment Series, Pergamon Press, Oxford.

134. Renfrew, J. (1973). *Palaeoethnobotany. The Prehistoric Food Plants of the Near East and Europe.* Methuen, London.

A varied range of cereals and fruits are found in the remains of archeological sites from the period around 6000BC. The main cereals include einkorn, emmer, barley. Collected fruits include: hazelnuts, cornelian cherries, crab apples, rosehips and wild grapes.

135. Richards, A. (1939). *Land, Labour, and Diet in Northern Rhodesia: An Economic Study of the Bemba Tribe.* International Institute of African Languages and Cultures, London.

This is a classic ethnographic text on the Bemba in Zambia. The book details many years of fieldwork by Audrey Richards, exploring many aspects of Bemba life. The role of wild foods in the shifting cultivation and garden plots features prominently.

136. Richards, P. (1980). Community environmental knowledge in African rural development. In: D.W. Brokensha, D.M. Warren and O. Werner, *Indigenous Knowledge Systems and Development,* pp. 183-196, University Press of America, Lanham, Maryland, USA.

137. Riley, B.W. and Brokensha, D. (1988). *The Mbeere in Kenya. Volume I. Changing Rural Ecology.* Institute for Development Anthropology (IDA) and University Press of America, Lanham, Maryland, USA.

The Mbeere people live in Embu District, and this study is concerned with the people of Siakago, Gachoka and Kiang'ombe Divisions. The main focus of the study is on changes in the uses and incidence of plants, especially woody vegetation, but also including cultivated crops. The period of study was one of dramatic changes, starting in the 1970s with the privatization of land (then just beginning) and covering an increasing commercialization of natural resources (including trees and tree products) and an increase in the production of cash crops. Part I covers social, historical and environmental aspects. Part II demonstrates how plants are intertwined with people's lives. Aspects covered are: traditional homestead usage; fuelwood and charcoal; tree planting; wild plants as food; honey; medical uses; poisons; ritual uses; grasses; and taxonomy. Part III covers farms and farming, describing infrastructure, practices, cultivated plants and cash crops, pests, drought, livestock, labour and its division, capital and government interventions, and land rights. Part IV summarizes the changes which have occurred. The second volume of the book, *Botanical Identities and Uses,* describes in detail the plants mentioned in this first volume.

138. Rocheleau, D, Weber, F. and Field-Juma, A. (1988). *Agroforestry in Dryland Africa.* ICRAF, Nairobi.

This is an important and easy to read source book on dryland agroforestry for Africa. It emphasises both technical aspects the rough descriptions of various potential agroforestry interventions (in cropland, with conservation measures, and in-between places), as well as approaches to research and extension. This combination of perspectives is the book's real strength. It is insufficient to suggest appropriate technical interventions without an effective approach to participatory planning and extension that involves local people in the design and implementation of solutions. The final section of the report provides an accessible range of tools for extension workers (tree lists and descriptions, guidelines for interviewing, contact lists etc).

139. Rocheleau, D., Wachira, K., Malaret, L., and Wanjohi, B. (1989). Local knowledge, innovations, and ethnological methods for agroforestry and indigenous plants. In: R. Chambers, A. Pacey; and L. Thrupp, *Farmer First.* Intermediate Technology Publications, London.

This chapter develops the argument that only through understanding the details of local practices can successful agroforestry interventions be implemented. This requires new tools and approaches for both research and extension. The example of plant domestication by women farmers in Kenya is taken to illustrate this theme. The factors that influence selection of indigenous species for the gardens include abundance, ease of access, preparation requirements and palatability. Self-help groups worked on the establishment of small scale gardens for vegetables and the planting of fruit trees.

There is a focus on women's use of off-farm lands. Various formal and informal surveys confirmed that women use 65 indigenous species of plants for food and 99 for medicinal purposes, among them woody species, wild leafy vegetables and wild roots. Some 90% of women reported using gathered leafy vegetables to some extent, 10% said they use wild greens year round, and 70% reported that they or their children eat wild fruits daily.

140. Ruddle, K. (1973). The human use of insects: examples from the Yukpa. *Biotropica, 5(2), 94-101.*

This study details the use of insects for food as well as rituals and instruments by the Yukpa of Venezuela and Colombia. It examines the collection and preparation of 22 genera of 7 orders. There is often a seasonal dimension to collection of insects, with the greatest abundance found during the rainy season. Ants (Atta spp.) are forced from their nests at the beginning of the rainy season when the females are carrying eggs. Their abdomens filled with these eggs are a delicacy. Beetle larvae of the genus Caryobruchus grow in the nuts of the palm Scheelea spp. After these nuts fall to the ground, the Yukpa wait two months for the larvae to grow large enough for harvesting. During the "food short season" caterpillars are collected from maize fields. Insects are harvested from almost any location. Beetles and grasshoppers are simply gathered by women and children walking through fields. In addition to providing food, this practice reduces the number of pests which can damage crops. Larvae (Corydalus spp.) can also be collected from under rocks in streams. Wasp nests are found in primary and secondary forests. In the grasslands, men set fires to cause grasshoppers (Tropidacris latreilli) to swarm allowing them to be easily caught by women and children. Most insects are consumed as side dishes or relishes. The stingless bees of the genus Trigona are the most important insects to the Yukpa for their honey and wax. As game becomes depleted in the area through the introduction of shot guns, insect gathering may increase to compensate for the loss of animal protein, fat and calories. Such dietary substitutes are particularly important as not all the Yukpa find domestic meat acceptable to eat.

141. Ruthenberg, H.H. (1981). *Farming Systems in the Tropics.* 3rd Edition, Clarendon

Press, Oxford, UK.

This is the classic text describing tropical farming systems. The conventional distinctions between dryland, irrigated, swidden and pastoral systems are made. However the emphasis throughout is on the differences in crop or livestock production techniques. The common features of wild food use in all systems are largely unmentioned.

142. Salick, J. (1989). Ecological basis of Amuesha agriculture, Peruvian Upper Amazon. *Advances in Economic Botany, 7, 189-212.*

143. Scudder, T. (1962). *The Ecology of the Gwembe Tonga*. Manchester University Press, UK.

144. Scudder, T.S. (1971). Gathering among African woodland savannah cultivators. A case study. The Gwembe Tonga. *Zambian Papers, 5, 316-324.*

This study summarises the extensive fieldwork carried out in the Zambezi valley among the Gwembe Tonga people. The importance of bush foods is highlighted in this paper. A more extensive ethnographic account, focusing on the human ecology of adaptive strategies can be found in 143.

145. Secoy, D.M. and A.E. Smith (1983). Use of plants in the control of agricultural and domestic pests. *Economic Botany, 37, 57.*

146. Sen Gupta, D. (1980). Food consumption and nutrition of regional tribes of India. *Ecology of Food and Nutrition, 9, 93-108.*

147. Senanayake, R. (1984). The ecological, energetic and agronomic systems of ancient and modern Sri Lanka. In: Douglas, G.K (ed). *Agricultural Sustainability in a Changing World Order*. Westview, Boulder.

The implications of agricultural change on wild food use are demonstrated in the case study presented in this paper. The replacement of buffaloes by tractors in Sri Lankan rice farming systems has reduced the presence of buffalo wallows. These are important micro-environments for a range of wild foods including crabs, lizards and fish.

148. Sharland, R.W. (1989). *Using Indigenous Knowledge in Relation to Subsistence Sector Extension: Interaction Between the Agricultural and Wild Environments in Moru Agriculture in Southern Sudan.* PhD. Thesis. Agricultural Extension and Rural Development Department, University of Reading, UK.

Chapters within this thesis discuss wild plant resources and the meanings of weeds and pests. Wild plants are divided into two categories: those which are harvested on a daily basis, such as fruits and leafy vegetables, and those used as famine foods, mainly tubers and seeds. The leafy vegetables are used as relishes and they are important to people for adding variety to diets. The fruits are mainly consumed by children. Others consume fruits when travelling. The famine foods are used only in times of emergency, as they are difficult to prepare and are not very palatable. Lists of species used and methods of preparation are given. Knowledge of these famine foods is being lost between generations. Weeds are divided into four categories: self-sown species; wild species whose seeds are collected and scattered in fields; those commonly collected as they appear; and those which can be eaten, but are usually only collected during famine. Whether these species remain in gardens or are removed depends upon their usefulness to individuals at the time of their appearance. Examples of

species for each of these categories are given. The dangers of pests, such as termites, are well-recognized by local people; however, they are also seen as a food source. Conflicts can arise between a husband and wife as he sees the damage done to the house and she sees food for their family.

149. Sharland, R.W. (1989). Indigenous knowledge and technical change in a subsistence society: lessons from the Moru of Sudan. *Agricultural Administration Research and Extension Network Paper, 9*, Overseas Development Institute, London.

Indigenous knowledge is increasingly seen as a rational response to prevailing conditions. It has, however, often been difficult to use this knowledge in the development process. The Moru of southern Sudan highlight the complexity of the agricultural system and its interactions with the wild environment. Gaps of knowledge highlight spheres in which indigenous knowledge can intertwine with more formal knowledge in developing solutions. A methodology for using indigenous knowledge is presented, based on internal processes of change and indigenous experimentation.

150. Silow, C.A. (1976). *Edible and Other Insects of Mid-Western Zambia: Studies in Ethnoentomology.* PhD Thesis, University of Uppsala, Sweden.

151a. Soemarwoto, O. and Conway, G.R. (1991). The Javanese homegarden. *Journal for Farming Systems Research-Extension 2(3), 96-117*

151b. Soemarwoto, O. and Soemarwoto, I. (1984). The Javanese rural ecosystem. In: A.T. Rambo and P.E. Sajise (eds). *An Introduction to Human Ecology Research on Agricultural Systems in Southeast Asia.* pp. 254-287, University of Philippines at Los Banos, Laguna, Philippines.

The Javanese production systems of homegardens, talun-kebun and annual cropping are reviewed. In the late 1970s these systems supported 1,000 people per square kilometre. Homegardens have a multistoried structure, contain a great diversity of species and yield throughout the year. They can provide on average 21.2% of the net incomes of households. Of a garden's produce, 44.4% is consumed within the household and 55.6% is sold. Harvesting from gardens increases when rice is in short supply. A second agroforestry system, the talun-kebun is found outside villages and is composed of perennial and annual crops. Fish are also an important component of Javanese ecosystems. They are found within rice fields, as well as in ponds within homegardens. Fish ponds are sites for the recycling of wastes. The authors note that most research for rural development has been aimed at rice cultivation. Given the population growth of Java and the reduction in the area of family land holdings, the home garden and talun-kebun hold production potentials for households. These potentials which require little land include fish ponds, orchid cultivation and chicken raising. Additionally, the authors recommend that farmers be trained in the processing of these products and be given opportunities for off-farm employment. Finally, home gardens and the talun-kebun systems are valuable in reducing soil erosion and conserving genetic diversity.

152. Somnasang, P., Rathakette, P., and Rathanapanya, S. (1988). The role of natural foods in Northeast Thailand. In: G.W. Lovelace, S. Subhadhira, and S. Simaraks (eds.), *Rapid Rural Appraisal in Northeast Thailand.*, pp. 78-103, KKU-Ford Rural Systems Research Project, Khon Kaen University, Khon Kaen, Thailand.

This study investigated the harvesting, consumption, preparation and preservation of wild foods during rainy, cool and hot seasons in Northeast Thailand. Eight villages with varied water sources and forest availability were studied. During the rainy season, 50% of all foods consumed were wild foods such as fish, snails, insects, mushrooms, fruits and vegetables. At this time, the majority was harvested from rice paddy fields. The amount of rainfall directly affects their presence in the fields. Other areas for

collection are the forest, and common property areas such as ponds and streams. Silkworms and termites are also eaten. These foods are less abundant in the cool and hot seasons which follow, but are still collected. In the cool season, more foods are gathered from forests than from other locations. The abundance of forest foods is directly dependent upon the amount of rainfall in the previous season.

As would be expected, when villages are compared, the more water and forest that they have available, the more forest foods are consumed. The overall supply of natural foods, however, has been diminishing over the years as populations increase. Other findings of the study include that chemical fertilizers and pesticides in paddy fields can have either a positive or negative effect on natural food production. Also as villagers become employed in wage labour, they spend less time gathering and purchase more of their foods, particularly during the dry season when it is very difficult to find natural foods.

These wild foods are important sources of proteins, vitamins and minerals. The nutritional values for some animals, fish, insects and vegetables are given. Two species of insect had a higher protein and iron content than fermented fish. One-half of the children in Northeast Thailand suffer from protein energy malnutrition. Although wild foods were available, the authors were unable to explain why the people still appeared to be malnourished. They suggest further research and the implementation of nutrition extension programmes. They also advocate the protection of forests as sources of wild foods and the continued existence of waterways as common property areas for collection. The use of fertilizers and chemicals in rice paddy fields must also be carefully considered as rice is not their only produce. In summary, wild foods are crucial to poor people's livelihoods as they provide a supply of nutrients at no monetary cost and are also a source of cash income.

153. Stoler, A. (1978). Garden use and household economy in rural Java. *Journal of Indonesian Studies, 14(2), 85-101.*

154. Storey, R. (1985). Some plants used by Bushmen in obtaining food and water. *Botanical Survey of South Africa Memoir, No. 30.*

155. Swaine, G. (1964). The bush cricket Homorocoryphus nitidulus Walker (Tettigoniidae). *East African Agriculture and Forestry Journal, 29, 340-342.*

156. Tallantire, A.C. and Goode, P.M. (1975). A preliminary study of the food plants of the West Nile and Madi Districts of Uganda. The utilization of leaves and fruits of local and mainly indigenous plants in supplementing the staple foods. *East African Agriculture and Forestry Journal, 40, 233-255.*

157. Taylor, K.D. (1968). An outbreak of rats in agricultural areas in Kenya in 1962. *East African Agriculture and Forestry Journal, 34, 66-77.*

158. Tewari, S. (1990). The role of off-season vegetables in the development of hill agriculture. In: *Agricultural Development Experiences in the Hindu-Kush Himalayas.* Workshop report, 1. ICIMOD, Nepal.

This short paper documents the vast range of wild products harvested in the Himachal Pradesh mountain areas. The paper focuses on the value of mushrooms. They occupy an important ecological niche in the local farming system and provide a protein rich diet source. Pressure on forest resources and changing farming practices have changed the patterns of availability of mushrooms. The paper argues that these impacts need to be taken into account.

159. Thompson, B.P. (1954). Two studies in African nutrition: An urban and a rural

community in Northern Rhodesia. *Rhodes-Livingstone Papers, 24.*

160. Toffin, G. and Wiart, J. (1985). Research on the ethnobotany of the Tamang in the mountains of Ganesh Himal (central Nepal): uncultivated plants. *Journal d'Agriculture Traditionelle et de Botanique Appliquee, 32, 127-175.*

A survey is given of the wild plants collected by the Tamang people of central Nepal for food, medicinal, religious and other purposes such as clothing, construction and tool making. Quercus semecarpifolia and Q. lanata were important sources of green forage for domestic animals, and Eurya acuminata and Lithocarpus spicata were the main fodder trees used in April-June. Chenopodium album and Urtica dioica are used for human consumption either fresh or as flour. C. album seed is also used as a condiment.

161. Trigger, B.G. (1969). *The Huron: Farmers of the North.* Holt Reinhart and Winston, New York.

The book documents the collection practices of women who gathered a wide variety of wild plants, including berries, acorns, walnuts and wild grapes. Men were the hunters, but intensive use resulted in the decline of game populations. Agricultural crops accounted for about 75% of food eaten.

162. Ulijaszek, S. (1983). Palm sago as a subsistence crop. *Journal of Plant Foods, 5, 115-134.*

163. Van der Zon, A. and Grubben, G. (1976). *Les Legumes Feuilles Spontanes et Cultives de Sud-Dahomey.* Communication 65, Department of Agronomic research, KIT, Amsterdam.

This study from southern Benin estimated that 10% of marketed vegetables are collected from the wild. This varies regionally and seasonally. Common species include: Justica anselliana, Polygonum pulchrum and Talinum triangulare.

164. Warren, D.M., Brokensha, D. and Slikkerveer, L.J. (eds.) (in press). *Indigenous Knowledge Systems and Development.* The International Library of Development and Indigenous Knowledge, Kegan Paul International Limited, London.

This book continues on the themes of Indigenous Knowledge Systems and Development (Brokensha, Warren and Werner, 1980). The chapters are written by authors from a wide range of disciplines (anthropology, entomology, ecology, botany, veterinary medicine and agricultural economics). The book is divided into the following major sections: indigenous knowledge systems; indigenous decision-making systems; indigenous organizations; indigenous experimental and innovations; international institutions and indigenous knowledge; and bibliographic essays on indigenous knowledge systems.

165. Weaver, P. (1979). Agri-silviculture in tropical America. *Unasylva, 31 (126), 2-12.*

166. Weiss, E.A. (1973). Some indigenous trees and shrubs used by local fisherman on the East African Coast. *Economic Botany 27, 175-192.*

167. Werner, D.W., Flowers, N.M., Ritter, M.L. and Gross, D.R. (1979). Subsistence productivity and hunting effort in native South America. *Human Ecology, 7(4), 303-315.*

168. Wiersum, K.F. (1982). Tree gardening and taungya on Java: Examples of agroforestry techniques in the humid tropics. *Agroforestry Systems, 1(1), 53-70.*

169. Wilson, G.L. (1917). *Agriculture of the Hidatsa Indians: an Indian Interpretation.* Bulletin of the University of Minnesota, Studies in the Social Science, 9. Minneapolis.

This book describes the resource management practies of the Hidatsa Indians of Missouri. The agriculture was experimental, complex and productive, and a wide range of wild products were used.

170. Wilson, K.B. (1989). The ecology of wild resource use for food by rural Southern Africans: Why it remains so important. Paper presented to the conference: *The Destruction of the Environment and the Future of Life in the Middle East and Africa*, 14th to 17th July 1989, Swansea, U.K.

This paper is a review of the importance of wild resources (fruits, greens, insects, wild game) in the daily lives of rural people in southern Africa and the effects of increasing pressures on wild lands. As common property areas decrease, the protection and privatisation of wild foods on agricultural land increases. Attempts to domesticate wild species also occur in order to ensure their supply. Through these management efforts, the diversity of cropped lands can be seen to increase. Ecologically, as woodland areas are replaced by grasslands, there is of course a decline in woodland associated species; for example, fungi; however there is an in crease in other species which can thrive in the newly created habitat, such as grasshoppers and rodents. Although these species are often viewed as agricultural pests, they are consumed by the people and contribute fats and proteins. Even weed species are collected and protected by women as relishes. As populations grow, increased harvesting of wild foods does not necessarily cause a steep decline in availability. The critical factor is: does harvesting affect the plant's survival and ability to reproduce? For example, little harm is done to the plant if only leaves and fruits are collected as opposed to the collection of roots. More detail of the themes covered within this paper can be found in: Ecological Dynamics and Human Welfare: A Case Study of Population, Health and Nutrition in Southern Zimbabwe (172).

171. Wilson, K.B. (1989). Trees in fields in Southern Zimbabwe. *Journal of Southern African Studies, 15(2), 1-15.*

Maintaining trees in fields has long been an indigenous method of conservation. Using this practice as an example, this article illustrates the conflicts which can arise between local people and government policies. The Shona farmers in Southern Zimbabwe have traditionally preserved trees in fields for the benefits of fruits, shade, fodder and nutrient retention. The government, however, viewed trees as a threat to crop yields and insisted that they be removed. Not all farmers complied as the trees also possess spiritual significance. Once trees and their stumps were removed, the woodland did not regenerate. Farmers blame the resulting environmental degradation, particularly in communal areas, directly on government policies. It is through an understanding of such conflicts that indigenous groups can determine the steps to take in order to gain control of their own natural resources. Also, their needs can only be communicated if farmers are allowed to actively participate in research.

172. Wilson, K.B. (1990). *Ecological Dynamics and Human Welfare: A Case Study of Population, Health and Nutrition in Southern Zimbabwe.* PhD Thesis. Department of Anthropology, University College, London.

This thesis investigates the effects of seasonal and interannual differences in rainfall on the food supply and health of communities living in two distinct ecological regions, the clayveld and sandveld in the savannas of southern Zimbabwe. The use of a variety of wild foods, such as indigenous trees, vegetables, weeds, insects, fungi and game are included in the analyses. The sandveld environment contained greater species diversity than the clayveld; this provided better nourishment for the sandveld population during the dry season and droughts as compared to the clayveld. Many tree species in the sandveld fruit during the dry season and are particularly relied upon for meals. At this time one-quarter of the poor's meals are composed of fruit. On the whole children rely upon fruit collection more than

adults and the poor on wild food collection more than the wealthy. The importance of fruit trees is evidenced by their preservation when woodland is cleared for farms and farmers' planting of indigenous and exotic varieties. As woodland is utilized for farms there is an increase of species which can grow in these disturbed areas. These species are useful as relishes and make the staple crop more palatable. Consequently, woodland species are found to decline. The change from woodland to grassland has increased the number of herbivores. These include agricultural pests like locusts, mice and birds are trapped and eaten. Insects and their larvae can be high in fat and protein. Agricultural weeds are also important as relishes. Appendix One, The Ecology of Hunting, Gathering and Fishing, and the Contribution to the Diet is extremely useful; species of gathered plants are listed together with their location, changing abundance, season of harvest and part eaten.

173. Wonjohi, B (1987). Women's groups, gathered plants and their agroforestry potentials in the Kathama area. In: Wachiira, K. (ed.). *Women's Use of Off-farm and Boundary Lands: Agroforestry Potentials.* ICRAF, Nairobi.

174. Yarnell, R. A. (1964). Aboriginal relationships between culture and plant life in the Upper Great Lakes region. *University of Michigan Anthrop. Papers No. 23.*

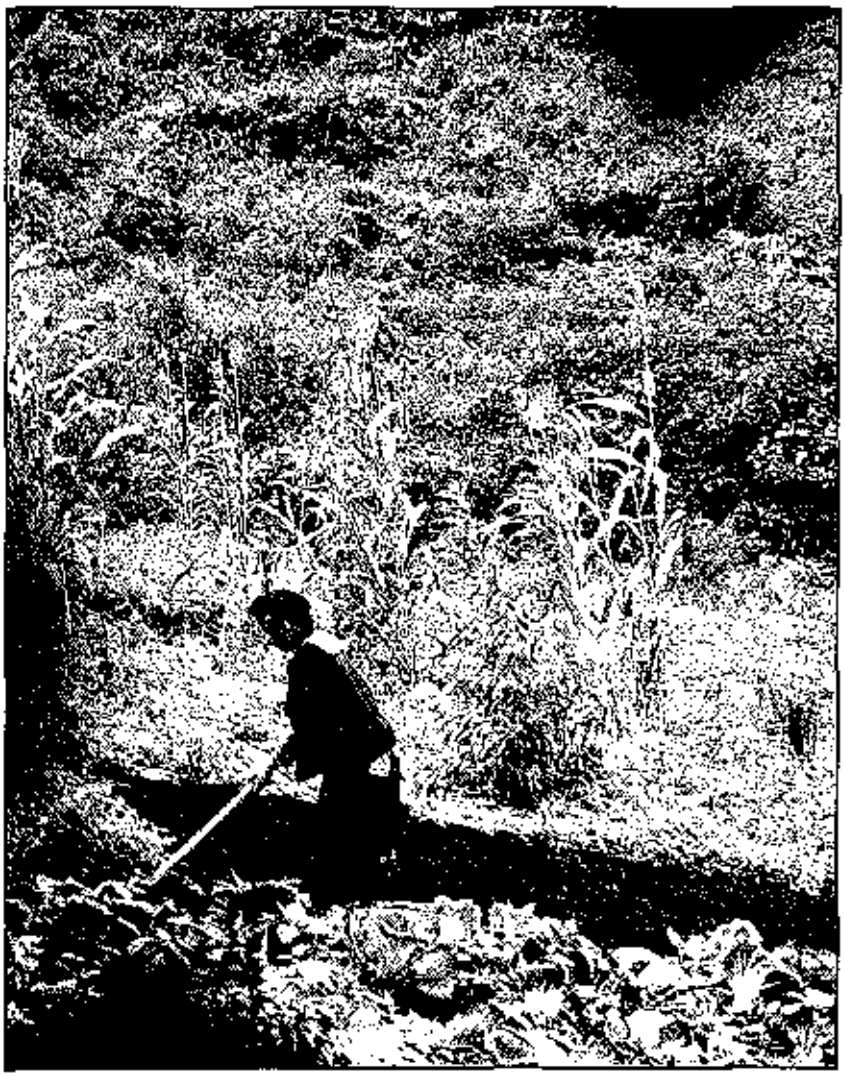
A range of plant species used for food (130 spp.) and other uses (400 spp.) are documented. A discussion of the cropping regularity of fruiting tree species is included. The diverse range of nuts (hazelnut, walnut, hickory, oak, beech etc) are discussed, most only providing good crops every 2-3 years.

175. Zmarlicki, C., Wehmeyer, A.S. and Rose, E.F. (1984). Important indigenous plants used in the Transkei as food supplements. *Ecology of Food and Nutrition.*

Some of the wild plants used in the Transkei as food supplements were analysed for nutrient composition. Many potentially useful spp. are also regarded as weeds, but their cultivation should, in some cases, be encouraged eg. Sonchus asper, Chenopodium album, Amaranthus spp., Galinsoga parviflora and Urtica urens.

Chapter Two

Swidden Agriculture and Foraging in Tropical Forest Systems



Swidden Cultivation by Hmong, Northern Thailand
Photo: Jules Pretty

2. SWIDDEN AGRICULTURE AND FORAGING IN TROPICAL FOREST SYSTEMS

The cycle of swidden, or shifting, cultivation begins when an area of vegetation is cut, dried and burned. The use of fire releases nutrients from the cut vegetation in preparation for the planting of staple foods. The cropped phase may last for between one and five years, and is followed by a fallow phase. The uncultivated land is left to regenerate until the next cycle of burning and cultivation begins (186; 188; 189).

The Swidden Cycle and the Changing Availability of Wild Foods

Swidden cultivators are not solely reliant on produce from the cropped phase of this cycle. The term 'fallow' may be misleading. It does not imply unused, but simply uncultivated and unweeded (177). Many swidden cultivators hunt and gather in order to supplement their diets (189 for the Philippines; 181 for Peru; 211 for Venezuela; 232 for SE Asia. Also: 177; 180; 184; 186; 195; 205; 226-230; 242; 243). The fallow fields are an important source. Those of the Lua in northern Thailand contain 110 varieties of food plant and 42 medicinal plant varieties (218), and those of the Bora Indians of Peru contain 118 useful species (190-194). In SE Asia, bamboo and rattan, both important non-timber forest crops, are harvested during the regrowth phase of shifting cultivation systems (188; 219). As many trees are planted or protected during the production of staples, the production process can be viewed as continuous (191; 198).

Fields are revisited in order to collect foods and hunt game (221). In many cases these fallow fields are also actively managed (191; 203). Management for wild food production begins as the fields are cleared and selected trees are protected from burning (207; 208; 214). Within the field, seeds of trees may be planted or germinated tree seedlings allowed to grow (217; 219). Surrounding vegetation may also be managed to ensure the growth of valued wild products (238-240). A field study from Peru listed a total of 37 planted or managed species, including cashew and peach palm (193). Near Ibadan, Nigeria, 14% of all trees in an 8 year old fallow were found to be protected or planted by people (208). The diversity and number of useful species that appear in the fallow field will be highly dependent on the degree and

type of management applied during the cropping phase (238). Unmanaged fallows contain fewer useful food plants than managed fallows of a similar age (240).

In swidden systems, therefore, the distinction between wild and managed is not clear. It is often difficult to tell what is part of the natural forest succession and what has been influenced by human management.

Ecological Processes and Swidden Agriculture

The ecological processes of succession following the end of the primary cropping phase are important in determining the changing availability of wild food resources in a swidden system (eg. 211; 220; 222; 235; 237; 238). An enormous variety of useful products are found in the regenerating fallows of eastern Amazonia (932). In the early stages of regrowth the secondary vegetation is short, so attracting small game and forest floor plants requiring light. A few larger trees retained within the crop land usually yield fruit. These can continue to be harvested for the full fallow period. As succession proceeds, tree regrowth occurs and vegetation structure and species composition changes; this has an impact on the nutrient dynamics of the system (930). There is an increasing availability of tree based products - fruits, nuts, medicinals, firewood etc. As the fallow ages there is a general decline in labour inputs into management, as the highest labour inputs are required during clearance and cropping. Active harvesting of products continues at a declining rate as the succession to closed forest occurs. Useful products may thus be harvested for up to 50 years (224; 225 for Peru).

Patterns of disturbance in swidden systems due to clearance and burning influence the species composition, species diversity and spatial distribution of available wild foods. Following disturbance, it is the ruderal, ephemeral, weedy species that recolonise. Disturbance through clearance and burning may thus act to increase the diversity of wild foods (222). Fire tolerant species also have an advantage in surviving burning regimes in swidden systems (214 for the babassu palm). Open patches may attract particular types of game animal or bird, whose impact (through seed dispersal or further disturbance) in turn may affect the course

of the successional process (238; 239). For instance, wild pigs, attracted to open fallow fields in Papua New Guinea, forage on herbaceous material, so reducing competition with regrowing fruit trees (233).

Specific plants unavailable in the primary forest may occur only in disturbed fallow areas that are unavailable in the primary forest. These may attract wild game to the area (221). In Venezuela, although the primary forest contains a wide range of foods for the Cracidae bird family, important food for the Piaora Amerindian people, the secondary forest in fallow areas provides a greater concentration. The birds are more attracted to fallow patches, where they are easily hunted (245).

Hunting and Gathering and Agricultural Complementarity

Tropical forests are food rich areas for human foragers throughout the world (215, 928 for African tropical rain forests; 223 for Indian tribal areas; 187; 231; 293; 294 for Amazonia; 244 elsewhere in S America; 180 for Malaysia; 321 for the Papua New Guinea highlands). In these areas, hunting and gathering is usually complementary to crop-based agriculture (49 for a Ghanaian case). Different groups are more or less engaged in each activity (eg. 178 for the Philippines; 206 for Yanomani of Venezuela) and there may be important exchanges between predominantly agricultural and foraging societies (eg. 200 for the Philippines; 236).

However, there are often scarcities of wild starch foods (eg. yams; 213) in tropical forests, necessitating the development of complementary relationships between foragers and farming communities (236). The seasonal availablity of wild foods of the Mbuti in the tropical forests of eastern Zaire shows that the supply of food is seasonally precarious. This requires the Mbuti to trade with agriculturalists or foraging on the forest edge to compensate for food shortfalls from forest sources (212).

Swidden Systems Under Pressure

Swidden systems are constantly undergoing change. Resource pressures in many areas have

shortened fallows (182; 736; 738). These pressures have been exacerbated by the removal of land for commercial agriculture or ranching (182; 682), and by the migration of settlers from other areas pressure (738). The indigenous adaptive strategies of swidden cultivators and forest dwellers (178; 210; 226-230) may be unable to cope with these processes of modern change.

The result is often an intensification of the cropping system with a move to cash cropping (120; 167; 185; 204; 244). This may mean the extension of continuously cultivated gardens, often already an important part of the agricultural system (eg. 423 for Zambia). It may also mean changes in the gender division of labour in swidden and foraging systems, where labour allocation to agriculture, hunting and gathering is already differentiated. Among the Cuiva foragers of Venezuela, for example, men spend more time hunting, while women concentrate on gathering activities (216). Changes in the production and marketing system may result in reductions and hunting and gathering activity. For instance in the Philippines, Batak foraging camps are now shorter and more seasonal as a result of increased market contact with lowland areas (201).

In swidden systems, the distribution between the forest and the field and the wild and the cultivated is blurred, as the management of fallows and field sites is closely integrated. As swidden systems change and adapt to new circumstances, so agricultural planning and policy must recognise this integration and ensure that the wild food resources are taken into account.

CHAPTER 2: SWIDDEN AGRICULTURE AND FORAGING IN TROPICAL FOREST SYSTEMS

176. Allen, B.J. (1985). Dynamics of fallow successions and introduction of robusta coffee in shifting cultivation areas in the lowlands of Papua New Guinea. *Agroforestry Systems, 3(3), 227-238.*

> The traditional shifting cultivation system of the lowlands of Papua New Guinea consists of mixed food crop gardens in which yams, bananas, taro and sugar cane predominate. During the cropping cycle two fruit tree species, Pometia pinnata and Artocarpus altilis, are commonly planted.

177. Beckerman, S. (1984). Swidden in Amazonia and the Amazon Rim. In: B.L. Turner and S.B. Brush, *Comparative Farming Systems.*, pp. 55 -94, Guildford Press, New York.

> This chapter reviews the cropping cycle, labour requirements, the physical conditions and changes to traditional swidden agriculture in Amazonia. Comparative tables for several Amerindian groups are given for cultivars, crop densities, productivities, length of cropping, and labour inputs. Throughout the text, specific examples are given of the Bari system of production. This is located in the South West Maracaibo basin on the Colombian and Venezuelan borders. The 'abandonment' of the swidden *field is defined as the end of weeding and it is noted that many products, particularly fruits, are used* as food.

178. Cadelina, R.V. (1988). A comparison of Batak and Ata subsistence styles in two different social and physical environments. In: Rambo, A.T., Gillogly, K. and Hutterer, K.L. (eds), *Ethnic Diversity and the Control of Natural Resources in Southeast Asia.* Michigan Papers on South and Southeast Asia, Center for South and Southeast Asian Studies, Michigan.

> The paper considers two Philippine Negrito groups, the Ata and Batak, which live in different social and physical environments and comprise a collection of ethnic groups. Both groups were originally nomadic forest foragers but they have evolved different subsistence strategies in recent years. The Batak were found to obtain 60% of their carbohydrate from farms compared with 75% for the Ata who farm more intensively and do not have access to wild foods. The protein content of the Batak diet generally comprises wild meat and fish, while the Ata obtain protein preserved fish and domestic livestock. Both the Batak and the Ata have an increasing desire for material items such as clothing, housing and kitchen utensils which are obtained through barter, purchase and as gifts. Although the ethnic groups in the Ata and Batak communities have maintained some of their socio-cultural markers, they have nevertheless succeeded in establishing a variety of relationships with other ethnic groups living outside each community.

179. Best, J.R. (1988). Change over time in a farming system based on shifting cultivation of hill rice in Sarawak, Malaysia. *Agricultural Administration and Extension, 29(1), 69-84.*

180. Carey, I. (1976). *Orang Asli, the Aboriginal Tribes of Peninsular Malaysia.* Oxford University Press, Kuala Lumpar, Malaysia.

181. Carneiro, R. (1964). Shifting cultivation among the Amahuaca of Eastern Peru. In: *Beitrage zur Volkerkunde Sudamerikas.* Volkerkundliche Abhandlungen I:9-18, Kommissionsverlag Munstermann-Druck GMBH, Hannover.

This brief overview of Amahuaca swidden cultivation estimates that 40% of subsistence food is obtained from hunting and 10% from fishing and gathering. Primary forest is usually cleared and cropped for one year. Afterwards, households usually move on to other areas only sometimes returning to collect bananas and papayas from fallow sites.

182. Chidumayo, E.N. (1987). A shifting cultivation land use system under population pressure, Zambia. *Agroforestry Systems, 5(1), 15-26.*

The paper presents results concerning changes in nutrient status of soils under chitemene cultivation and the relationship between population density and deforestation. Increases in population in northern Zambia has resulted in decreases in fallow periods from around 25 years to 12 years. Clearance of chitemene gardens has increased dramatically. These changes in resource management strategy have acted to increase the population's carrying capacity. The role of wild food use has changed accordingly, with a greater concentration on cropped fields than in earlier times.

183. Clark, K. and Uhl, C. (1984). Deterioro de la vida de subsistencia tradicional en San Carlos de Rio Negro (Deterioration of traditional subsistence livelihoods in San Carlos de Rio Negro). *Interciencia, 9(6), 358-365.*

184. Clark, K. and Uhl, C. (1987). Farming, fishing, and fire in the history of the Upper Rio Negro Region of Venezuela. *Human Ecology, 15(1), 1-26.*

The article begins with a history of fire disturbance in the Upper Rio Negro region of Venezuela due to agriculture and wildfires. It then evaluates the area's carrying capacity based on agricultural energy inputs and outputs and land availability. Fish are the main protein source to supplement bitter manioc.

185. Clarke, W.C. (1966). From extensive to intensive shifting cultivation: A succession from New Guinea. *Ethnology, 5, 347-359.*

This study examines four different communities on a continuum from low population density and abundant forest to high density and mainly grassland. It is assumes that it is population increase and more intensive land use which has converted forests to grasslands. The main discussion revolves around differences in crops grown and the increase in labour needed in grassland areas for food production. A greater scarcity of wild game and forest products in grassland areas is mentioned.

186. Clarke, W.C. (1976). Maintenance of agriculture and human habitats within the tropical forest ecosystem. *Human Ecology, 4(3), 247-259.*

This is a general article on swidden cultivation in the tropics. Management techniques which favour forest regeneration after cropping include: few and selective weedings; short cropping periods; planting of trees and prevention of fire. Although no details are given, the dietary importance of forest products is acknowledged.

187. Colchester, M. (1981). Ecological modelling and indigenous systems of resource use: Some examples from the Amazon of South Venezuela. *An Tropologica, 55, 51-72.*

188. Conklin, H.C. (1954). An ethnoecological approach to shifting agriculture. *Transactions of the New York Academy of Sciences, 17, 133-142.*

This is a brief summary of the swidden cultivation system of the Hanunoo of the Philippines - the cycle of clearing, burning, planting, as well as their corresponding ceremonies. Ordinarily secondary forests are cut with certain large trees protected in order to provide seedlings for regeneration. Maize and

rice are planted with other vegetables, root crops and fruit trees intercropped. This intercropping is considered as a form of crop rotation. One example observed 40 different crops in a single field. In this way, products can be harvested from the field for up to six years, after which secondary vegetation, such as bamboo, dominates. The fallow period lasts from five to fifteen years before reclearing. Houseyard gardens are also maintained for varietal experimentation, medicinals and ornamental plants. The Hanunoo consider over 1,500 plants to be useful and have cultivated about 430 of these within their swiddens. The article notes that although Imperata grass may be considered a weed, it is still important as a source of fodder and thatch.

189. Conklin, H.C. (1961). The study of shifting cultivation. *Current Anthropology, 2, 27-61.*

This is a guide for researchers planning to study swidden cultivation. It briefly describes some difficulties which the researcher may encounter such as swidden field sites dispersed over large areas and informants reluctant to discuss crop yields. It also provides an outline of topics for investigation with "Hunting and Trapping" and "Foraging" listed last under the fallow section. A bibliography of over 1200 references is given, followed by a geographical index.

190. Denevan, W.M. (1971). Campa subsistence in the Gran Pajonal, Eastern Peru. *Geographical Review, 61, 496-518.*

This article describes the subsistence system of the Campa in Eastern Peru. Their staples include manioc and maize. Game is also important, as the men spend 50% of their time hunting. It is game depletion which may cause villages to move to other sites. Children often spend much time searching for insects to eat. The Campa pile together maize cobs in order to provide a habitat for a particular grub species. They also clear shrubs from the hills of leaf-cutter ants and collect them when they swarm. Wild animals are sometimes raised and then eaten when there are food shortages. Wild fruits and vegetables are gathered. Often these appear along trails and near houses.

191. Denevan, W.M. and Padoch, C. (1987). Introduction: The Bora Agroforestry Project. In: W.M. Denevan and C. Padoch (eds.) *Swidden-Fallow Agroforestry in the Peruvian Amazon, Advances in Economic Botany, 5, 1-7,* The New York Botanical Garden, New York.

This introduction to the volume provides a description of the UNESCO Man and the Biosphere project carried out in the Amazon of eastern Peru on the swidden-fallow agroforestry of the Bora Indians. The Bora Indians, although maintaining traditional agroforestry systems, were settled in the mission town of Brillo Nuevo, speak Spanish and participate in markets. They do not abandon their swidden fields after staple cultivation but continue to protect, plant and harvest useful species in their fallows for up to 35 years. This Bora system of fallow management coordinated with forest succession is compared with other tropical systems through a review of the literature.

192. Denevan, W.M. and Padoch, C. (eds.) (1987). *Swidden-Fallow Agroforestry in the Peruvian Amazon. Advances in Economic Botany, volume 5,* The New York Botanical Garden, New York.

This volume in the Advances in Economic Botany series is devoted to detailed studies on the swidden-fallow agroforestry of the Bora Indians in Peru. The aim of these studies is to document existing successful agroforestry systems. Such information can be applied to the design of agroforestry systems whose objectives are to improve livelihoods without degrading the environment. The chapters investigate the types of products collected, the stages of fallow succession in which they grow and their sale in markets. The data provides evidence that the swidden field is not abandoned after cultivation, but that management and collection of products continues. In this context, the succession from young

to old fallow is described. A comparison of the Bora system is also made with lo cal farmers of mixed ancestry who practice a form of commercial agroforestry quite profitably. These studies begin to investigate the potential which swidden-fallow agroforestry holds for rural communities. Further research is needed on the succession of individual fallows, the effects on nutrient cycling and the labour demands of management. Institutional an infrastructural improvements needed to promote these products for home and for sale are discussed.

193. Denevan, W.M. and Treacy, J.M. (1987). Young managed fallows at Brillo Neuvo. In: W.M. Denevan and C. Padoch (eds.) *Swidden-Fallow Agroforestry in the Peruvian Amazon, Advances in Economic Botany, 5,8-46*, The New York Botanical Garden, New York.

This study investigated five young managed fallows, all less than ten years, an unmanaged fallow, a nineteen-year old fallow and dooryard gardens. Data was collected on the types of vegetation and products harvested, and management techniques which occur during the first ten years of fallow. The history of the fallow begins with the swidden field itself. The Bora plant about 22 varieties of manioc (Manihot esculenta), as well as tree seeds and seedlings such as cashew (Anacardium occid entale), peach palm (Bactris gasipaes), citrus (Citrus aurantifolia, C. reticulata, C. sinensis), guaba (Inga edulis). A total of thirty-seven of these species are listed. After the manioc is harvested, peanuts are planted in their place. The diversity of crops, their spacing and weeding influence the species composition of the fallow. Ordinarily the more diverse the initial field is, the more useful plants follow in the fallow. Women are responsible for the planting and management of fields. Through the line-intercept method, data on the vegetation present in fallows is given with at least 118 useful species encountered. Although not of similar histories, fields of different ages were compared in order to begin to understand how vegetation changes through succession. There is no abandonment of fields, but forest regeneration is man ipulated to produce fruit, fuelwood, construction materials.

The fallows studied were distinguished as follows: transitional swidden (3 years old); transitional orchard-fallow (5 years old); orchard fallow (6, 8 and 9 years old); an unmanaged fallow (6 years old) and a forest fallow (19 years old). Manioc was still present in the transitional swidden as well as 20 other cultigens, with guaba (Inga edulis), uvilla (Pourouma cecropiifolia), macambo (Theobroma bicolor) and peach palm (Bactris gasipaes) the dominant tree species. The transitional orchard-fallow also contained a small amount of manioc and species such as uvilla and peach palm were harvested along with other species for construction and handicrafts. The orchard fallows still contained cultivated tree species and were even weeded.

In one eight-year old fallow, 27 uvillas, 21 peach palms and 14 banana plants had been planted. Its farmer was able to identify 60 other wild plants growing in the same area as the fruit trees. Some of these are used for food, construction, handicrafts and fuel. Areas of orchard, forest regrowth and sapling thickets were distinguished as three separate zones within these fallows. The unmanaged fallow contained no fruit trees illustrating the importance of care such as weeding. Trees for construction materials, however, were present. Dooryard gardens are more intensively managed and contain not only species in the swidden-fallows, but also others which may need closer protection from predators. As the fallows can provide products for home and for sale, it is suggested that this traditional fallow-management system may be a model from which to design agroforestry systems which could improve areas of swidden cultivation where fallow lengths are shortening.

194. Denevan, W.M., Treacy, J.M., Alcorn, J.B., Padoch, C., Denslow, J. and Paitan, S.F. (1984). Indigenous agroforestry in the Peruvian Amazon: Bora Indians, management of swidden fallows. *Interciencia, 9, 346-357.*

195. Dove, M.R. (1985). *Swidden Agriculture in Indonesia, the Subsistence Strategies of the Kalimantan Kantu*. Mouton Publishers, Berlin.

The swidden cultivation system of the Kalimantan Kantu is comprehensively detailed from local ecology to production data. Cutting, burning, planting, weeding, harvesting phases of swidden are described, as well as their labour requirements. Data on the seasonality of cultivated and uncultivated relishes as well as their relative importance are presented.

196. Duke, J.A. (1970). Ethnobotanical observations on the Choco Indians. *Economic Botany, 24(3), 344-366.*

197. Eden, M.J. (1974). Ecological aspects of development among Piaroa and Guahibo Indians of the Upper Orinoco basin. *Antropologica, 39, 35-56.*

198. Eden, M.J. (1980). A traditional agro-system in the Amazon region of Colombia. *Tropical Ecology and Development, 509-514.*

This paper discusses the types of plants found in the swidden fields of the Andoke and Witoto Indians of the Colombian Amazon. Their frequencies within the fields are given; for example fruit trees comprise 3% of the crops yielding 5-10 years after the fields were cleared.

199. Eden, M.J. and Andrade, A. (1988). Colonos, agriculture and adaptation in the Colombian Amazon. *Journal of Biogeography, 15, 79-85.*

Traditional Andoke and Witoto Indians' swidden cultivation is compared with that of non-indians, the colonos, in the area. The staples are emphasized; however, it was observed that the colonos maintained home gardens with fruit trees like mango and lime.

200. Eder, J.F. (1988). Hunter-gatherer/farmer exchange in the Philippines: some implications for ethnic identity and adaptive well-being. In: Rambo, A.T., Gillogly, K. and Hutterer, K.L. (eds.). *Ethnic Diversity and the Control of Natural Resources in Southeast Asia.* Michigan Papers on South and Southeast Asia, Center for South and Southeast Asian Studies.

Exchanges occur of non-domestic protein food, such as wild pig and deer, and domestic carbohydrate food, such as maize and yam, between Agta hunter-gatherers and Palanan sedentary agriculturalists in Luzon, Philippines. By reifying cultural boundaries and subsistence economic types, by emphasizing complementarity and voluntarism, and by being frozen at a particular point in time, earlier arguments overlook a vital broader pattern of historical, political and economic changes involving the Agta and the Palanan, and Negritos and lowland Filipinos generally. Consideration of this broader pattern suggests that what appear to be symmetrical, complem entary exchange relationships between two otherwise independent populations have the potential to become classlike ethnic relations within a single society, with attendant marginalization of the 'hunter-gatherers' in question.

201. Eder, J.F. (1988). Batak foraging camps today: a window to the history of hunting-gathering economy. *Human Ecology, 16, 35-5 6.*

Incorporation into wider social and economic systems has brought a variety of changes to the hunting-gathering lifestyle of the Batak of the Philippines. Compared with 100 years ago, Batak hunting-gathering camps today are more limited in duration and smaller in size, hunting-gathering itself is more seasonal in importance, and there are significant differences in technology, resource utilization, the organization of labour, and length of workday. These changes are related to the growing importance of other economic activities and to the nature of Batak market articulation with lowland Filipino society.

202. Flannery, K. (1973). The origins of agriculture. *Ann. Rev. Anthropology,* 2, 271-309.

Around the close of the fifth millenium BC, the Indians of Mexico first began to cultivate a series of native plants; these would later become the staples of agriculture in middle America. Prior to this the Indians adopted a broad collecting strategy, using acorns, wild beans, wild onion flowers and so on. The management strategies involved the clearing of forest patches. These would be colonised by a range of plants, including Teosinte (wild maize), wild beans and wild squash. This natural succession of plants in cleared forest areas could subsequently be harvested. It was this combination of maize-beans-squash that subsequently became the mainstay of agriculture in this area.

203. Flores Paitan, S. (1987). Old managed fallows at Brillo Nuevo. In: W.M. Denevan and C. Padoch (eds.) *Swidden-Fallow Agroforestry in the Peruvian Amazon,* Advances in Economic Botany 5:53-66, The New York Botanical Garden, New York.

Data is presented on the floristic composition, vegetation structure and soils of old fallows aged 10, 15, 20 and 35 years. A table of the species found and their uses and tree profiles are given. This information combined with that of species' usefulness are important if specific multipurpose species are to be incorporated into agroforestry projects.

204. Flowers, N.M., Gross, D.R., Ritter, M.L. and Werner, D.W. (1982). Variation in swidden practices in four Central Brazilian Indian societies. *Human Ecology, 10(2), 203-217.*

This study compares the swidden systems of four Indian groups in Central Brazil living in the cerrado (savanna) regions. Although staple crops are emphasized the relationship to gathered products and the effects of change on their use is drawn into the discussion. The Indians' access to their land has been diminished with some groups being placed on reservations. The result has been a decline in the gathering of wild products. In response, many new crops such as manioc, rice and maize have been introduced and their production intensified as Indians begin to live in more permanent settlements. Tree crops such as mangoes and citrus have also been introduced. The Mekranoti Indians still go on hunting and gathering treks; however, now they take along staple foods. This may be due to the fact that the area is not their original territory and they are not as familiar with the wild resources at hand.

205. Freeman, J.D. (1955). *Iban Agriculture: A Report on the Shifting Cultivation of Hill Rice by the Iban of Sarawak.* London.

206. Fuentes, E. (1980). Los Yanomani y las plantas silvestres (The Yanomami and wild plants). *Antropologica, 54, 3-138.*

207. Gomez-Pompa, A. and Kaus, A. (1989). Traditional management of tropical forests in Mexico. In: Anderson, A. (ed.). *Alternatives to Deforestation: Steps Towards Sustainable Use of the Amazon Rainforest.* Columbia University Press, New York.

The challenge of forest management in a setting where immigrant populations have a huge impact is discussed. The local knowledge base about particular plant and tree species is being lost and the traditional management practices of forest garden development are diminishing. The chapter includes a listing of key species and uses from the Mexico study area.

208. Hall, J.B. and Okali, D.U.U. (1979). A structural and floristic analysis of woody fallow vegetation near Ibadan, Nigeria. *Journal of Ecology, 67, 321-346.*

This study documented the structural and floristic composition of fifty randomly selected 25m x 25m plots of eight year old regrowth forest. On average about 14% of the trees found in the plots had been

planted or protected by people. These species include fruit trees, cocoa, coffee and rubber.

209. Hames, R. (1983). Monoculture, polyculture and polyvariety in tropical forest swidden cultivation. *Human Ecology, 11(1), 13-3 4.*

The discussion questions that all swiddens are polycultural and that complexity equates stability in tropical systems. Using data from the Ye'kwana and Yanomamo Indians of Venezuela the author provides evidence for monocultures and polyvariety.

210. Hames, R.B. and Vickers, W.T. (eds.) (1983). *Adaptive Responses of Native Amazonians*. Academic Press, New York.

211. Harris, D.R. (1971). The ecology of swidden cultivation in the Upper Orinoco Rain Forest, Venezuela. *The Geographical Review, 61(4), 475-495.*

A description of the swidden cultivation systems of the Upper Orinoco region of Venezuela. The nutrient content of the soils and the products found in both the cultivated (conucos) and the fallows (rastrojos) of the Waika (Yanomamo) are investigated. Questions are raised regarding the extent of human influence upon the structure and dynamics of the forest ecosystem. Several species growing in the fallows are still harvested after 'abandonment' of the conucos. The complexity of species contained within the fallows is noted.

212. Hart, T.B. and Hart, J.A. (1986). The ecological basis of hunter-gatherer subsistence in African rain forests: the Mbuti of eastern Zaire. *Human Ecology, 14, 29-55.*

Forest food resources (plant and animal) were assessed to determine their adequacy to support the economy of the Mbuti pygmies, hunter-gatherers of the Ituri forest of Zaire, who trade forest products and labour for agricultural foods. For five months of the year essentially none of the energy-rich forest fruits and seeds are available; honey is not abundant during that period. Wild game meat is available throughout the year, but the main animals caught have a low fat content which makes them a poor substitute for starch-dense agricultural food, staples in the Mbuti diet. It is unlikely that hunter-gatherers would have lived independently in the forest interior with its precarious resource base, when many of the food species they exploit are more abundant toward the savanna border.

213. Headland, T.N. (1987). The wild yam question: how well could independent hunter-gatherers live in a tropical rain forest ecosystem? *Human Ecology, 15, 463-491.*

It has been generally assumed until recently that tropical rain forests are food-rich biomes for human foragers, and that prehistoric hunter-gatherers once lived completely independently of cultivated foods in such environments. An alternative hypothesis that such forests are actually food-poor is proposed. Specifically, that wild starch foods such as yams were so scarce and so hard to extract that human foragers could not have lived in forests without recourse to cultivated foods. The symbiotic relation found today between tropical forest hunter-gatherers and farmers is not a recent phenomenon, but evolved long ago as an adaptive strategy for successfully exploiting the tropical forest. Evidence is given mainly from Agta Negrito hunter-gatherers in Luzon, Philippines.

214. Hecht, S.B., Anderson, A.B. and May P. (1988). The subsidy from nature: Shifting cultivation, succesional palm forests and rural development. *Human Organization, 47(1), 25-35.*

This key paper provides detailed evidence of the importance of an 'invisible' forest resource, the babassu palm (Orbignya phalerata), to the rural poor of Northeast Brazil. Thorough ecological, social

and economic analyses of the role of babassu are given which include data from past studies of the palm. In the state of Maranhao, 85% of the rural population is considered landless with less than one hectare. These people are dependent on the extraction of its fruit for income, food, fuel and fibre. The kernels of these nuts can be processed into a milky beverage, oil, soap or animal feedcakes. The oil is of a similar quality to coconut oil. The fruit husks (shell, endocarp) can be used directly as fuel or processed into charcoal.

The ecology of the babassu palm is unique in that it can survive the clearing and burning of swidden plots, and regenerate during the fallow. This survival is due to its apical meristem growing horizontally under the soil before it emerges vertically. The palm has gained dominance in the area directly as a result of swidden agriculture. During its growth, much biomass is contained in the l eaves. Enough biomass has accumulated by the fourth year of fallow that farmers can reclear and burn the land. Ordinarily only th e palm's leaves are removed allowing the tree to survive. An added benefit is that crops will not be shaded. Such fallow products have been largely ignored; however, such products can be quite significant, as secondary forest covers 896 million hectares and is usually situated near communities.

The babassu fruit provides at least 14 useful products which are particularly important for the poor, as they are unable to afford substitutes. The average percentages of rural families in four counties using the following products are given *thatch, 86%; basketry, 85%; charcoal, 83%; milk, 69%; oil,* 71% and palmito, 22%. Economically, its collection and processing are the main source of income for the landless and especially for women. Of the collectors and processors, 93.2% are landless and 86.4% are women. Kernel and charcoal sales alone provided on average 29.9% of the cash income for individuals in two communities. Women usually buy food and medicine with their earnings. An additional advantage of the palm is that its harvesting occurs during slack periods in agricultural production. As the fruit can be stored, their kernels can be extracted at any time particularly when cash is needed for emergencies. Each year over 200,000 metric tons of kernels are produced in Brazil.

Despite these contributions, development policies for mechanized rice production and particularly for cattle ranching, are either destroying the palms directly or denying the poor's access to them. The authors state that *"for the most impoverished landless households, survival without the babassu palm is unimaginable"*.

215. Hladik, C.M., Bahuchet, S. and De Garine, I. (1989). *Se Nourrir en Foret Equatoriale: Anthropologie Alimentaire des Populations des Regions Rorestieres Humides d'Afrique (Food and Nutrition in the African Rainforest).* UNESCO/MAB, Paris.

216. Hurtado, A.M. and Hill, K.R. (1987). Early dry season subsistence ecology of Cuiva (Hiwi) foragers of Venezuela. *Human Ecology, 15, 163-187.*

The subsistence ecology of Venezuelan Cuiva foragers during the early dry season is described. Data on diet, time allocation, demography, and physical measurements are presented. Analyses show that the Cuiva depend primarily on game and wild roots during the early dry season for their subsistence. Sex differentials in productive efficiency, total contribution to the diet, and time allocation to food acquisition and other activities are also examined. As in most other foraging societies, men specialize in hunting while women specialize in gathering. During the early dry season, men provide more calories than women and are the more efficient food producers. However, men spend slightly less time than women in food acquisition. Comparisons between the patterns found among the Cuiva and other foraging populations are made.

217. Johnson, A. (1980). Ethnoecology and planting practices in a swidden agricultural system. In: D.W. Brokensha; D.M. Warren and O. Werner (eds.), *Indigenous Knowledge Systems and Development.*, pp. 49-66, University Press of America, Lanham, Maryland, USA.

218. Kunstadter, P., Chapman, E.C and Sabhasri, S. (1978). *Farmers in the Forest: Economic Development and Marginal Agriculture in Northern Thailand.* An East-West Center Book, The University Press of Hawaii, Honolulu.

The chapters in this book cover the ecology and economics of swidden cultivation and address development issues such as growing pop ulations, indebtedness, deforestation and improved production. Only passing reference is given to the collection of wild food and fallow products; for example, that mainly children eat fruits and that farmers may plant seeds for trees in their fields to encourage regeneration. The swidden fallows of the Lua of Northern Thailand contain 110 varieties of food plants and 42 medicinal plants; they also collect 27 wild food plants.

219. Kunstadter, P., Sanga Sabhasri and Tem Smitinand (1978). Flora of a forest fallow farming environment in northwestern Thailand. *Journal of the National Research Council of Thailand, 10(1), 1-45.*

220. Manner, H.I. (1981). Ecological succession in new and old swiddens in montane Papua New Guinea. *Human Ecology, 9, 359-377.*

Swidden plots in montane Papua New Guinea showed a successional sequence of crop composition, diversity and biomass. This is regulated by human use and ecological processes. In contrast to new *swiddens, old plots were characterised by simplified crop composition and vertical stratification.*

221. Nations, J.D. and Nigh, R.B. (1980). The evolutionary potential of Lacandon Maya sustained-yield tropical forest agriculture. *Journal of Anthropological Research, 36(1), 1-30.*

The ancient Maya were able to support large populations within the tropical forest for a thousand years. The paper investigates existing Lacandon Mayan systems for clues which may provide for sustainable food production in the forests today. Unfortunately such traditional systems are disappearing as Mayan territories are logged and colonized. The Maya are able to collect foods from a variety of locations: their swidden fields, primary and secondary forests, and along rivers and streams. These areas may be actively managed, or protected. For example, once crops have been grown, the fields are then planted with trees to aid forest regeneration. In addition to planted species, many wild species are found and harvested on fallow land known as the *acahual*. Of the 58 useful plants listed for this stage, 13 are wild. They not only provide fruits, food, condiments and medicinals, but also are relied upon if corn harvests fail. The *acahual* is also important as an area which attracts wildlife. Managed habitats promote the presence of wild game and in return humans acquire much needed protein. From the primary forest, 74 species of plants used for food, beverages, fibre, medicine are listed. Another table lists 38 aquatic food animals including fish, snails, turtles and crocodiles. The authors conclude that the diversity of species and management strategies utilized by the Maya could provide many lessons for farming in the tropics.

222. Nyerges, A. (1989). Coppice swidden fallows in tropical deciduous forest: biological, technological and socio-cultura determinants of secondary forest succession. *Human Ecology, 17, 379-400.*

Swidden farming practices are shown to influence the pattern of coppicing in old field sites in Sierra Leone. The standard pattern of minimal cultivation encourages coppice regrowth, whereas if more intensive cultivation practices are then stump deaths occur, resulting in the invasion of fallow sites by grasses and savanna pioneer trees. Variations in the outcomes of disturbance are the result of the interaction between processes of tree reproduction and the agricultural practices of farmers. The pattern of availability of resources in swidden systems, including the prevalence and diversity of wild foods, is thus dependent on this biological-social interaction.

223. Oommachan, M and Masih, S.K. (1988). Multifarious uses of plants by the forest tribals of Madhya Pradesh: wild edible plants. *Journal of Tropical Forestry, 4, 163-169.*

The results are reported of ethnobotanical surveys made in the forest tribal belts of Madhya Pradesh (Bastar, Betul, Bilaspur, Chatarpur, Durg, Jabalpur, Rajnandgaon and Shahdol). Some 52 wild food plants were identified, and these are listed giving botanical and common names and details of uses and distribution.

224. Padoch, C. and De Jong, W. (1986). Traditional agroforestry practices of native and ribereno farmers in the lowland Peruvian Amazon. In: H.L. Gholz (ed.), *Agroforestry Realities, Possibilities and Potentials,* Martinus Nijhof, Dordrecht.

225. Padoch, C.J., Inumo, C., De Jong, W. and Unruh, J. (1985). Amazonian agroforestry: A market oriented system in Peru. *Agroforestry Systems, 3, 47-58.*

This article discusses a market-oriented cyclic agroforestry system practised by non-tribal 'Mestizo' farmers in Tamshiyacu, Peru. The sale of wild products and crops provides a substantial cash income for many farmers. The major constraints for the development of commercial agroforestry systems are transport and marketing networks. In this case, close proximity to markets and good transport systems allows farmers to market large quantities of perishable fruits. This situation does not apply in large parts of the Amazon.

226. Posey, D.A. (1983). Indigenous knowledge and development: an ideological bridge to the future. *Ciencia e Cultura, 35(7), 877-894.*

227. Posey, D. A. (1983). Indigenous ecological knowledge and development of the Amazon. In: E. Moran, (ed), *The Dilemma of Amazonian Development.* pp. 225-257, Westview Press, Boulder, Colorado.

228. Posey, D.A. (1984). A preliminary report on diversified management of tropical forest by the Kayapo Indians of the Brazilian Amazon. *Advances in Economic Botany, 1, 112-126.*

This paper reports information on the collection and management of forest products by the Kayapo Indians. The extent of this management makes it very difficult to draw boundaries between domesticated, semi-domesticated and wild species, and between natural and managed forests. As *swidden cultivation ceases, the root crops can still be harvested from old fields for many years to* come. As the forest regenerates many useful medicinal plants grow. Trees are also transplanted to these old fields from other secondary and primary forest areas. Animals are also attracted to the ground cover and fruit trees. Information on the use of 17 plant species by people and animals is given in tabulated form. Another table lists 45 tree species planted for food or to attract game and fish. Other uses for these plants are also detailed. Areas along trails are also planted with many food and medicinal species as the Kayapo do not want to be weighted down with provisions on long treks. The paper reports: *"In a survey of a three kilometre trail...the following were observed: 1) 185 planted trees representing at least 15 different species, 2) approximately 1500 medicinal plants of an undetermined number of species, and 3) approximately 5500 food-producing plants of an undetermined number of species."* Even openings made in primary forests from a single tree-fall are planted with root crops and beans. Women also manage hill gardens of tubers in case of emergency food shortages due to floods. Finally, there are also home gardens planted; with one survey finding *"86 varieties of food plants... and dozens of additional medicinal plants".*

229. Posey, D.A. (1985). Indigenous management of tropical forest ecosystems: The case of the Kayapo Indians of the Brazilian Amazon. *Agroforestry Systems, 3, 139-158.*

Useful native plants are concentrated by human activity in special forest areas (resource islands, forest fields, forest openings, tuber gardens, agricultural plots, old fields, trail sides). Semi-domestication of many species has occurred. Animal species are also used as game; these are particularly attracted to old field sites. Micro-climates and spatial patches are used to increase diversity in forest areas. Indigenous knowledge recognises a wide range of ecozones and patches. Such knowledge is extremely important in developing new strategies for campo/cerrado conservation.

230. Posey, D.A. and Balee, W. (1989). Resource management in Amazonia: indigenous and folk strategies. *Advances in Economic Botany 7.* New York Botanical Gardens, Bronx, New York.

231. Prance, G.T. (1984). The use of edible fungi by Amazonian Indians. *Advances in Economic Botany, 1, 127-139.* New York Botanical Gardens, Bronx, New York.

The collection of edible fungi by three Yanomami villages in the Brazilian Amazon were investigated. The majority of these species (e.g. Favolus brasiliensis and Polyporus tricholoma) grow on felled and decaying logs in swidden fields. Of the 21 species consumed in one village, 19 were gathered from a cultivated or fallow fields. The other two were found in the forest. Women pick the fungi while weeding or harvesting their fields. Other fungi such as Polyporus indigenus and Polyporus saporema have their hyphae growing underground. This sclerotium can weigh over 3 kg, half of which is carbohydrate. These fungi are eaten when staple foods are in short supply.

232. Rambo, A.T. (1984). Orang Asli interactions with the Malaysian tropical rain forest ecosystem. In: A.T. Rambo and P.E. Sajise (eds.), An *Introduction to Human Ecology Research on Agricultural Systems in Southeast Asia*, pp. 237-253, University of the Philippines at Los Banos, Laguna, Philippines.

This chapter identifies four ways in which the Orang Asli have modified their tropical forest environment: direct selection, dispersal, habitat modification and domestication. Hunting is an example of the direct selection of forest species: a team of 10 men hunting for 10 days were found to capture 92 animals. Certain species are protected within swidden fields, while others, such as rattan and medicinal plants, are harvested for market. Through the dispersal of seeds and plants, the Orang Asli have altered the structure of forests. For example, high concentrations of palms and fruit trees are found in abandoned fields. Swidden cultivation itself is a major form of habitat modification and increases the diversity of species. Wildlife are attracted to abandoned gardens; ho wever, a reduction of bird species in swidden fields is noted. These systems of interactions, however, are undergoing change, as plantations of oil palms and rubber are increasing and the Orang Asli are being resettled.

233. Rappaport, R.A. (1971). The flow of energy in agricultural society. *Scientific American, 224(3), 116-132.*

This article is a description of the energy inputs and outputs from the swidden fields of the Tsembaga of New Guinea. Although it emphasizes cultivated crops, products from the natural forests are mentioned. These are used and are important in providing forage for feral and domestic pigs. After fields are cleared, tree seedlings are allowed to grow and are called "mother of gardens". Their presence not only facilitates forest regeneration, but also their roots take up nutrients which might otherwise be leached away. The presence of pigs may also aid forest regeneration by eating herbaceous plants which may compete with seedlings. The paper also contrasts the succession of natural with man-made ecosystems: the former, move towards "complexity and stability" while the latter, "simplicity and fragility". This complexity and stability allowed the Tsembaga to be economically self-sufficient; however such traditional systems are disappearing rapidly. The author argues that complexity and diversity in agricultural systems are essential for survival.

234. Ruddle, K. (1974). The Yukpa cultivation system: A study of shifting cultivation in Colombia and Venezuela. *Ibero-Americana, 52, 1-197.*

235. Toky, O.P. and Ramakrishnan, P.S. (1982). A comparative study of the energy budget of hill agro-ecosystems with the emphasis on the slash and burn system (Jhum) at lower altitudes of North-Eastern India. *Agricultural Systems, 9, 143-154.*

236. Treloggen Peterson, J. (1978). Hunter-gatherers-farmers exchange. *American Anthropologist, 80, 335-351.*

237. Uhl, C. and Murphy, P. (1981). A comparison of productivies and energy values between slash and burn agriculture and secondary succession in the Upper Rio Negro Region of the Amazon Basin. *Agro-ecosystems, 7, 63-83.*

> This study found the ratio of energy output from staple crops to energy inputs for their production in swidden fields to be 13.9 to 1. It also compared the productivity of these crops with that of successional forest vegetation. Two plots had been cleared and burned for the study. The cropped field had a greater productivity in the first year than the forest regrowth area; however, in the second year the successional forest had a greater productivity (see also: 930-931).

238. Unruh, J.D. (1988). Ecological aspects of site recovery under swidden-fallow management in the Peruvian Amazon. *Agroforestry Systems, 7(2), 161-184.*

> Species present in the managed swidden fallow are influenced by the farmer's objectives for protection and planting. Residual nutrients in pockets of fields may also be beneficial to species. The pattern of succession can be determined by the weed composition resulting from the swidden. Managed fallows contain more understorey growth and a more open canopy than unmanaged fallows; this may result in a possible improvement in nutrient recovery. The existence of fruit trees may attract birds and bats to the area. As they visit the sites, they in turn will be depositing seeds and perhaps further enriching the fallow area with more useful species.

239. Unruh, J.D. (1990). Iterative increase of economic tree species in managed swidden fallows of the Amazon. *Agroforestry Systems, 11(2), 175-197.*

> This paper presents evidence for the cyclic enrichment of fallow lands with valuable plant species in the Amazon. As valuable plants are left uncut in the swidden field, seeds are better able to survive the burn, and may germinate and establish better because of reduced competition, enhanced fertility in recently cleared fields, nutrient inputs from litter fall and more favourable micro-climatic conditions. Seed dispersal into available establishment sites is enhanced by the creation of local micro-habitats for frugivores who disperse seeds spatially to canopy gaps or trail lines created by swidden management practices. Certain fruit trees adapted to managed fallows have a fruiting strategy that encourages localised seed dispersal through attraction of frugivores; again this results in greater concentration of fruiting trees within fallow areas of the swidden system. This combination of biological adaptation and human induced ecological disturbance, results in a continuous process of enrichment of forest fruit trees that is enhanced by swidden management (see also 932).

240. Unruh, J. and Alcorn, J.B. (1987). Relative dominance of the useful component in young managed fallows at Brillo Nuevo. In: W .M. Denevan and C. Padoch (eds.) *Swidden-Fallow Agroforestry in the Peruvian Amazon. Advances in Economic Botany, 5,47-52.* The New York Botanical Garden, New York.

Through the line-intercept method, the dominance of food, construction, medicinal, handicraft and other plants are compared between zones within a fallow and between different fallow fields. Construction and firewood species were dominant overall and found mainly in the forest regrowth zones and unmanaged fallows. Food plants were next in dominance appearing in the orchard zone. The unmanaged fallow contained the fewest categories of useful species, containing mainly construction and firewood species. Comparisons and conclusions on the dominance and succession of fallow species are difficult to make, as only one fallow of a particular age class was sampled and each of those sampled had different management histories.

241. Vayda, A.P. (1981). Research in East Kalimantan on interactions between people and forests: a preliminary report. *Borneo Research Bulletin, 13(1), 3-15.*

242. Vayda, A.P. and Kartawinata (1986). *Interactions Between People and Tropical Forests.* MAB project No. 1 East, K. Kalimantan, UNESCO, Paris.

243. Vickers, W.T. (1978). Native Amazonian subsistence in diverse habitats: The Siona-Secoya of Ecuador. *Studies in Third World Societies, 7, 6-36.*

244. Warner, K. (1991). *Shifting Cultivators. Local Technical Knowledge and Natural Resource Management in the Humid Tropics.* FAO, Rome.

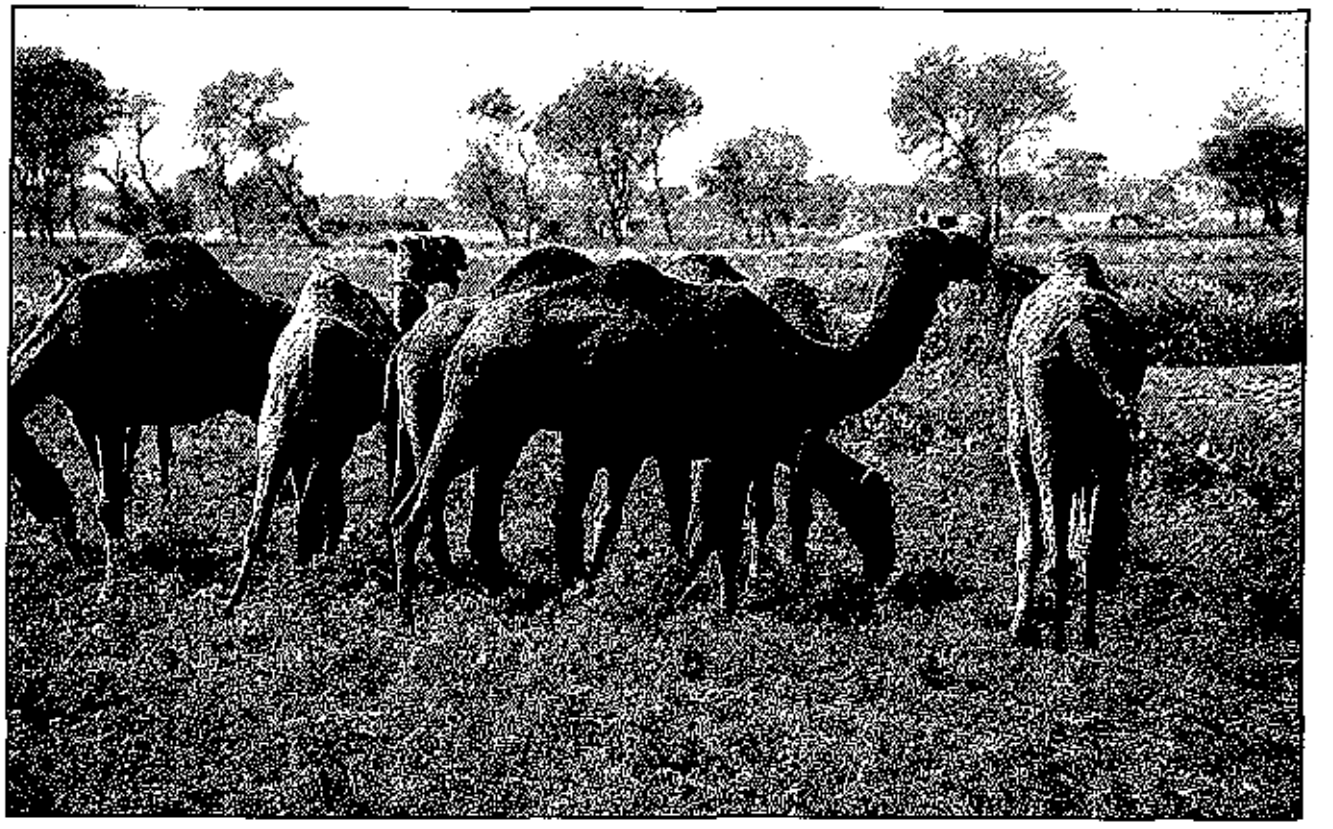
All too often in the past, swidden was perceived as exploiting not managing the natural resources of the humid tropics. The research reviewed in this report, provides ample evidence that swidden cultivation involves complex management of natural resources, focused on maintaining the highly valued diversity of the forest ecosystem. Selective weeding, planting and protection of trees, management of animals and fish all occur in a suite of flexible responses to environmental changes and site specific differences. This reports argues that the local knowledge that such systems are based on is critical in building a sustainable agriculture for the future, under changed conditions of reduced forest areas and shortened fallows.

245. Zent, S. (1988). Piaroa and the Cracidae: Game Management under Shifting Cultivation. In: *Proceedings from the Second International Congress of the Cracidae.* Unpublished mimeo, Department of Anthropology, Colombia University.

This study compares the availability of food resources between cultivated gardens, secondary forests, primary forests and rocky out crops for four bird species of the Cracidae family. Within a 74-day sample period, these species comprised 26% of the game hunted by a group of the Piaroa Amerindians of Venezuela. A list of 55 food species and their locations is given. It was found that the primary forest contained the greatest diversity of food plants for the Cracid species; yet 39% of food types can be found within secondary forests. Further vegetation analysis through plot sampling showed that the greatest density of food plants was found in the secondary forest rather than primary forest. This more concentrated food supply in forests, regenerating after swidden cultivation, enhances the presence of wild game for local households. The author cautions, however, that secondary forests alone are not enough to support populations of Cracids; primary forests are also needed for other phases in the life cycle, such as breeding.

Chapter Three

The Hidden Harvest in Pastoral Production Systems



Camels belonging to nomads, Punjab Province, Pakistan
Photo: Jules Pretty

3. THE HIDDEN HARVEST IN PASTORAL PRODUCTION SYSTEMS

The hidden harvest of extensive pastoral production systems includes a range of products. These include medicinal products collected for human or animal health care, wild foods such as grasses and berries, and wild products, such as gum arabic, that can be sold or exchanged. As with other production systems the hidden harvest plays an important role in pastoral livelihoods. However the importance of these products varies, both in space and in time.

Many studies list the range of plants and other products collected for different uses, including nutritional value (256). For the whole of the Sahel some 800 edible plant species are recorded (250; 251). However there is still a gap in the literature on the details of labour inputs in collection, the relative importance of wild foods in the diet (at different times and for different people) and the environmental management implications of wild product use in pastoral areas.

Wild Grain Harvesting in the Sahel

Although the pastoral diet is largely made up of livestock products, most pastoral peoples complement this with grains which are either cultivated or exchanged/purchased (264). In times of stress, particularly, these grain crops (sorghum, millet etc.) may be supplemented or replaced by wild foods. In many parts of the Sahel, the collection and consumption of wild grains, such as Echinochloa colona and Panicum laetum, are an important part of the pastoral production system. The movement patterns of the Tuareg of north east Burkina Faso are influenced by the siting of particularly good patches of wild Panicum laetum (248). Similarly the Tuareg of Niger harvest wild cereal as part of their annual migration between dry and wet season pastures (279a). Other pastoral groups also collect of wild grains, including the Turkana in Kenya (273), who collect a range of grains, and the Zaghawa in Darfur (277), where similar practices are observed.

The productivity of wild grain harvesting is high relative to alternative options of cultivation. The collection of Panicum laetum (locally known as fonio) yields 400-1100 kg/ha in the most

productive, low-lying valley parts of the Malian Gourma, higher than local yields of millet. The returns to labour were also found to be higher than for millet cultivation (269). Similarly high yields of wild grain crops were found in north west Burkina Faso (262). In the Fertile Crescent, wild wheat and barley can produce 500-800 kg of grain/ha in a good year (279b).

The potential output of wild grains in the Sahel is high. In the Gourma of Mali, the wild grain growing areas are thought to represent up to 20% of the total area (269). Within this there are high and low producing patches with different species composition.

Wild grains are nutritionally important in pastoral diets. Wild fonio (Panicum laetum) and cram-cram (Cenchrus biflorus) were found to be the most important wild grains in the local diet in Mali. These are complemented by the fruits of Boscia senegalensis, which are stored for staple consumption in the dry season. For some people this may be the key food that maintains people until the following rains. Other wild foods include the fruits of Zizyphus mauritania, the tuber of Nymphea lotus and the leaves of Maerua crassifolia. A dietary study showed that in the 1990 dry season wild plants are the most used component of the diet. Most were collected from the wild, although cram-cram was largely purchased (253; 269).

Collection and Management of Wild Grasses and Grains

Much of the collection and processing in Tuareg areas is carried out by women. A variety of harvesting techniques exist. Grains are harvested directly from the grass stalk into baskets; the grass is cut and dried and later threshed; grains are left to fall, the standing biomass is removed and the grains are swept up (273). Grains can also be collected from termite stores (254). A similar practice is reported in Chad, where up to 130kg of grain can be collected from a termite mound in a day (275).

In wild grain growing areas there is often a seasonal market in grains. The trade in wild grains increases during drought. Some pastoral groups rely on others to collect and will then acquire them through purchase or exchange. For instance, the WoDaabe of Niger are reliant on the Twareg, exchanging locally-grown tobacco for grains (273).

The importance of wild grains means that local land use management in pastoral areas takes account of such areas. Particularly important wild grain growing patches have patterns of regulated use. In Zaghawa areas of northern Sudan, grazing is restricted in wild grain patches until after the harvest (277). Some degree of private control over valuable grain growing areas may emerge. This may be at the clan level, where particular pastoral groups have prior access to the grain resource or at the individual level, where individual women may harvest particular portions of land.

Little is known of the sustainability of wild grain harvesting in pastoral areas in the Sahel. The impact of seed removal on seed stocks of grain growing areas and the impact of selective harvesting on grass species composition remains to be fully explored (269). Changes in land-use in pastoral areas may represent another threat to the viability of wild grain production. The best wild grain areas are low-lying, relatively wetter parts of the landscape. But these are also the best microenvironments for arable agriculture and grazing. With increasing competition for land resources in marginal pastoral areas the impact of land-use change on wild grain growing areas remains unknown (269).

Wild Foods in the Diet

In other pastoral areas wild foods do not seem to be so important. They are a source of snack food for Maasai herd boys and girls, but these are eaten only occasionally and do not represent an important dietary component (247). Similarly, the Gabra of northern Kenya collect only 17 wild food species which provide an insignificant supplement to the pastoral diet (276). In south Turkana 53 wild plants are part of the local diet collected largely from along the important riverine areas (272). However, these are insignificant in the overall Ngisonyoka Turkana diet (268).

However it is in times of drought and food stress that wild foods become an important component of the diet in many pastoral areas (252 for Senegalese Ferlo; 267 for Awash valley, Ethiopia; 250 for Kenya; 261 for Botswana; Senegal and 265 for NW Sudan), though the collection of foods was said to be an unimportant food acquistion strategy for the

Samburu of Kenya during the 1983-4 drought (444). In North Darfur in the Sudan, pastoralists who had lost livestock and other means of income and sustenance, resorted to the the consumption of Boscia senegalensis (mukheit) and other wild foods during the drought of 1984-5 (10; 392).

In Turkana, Kenya wild foods constitute only 3% of Ngikamatak wet season diets, but 9% of dry season diets. By contrast, among the Ngiboceros of Turkana, wild foods constitute a staple, making up 25% of annual food supply (up to 42% in the dry season). Wild foods, particularly doum palm (Hyphenae ventricosa) fruits, are collected from along the Turkwell river and sold in order to buy maize. In other areas of Turkana, wild foods contributed less, as the free supply of relief foods influenced traditional collection strategies (257).

In Asian pastoral systems, wild foods are also found to be complementary to livestock products and purchased or cultivated grains (265 for Afghanistan; 270 for western India). This is also the case in the aboriginal areas of Australia (259; 260 for historical perspectives).

Pastoralists and Trees

Tree products are vital to pastoralists, not only as animal fodder and local veterinary medicine, but for human food and cash income. Experience of woodland management and tree planting in pastoral areas has been mixed (249; 572), but some successes have been achieved (89; 249). Certainly, particular tree species are prized and protected by local rules in many pastoral areas (eg. the Barabaig, Turkana, Njemps and Maasai in east Africa - see 128). In Pokot in northern Kenya, Balanites aegyptica and Tamarindus indica are protected locally and Balanites trees may be planted near a water point in order to supply fruit for clan gatherings (128).

The pastoral areas are the site of a number of tree products that can be harvested and sold. These often form an important part of the dryland pastoral economy. The gum products from Acacia senegal (gum arabic) and Acacia seyal (gum talh) are an important source of income

for pastoralists in northern Sudan. Although much of current gum production is based on *gum gardens in agricultural communities or large plantations, collection by nomadic or* transhumant pastoralists still constitutes an important part of the gum economy (631). Gum is tapped and collected at different stages of pastoral migrations. Individual trees may be owned by particular pastoralists.

Wildlife in Pastoral Areas

The extensive pastoral areas of dry Africa are also the site of many of the world's large wildlife concentrations. The plains of East Africa are potentially the source of many wildlife products. However competition over use rights and between preservationist, tourist use and the livestock grazing and wildlife use objectives of pastoralists constrains the potential income for pastoral populations derived from wildlife areas in much of pastoral east Africa (247; 266; 278; see also 280-373).

CHAPTER 3: THE HIDDEN HARVEST IN PASTORAL PRODUCTION SYSTEMS

246. Abel, N., Flint, M., Hunter, N., Chandler, D. and Maka, G. (1990). *Cattle Keeping, Ecological Change and Communal Management in Ngwaketse.* ILCA, IFPP and Overseas Development Group, UEA, Norwich.

247. Arhem, K. (1985). *Pastoral Man in the Garden of Eden. The Maasai of Ngorongoro Conservation Area, Tanzania.* Uppsala Research Reports in Cultural Anthropology, Uppsala.

248. Barral, H. (1977). Les populations de l'Oudalan et leur espace pastoral. *Travaux et documents de l'ORSTOM, no. 77*, France.

249. Barrow, E. (1988). Trees and pastoralists: the case of the Pokot and Turkana. *ODI Social Forestry Network Paper 6b*, Overseas Development Institute, London.

> Management of grazing is communal in Pokot and Turkana however, there is private ownership of valuable tree species, such as Acacia tortilis whose pods provide fodder. This ownership is most noticeable during the dry season when fodder is scarce. Trees also provide food, medicines, fuel, shade and construction materials. Although trees are not planted, many are protected and may be important food species. For example: Acacia tortillis, Hyphaene coriacea, Cordia sinensis, Zizyphus mauritiana, Dobera glabra, Acacia albida.

250. Becker, B. (1984). Wild plants in the nutrition of the population of arid regions in Africa: 3 case studies from Kenya and Senegal. *Gottinger Beitrage zur Land und Forstwirtschaft in den Tropen und Subtropen, 6*, 343pp.

> The traditional use of wild plant species, in diet or as medicine were investigated through interviews largely with women in the pastoral areas of Turkana and Samburu districts of northern Kenya and in the Ferlo, northern Senegal. The most important food plants, providing fruits, berries, nuts, seeds or leaves, were recorded. In Turkana these were: Hyphaene ventricosa, Cordia sinensis, Salvadora persica, Boscia coriacea and Dobera glabra; in Samburu: Grewia tenax, G. villosa, Cyphostemma maranguensis, Cordia sinensis and Hyphaene coriacea; in Ferlo: Adansonia digitata, Balanites aegyptiaca and Ziziphus mauritiana and among the Peulh ethnic group also Boscia senegalensis and Cassia obtusifolia. In the study areas about 80, 170 and 20 indigenous species were consumed, contributing theoretically about 10% of dietary energy and considerable amounts of minerals and vitamins, especially A and C and riboflavin, leaves of C. obtusifolia and C. maranguensis were particularly valuable. Plant foods were useful at the start of the rainy season, when staple items were scarce, but the potential supply of edible species, totalling nearly 800 for the whole Sahel area, remains largely unexploited.

251. Becker, B. (1986). Wild plants for human nutrition in the Sahelian zone. *Journal of Arid Environments, 11(1), 61-64* (see 250).

252. Benefice, E.S., Chevassus-Agnes and Barral, H. (1984). Nutritional Situation and Seasonal variation for pastoralist populations of the Sahel (Senegalese Ferlo). *Ecology of Food and Nutrition, 14,229-242.*

253. Berge, G. and Pederson, J. (1990). Rapport comportant les resultats de l'enquete en cours sur la composition des repas au Gourma Malien, Periode:1.4-14.6.1990.

"Environnement et Developpement au Mali", Universite d'Oslo, programme du Mali projets: *Role des Planets Sauvages dans l'Alimentation, la Sante et l'Artisanat au Gourma, Mali & Securite Alimentaire-Femmes.* University of Oslo.

This case study from the Gourma of Mali shows that wild foods are nutritionally significant for the pastoral population. Wild fonio (Panicum laetum) and cram-cram (Cenchrus biflorus) were found to be the most important wild foods in the local diet. These are complemented by the fruits of Boscia senegalensis which are stored for staple food consumption in the dry season; for some this may be the key food that maintains people until the following rains. Other wild foods include the fruits of Zizyphus *mauritania, the tuber of Nymphea lotus and the leaves of Maerua crassifolia.*

254. Bernus, E. (1967). Cueillette et exploitation des ressources spontanees du Sahel Nigerien par les Kel Tamasheq. *Cahiers ORSTOM, 4, 31-52.*

255. Casimir, M.J. (1988). Nutrition and socio-economic strategies in mobile pastoral societies in the Middle East with special reference to West Afghan Pashtuns. In: *I. DeGarine* and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*. pp. 337-359, Clarendon Press, Oxford, UK.

256. Dowler, E., Hall, A. and Schofield, C. (1986). *The Nutrition and Health of Pastoralists and Agro-pastoralists in Africa: A Bibliography* (2nd ed.). Department of Human Nutrition, London School of Hygiene and Tropical Medicine, London, International Livestock Centre for Africa, Bamako, Mali.

An annotated bibliography in which French and English references are listed in alphabetical order. A very useful key word index is included. Each key word entry is followed by relevant titles.

257. Ellis, J.E., Galvin, K, McCabe, T. and Swift, D.M. (1988). *Pastoralism and Drought in Turkana District, Kenya.* A report to NORAD, Nairobi, Development Systems Consultants, Colorado.

258. Elmi, A.S., Ahmed, A.M. and Abdi, Y.A. (1984). Use of plants in Somali traditional medicine. In: T. Labahn (ed.), *Proceedings of the 2nd International Congress of Somali Studies*, 1-6 August 1983, Univ. of Hamburg, vol. 3: Aspects of Development, Verlag, Hamburg.

259. Eyre, E.J. (1845). *Journals of the Expedition of Discovery into Central Australia Vol. 2.* Boone, London.

The journals record the gathering practices of the aborigines of southern Australia. Eyre notes: *"in almost every part of the continent which I have visited where the presence of Europeans or their stock has not destroyed their original means of subsistence, I have found that the natives could procure as much food as would last for a day in 3-4 hours."*

260. Grey, G (1841). *Journals of Two Expeditions of Discovery in NW and W Australia.* Boone, London.

The journals record that in an ordinary season the aborigines of SW Australia between Swann River and Shark's Bay can obtain a sufficient supply of food for the day in around 2-3 hours.

261. Grivetti, L.E. (1979). Kalahari agro-pastoral-hunter-gatherers: The Tswana example. *Ecology of Food and Nutrition, 9, 235-256.*

262. Grouzis, M. (1988). *Structure, Productivite et Dynamique des Systemes Ecologiques Saheliennes (Mare d'Oursi, Burkina Faso).* ORSTOM (eds.), Paris.

This study deals with the structure, aspects of functioning and dynamics of the natural vegetation types of the sahelian short grassland of the north of Burkina Faso. Detailed botanical work reveals the yields of different grass species used for human food. Harvesting and processing methods are also recorded.

263. Harlan, J. R. (1967). A wild wheat harvest in Turkey. *Archaeology, 20, 197-201.*

The labour productivity of hand stripping or harvesting einkorn (Triticum boeticum) is recorded. The author estimates that a family group beginning at the base of a mountain and working upslope as the season progressed could easily harvest sufficient grain to last a year.

264. Harlan, J.R. (1989). Wild-grass seed harvesting in the Sahara and Sub-Sahara of Africa. In: D.R. Harris and G.C. Hillman, (eds.), *Foraging and Farming: The Evolution of Plant Exploitation.* One World Archaeology-B, pp. 79-98, Unwin Hyman, London.

From literature dating back to the nineteenth century, this article reviews the harvesting of wild grains as staples in Africa. There are at least 60 wild grass species in desert, savanna and swamp lands utilized as food. Although they can be eaten during famines, they were also collected on an annual basis as staples and as items of trade. They were often protected from grazing animals and sometimes collected from ants' nests.

In desert zones the perennials Aristida pungens and Panicum turgidum were harvested. An annual, Cenchrus biflorus, found here is one of the most nutritious grains in the world with contents of 21% protein and 9.3% fat. Its grain is enclosed in a bur which is pounded for its release. A mixture of wild species can grow together in savanna zones. These include Eragrostis spp., E. ciliianensis lutati, and E. pilosa and Sorghum bicolor. Although sorghum and millet were cultivated in the area, these wild grains were collected for their taste and for sale. Wild sorghums are also found in agricultural fields. These might be considered weeds, but were harvested to make beer. In the swamp land areas, the wild rices (Oryza barthii, O. longistaminata) are harvested. These too can be mixed with cultivated varieties and increase the quantity of grains collected particularly when cultivated rice yields are low. The Bourgou grasses (Echinochloa spp., and Oryza longistaminata) of seasonally flooded swamps are useful, not only as food but also fodder. In addition, the stems of Echinochloa stagnina could be processed into sugar. In 1900 it was estimated that 250,000 hectares of Bourgou grasses were growing along the bend of the Niger river. Most of this area is now under cultivation.

265. Holter, U. (1988). Food habits of camel nomads in the north west Sudan: food habits and foodstuffs. *Ecology of Food and Nutrition, 21, 1-15.*

The diet of a group of nomadic camel herders (Mahria) from northern Darfur, Sudan was studied. The staple food was bullrush millet (Pennisetum typhoideum). Camel's milk was drunk but not made into cheese, although some butter was produced. Fresh meat and dishes prepared from wild grain were eaten only occasionally. Foods bought at markets were mainly millet, dried vegetables, spices, dried meat, oil, tea and sugar.

266. Kituyi, M. (1990). *Becoming Kenyans. Socio-Economic Transformation of the Pastoral Maasai.* ACTS, Nairobi.

This book provides a historical account of change in Maasailand. It lucidly explores the changes in *Maasai identity as the production system has changed from open rangelands under communal* management to increasingly private or group ranch tenure settings. This has resulted in changes in resource management strategies, including the role of wild products in peoples' livelihoods.

267. Le-floc, H.E., Lemordant, D., Lignon, A. and Rezkallah, N. (1985). Ethnobotanical practices of the populations of the Middle Awash Valley, Ethiopia. *Journal of Ethnopharmacology, 14(2-3), 283-314.*

268. Little, M.A., Galvin, K. and Leslie, P.W. (1988). Health and energy requirements of nomadic Turkana pastoralists. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 290-317, Clarendon Press, Oxford.

The health, growth, diet and energy requirements of Turkana pastoralists are reviewed. Their diet consists mainly of milk and blood and some meat, although they do trade for grain. Wild foods are collected, however, the author notes that they are not significant. The relocation of herds to areas with *sufficient forage is their principal strategy for ensuring a steady food supply.*

269. Maiga, A., De Leeuw, P., Diarra, L. and Hiernaux, P. (1991). The harvesting of wild growing grain crops in the Gourma region of Mali. *IIED Drylands Issues Paper, 27, IIED, London.*

This paper highlights the high productivity of wild grain production, particularly fonio (Panicum laetum), in terms of both absolute grain production per unit area and returns of labour. The importance of wild grain production sites is also highlighted. These are identified as 'key resources' within the pastoral landscape. Control over these resources is vital for sustaining livelihoods in this area of Mali, so issues of tenure rights and local management regulations are central.

270. Malhotra, K.C. and Gadgil, M. (1988). Coping with uncertainty in food supply: Case studies among the pastoral and non-pastoral nomads of western India. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 379-404, Clarendon Press, Oxford.

The livelihood systems of two pastoral and three non-pastoral nomadic groups are described in relationship to their food procurement strategies. The Gavli and Hatkar pastoralists depend upon animal products. Most fodder is derived from wild vegetation or crop residues. Animal products such as butter, milk and wool are traded for cereals. As both the area and quality of pasture land declines, herd size and biomass decreases. Also goats tend to replace the traditionally herded buffalo and sheep. The non-pastoralist nomads provide services and trade goods with agricultural communities for food. The Nandiwallas are entertainers and organizers of religious events. The Vaidus are traditional herbalists, while the Phasepardhis have traditionally been hunter-gatherers. All three groups, however, hunt a variety of animals from blackbuck, wild pigs to wolves. Each group hunts different game, thereby avoiding competition. Loss of habitat has reduced the catch by 50%. Hunting of certain animals such as the blackbuck has been made illegal. The result has been the complete loss of the Phasepardhis' livelihoods. They are now becoming known as thieves, beggars and prostitutes.

271. McCabe, J, Schofiled, E and Nygaard Pedeser, G. (1989). *Food Security and Nutrition among the Maasai of the Ngorongoro Conservation Area.* Ngorongoro Conservation and Development Project Technical Report, 10. IUCN Regional Office for East Africa, Nairobi.

272. Morgan, W.T.W. (1980). *Vernacular Names and the Utilisation of Plant Species among the Turkana of Northern Kenya: Plants Collected by the Royal Geographical Society*

South Turkana Expedition 1968-70. University of Durham Special Report, Durham.

273. Niamir, M. (1990). *Community Forestry: Herders' Decision-Making in Natural Resources Management in Arid and Semi-Arid Africa.* Community Forestry Note 4, FAO, Rome.

This review provides an excellent overview of the literature on local knowledge and management of pastoral resources. Subject areas include issues of herd management, tree and shrub use, organisations and institutions for resource management and policy implications. Some sections provide references to research carried out on wild products both for food and medicines.

274. Parkipuny, M. (1991). Pastoralism, conservation and development in the greater Serengeti region. *IIED Drylands Issues Paper, 26.* IIED, London.

This paper highlights the issues of conflict over resource access in areas adjacent to national parks. The case of the Serengeti region of Tanzania is documented. The paper provides a historical background to the wildlife-livestock and people conflicts in Maasai land, exploring the expansion of the parks estate, the encroachment of agriculture and the insecurity of tenure of pastoral populations. The paper concludes with the recognition that both livestock and wildlife are valuable resources in the Maasai area and that this has to be recognised in development planning. Cosmetic changes that retain a preservationist outlook are insufficient; plans and policies for the area must meet the legitimate socio-economic needs of the local communities.

275. Scott, M. and Gormley, B. (1980). The animal of friendship (habbanae): an indigenous model of Sahelian pastoral development. In: Brokensha, D., Warren, D.M. and Werner, O. (eds.). *Indigenous Knowledge Systems and Development.* University Press of America, Washington.

276. Stiles, D. and Kassam, A. (1986). An ethno-botanical study of Gabra plant use, Marsabit District, Kenya. *Journal of the East Africa Natural History Society and National Museum, 76(191), 1-23.*

277. Tubiana, M-J. and Tubiana, J. (1977). *The Zaghawa from an Ecological Perspective.* Balkema, Rotterdam.

This ethnographic monograph reports on some years of research among the Zaghawarab pastoralists of northern Sudan. Pastoral management is discussed in relation to herding, natural resource management and the economic issues of marketing and trade. Survival strategies in a highly variable environment at the desert edge are a recurrent theme and the role of wild foods, particularly wild grains, are mentioned.

278. Western, D. (1982). Amboseli national park: enlisting landowners to conserve migratory wildlife. *Ambio, 11 (5).*

The management arrangements between the government of Kenya's wildlife department and Maasai pastoralists are discussed for the case of Amboseli national park.

279a. Winter, M. (1984). The Twareg. In: J.J. Swift (ed.), *Pastoral Development in Central Niger.* Report of the Niger Range and Livestock Project, pp. 531-620, USAID/Ministry of Rural Development, Niamey.

279b. Zohary, D.(1969) The progenitors of wheat and barley in relation to domestication and agricultural dispersal in the old world. In: Ucko, P.J. & Dimbleby, G.W. (eds). *The Domestication and Exploitation of Plants and Animals*. Aldine-Atherton, Chicago.

In a productive year wild wheat (Triticum boeoticom) and wild barley (Hordeum spontaneum) can produce 500-800 kg/ha of grain. The grains are relatively large, an adaptation to survival through long hot summers, making them an ideal food source for humans. Maps of the distribution of wild wheats and barley in the Fertile Crescent are provided.

Chapter Four

Wildlife Utilisation

Pangolin hunted for food, Ghana
Photo: Simon Rietbergen

4. WILDLIFE UTILISATION

The benefits of wildlife to local livelihoods often go unseen, yet food and income from hunting may be very significant (747; 749). The conventional approach to wildlife management has focussed on the conservation of large mammals within game reserves, where local exploitation is deemed to be poaching and illegal (348; 370). However, wildlife use extends well beyond the use of big game animals; much of the hidden harvest of game meat is derived from small animals - rats, mice, squirrels, rabbits, hares, small buck etc (91a). The yields of bush meat from these sources often go unrecognised (355; 363) and so harvesting of wildlife commonly remains part of the hidden (and sometimes illegal) rural economy (325).

It is increasingly being recognised that wildlife conservation must operate hand in hand with sustainable use by local communities. Incentives for wildlife management are only effective if the community has a long term vested interest in managing the wildlife resource for economic gain (315; 346; 347; 364). Where local people have been prevented from utilising wild resources, especially following the establishment of National Parks, they very quickly become impoverished (324b for examples from Thailand and Madagascar). Managing wildlife as wild food resource for local people is an important step towards sustainable use.

Bush Meat in Local Diets

The use of meat from wild animals varies according to ecological region and dietary custom. In West Africa there remains a high level of consumption of bushmeat, especially in areas close to remaining forest (49; 285; 287; 290-293; 396). The greatest consumption occurs in the tropical moist forest zones in Cameroun (747), Liberia and Ivory Coast (285) and Benin/Nigeria (308; 318). Similar patterns occur in the tropical forests of South America and South East Asia (306; 319; 320 for Peru; 326; 354; 356 for Colombia and Venezuela; 303 for Sarawak; 321 for Papua New Guinea).

In the forests of Latin America, hunting is an important component of livelihood strategies (294; 327; 329; 352; 356; 362) In early years of settlement in Amazonia, game meat contributes to a greater proportion of the diet than in long established settlements in Amazonia.

Converted agricultural lands may also be good habitat for wild animals, often pests of crops (327; 328). Rodent populations increase with the conversion of dense forest to arable lands. For instance, the grasscutter rat, (Thyronomys swinderianus) has extended into agricultural lands south of its original range in West Africa (293). Agricultural lands may be managed to encourage wild life. Farmers in Thailand plant or retain particular trees on paddy irrigation dikes to attract lizards, rats and other potential food items (69). Fallow areas within swidden cultivation systems often attract small mammals and birds suitable for garden hunting (221; 245; 337).

Much of the population in southern Nigeria consumes bush meat, a high quality protein source (280; 289; 316; 317; 344; 527). The harvesting of bush meat is reflected in the extensive markets for wild meat found in West African cities (289). Wild meat is priced higher than beef or mutton in Cameroun (Sabouang), Nigeria (Ibadan, Bendel State), Ghana (Accra), Ivory Coast (Abidjan) and Liberia (Monrovia) (293).

Much of this meat is from small animals, particularly rodents (282; 283; 295; 316; 317). Bush meat harvesting and trade is dominated by the exploitation of the African giant rat (Cryceiomys gambiani) and the grasscutter in West Africa (353 for a case study from Accra). Similarly in Peru, over 40% of the meat is derived from four small animals (320). Agropastoralists in some parts of Botswana obtain most of their animal protein from wild meat, notably spring hares (300; 301).

The hunting of large animals for meat and other products is also part of local livelihoods. Many agricultural communities have historical traditions of hunting large mammals for food (341-343 for Zambia; 170 for Zimbabwe). In the past, the ivory trade was an important part of African rural economies. International trade in furs, skins and other animal products is still important (296; 331; 700a), although conservationist lobbying has restricted trade in

some products, notably ivory. This is despite economic arguments for the maintenance of a regulated trade in elephant ivory to encourage sustainable exploitation practices, particularly in southern Africa (296).

Domestication of Wildlife

A number of attempts at domestication of wildlife have been made. Few have been economically successful (322). A series of experiments on the domestication of the eland were carried out in Kenya during the 1970s (305). The eland was claimed to be more productive than cattle on dry range, but eland ranching has never been a successful commercial venture. Ranching of reptiles has had some successes, with different degrees of intervention involved - from total life-cycle in controlled conditions to partial wild breeding. Crocodile ranching is now an increasingly important enterprise (298; 339; 351). Iguana ranching is more recent (700a).

The Value of Wildlife

Wildlife resources can yield economic value in several ways: by the direct sale or use of *products (meat, skins, furs, bone, ivory), by the sale of rights to hunt wildlife, or by the* exploitation of the tourist potential (357; 358; 365; 747). The highest returns are derived where a combination of these revenue earning activities exist. This is possible in some areas adjacent to large wildlife reservoirs (usually National Parks), particularly if big game such as elephants, rhino, lion, buffalo, are abundant. Revenues generated may be put to the use of conserving the habitat and its wildlife and generating incomes for local inhabitants.

Zimbabwe estimates that elephant goods and services yield US$4.7 million annually (from culling programmes, ivory sales, hunting licences and tourist operations in 1989). This represents a return of about US$75 per square kilometre in prime elephant habitat (372). However recent restrictions on ivory trading may reduce this income and act to undermine conservation efforts.

Tourism represents a significant income earner, especially important in foreign exchange starved Africa. Kenya derives 30% of its export earnings from tourism (700a). However profits are also exported by foreign tour operators, reducing the value to the local economy. Sport hunting is particularly lucrative. Large fees can be charged for the licences and for the trophy itself (312).

Some claim that the returns to wild resource utilisation are higher than for alternative agricultural or livestock operations in the same area (309 for Zimbabwe; 369 for Kenya; 696 for Amazonia; 368 for Malaysia). The assumptions for these comparative analyses must be carefully examined before general conclusions are reached. In many cases, economic wildlife utilisation assumes extensive tourist, hunting, and marketing infrastructure, together with a sustained demand for wildlife products and services at high prices.

However the opportunites for economic development of wildlife resources are clear in some areas. Use of natural habitats offers a range of goods and services - a diverse output base that is more resilient to changes in market conditions. Wild species are more adapted to natural habitats than introduced crops or livestock (322), and may result in lower environmental impact (309). However the conventional argument that wildlife communities are necessarily efficient, non-overlapping resource users is not supported by empirical evidence (367). On ecological and economic grounds a mixed livestock-wildlife option may be preferable.

Wildlife Management by Local Communities

The economic benefits of wildlife may be evident but, unless they are made available to local communties, commitment to manage wildlife resources will remain limited. If so, wildlife will continue to be regarded locally as major agricultural pests and a danger to human life (342; 694a). There are a number of wildlife utilisation schemes in existence or planned (307; 315; 335; 336; 360; 361 for Zambia; 314 for Namibia; 274, 369 for East Africa; 359; 369 for cases in Asia, Latin America and Africa).

A number of problems have beset the establishement of revenue earning schemes from

wildlife utilisation. Zimbabwe's experiments with local management of wildlife resources provide some important lessons (310; 332; 333; 349; 350; 373; 612). Local commitment to and ownership of the scheme is critical, otherwise revenues earned are simply regarded as government or aid hand outs. This fosters dependency rather than development. The establishment of local institutional capacity to manage resources, negotiate income earning options, and distribute benefits is also important. The reduction of bureaucratic hurdles to receiving benefits at the local level is vital - delays, rent extraction by the centre and corruption further reduce incentives for local management. Successful schemes operate where there is a clear legal framework; where strong local institutions exist with real power devolved to them; where financial mechanisms for revenue earning and redistribution are in place; and where technical, managerial and administrative support is available.

CHAPTER 4: WILDLIFE UTILISATION

280. Adeola, M.O. and Decker, E. (1987). *Wildlife Utilization in Rural Nigeria.* Paper presented at the International Symposium of Wildlife Management in Sub-Saharan Africa, 6-13 October 1987, pp. 512-521, FAO and the International Council for Game and Wildlife Conservation, Harare, Zimbabwe.

281. Agbelusi, E.A. and Afolayan, T.A. (1987). *The Role of Wildlife in the Nigerian Economy.* In: Proceedings of the 17th Annual Conference of the Forestry Association of Nigeria, Ikeja, Nigeria. F.A.N, Ikeja, Nigeria.

282. *Ajayi, S. S (1974). Giant rat for meat and some taboos. Oryx, 1, 379-380.*

283. Ajayi, S.S. (1971). Wildlife as a source of protein in Nigeria: Some priorties for development. *Nigerian Field, 36(3), 15-120.*

284. Ajayi, S.S. (1979). *Utilization of Forest Wildlife in West Africa.* Report FO:MISC/79/26. FAO, Rome

285. Ajayi, S.S. (1979). Wildlife management in savannah woodlands. *Journal of Ecology, 68, 339-345.*

286. Ajayi, S.S. and Olawoye, O.O. (1974). Some indications of the social acceptance of the African giant rat (Cricetomys gambianus) in southern Nigeria. *Nigerian Journal of Forestry, 4(1), 36-41.*

287. Ajayi, S.S. and Tewe, O. (1983). A quantitative assessment of wildlife and their nutritive value as a source of food in Nigeria. In: Akinyele, L. and Atinmo, T. (eds.), *Nutrition and Food Policy in Nigeria.*, pp. 138-148, National Institute for Policy and Strategic Studies (NIPSS), Ibadan, Nigeria.

288. Ajayi, S.S., Tewe, O., Moriarty, C. and Awesu, M.O.A. (1978). Observations on the biology and nutritive value of the African giant snail (Archachatina marginata). *East African Wildlife Journal, 16, 85-95.*

289. Anadu, P.A., Elamah, P.O. and Oates, J.F. (1988). The bushmeat trade in Southwestern Nigeria: A case study. *Human Ecology, 16 (2), 199-208.*

290. Asibey, E.O.A. (1965). Utilization of wildlife in Ghana. *Ghana Farmer, 9, 91-93.*

291. Asibey, E.O.A. (1974). Wildlife as a source of protein in Africa south of the Sahara. *Biological Conservation, 6(1), 32-39.*

Protein malnutrition is a problem in Africa as domestic meats are in short supply. Bushmeat can supplement domestic meat; however, even supplies of wild meat are declining due to over-exploitation. The management of bushmeat production is called for. A general review is given of the consumption

of bushmeat in several African countries, particularly Ghana. A list of the variety of wild animals eaten is given. Since 1963, Ghana had been surveying the hunting and consumption of bushmeat. Examples of the survey forms are given. Also the prices paid for these species in Ghana are listed. From December 1968 to June 1970, 116, 835 kg of grasscutter (Thryonomys swinderianus) with a value of US$125,181 were hunted. Bushmeat is not only important in rural communities, but also in urban areas. For example, during the above time period US$159,985 worth of bushmeat from 13 species was sold in a single market in Accra, Ghana.

292. Asibey, E.O.A. (1977). Expected effects of land-use patterns on future supplies of bushmeat in Africa south of the Sahara. *Environmental Conservation, 4(1), 43-49.*

This article provides data on the importance of bushmeat for both rural and urban communities and urges consideration of wild animals and bushmeat hunting in the development of land-use plans. The author estimates that 70% of the Sub-Saharan population consumes bushmeat, both vertebrates and invertebrates. There is a great demand for bushmeat and high prices are paid. The amount of bushmeat consumed in a Ghanaian restaurant was measured over 27 days. During this period, 600.9 kg of bushmeat were served, with the Bush buck (Tragelaphus scriptus) and grasscutter (Thryonomys swinderianus) the most commonly eaten. On average, customers spent C104.27 (US$91.76) per day on bushmeat. It was found that farmers selling bushmeat earned C1.78 (US$1.57) per day which was comparable to a government daily wage of C2.00 (US$1.76) per day. One farmer was able to earn C2,035 (US$1790.8) in the year 1974-5. The management of bushmeat production from hunting to hygienic sale is urged, as well as the domestication of species.

293. Asibey, E.O.A. (1986). *Wildlife and Food Security*. Paper prepared for Forestry Department, FAO, Rome.

This paper reviews the contribution of wildlife meat to the diets and economies of rural and urban populations, mostly with data from West Africa. Game hunting may be an important source of income. Returns from hunting may be comparable to or higher than labouring wages in the formal sector. Examples of hare hunters from Argentina and bush meat hunters in Ghana are given to support this argument. Bushmeat often sells for a higher premium than other domestic meats and often has a higher nutritional value. The paper concludes with reviews of issues of habitat management, ranching options and the management of agricultural areas for wild meat production. Appendices contain data on bushmeat markets and summarise information from different countries.

294. Ayres, J.M. and Ayres, C. (1979). Aspects of hunting in the upper Aripuana river. *Acta Amazonica, 9, 287-298.*

The amount of game killed by hunters in rain forest surrounding Dardanelos (Mato Grosso, Brazil) was recorded from January to April 1978. White-lipped peccaries (Tayassu pecari), tapirs (Tapirus terrestris) and collared peccaries (Tayassu tajacu) represented 89% of the 8857 kg of game killed. Wild meat was an important supplementary protein source, and was present in 19% of the meals consumed. Human population demography and local hunting methods are described and the necessity of wildlife conservation in the region is discussed. A list is presented of tree species frequented by diurnal and nocturnal game species found in the region.

295. Baptist, R and Mensch, G. (1986). The cane rat: farm animal of the future? *World Animal Review, 60, 2.*

296. Barbier, E., Burgess, J, Swanson, T., and Pearce, D. (1990). *Elephants, Economics and Ivory*. Earthscan Publications Ltd., London.

This book provides a thorough economic justification for the sustainable utilisation of elephant

populations. Only with sustainable use, with benefits accrued to local populations, will elephants and their habitats be conserved. The authors argue that bans on elephant culling and hunting are inappropriate incentives for conservation measures.

297. Biesele, M. (1971). Hunting in semi-arid areas: The Kalahari bushmen today. In: Botswana Society (ed.) *Proceedings of a Conference on Sustained Production from Semi-Arid Areas.*, pp. 62-67, Botswana Society, Gabarone.

298. Blake, D. and Loveridge, J. (1975). The role of commercial crocodile farming in crocodile conservation. *Biological Conservation, 8, 261.*

299. Bressani, R. (1976). The role of small animal species in nutrition and food production. *Bulletin of the Pan American Health Organization, X(4), 293-300.*

This study examines the diets of rural people in Guatemala and assesses the advantages of various animals as a protein source. Diets are composed mainly of cereals and beans. Vegetables contribute *6.5% of the weight of foods consumed by pre-school children. For adults, fruits and vegetables* comprise 10.9% of total food intake by weight. Among pre-school children, about 4% of the total weight of foods consumed are from animals. As a result, their diets lack sufficient protein and calories. The amino acids lysine and tryptophan are particularly deficient. Animal products comprised 18.4% of the weight of foods consumed by adults. In addition to domestic animals (pigs, cattle and chicken), wild game, such as armadillo (Dasypus sexcinctus), iguana (Lacerta iguava), and capybara (Hidrochaeri shidrochaeris), are hunted when available. But they are becoming increasingly scarce. These animal *meats have similar protein, fat and energy contents. Their specific amino acid contents are also given.*

300. Butyinski, T. (1973). Life history and economic value of the spring hare (Pedetes carpernis) in Botswana. *Botswana Notes and Records, 5, 209-213.*

301. Butynski, T.M. and Von Richter, W. (1974). In Botswana most of the meat is wild. *Unasylva, 26(106), 24-29.*

This paper discusses the importance of wild game to local and national economies. Over 46 species of game larger than a jackal are hunted. For bushmen, all of the meat eaten is wild; even for farmers with livestock, 80% of the meat consumed was wild. A licensing and quota system for hunting exists for both local communities and sport hunters. This system not only maintains records of amounts of game taken, but also provides revenue for national and local governments. In 1973, the annual income *from wildlife totalled* US$10 *million.* The food and income value of game to the subsistence economy was estimated to be worth US$3.4 per year. When it is taken into account that Botswana has many areas of marginal land which are unsuitable for crops or livestock grazing, the maintenance of wild game for meat production and revenue is a sensible land-use. Wild species are not only more efficient in turning the local vegetation into food for people, but they are also resistant to tsetse fly which is present in the north of Botswana. The authors state that if hunting is properly controlled, species populations can be maintained.

302. Caldecott, J. (1988). *Hunting and Wildlife Management in Sarawak.* IUCN, Gland, Switzerland and Cambridge, U.K.

303. Caldecott, J. and Nyaoi, A. (1984). Sarawak's wildlife: A resource to be taken seriously. *Sarawak Gazette, 111,31-32.*

304. Campbell, A.C. (1971). Traditional utilization of wildlife in the Kalahari. In: Botswana

Society (ed.) *Proceedings of a Conference on Sustained Production from Semi-Arid Areas,* pp. 108-113, Botswana Society, Gabarone.

305. Carles, A., King, J. and Heath, B. (1981). Game domestication for animal production in Kenya. An analysis of growth of oryx, eland and zebu cattle. *Journal Agricultural Science Camb. 97, 453-463.*

> This is one of a series of technical papers from a project in Kenya that, through long term experiments, is trying to evaluate the possibilities of game domestication for meat production.

306. Castro, N., Revilla, J., and Neville, M. (1976). Carne de monte como una fuente de proteinas en Iquitos, conreferencia especial a monos (Wild meat as a source of protein in Iquitos with special reference to monkeys). *Rev. Forestal del Peru, 6(1-2), 19-32.*

307. Chabwela, H.N. (1990). The exploitation of wildlife resources in Zambia: a critique. In: Lungwangwa, D. and Sinyandwe, I. (eds.) *Utilizing Local Resources for Development.* Proceedings of the 9th PWPA conference, Eastern, Central and Southern Region, Musu ngwa Lodge, Zambia, July 1988.

> The paper considers the exploitation of wildlife, in Zambia. Human-related factors are examined as the cause of wildlife decline: the modern tools of exploitation; lack of development of wildlife resources; trade and public policies and lack of local involvement are all blamed. Large scale developments in Zambia, such as dams, agricultural projects and the designation of national parks, have rarely taken into consideration what consequence these developments have for the local use of the wildlife resource.

308. Charter, J.R. (1973). *The Economic Value of Wildlife in Nigeria.* Research Paper No. 19 (Forest Series), Federal Forestry Department, Nigeria.

309. Child, B.A. (1989). *The Role of Wildlife Utilization in the Sustainable Economic Development of Semi-Arid Rangelands in Zimbabwe.* DPhil Thesis, University of Oxford, UK.

> This study explores the comparative advantages of game and beef production on a ranch in the SE of Zimbabwe. Economic and ecological analyses find that, in the context of commercial ranching in a remote area with plentiful game supplies, game farming is preferable.

310. Child, B. and Peterson, J. (1991). *CAMPFIRE in Rural Development: The Beitbridge Experience.* CASS/WWF Joint working paper series 1-91. Centre for Applied Social Sciences, Harare.

> This paper reports on a series of meetings held in the Beitbridge area of southern Zimbabwe, where a wildlife management programme had been initiated during 1991. The paper documents in detail the issues surrounding the handing over of responsibility for management of the resources and distribution of the funds to the local community. The social and institutional dynamics of decentralised resource management are highlighted by this case study.

311. Child, G. (1970). Wildlife utilization and management in Botswana. *Biological Conservation 3, 18-22.*

312. Child, G. (1984). Managing wildlife for people in Zimbabwe. In: McNeely and Miller, K. (eds.). *National Parks, Conservation and Development*. Smithsonian Institute, Washington.

313. Cremoux, P. (1963). The importance of game meat consumption in the diet of sedentary and nomadic peoples of the Senegal River Valley. In: *Conservation of Nature and Natural Resources in Modern African States*, International Union for the Conservation of Nature (IUCN) Publication, New Series 1, Morges, Switzerland.

314. Cumming, D. (1990). Communal land development and wildlife utilisation: potential and options in Northern Namibia. *Multispecies Animal Production Systems Project, Paper 14*. WWF, Harare.

> This project paper provides an overview of developments in community based wildlife utilisation in east and southern Africa and draws from these some principles and policy issues relating to planning and implementation. The paper then explores potentials in communal areas in northern Namibia and presents a proposal for Bushmanland. This includes some outline economic assessments of the potential returns of combining game meat use with tourist enterprises.

315. Dalal-Clayton, B. (1989). Wildlife working for sustainable development. *Gatekeeper Series, SA9*. Sustainable Agriculture Programme, International Institute for Environment and Development, London.

> This paper summarises the rationale for a sustainable wildlife management programme in the Luangwa valley of Zambia. The need for ensuring that benefits are received by the local population is stressed.

316. De Vos, A. (1977). Game as food: A report on its significance in Africa and Latin America. *Unasylva, 29(116), 2-12.*

> This article reviews the consumption of wild game as food in Africa and Latin America. Popular game species are the grey duiker (Sylvicapra grimmia), capybara (Hydrochoerus hydrochaeris), grasscutter (Thryonomys swinderianus), bushfowl (Francolinus bicalcaratus), guinea fowl (Numida meleagris galeata) and giant snails (Archachatina calachatina marginata). Most of the studies cited were carried out in Africa. In the past in Africa, people were more selective of the types of game captured; however, now a greater diversity of species is eaten, which includes many smaller animals such as rodents. Large game are becoming scarce as human populations increase and with greater reproductive rates, small animal populations are not as adversely affected by hunting. Also there are no laws forbidding their capture. General advantages of wild game include: their adaptation to local vegetation, particularly in semi-arid areas and their efficient conversion of this fodder to produce more lean meat and less fat than domestic livestock. Some species, such as the oryx, require less water than domestic animals. The author concludes that wildlife management can, in certain circumstances, can be more efficient in producing food than agriculture or livestock.

317. Den Hartog, V. and de Vos, A. (1973). The use of rodents as food in tropical Africa. *Nutrition Newsletter, 11(2), 1-14.*

318. Dietworst, D. (1987). *Household Meat Consumption Survey in Communities in Southern Nigeria*. International Livestock Centre for Africa (ILCA), Humid Zone Programme, Ibadan, Nigeria.

319. Dourojeanni, M.J. (1972). Impacto de la produccion de la fauna silvestre en la

economia de la amazonia peruana (Impacts of the production of wild fauna on the economy of the Peruvian Amazon). *Rev. Forestal del Peru, 5(1-2), 15-27.*

320. Dourojeanni, M.J. (1978). *The Integrated Management of Forest Wildlife as a Source of Protein for Rural Populations*. Paper presented at the Eighth World Forestry Congress, Jakarta, Agenda Item No. B. FFF/8-0.

> This paper provides an overview of the utilisation of wildlife for subsistence, market and sport. Examples of past studies illustrate how dependent people were upon wild game and fish. In Zaire (during 1957 and 1958) and Peru (between 1965 and 1973) over 85% of animal protein consumed were from wild sources. In 1972 the value of such wildlife to the economy of the Peruvian Amazon was equal to or greater than timber. The availability of wildlife is diminishing as they are being over-hunted *and/or their habitats are destroyed. Given wildlife's nutritional importance as a protein source for the* poor, its adaptation to tropical conditions, and its greater productivity than introduced domestic livestock, the author recommends management of forest areas for multiple uses including wildlife, non-wood products, timber and tourism. Such management ranges from a mixture of agriculture and forestry to wildlife reserves or communal reserves where villagers are given control over wild resources.

321. Dwyer, P.D. (1985). The contribution of non-domesticated animals to the diet of Etolo, Southern Highlands Province, Papua New Guinea. *Ecology of Food and Nutrition*, 17, 101-115.

> In one Etdo community of 109 persons, medium-sized wild mammals provided significant amounts of protein (on average 6 g/person daily). The supply was regular, and twice as great as that of protein from domestic pigs. Consumption of insects, fish, frogs, lizards, birds and small mammals is also recorded.

322. Eltringham, S. (1984). *Wildlife Resources and Economic Development.* John Wiley and Sons, New York.

> This book tries to cover a wide range of issues from harvesting theory to the trophy trade. It provides examples of attempts at wildlife use in Africa from Kenya and Tanzania, Zimbabwe and Zambia. All failed due to a variety of factors including: opposition from the meat trade, opposition from conservationists, lack of markets, poor transport, competition from poachers, migratory habits of wildlife and ecological change.

323. Federal Department of Forestry Nigeria (1987). *Wildlife Utilization and Wildlife Values in Nigeria.* Paper presented at the International Symposium on Wildlife Management in Sub-Saharan Africa, 6-13 October, Harare, Zimbabwe, Sponsored by FAO and the International Council for Game and Wildlife Conservation.

324a. Geist, V. (1988). How markets in wildlife meat and parts and the sale of hunting privileges jeopardises wildlife conservation. *Conservation Biology, 2(1), 15-26.*

> This article holds up as an example the wildlife conservation system in the United States and Canada and the threats being posed by game ranching and market hunting as well as sport hunting.

324b. Ghimire, K.B. 1991. *Parks and People: Livelihood Issues in National Parks Management in Thailand and Madagascar. Discussion Paper 29. United Nations Research* Institute for Social Development, Geneva.

This paper examines the interrelated socio-economic and natural resource impacts of national parks. In both Thailand and Madagascar, the national parks have contributed to the preservation of biodiversity and generation of foreign exchange earnings through tourism. But they have had adverse effects on food security and livelihood systems of people living there. Local people have faced restrictions on grazing, hunting, fishing, food gathering and collection of wood. In some cases, even the conservation objective has been threatened as displaced and affected people are forced to exploit other forests. The displaced groups also lose all interest in the long-term management of their resources.

325. Ghosh, A.K., Appayya, M.K., Gowda, C.D.K., Jacobs, M., Sekar, K.J., Ali, S.M. and Rajan, B.K.C. (1987). Special wildlife issue. *Myforest, 23, 121-180*, Forest Department, Karnataka, India.

This special wildlife issue contains 10 papers on various aspects of wildlife. Papers include: studies on wildlife in India: a critical appraisal; people vs. wildlife: India's delicate balancing act; and wild fauna and human food - on the capture and eating of termites by tribes in Tamil Nadu and Karnataka.

326. Gonzales, J.E. (1977). The capybara: an indigenous source of meat in tropical America. *World Animal Review, 21, 24-30.*

327. Hames, R. *(1980). Studies in Hunting and Fishing in the Neotropics.* Bennington College, Bennington, Vermont.

328. Hanagarth, W. (1985). Floodplains in the Peruvian region of the Amazon as a source of fauna found in agricultural areas. *Plant Research and Development, 21, 27-44.*

329. Hill, K. and Hawkes, K. (1983). Neotropical Hunting among the Ache of Eastern Paraguay. In: R.B. Hames and W.T. Vickers, (eds.), *Adaptive Responses of Native Amazonians.*, pp. 139-188, Academic Press, New York.

330. Hodasi, J. (1984). Some observations on the edible giant land snails of West Africa. *World Animal Review, 52, 24-28.*

331. Inskipp, T. and Wells, S. (1979). *International Trade in Wildlife*. Earthscan, London.

332. Jansen, D. (1989). *Joint Venture Options for Wildlife Utilisation in Zimbabwe*. Project paper 3, *Multispecies Animal Production Systems Project*, WWF, Harare.

This paper provides a simple explanation of joint venture arrangements for wildlife utilisation in the communal areas of the Zambezi valley, Zimbabwe. Joint ventures between tourist or hunting operators and district councils (the holders of appropriate authority for wildlife management in these areas) are recommended as routes for commercially successful co-management.

333. Jansen, D.J. (1990). *Sustainable Wildlife Utilization in the Zambezi Valley of Zimbabwe: Economic, Ecological and Political Tradeoffs*. Paper presented at the Ecological Economics of Sustainability: An International Interdisciplinary Conference, 21-23 May 1990, The World Bank, Washington, DC. Also WWF Multispecies Animal Production Systems Project.

This paper reviews the recent experience of wildlife utilisation in the Zambezi valley, Zimbabwe from

a number of different angles. Economic returns have been reasonable on many of the projects to date, but this revenue has been earned at the district council level and limited benefits have been received by local communities. Lack of participation by local communities in planning, management and distribution of revenues undermines the potentials for long term sustainability of wildlife utilisation in the area.

334. Jeffrey, S. (1977). How Liberia uses its wildlife. *Oryx, 14(2), 168-173.*

335. Lewis, D. and Kaweche, G. (1985). The Luangwa valley of Zambia: preserving the future by integrated management. *Ambio, 14, 362 -365.*

336. Lewis, D., Kaweche, G.B., and Mwenya, A, (1990). Wildlife conservation outside protected areas: Lessons from an experiment in Zambia. *Conservation Biology, 4(2), 171-180.*

This article describes the success to date of wildlife conservation in the Lupande Game Management Area in Zambia through the involvement of the local people. Village wildlife management committees and a sustained-yield utilisation scheme were established. The project generated employment for the villagers, for example, as scouts. Revenues from wildlife off-take and trophies were able to meet operation costs of the programme. Results of the programme included a decrease in elephant and rhino poaching and a positive change in attitude of local villagers to wildlife.

337. Linares, O. (1976). "Garden hunting" in the American Tropics. *Human Ecology, 4, 331-349.*

338. Lindsay, W. (1987). Integrating parks and pastoralists: some lessons from Amboseli. In Anderson, D. and Grove, R. (eds.). *Conservation in Africa: People, Policies and Practice.* Cambridge University Press, Cambridge.

339. Luxmoore, R., Barzdo, J., Broad, S., Jones, D.A. (1985). *A Directory of Crocodilian Farming Operations.* CITES Secretariat, IUCN Wildlife Monitoring Unit, Cambridge, U.K.

340. Mankoto ma Mbaelele, M., Dudu, A. and Colyn, M. (1987). *Data on Small and Medium Scale Game Utilization in the Rain Forest of Zaire.* Paper presented at the International Symposium on Wildlife Management in Sub-Saharan Africa, 6-13 October 1987, pp. 109-141 , FAO and the International Council for Game and Wildlife Conservation, Harare, Zimbabwe.

341. Marks, S.A. (1973). Prey selection and annual harvest of game in a rural Zambian community. *East African Wildlife Journal, 11, 113-128.*

342. Marks, S.A. (1983). *The Imperial Lion. Human Dimensions of Wildlife Management in Central Africa.* Westview Press, Boulder, Colorado.

343. Marks, S.A. (1977). Hunting behaviour and strategies of the valley Bisa in Zambia. *Human Ecology, 5, 1-36.*

This article describes the hunting tactics and prey selection of the Valley Bisa of Luangwa, Zambia. Valley Bisa hunters explain their behaviours in their own idioms, but their strategies and tactics are well adapted to the behaviour and ecology of their prey. The effects of outlawing traditional harvesting

techniques and the imposition and enforcement of external regulations on hunting in the area is discussed.

344. Martin, G. (1983). Bushmeat in Nigeria as a natural resource with environmental implications. *Environmental Conservation, 10(2), 125-132.*

Bushmeat trade and consumption in Nigeria is analysed through surveys of roadside sales, local markets, and people. The most commonly sold species along roadsides were grasscutter (Thryonomys swinderianus), small antelope, (Cephalophus spp.) and the brush-tailed porcupine (Atherurus africanus). In local markets the price obtained for wild species, such as the grasscutter and brush-tailed porcupine, were 5 Naira (US$7.50 in 1977) and N5.50 (US$8.25) per kg respectively. In comparison, domestic meats cost about N2 (US$3) per kg. As a result of this higher price for wild meats in urban areas, lower income groups purchased less than higher income groups. In rural areas, households ate bushmeat more regularly than urban dwellers. In the late 1970s the value of this trade to the national economy ranged from N150 million to N3.6 billion (US$225 million to US$ 5.4 billion). The author advocates domestication of species and the establishment of multi-purpose conservation areas which would include game-cropping and tourism.

345. Martin, G. (1985). Carcass composition and palatability of some wild animals commonly used as food. *World Animal Review, 53, 40-44.*

In West Africa the demand for meat from wild animals is heavy and such meat commands a high *market price. In southern Nigeria more than 50% of the population eat bush meat at least* once a month. This article describes the use and carcass characteristics of Maxwell's duiker (Cephalopus maxwelli), cane rat (Thryonomys swinderianus), brush-tailed porcupine (Atherurus africanus) and the giant snail (Archachatina marginata). The article recommends that the use of bush meat should be increased and commercial possibilities explored further.

346. Martin, R. (1984). Wildlife utilisation. In Bell, R. and McShane-Caluzi, E. (eds.). *Conservation and Wildlife Management in Africa.* US Peace Corps, Washington.

347. Martin, R.B. (1986). *Communal Areas Management Programme for Indigenous Resources (CAMPFIRE).* CAMPFIRE Working Document no. 1 /86, Branch of Terrestrial Ecology, Department of National Parks and Wildlife Management, Harare, Zimbabwe.

The CAMPFIRE programme aims: *"to obtain the voluntary participation of communities in a flexible programme which incorporates long term solutions to resource problems; introduce a new system of group ownership and territorial rights to natural resources; provide the appropriate institutions under which resources can be legitimately managed and exploited by the resident communities for direct benefit and provide the technical and financial assistance to communities which join the programme to enable them to reach these objectives."* This document represents the proposal for this now well known experiment in decentralised wildlife management. More recent studies (eg. 349; 350) provide a review of the project and some of the lessons learnt from implementation.

348. McNeely, J. and Miller, K. (1984). *National Parks, Conservation and Development.* Smithsonian Institute, Washington.

349. Murombedzi, J. (1991). Decentralising common property resources management: a case study of the Nyaminyami district council of Zimbabwe's wildlife management programme. *IIED Drylands Issues Paper, 32.* International Institute for Environment and Development, London.

The problems inherent in decentralisation of resource management and control are highlighted in this case study from Nyaminyami district in the Zambezi valley of Zimbabwe. A wildlife management project was established under the control of a local wildlife trust linked to the district council. The experience has demonstrated the difficulties surrounding the devolution of proprietorship to local communities, as planning processes, project formulation and tendencies to retain funds centrally by the district council all act against the decentralisation of control to villagers. This has undermined the success of the project; although financially successful with significant revenues being generated for district council projects, local people are less enthusiastic.

350. Murphree, M. (1990). *Decentralising the Proprietorship of Wildlife Resources in Zimbabwe's Communal Lands*. Centre for Applied Social Sciences Discussion Paper, CASS, Harare, Zimbabwe.

Proprietorship, where control, management and the distribution of benefits are all vested within one group, is seen as essential for the development of successful institutions for local natural resource management. The experience of the CAMPFIRE wildlife management project in Zimbabwe is used to illustrate this point.

351. National Research Council BOSTID: Board on Science and Technology for International Development (1983). *Crocodiles as a Resource for the Tropics*. National Academy Press, Washington, DC.

352. Nietschmann, B. (1972). Hunting and fishing focus among the Miskito Indians, Eastern Nicaragua. *Human Ecology, 1(1), 41-68.*

Hunting and fishing among the Miskito Amerindians of Nicaragua is detailed. Amounts of game and fish captured, as well as daily consumption of protein and calories from animals and vegetables are documented. Over one year of study, the green turtle (Chelonia mydas) accounted for 70% of the weight of animal meat consumed. This was followed by the white-lipped peccary (Tayassu pecari) and fish. The greatest yields from game and fish were achieved during the dry season. Green turtles were particularly easy to catch in the dry season. The little energy required for their collection coincided with the period when labour was necessary for the clearing and planting of fields. Also green turtles provided food when crops were scarce. Animals are increasingly being caught for sale in markets, rather than for subsistence. As a result, protein consumption is declining and is replaced to an extent by purchased carbohydrates. Animal populations such as the green turtle and hawksbill turtle (Eretomochelys imbricata imbricata) are disappearing as a result of increased market activity. Traditionally meat was exchanged between households; however, this system is breaking down as *market participation increases.*

353. Ntiamoa-Baidu, Y. (1987). West African wildlife: A resource in jeopardy. *Unasylva 156, 39(2), 27-35.*

The excessive exploitation of West African wildlife is threatening many species. Over-exploitation results from changes in traditional hunting and wildlife management practices, increased rural and urban demand from higher populations and a reduction in wildlife habitat through agricultural clearance. Rodents, which are able to adapt to a variety of disturbed habitats, are the only mammals that are not in danger.

354. Ojasti, J. and Medina, G. (1972). The management of capybara in Venezuela. In: *Transactions of the 37th North American Wildlife and Natural Resource Conference*, 12-15 March 1972, pp. 268-277.

355. Olanbosun, D, Olayide, S, Idusogie, E and Abiagom, J. (1972). Role of fish and animal products in Nigerian agricultural development and nutrition. *Ecology of Food and Nutrition, 1, 235-243.*

This paper documents the important role of bushmeat and fish in the Nigerian diet. Beef contributes a lower amount of protein on average.

356. Paolisso, M. and Sackett, R. (1985). Traditional meat procurement strategies among the Irapa-Yukpa of the Venezuela-Colombia border area. *Research in Economic Anthropology, 7, 177-199.*

This article describes the hunting techniques of the Irapa-Yukpa Amerindians and the proportion of the diet composed of wild game. 31 mammals and birds hunted are listed with the number of kills and their weights. During the 206 days of study, 82 kg of mammals and 80.5 kg of birds were captured. Within and close to gardens, rodents (Proechimys sp.), agouti (Dasyprocta sp.), and peccary (Tayassu sp.) are hunted for food. Within the forests, monkeys (Cebus albifrons spp., Alocuatta tetradactyla) anteaters (Myrmeco phaga tridactyla) and armadillo (Dasypus sp.) are sought. For the households studied, game provided only 18% of the total protein consumed. Game has become scarce due to the introduction of the shot gun and men have less time to hunt as they engage in wage labour. Households did however, exceed their recommended daily allowances of protein through the consumption of vegetable proteins.

357. Phillipson, J. (1977). Wildlife: A clue to balancing the environmental budget in Kenya. *Kenya Promotion of Science and Technology, 2(6), 3-8.*

358. Pittman, Dick (1990). Wildlife as a crop. *Ceres, 22(1), 30-35.*

The article quotes the President of Zimbabwe's policy commitment to wildlife use: *"It is proposed to make wildlife an agricultural option to complement crop production and cattle raising. Wildlife management will be rationalized to bring economic benefits to the rural communities that engage in it. Game meat will be processed in order to supplement our beef supply in the local market".*

359. Prakash, I. (1986). Wildlife resource and its management. In: K.A. Shankernarayan and V. Shanker (eds.), *Desert Environment: Conservation and Management*, pp. 19-22, C.A.Z.R.I. Publication No. 26, Jodhpur, India.

This article lists the many species of the Rajasthan Desert which are threatened by loss of habitat, shootings and competition with livestock. The author recommends the restoration of habitats, the reintroduction of species, the establishment of sanctuaries and more research on the animals' behaviours and conservation.

360. Pullan, R.A. (1981). Wildlife for food: Zambian experience. *Singapore Journal of Tropical Geography, 2(2), 101-113.*

361. Pullan, R.A. (1983). The use of wildlife as a resource in the development of Zambia. In: Ooi Jin Bee (ed.). *Natural Resources in Tropical Countries*, pp. 267-325, Singapore University Press, Singapore.

362. Saffirio, G. and Scaglion, R. (1982). Hunting efficiency in acculturated and unacculturated Yanomama villages. *Journal of Anthropological Research, 38(3), 315-327.*

363. Sale, J.B. (1981). *The Importance and Values of Wild Plants and Animals in Africa.* Part I. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland and The United Nations Environment Programme, Nairobi, Kenya.

A useful literature review of many issues related to wild food use is given in this report. Wildlife hunting is given prominent coverage, but other sections include reviews of wild vegetables, insects etc. Extensive referencing allows access to primary sources.

364. Sankhala, K.S. and Jackson, P. (1985). People, trees, and antelopes in the Indian desert. In: J.A. McNeely and D. Pitt (eds.), *Culture and Conservation: The Human Dimensions of Environmental Planning*, pp. 45-62, Croom Helm, London.

365. Surujbally, R.S. (1977). Game farming is a reality. *Unasylva, 29(116),13-16.*

This article advocates game ranching to produce meat for local communities. It stresses that domestication is not necessary and could increase pressure on the environment. The advantages of wild *game over domestic livestock include adaption to local vegetation, more efficient conversion of this* fodder to meat and a greater resistance to tsetse fly and trypanosomiasis.

366. Vickers, W. (1984). The faunal component of lowland South American hunting kills. *Interciencia, 9(6), 366-376.*

367. Walker, B. (1979). Game ranching in Africa. In Walker, B. (ed.) *Management of Semi-arid Savannas.* Elsevier, Amsterdam.

This chapter provides evidence to show that wildlife systems are not the highly efficient, non-overlapping systems people once thought. Recent experiments highlight the ecological benefits of game ranching, but, in general, the conclusions are tentative and the author cautiously suggests that perhaps a mix of cattle and wildlife would be the best ranching system.

368. World Bank (1990). Living with Wildlife: Wildlife Resource Management with Local Participation in Africa. *Technical Paper, 130.* World Bank, Washington.

369. Western, D. (1984). Amboseli National Park: Human values and the conservation of a savanna ecosystem. In: McNeely, J. and Miller, K. (eds). *National Parks, Conservation and Development.* Smithsonian Institute, Washington.

This paper describes how the co-operative arrangement between Maasai and wildlife officially works in the Amboseli National Park. The Maasai receive compensation for wildlife use of their dry season swamp grazing area and are paid fees for the use of group ranches by wildlife during the wet season.

370. Western, D. and Pearl, M. (eds.) (1989). *Conservation in the Twenty First Century.* Oxford University Press, Oxford.

371. White, C.M.N. (1956). The role of hunting and fishing in Luvale society. *African Studies, 15(2), 75-86.*

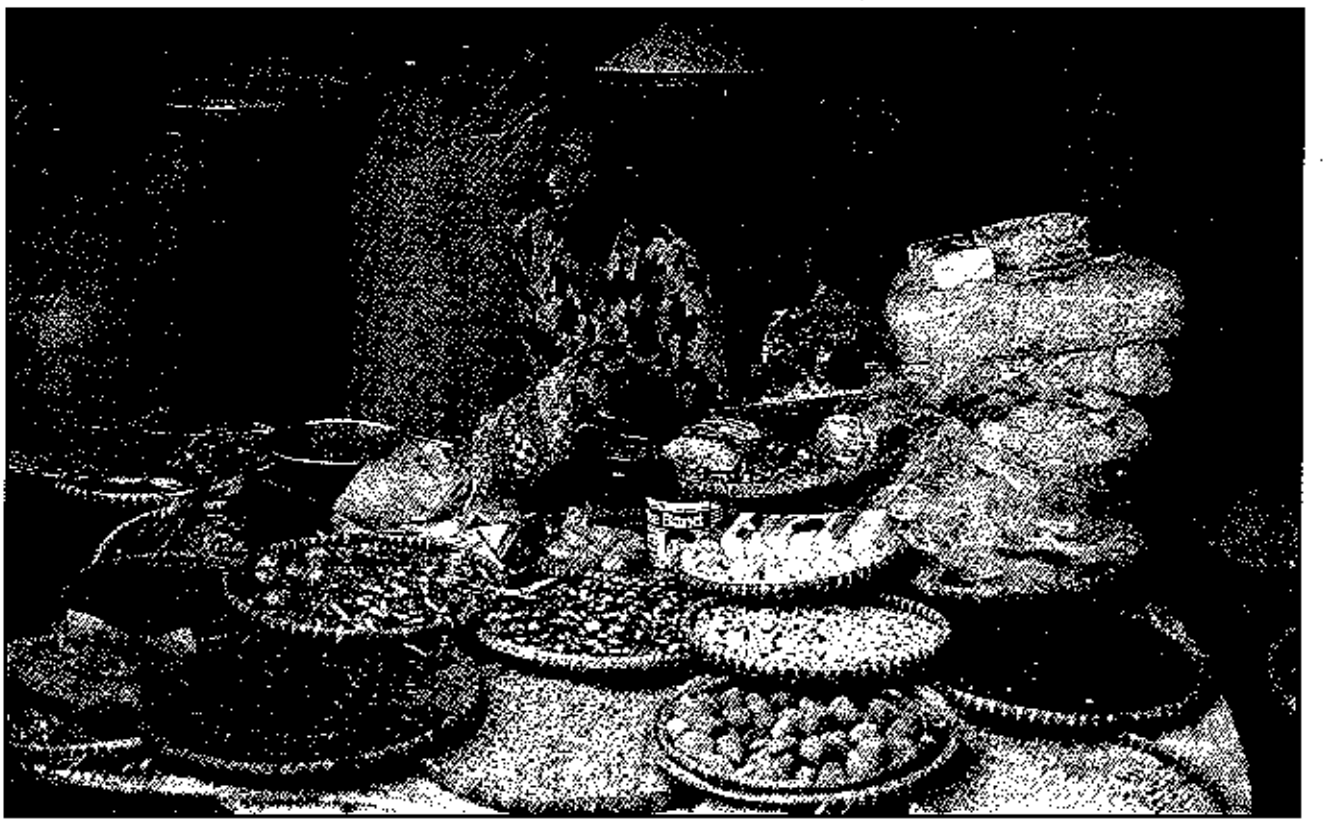
372. Zimbabwe Department of National Parks and Wildlife Management (1989). *Elephant Management in Zimbabwe.* Zimbabwe Department of National Parks and Wildlife Management, Harare.

373. Zimbabwe Trust (1990). *People, Wildlife and Natural Resources - the CAMPFIRE Approach to Rural Development in Zimbabwe*. Zimbabwe Trust, Harare, Zimbabwe.

Zimbabwe Trust is the leading NGO involved in the implementation of wildlife management schemes in Zimbabwe. This report outlines their approach and provides cases of existing wildlife utilisation projects in the country.

Chapter Five

Wild Foods and Food Security



Market, Java, Indonesia
Photo: Jules Pretty

5. WILD FOODS AND FOOD SECURITY

Food insecurity arises though several stages. These range through 'coping' (involving selling surplus animals and non-essential possessions, borrowing from close kin, collecting wild foods), to 'asset disposal' (involving sale of animals, outmigration, pledging or sale of farmland) to 'non-coping' (involving starvation or charity dependency) (380; 389; 422; 451). Wild foods may be important at all stages.

Contribution to Food Security

The use of wild foods as a component of local response strategies to increasing food insecurity is widely documented (374; 375; 383; 400a; 413; 414; 416; 417; 440; 441). 'Famine foods' include wild vegetables, berries, nuts, fruits, insects etc. In periods of limited food stress, such foods may be eaten only occasionally and more often by children and poorer sectors of society. However in periods of heightened food insecurity such foods may become widely consumed (386b; 387; 390; 418). For instance, in Java outputs from home gardens increase in times of rice shortage (151a, b).

Wild foods are not only important to food security in extreme cases, they often make up a portion of the diet in other times too (395; 396; 416). For instance, in Mali poorer housholds may combine the use of porridge derived from Boscia senegalensis fruit with their limited supplies of stored millet (421; 448). In northern Nigeria leafy vegetables and other bush foods are collected as daily supplements to relishes and soups (417). In Swaziland, a wide range of wild foods are used; these increase with staple food shortages (111-113). A similar pattern is shown in Ghana (375).

Having a diverse resource base with a range of different trees, plants and insect species increases the options for maintaining food security. Different products complement each other with seasonally different patterns of availablity, the potential for storage for 'hunger season' use or for use in times of extreme food stress (387; 412). In Venezuela and Colombia, Jessenia fruit is a protein substitute when hunting and fishing returns are poor (177).

Recent work has demonstrated the strong linkages between forests, trees and food security (394-399; 408). This is increasingly being taken into account in the development of forest projects and policies. However the role of wild foods in agricultural systems under stress is less well documented and an acknowledgement of their importance for food security has yet to influence mainstream thinking (703).

Seasonal Use

The seasonal variability of wild food supply from different sources influences the food acquistion strategies of pastoralists (378; 383; 444), agriculturalists (384; 439); fisherfolk and hunters (67; 429) and hunter-gatherers (48; 49; 92-94; 216; 376) alike. Seasonal variations in food intake from different wild sources have direct effects on nutritional status (404; 410 for Bangladesh; 405; 406 for Mali; 409 for Ghana; 430 for Zaire).

The seasonal availability of wild foods will depend on the patterns of fruiting, leaf production and population cycles of the species harvested. Complex plant phenologies may result in uncertain availabilities of foods (402 for beechnuts). In temperate climates, oak (Quercus spp) and beech (Fagus sylvatica) trees produce rich fruits harvests at a frequency partly determined by temperature - every 3-4 years in warmer countries and every 7-8 in cooler (601). During the medieval warm epoch (AD 950-1300), people relied heavily on pigs which in turn fed on the abundant tree fruits. Insect or larvae availability is often associated with the early rainy season (140; 430). Seasonal complementarity between food sources is a feature of a diverse wild food base (431 for south west Tanzania).

In the miombo woodlands of Tanzania, a few tree species provide food for the Sandawe throughout the year (425). In Zimbabwe, indigenous wild fruits seasonally complement exotic fruit trees as food sources in the communal areas, with indigenous trees providing an important dry season supplement (663). Wild foods that produce at times when other foods are in short supply are particularly important. In dryland farming areas of north India, Zizyphus spp. fruits provide food between February and April, when other foods are scarce (558). Similarly, locust bean (Parkia biocor) provides dry season food in West Africa where

it is prepared into the fermented dawa-dawa dish (385). In the Kalahari, the Basarwa use nuts of the Mongongo tree (Ricinodendron rautanenii) as a dry season staple food (415). When food is short in Bhutan, farmers gather wild avocadoes, bamboo shoots, orchids and mushrooms, as well as giant wild yams that grow to more than 1 metre in length (401a).

Some wild foods can be harvested all year round. For instance the products of the oil palm (Elaeis guineesis) are an important part of the West African diet (665), as are foods derived from the sago palm (Metroxylon sp.) for people in SE Asia and Oceania (162). Many wild foods can be collected and stored for later use. Wild grass grains are stored along with crops (273), nuts and berries can be processed and stored, wild vegetable leaves may be dried (79; 86; 426) and insects or wild meat can be preserved for later consumption (170).

'Famine' Foods

Historically wild foods have been an important component of local coping strategies at times of severe food shortage. Documentation of 'famines' in Malawi (449), Zimbabwe (411), Sudan (392; 443), northern Nigeria (424; 452), Ethiopia (434) and India (379; 432; 436; 441) shows the importance of wild foods in sustaining livelihoods. Such food sources remain important in many areas today, particularly for those with few direct or exchange entitlements.

In the Bihar famine in India during 1965-6 severely affected villages were found to be eating a lot of wild vegetable leaves (401b; 416). In Britain, the famine caused by the rains of 1314-16 that killed 10-15% population was more severe than previous famines because of the reduced availability of wild resources following agricultural expansion (601). But those resources that did exist were crucial for survival - even the king ate the bark of trees. In the 1974-5 famine in Bangladesh a range of wild foods proved important in people's coping strategies (433). In the 1973 famine in Sudan, the Berti of western Sudan collected wild grass seeds and survived off these (407). This pattern was repeated in the 1984-5 famine where grass seeds and tree fruits (notably Boscia senegalensis) were collected in order to survive (10; 392). A similar pattern is reported in Wollo, Ethiopia where leafy plants, plants with

seeds, berries, fruits and roots were incorporated into the diet during the food shortages during the 1980s (434). In the Senegalese Ferlo, Grewia bicolor fibre and Combretum aculeatum seeds are consumed only in extreme conditions (377). In extreme cases, wild foods may be the only food available. For instance, 41% of the Karimoja population in Uganda was subsisting off wild weeds and bush fruits and seeds during the famine of 1980 (381).

Monitoring and Early Warning Systems

Monitoring the use of such foods has been suggested as a possible local level 'early warning' indicator of impending famine (384; 392; 420; 451). The increased rate of collection of wild foods generally precedes large scale asset disposal or migration. Compared with direct measurement of food consumption or height/weight relationships, a wild food indicator may prove easier information to collect. But this needs a greater understanding of indigenous responses to food insecurity (400a-d), together with the evolution locally specific drought monitoring strategies.

Resource Access and Vulnerability

Reduced access to wild food resources increases vulnerability, particularly of poorer groups, women and children (386b; 445). But changes in access to common property resource land, shifts in tenure systems and reduced diversity of wild foods due to environmental change may reduce the supply of such foods to vulnerable groups. In many cases, such changes in land resource productivity and access have adversely affected the food security of vulnerable groups.

However other changes may occur to compensate for the loss of wild food resources. Increased access to alternative food sources in drought (food aid, commercial supplies etc) may mean that wild foods are becoming less significant in famine coping strategies in many areas. In Botswana, the commercialisation of food product markets, combined with the provision of food relief has meant the decline in use of wild food products in times of food

shortage (382). Similarly, in India wild food collection has significantly declined as a response to food scarcity when use is compared between the 1965-6 famine and 1987 (432). This may be due to the improvement of food distribution and supply systems in India over the past 20 years.

Improved food marketing and distribution systems are important components of ensuring household food security, along with safety nets of food relief in serious situations. However, reliance on the market and social welfare mechanisms of the state may be insufficient for the very poor and vulnerable groups in society. For them, the hidden harvest of emergency food will remain important in many areas.

CHAPTER 5: WILD FOODS AND FOOD SECURITY

374. Annegers, J.F. (1973). Seasonal food shortages in West Africa. *Ecology of Food and Nutrition, 2(3), 251-257.*

375. Asibey, E. O. A. and Beeko, C. Y. A. (1989). *Forest and Food Security*. Symposium on Ghana's Forest Policy, 3rd-7th April, 1989, Greenhill, Accra, Ghana.

376. Bahuchet, S. (1988). Food supply and uncertainty among the Aka Pygmies (Lobaye, Central African Republic). In: I. De Garine and G.A. Harrison (eds), *Coping with Uncertainty in Food Supply*, pp.118-149, Clarendon Press, Oxford.

377. Bahuchet, S. (1978). Les contraintes ecologiques en forets tropicale humide: l'exemple des pygmies Aka de la Lobaye (Centre Afrique). *Journal d'Agriculture Tropicale et Botanique Applique, 25, 257-285.*

378. Bernus, E. (1988). Seasonality, climatic fluctuations, and food supplies (Sahelian nomadic pastoralist societies). In: I. de Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 318-336, Clarendon Press, Oxford.

379. Bhandari, M.M. (1974). Native resources used as famine food in Rajasthan. *Economic Botany, 28(1), 73-81.*

> The people of Rajasthan classify famines according to the scarcity of food, water or fodder. It had not rained for seven years when this study was carried out. Twenty-five famine foods are listed with their uses. Examples include: the grains of Cenchrus biflorus which are high in fat and protein, fodder species (Lasiurus hirsutus and Dactyloctenium sindicum) and the desert locust (Schistocerca gregaria). Famine foods are usually less nutritious than other foods and at times have to be extensively processed to remove toxins.

380. Bharati, P. and Basu, A. (1988). Uncertainties in food supply, and nutritional deficiencies, in relation to economic conditions in a village population of southern West Bengal, India. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 418-436, Clarendon Press, Oxford.

> This study found that less than one-third of the households studied were able to produce enough food for a year. Responses to food shortages are under-eating, collection of wild foods, selling land, borrowing money, reducing family size and encouraging child labour.

381. Bieltik, R.J. and Henderson, P.L. (1981). Mortality, nutritional status and dietary conditions in a food deficit region: North Teso District, Uganda, December, 1980. *Ecology of Food and Nutrition, 11, 163-170.*

382. Campbell, A (1986). The use of wild food plants, and drought in Botswana. *Journal of Arid Environments, 11, 81-91.*

> The use of wild foods by foragers, pastoralists, riverine peoples and cattle-owning agriculturalists are

described. A table is given listing 75 wild food species and methods of usage. There are at least 150 edible plants, including species of Grewia, Ochna, Sclerocarya, Ximenia, Strychnos, Tylosema, Bauhinia, Ceropegia and Scilla. Though land use systems are altering the distribution and abundance *of food plants, they still constitute a significant supply. Certain wild foods such as* Tylosema esculentum, are being studied for domestication. Twelve Sclerocarya birrea trees planted in 1971 now each produce about 1000 fruits/year.

383. Campbell, D.J. (1984). Response to drought among farmers and herders in Southern Kajiado District, Kenya. *Human Ecology, 12(1), 35-64.*

The capacity of farmers and herders to cope with major reductions in rainfall and consequent drops in production are discussed. Responses are influenced by changed land-use patterns and altered resource availability. Vulnerability can only be reduced by increasing off-farm employment, as local resources (including the use of wild foods) are insufficient to offset the impacts of drought.

384. Campbell, D.J. and Trechter, D.D. (1982). Strategies for coping with food consumption shortage in the Mandara mountains region of North Cameroon. *Social Science and Medicine, 16, 2117-2127.*

385. Campbell-Platt, G. (1980). African locust bean (Parkia species) and its West African fermented food product, dawadawa. *Ecology of Food and Nutrition, 9, 123-132.*

386a. Cernea, M.M. (1990). *Poverty Risks from Population Displacement in Water Resources Development.* Development Discussion Paper No. 355, Harvard Institue for International Development, Harvard University, Massachusetts.

386b. Chambers, R. (ed). (1989). Vulnerability: how the poor cope. *IDS Bulletin 20 (2).*

Vulnerability is not the same as poverty. It means defencelessness, insecurity and exposure to risk, shocks and stress. Local criteria for assessing poverty and vulnerability may be different to outsiders'. For instance in India, Jodha's re-survey of villages in Gujarat, showed that among the households whose real incomes had declined over 20 years by more than 5%, they were better off on 37 of their 38 criteria of well-being. Strategies for coping with vulnerability are complex and diverse and include the use of wild foods. Policy mechanisms to support the poor must include the encouragement of diversification, security and current coping strategies. This special issue provides nine papers, each with a different case example of coping strategies, many involving the use of wild foods.

387. Chambers, R., Longhurst, R. and Pacey, A. (1981). *Seasonal Dimensions to Rural Poverty.* Frances Pinter, London.

This collection of papers provides an important contribution to the debate about seasonality. Seasonal dimensions of the rural poors' activities are critical in developing an understanding of livelihood strategies - in relation to agricultural activities, livestock keeping, hunting and gathering, health and nutrition. The case studies presented explore the complexities of the rural poors' responses to seasonal variations; many of which involve the use of wild products to offset food shortages or to provide income in times of stress.

388. Colson, E.F. (1979). In good years and bad: Food strategies of self-reliant societies. *Journal of Anthropological Research, 35, 18-29.*

389. Corbett, J. (1988). Famine and household coping strategies. *World Development, 16,*

1099-1112.

390. De Garine, I. and Harrison, G.A. (eds.) (1988). *Coping with Uncertainty in Food Supply*. Clarendon Press, Oxford.

This collection of papers were originally presented at a conference in Germany in 1982. Case studies of traditional societies mainly from the tropics, but also from temperate and arctic regions address the following topics: the types of foods which people eat; the availability of these foods in relation to local environment and seasons; adaptive responses to uncertainties in food supply; and the effects of modern technologies on communities. Most of the studies were performed in Africa and India and include hunter-gatherers, pastoralists, as well as agriculturalists. (see 376; 378; 391; 447).

391. De Garine, I. and Koppert, G. (1988). Coping with seasonal fluctuations in food supply among savanna populations: the Massa and Mussey of Chad and Cameroon. In: I. de Garine, and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 210-259, Clarendon Press, Oxford.

The Massa and the Mussey are agropastoralists growing sorghum and raising sheep and goats. Hunting and gathering occur to an extent. The seasonality of food procurement and consumption were studied for one Massa village and two Mussey villages. Anthropometric measurements were also made. Data on the above, as well as the nutritional content of foods is given. Fishing was dominant for the Massa community studied. Of the two Mussey villages, it was found that gathering was a more significant activity for the village located on poorer land. Zizyphus jojoba, Tamarindus indica, Balanites aegyptiaca, Hyphaene thebaica and Ficus gnaphalocarpa fruits were important vitamin sources. During periods of severe food shortages, wild cereals (Eragrostis teff, Dactyloctenium aegyptiacum) and tubers (Tacca leontopetaloides, Cyperus rotondus, Amorphophallus spp. and Cochlospermun tinctorium) are gathered.

392. De Waal, A. (1988). Famine early warning systems and the use of socio-economic data. *Disasters, 12, 81-91.*

Socio-economic data is not good at differentiating between qualitatively different kinds of famine. With an illustration from the famine in western Sudan (Darfur) in 1984-5, the paper shows that four of the most widely used indicators of famine (grain price; livestock markets; migration; labour markets) were of little use in providing an early warning of a famine that killed. There is a need for local level indicators, based on an understanding of peoples' phased coping strategies (including the collection of increased quantities and different kinds of wild foods), to inform the development of effective famine early warning systems.

393. De Waal A. (1989). *Famine That Kills: Darfur, Sudan, 1984-1985*. Clarendon Press, Oxford.

This book, chronicling the events of the famine in Darfur in 1984-1985, challenges views that starvation causes deaths and that during such times, peoples' main goal is simply to feed themselves. The author argues that it is the lack of potable water and the spread of disease which causes most mortality. Rural populations' responses to the drought are presented. The author attributes people's survival to these adaptations, rather than the receipt of food aid. He provides evidence that even when people have income available during a period of drought and crop failure, they spent on average only one-tenth to buy grain for their immediate food needs. Money would then go towards the purchase of seed for the next growing season or towards the maintenance of livestock. Such behaviour illustrates that people are willing to suffer and be hungry in the present to ensure their livelihoods for the future. Rather than purchasing grains, the harvesting of wild foods was increased and is given as a major reason for the survival of many.

In one village 91% of the people were collecting or buying on average 2.3 types of wild foods. These foods include wild grass (Echinochloa colonum), wild rice (Echinochloa crusgalli), wild finger millet (Dactyloctenium aegyptium) and fruits (Balanites aegyptiaca, Boscia senegalensis). The berries of Boscia senegaliensis ('mukheit') were eaten either cooked or dried by 94% of the households in northern Darfur and were the most important food in the diet, providing, when cooked, 70% of the energy and 75% of the protein of cultivated millet. A market developed in these berries which replaced sorghum and millet as staples. They are particularly important as they are harvested during the rainy season when stocks of cultivated grains are low. It was noted that female-headed households were better off than male-headed, because women were more knowledgeable in the collection of wild foods and, when employed, were often paid in grain. Although wild foods such as 'mukheit' may require laborious processing, lack taste and are stigmatized as poor peoples' famine food, they are most important in replacing the failed staple.

394. Falconer, J. (1990). Hungry season food from forests. *Unasylva, 41, 14-19.*

395. Falconer, J. and Arnold, J.E.M. (1988). Forests, trees and household food security. *ODI Social Forestry Network Paper, 7A*, Overseas Development Institute, London, UK.

This is an abridged version of the review "Household Food Security and Forestry: An Analysis of Socio-Economic Issues" (see 399). It discusses the importance of forest resources to nutrition and income-generation, particularly for the poor and women. Information is presented in concise and well-organized summary tables. Farmers' responses to decreasing forested areas, smaller land holdings and increased participation in the cash economy include increased labour inputs into and intensification of home gardens and fallow fields. On the other hand, farmers may plant trees requiring little care while being employed off farm. In conclusion, the authors point out that forestry is not the sole solution to maintaining food security, yet they are important. No general models for development can be made, as the use of forest products varies between communities.

396. Falconer, J. (preparer) and Koppell, C.R.S. (ed.) (1990). *The Major Significance of 'Minor' Forest Products: The Local Use and Value of Forests in The West African Humid Forest Zone*. Community Forestry Note 6, Forests, Trees and People, Swedish International Development Authority and Food and Agriculture Organization of the United Nations, Rome.

This is a very useful review of the role of 'minor' forest products in West Africa. Based on a very substantial review of the literature, much of it 'grey' and inaccessible, the book provides useful information on: how forests are used at the local level and how they contribute to household livelihoods; in what ways different communities value forest resources and how these values are changing with changes in economic and ecological circumstance; and how commercialisation of rural economies has affected the exploitation of forest resources. The research draws on a variety of sources drawn from different disciplines, ranging from medicine, through agriculture to anthropology. Tables help to summarise material from diverse sources and provide the beginnings of a comparative analysis of wild resource use for West Africa. Chapters are divided into: Household consumption of forest resources; The use of forest resources in other sectors; Forest resources as a source of cash income; Changes in forest uses; Assessing the value of non-timber forest products; Gearing forest activities to meet peoples' needs and demand for non-timber forest products. Appendices provide overviews of the literature and an annotated bibliography of nearly 350 references.

397. FAO (1985). *The Role of Minor Crops in Nutrition and Food Security*. FAO Committee on Agriculture, Session 8, Rome, 18 March 1985, FAO, Rome.

398. FAO (1989). *Forestry and Food Security*. FAO Forestry Paper 90, Forest, Trees and People, FAO and SIDA, Rome.

A report based upon the papers and recommendations presented at an expert consultation on Forestry and Food Production/Security in India in 1988. It draws together information from the literature on the role in which forestry plays in improving food security. It introduces the following issues: trees as a source of food and income, their biophysical effects on the environment, and the influence of land and tree tenure policies as well as access to common property have on their planting and harvesting. The overall discussion points out that forest products cannot replace staples and that tree planting can have negative effects on crop growth. There are specific sections on wild plants and animals, fodder for livestock, fuelwood, mangrove forests, home gardens and the management of forest fallows. The final chapter contains extensive recommendations to incorporate food security objectives in forestry projects. Adjustments need to be made in policies and institutions which will recognize the role of forest products in people's lives. Specific nutritional deficiencies and needs of local communities should be identified when programmes are developed. An interdisciplinary approach involving foresters, agriculturalists and social scientists should be employed in the design of such programmes.

399. FAO (1989). *Household Food Security and Forestry: An Analysis of Socio-Economic Issues*. Forests, Trees and People, Swedish International Development Authority and FAO, Rome.

This publication reviews the role of trees and forest products in household food security by discussing in detail case studies of their contributions to nutrition and income. Systems of tree cultivation and the effects of reduced access to forest resources, decreasing land holdings and the cash economy are explored. Forest products contribute directly to household nutrition as dietary supplements used daily to enhance the flavour of staples (most important are wild leaves), and as snack foods (e.g. fruits). Their consumption is increased during hunger seasons when staples supplies may be low, particularly before harvest time. Certain species, mainly roots and tubers, are also collected during emergencies of drought, famine and war. These are relied upon only during times of hardship as their preparation requires lengthy processing. The effects of greater incorporation into the cash economy on nutritional well-being can either be positive or negative: what remains important is a diversity of foods within diets. Appendices on the nutrient composition of specific species of wild leaves, wild fruits and wild nuts and seeds are given. Examples are given illustrating how the poor and women can earn an income through the collection and processing of products such as rattan, bamboo, babassu nuts and fuelwood.

Trees on farms are important in improving agricultural production for example when farmers cannot afford inputs such as fertilizer. They also are a form of savings whose products can be "cashed in" during emergencies such as illness or paying school fees. Farmer's responses to decreasing land holdings for staple cultivation include intensification of home gardens and fallow lands with tree crops. When even this intensification is no longer sufficient to meet subsistence needs, often off-farm employment is sought with the land placed under low-input perennial tree crops. It is important to analyse and understand farmers' priorities and the constraints of land, labour and capital which they may face as well as possible nutritional deficiencies, when designing forestry projects with the improvement of household food security in mind.

400a. Fleuret, A. (1986). Dietary and therapeutic uses of fruit in three Taita communities. In: N.L. Etkin (ed.), *Plants in Indigenous Medicine and Diet: Biobehavioral Approaches*, pp. 151-170, Redgrave, Bedford Hills, New York.

400b. Fleuret, A. (1986). Indigenous responses to drought in sub-Saharan Africa. *Disasters, 10, 224-229.*

400c. Fleuret, A. (1989). Indigenous Taita responses to drought. In: R. Huss-Ashmore, and S.H. Katz (eds.), *African Food Systems in Crisis: Part I: Microperspectives, pp. 221-237, Gordon and Breach, New York.*

400d. Fleuret, A. (1990). The impact of fuelwood scarcity on dietary patterns: Hypotheses for research. *Unasylva 41(160):29-34.*

See also: 493; 494.

401a. Gupta, A.K. and Ura, K. (1992). Indigenous farming technologies and environment; experiences in Bhutan. In: Jodha, N.S. Banskota, M. and Partap, T. (eds.). *Sustainable Mountain Agriculture. Farmers' Strategies and Innovative Approaches.* pp 540-568. Oxford and IBU Publication Co, New Delhi.

> This chapter deals with the experiences of Bhutan, a relatively small, land-locked Himalayan country which has established common property and other collective institutions for resource management. It describes a wide range of local farming innovations, together with emerging issues in technology transition. Farmers use wild products, such as wormweed (Artenesia), for mulching, green manuring and composting. Gathering wild foods is an important means of supplementing food shortages, and wild avocadoes, wild taro, bamboo shoots, orchids, mushrooms and giant wild yams (growing to more than 1 metre in length) are commonly eaten. Mushrooms are sold to urban markets (see also case study from China, no. 702b).
>
> Wild pests can be a problem to farmers. Buckwheat is favoured by bears and wild boars, so farmers cultivate buckwheat in one place. During the maturation period they can act together to scare away the wild animals.

401b. Gupta, R.K. and Kanodia, K.C. (1968). Plants used during scarcity and famine periods in the dry regions of India. *Journale d'Agriculture Tropicale et de Botanique Appliquee, 15(7-8), 265-285.*

402. Gysel, LW (1971). A ten-year analysis of beechnut production and use in Michigan. *Journal of Wildlife Management, 35, 516-532.*

> The variable masting and seed production of beech trees is recorded. Viable nuts were a failure for 2 years, low for 4 years, intermediate for 3 years and high for only 1 year out of ten. Although these nuts do not provide human food, similar patterns of variable production are observed in many temperate nut producing trees.

403. Harrison, G.A. (1988). Seasonality and human population biology. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 26-31, Clarendon Press, Oxford.

> A general overview of the many elements of tropical life which vary according to seasons. These include: disease, births, marriages, and deaths. It is also noted that the traditional hunger season usually occurs during the rainy season when labour requirements are greatest. Micronutrients, such as riboflavin, vitamins A and C, are stored within the body and slowly released over time as an adaptation to periods in which they are not consumed.

404. Hassan, N., Huda, N. and Ahmadi, K. (1985). Seasonal patterns of food intake in rural Bangladesh: its impact on nutritional status. *Ecology of Food and Nutrition, 17(2), 175-186.*

405. Hildebrand, K. (1985). Assessing the components of seasonal stress amongst Fulani of the Seno-Mango, Central Mali. In: A.G. Hill (ed.), *Population, Health and Nutrition in*

the Sahel: Issues in the Welfare of Selected West African Communities, pp. 254-287, Kegan Paul International, UK.

406. Hildebrand, K., Thiam, A., Tomkins, A., and Dowler, E. (1985). *Food, Work, Health and Nutrition: A Comparative Study of the Seasonal Effects in the Agro-Pastoral Populations from the Malian Gourma.* Report to ODA/London School of Hygiene and Tropical Medicine/International Livestock Centre for Africa.

407. Holy, L. (1980). Drought and Change in a Tribal Economy: The Berti of Northern Darfur. *Disasters, 4, 65-72.*

408. Hoskins, M. (1990). The contribution of forestry to food security. *Unasylva, 41(160), 3-13.*

409. Hunter, J.M. (1967). Seasonal hunger in a part of the West African savanna: a survey of body weights in Nangodi, north-east Ghana. *Transactions of the Institute of British Geographers, 41, 167-185.*

410. Hussain, M.A. (1985). Seasonal variation and nutrition in developing countries. *Food and Nutrition, 11(2), 23-27.*

411. Illiffe, J. (1990). *Famine in Zimbabwe, 1890-1960.* Mambo Press, Zimbabwe.

This short book provides an accessible account of famine responses in Zimbabwe during the colonial period. Most of the material is drawn from colonial archives and documents both peasant responses *(including movement, exchange of animals and grain, pledging of daughters,* collection of wild foods, hunting of wild animals etc.) and state responses (food aid, loans etc.). Comparisons between the droughts of 1916, 1922 and 1947 are made, providing evidence that both state and peasant responses are different over time.

412. Irvine, F.R. (1952). Supplementary and emergency food plants of West Africa. *Economic Botany (Devoted to Applied Botanical Plant Utilisation), 6(1), 23-40.*

A range of wild foods gathered in Africa are reviewed with an emphasis on those foods consumed during times of famine. These wild foods include: roots, rhizomes, tubers, bark, buds, gums, leaves, flowers, fruits and seeds.

413. Kingamkono, R. and Lindstrom, J. (1990). *Forests and Fields: The Role of Livestock and Collected Food Products in Food Production and Security Systems: The Case of Babati District, Tanzania.* Preliminary Research Report prepared for Forest, Trees and People Project: A project under Community Forestry Section, Ministry of Land, Natural Resources and Tourism, Tanzania Food and Nutrition Centre, July 1990.

This study is an extensive look at the role of livestock, wild and cultivated foods in agricultural households with or without livestock (agro-pastoralists) in Babati district, Tanzania. The field sites were two villages; one near a forest reserve and the other in an area undergoing deforestation and erosion. The field study was conducted via interviews and direct observation at the end of the rainy season with yearly information gained through recall interviews. Data is presented for species collected, their frequency of use, the nutritional status of men, women and children, and seasonal variations. Additional topics discussed include the importance of variety in household food security and collection

according to location, availability, gender and age. Of the wild foods, emphasis is placed on green leafy vegetables and fruits.

414. Kumar, S.K. (1988). Effect of seasonal food shortage on agricultural production in Zambia. *World Development, 16(9), 1051-1063.*

415. Lee, R.B. (1973). Mongongo: The ethnography of a major wild food resource. *Ecology of Food and Nutrition, 2, 307-321.*

The !Kung San are hunter gatherers in northwest Botswana who collected over 150 wild plants and animals. This article concentrates upon the ecology and nutritive value of the !Kung San's principal food, the wild mongongo tree (Ricinodendron rautanenii Schinz). It is found growing on the sand dunes and rock outcrops of the Kalahari. At the beginning of the dry season its fruits fall from the trees. The fruits and/or nuts can be collected from the ground throughout the year; however, over time the pulp of the fruit decomposes or is eaten by animals leaving only the nuts to be harvested. Ordinarily only a two or three day supply are gathered at any one time. The pulp of collected fruits may be eaten raw or cooked in water to produce a gruel. The nuts are roasted, and cracked; then the kernels can be eaten whole or pounded in a mortar to be mixed with other foods. Its yield and nutritional composition are similar to or greater than cultivated staples. The pulp and kernel supply 312 kcal per 100g and 641 kcal per 100g respectively. Their respective protein contents equal 6.6g and 28.8g per 100g. Values for fats and other micronutrients are also given. Production by 35 groves was estimated to equal 25.6 million nuts. At the time of the article, the !Kung San saw no need to cultivate the mongongo because it was so abundant.

416. Longhurst, R. (1985). Cropping systems and household food security: evidence from three West African countries. *Food and Nutrition, 11, 10-16.*

Nigeria, Sierra Leone and the Gambia are countries with comparable agricultural conditions regarding seasonality, but different staple crops. They also diverge culturally regarding male and female roles, responsibilities and labour allocation patterns. However, similar elements of cropping strategies can be identified in all three countries. Mixed cropping is practised everywhere, although different crops are cultivated. In all three countries, women carry a large responsibility in ensuring household food security. Everywhere, even in northern Nigeria where seclusion forbids women to work in the fields, they cultivate a small garden plot intensively to bring some crops to an early harvest. In Sierra Leone and the Gambia they play equal roles with men in producing food on the family farm. Often, in order to overcome the pre-harvest hungry season, but also to complement and diversify the diet, fruits and vegetables are collected from the wild, usually by women and children.

417. Longhurst, R. (1986). Household food strategies in response to seasonality and famine. *IDS Bulletin, 17, 27-35.*

418. Longhurst, R. (1987). Household food security, tree planting and the poor: The case of Gujarat. *ODI Social Forestry Network Paper, 5d,* Overseas Development Institute, London.

419. Longhurst, R (1987). Famines, food, and nutrition: issues and opportunities for policy and research. *Food and Nutrition Bulletin, 9, 30-38.*

The paper looks at changes in nutrition during famine, indicating that household sources of food during famine include wild and low-status foods, enhancing the production and use of these foods, as well as other strategies for survival. Ways of addressing the special problems of vulnerable groups and effective systems of warning of nutritional problems, feeding programmes and emergency relief are

also discussed.

420a. Maikhuri, R. K. (1991). Nutritional value of some lesser-known wild food plants and their role in tribal nutrition. A case study in North East India. *Tropical Science, 31, 397-405.*

420b. Margoulis, R. and Omer Mukhier, M. (1989). *Community Based Information Systems For Food Security Monitoring: The Role of the Sudanese Red Crescent Drought Monitoring Programme in N. Darfur Sudan.* Sudanese Red Crescent, Khartoum.

421. Martin, M. (1985). Design of a food intake study in two Bambara villages in the Segon region of Mali with preliminary findings. In: A. Hill (ed.), *Population, Health and Nutrition in the Sahel*, Routledge Kegan Paul, London.

422. Maxwell, S. (ed) (1991). *To Cure all Hunger: Food Policy and Food Security in Sudan.* Intermediate Technology Publications, London.

> The papers collected together in this book suggest reasons why food insecurity occurs. The weakness of the macroeconomy, the unstable and inequitable foods system, agricultural commercialisation, war and drought are all contributory factors. Targeting of relief and drought assistance has been ineffective - too little attention has been paid to offsetting drought vulnerability, leaving the focus on famine relief. Clearer understanding of local strategies for famine avoidance and coping are needed to inform reviews of drought assistance strategies and government support structures.

423. Moore, H. and Vaughan, M. (1987). Cutting down trees: Women, nutrition and agricultural change in the northern province of Zambia 1920-1986. *African Affairs, 86(345), 523-540.*

424. Mortimore, M. (1989). *Adapting to Drought Farmers, Famines and Desertification in West Africa.* Cambridge University Press, Cambridge.

> This book provides a very thorough review of drought response and environmental change in northern Nigeria. A long time perspective is taken that reveals how local response strategies have shifted over time. The author comments: "Drawing on generations of ethno-botanical experience, social relations of kinship and clientage and improved opportunities for personal mobility, the impoverished respond [to drought] with a degree of flexibility and diversity that is perhaps surprising". This includes the searching for alternative foods in the market and the bush. Famine foods are largely sought out by women. The significance of bush foods cannot be underestimated.

425. Newman, J.L. (1975). Dimensions of Sandawe diet. *Ecology of Food and Nutrition, 4, 33-39.*

426. Ogle, B., Malambo, L., Mingochi, D., Mkomesha, A. and Malasha, I. (1990). *Traditional Vegetables in Zambia. A Study of Procurement, Marketing and Consumption of Vegetables in Selected Rural and Urban Areas in Zambia.* Swedish University of Agricultural Sciences, Uppsala.

427. Ogubu, J. (1973). Seasonal hunger in tropical Africa as a cultural phenomenon. The Onich Ibo of Nigeria and Chakaka Poka of Malawi. *Africa, 43, 317-332.*

428. Oguntoyinbo, J.S. and Richards, P. (1978). Drought and the Nigerian Farmer. *Journal*

of Arid Environments, 1, 165-194.

429. Omohundro, J (1985). Efficiency, sufficiency and recent change in Newfoundland subsistence horticulture. *Human Ecology, 13, 291-308.*

Traditional Newfoundland agriculture, based on tuber-root and brassica gardening, has been criticised as inefficient and environmentally damaging. However this paper shows how this system is efficient and contributes to diet in food deficit periods caused by poor land quality and climate. The plural economy of households comprises a mix of hunting and fishing with potato and vegetable cultivation. When the weather inhibits cultivation, it brings the cod close to the shore; when it disturbs fish movements, it favours farming. Fish and seaweed are used for green manuring crops.

430. Pagezy, H. (1988). Coping with uncertainty in food supply among the Oto and Twa living in the equatorial flooded forest near Lake Tumba, Zaire. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 175-209, Clarendon Press, Oxford.

Although seasonality may not be immediately recognized in equatorial regions, a bimodal pattern of rainfall exists. This study illustrates the seasonal food consumption patterns for the Oto and Twa of Zaire. The Oto are established agriculturalists while the Twa are hunter-gatherers. In the rainy season there is an abundance of edible caterpillars and insects, mushrooms and wild leaves. Game are most easily hunted at this time, as the flooded rivers force them to move to higher ground which is where most villages are located. Most fruit and honey are consumed during the dry season. Many of these products are also sold in local markets. A system of exchange has long existed between these two groups; however, the Twa are being forced to settle and their foraging territories are being converted to agriculture. The result is that their nutritional status is poorer than the Oto. They are also becoming involved in the labour market, yet can afford to buy very little.

431. Peters, C.R., Maguire, B. and Box, E.O. (1984). Plant types and seasonality of wild plant foods, Tanzania to southwestern agriculture: Resources for models of the natural environment. *Journal of Human Evolution, 13, 397-414.*

432. Pralhad Rao, N. (1989). Diet and nutrition during drought - an Indian experience. *Disasters, 13, 58-72.*

In 1987 India experienced one of the century's worst droughts with two-thirds of its sown area receiving deficient rainfall. In order to assess the diet and nutritional situation of the vulnerable population in the severely affected areas, rapid surveys were undertaken by the National Institute of Nutrition, Hyderabad, in Andhra Pradesh, Tamil Nadu, Karnataka, Orissa and Gujarat, during the months of October-December 1987. A total of 5899 pre-school children and 7941 adults were examined for nutritional status and 1035 households covered for dietary assessment in 162 villages. The average energy intakes of landless and other labourer households was found to be closer to the non-drought level of about 2000 Kcal. This compares favourably with 1100-1400 Kcal levels revealed by earlier drought surveys in 1965-67 and 1973. The households subsisting on starvation diets (500 Kcal/day) was far fewer than in the earlier droughts, and there was a virtual absence of households subsisting on wild leaves and tubers (famine foods), such as was seen in the drought of 1965/66. It is concluded that the widespread hunger and its consequences encountered in earlier droughts has been averted, due mainly to the better food security and distribution mechanisms now available.

433. Rahaman, M. (1978). The cause and effects of famine in the rural population: A report from Bangladesh. *Ecology of Food and Nutrition, 7, 99-102.*

434. Rahmato, D. (1988). Peasant survival strategies in Ethiopia. *Disasters, 12, 326-344.*

With evidence from the famine periods of 1973 and 1984, this paper argues that food relief for the people of Wollo, Ethiopia is an option of last resort. Wild food sources are an important component of peasant survival strategies and it is women who are particularly knowledgeable about species used for food. A variety of plants were eaten during the 1984 drought. These included leafy vegetables (Portulae oleracea; Amaranthus sp.), berries and fruits (Clarissa edula; Rosa abyssinica; Ficus sur) and roots and tubers. These were an important component of local coping strategies.

435. Rai, S. (1987). Chemical examination of edible plants in Rajasthan desert with special reference to Capparidaceae. *Current Agriculture, 11, 15-23.*

The results of a survey of 24 species, which can be used as emergency famine foods, are reported. The botanical and common names of the species, and their uses, are given.

436. Rao, N.P., Rao, D.H., Brahmam, G.N.V., Sastry, J.G., Vijayaraghavan, K., Satyanarayana, K., Sarma, K.V.R., Neela, J., Reddy, C.G. and Kuma, R.K.(1988). Diet and nutrition during drought. *Nutrition News,India, 1-4.*

A survey made in the Indian States of Gujarat, Orissa, Andhra Pradesh, Tamil Nadu and Karnataka to assess the impact of the drought of 1987 on the nutritional state of the population is reported briefly. Availability of and access to staple food for most people was better than during earlier droughts. Mean energy intakes tended to be near 2000 kcal, except in Tamil Nadu (1670 kcal), compared with 1100 to 1400 kcal reported during earlier droughts. No household subsisted on less than 500 kcal per head daily. During the drought no household subsisted on wild leaves and tubers which was usual during earlier famines.

437. Reardon, T., Matlon, P. and Delgado, C. (1988). Coping with household-level food insecurity in drought-affected areas of Burkina Faso. *World Development, 16(9), 1065-1074.*

438. Richards, P. (1986). *Coping with Hunger.* Allen and Unwin, London, UK.

Coping with hunger in Mozbuama, Sierra Leone includes the harvesting of farm bush,forest and grassland products. The wild yam (Dioscorea minutiflora) is particularly important. It serves as a short term staple when all the rice has been eaten. Oil Palms are also harvested, largely due to production of palm wine. This is marketed and provides a larger and more regular income than palm oil. Fish and game are also important wild resources in the area. Women fish dry season pools and men trap rodents in the course of pest control work in upland rice fields. Occasionally African buffalo (Syncercus caffer) and warthog are hunted in the grassland areas. This requires access to firearms, ammunition and much courage. However, the returns are high. Meat sales from one is equivalent to the value of rice produced by a whole year's farming effort.

439. Rosetta, L. (1986). Seasonal variations in food consumption by Serere families in Senegal. *Ecology of Food and Nutrition, 20, 275-286.*

440. Saxena, S.K. (1979). Plant foods of Western Rajasthan. *Man and Environment III, 35-43.*

Local wild plants are well adapted to the dry conditions in Western Rajasthan: they can germinate and produce seeds even during droughts. This ability allows them to be utilised as a food resource when cultivated crops have failed to grow. These plants are classified according to their parts eaten (leaves, seeds, fruits, roots, tubers and rhizomes) with information listed on their seasonality, habitat and uses.

441. Saxena, S. (1986). Desert plants used as human food during scarcity and famines. In: K.A. Shankernarayan and V. Shanker (eds.), *Desert Environment: Conservation and Management*, pp. 43-47, C.A.Z.R.I. Publication No. 26, Jodhpur, India.

> During times of food shortages and famines, it is the poor who most depend upon wild resources for food. This paper discusses such wild foods, their uses and preparation under the following categories: foliage, seeds, fruits, flowers and buds, roots and tubers, stem bark under leaf pulp.

442. Shankarnarayan, K.A. and Saxena, S.K. (1987). Life supporting arid zone plants in famine period. In: R. Poorada, P. Kapoor, and R. Arora. *Plants in Arid Lands*. Bhagmed, National Bureau of Plant Genetic Resources, New Delhi, India.

> In India when famine occurs, the poor, nomads and tribesmen rely upon wild foods. Vegetables such as Amaranthus spp., Achyranthes aspera, and Digera muricata are harvested from wastelands and fallow fields. Grains (Cenchrus spp., Echinochloa spp.), fruits (Capparis decidua, Zizyphus mummularia), roots (Butea monosperma and Bombax ceiba) and tubers (Ceropegia tuberosa and Cyperus spp.) are also gathered.

443. Shepherd, A. (1988). Case studies of famine: Sudan. In: D. Curtis, M. Hubbard and A. Shepherd. *Preventing Famine: Policies and Prospects for Africa*, pp. 28-72, Routledge, London.

444. Sperling, L. (1987). Food acquisition during the African drought of 1983-1984: A study of Kenyan herders. *Disasters, 11(4), 263-272.*

> This paper documents the spread of drought during 1983-4 in northern Kenya. It focuses on the food acquisition by Samburu pastoralists during the drought. Local strategies of herding, hunting and gathering offered limited benefits. Similarly commercial channels for procuring food were inadequate. Lacking alternative means, Samburu had to rely on hand-outs.

445. Swift, J. (1989). Why are rural people vulnerable to famine?. In R. Chambers (ed.) *Vulnerability: How the Poor Cope. IDS Bulletin, 20(2)*, Institute of Development Studies, Sussex.

> Vulnerability to famine has been generally explained in terms of failures of production and failures of exchange, but neither is adequate. Some of these problems are resolved by an analysis of the status and trends in assets of a household - investments and stocks of foods and value and claims that households, individuals and communities can exert on others. A more complete analysis of factors affecting vulnerability has implications for policy development.

446. Taha, S.A. (1987). Household food consumption in five villages in the Sudan. *Ecology of Food and Nutrition, 7, 137-142.*

447. Testart, A. (1988). Food storage among hunter-gatherers: More or less security in the way of life?. In: I. De Garine and G.A. Harrison (eds.), *Coping with Uncertainty in Food Supply*, pp. 170-174, Clarendon Press, Oxford.

448. Toulmin, C. (1986). Access to food, dry season strategies and household size among the Bambarra of Central Mali. *IDS Bulletin, 17, 58-66.*

> This article describes the seasonal variation in production and household organisation in a Sahelian

village. The dry season offers a range of income-earning activities for the individual to pursue. Different households, depending on their asset holdings and food security, are able to make use of the dry season in different ways. Poorer households must engage in ensuring food supplies through the dry season and until the next harvest and wild food collection and storage may be important. Richer households, with relatively large food stores, are able to engage in investment and productive development, such as well building.

449. Vaughan, M. (1987). *The Story of an African Famine: Gender and Famine in 20th Century Malawi*. Cambridge University Press, Cambridge.

450. Velarde, N. (1991). *The Zambian Farming Systems Approach to Studying Household Food Security*. Working seminar on Dependency on Forest foods for Food security. IRDC, Uppasala. March 13-15.

The impact of taking household food security and nutrition issues seriously in farming systems research programmes is documented in this Zambian case study. Incorporating these elements into diagnostic surveys focuses attention on wild food use, particularly by women. These may have been missed in conventional exercises which tend to have a 'main crop' bias. The impact this approach has had on government farm production research activities is documented.

451. Walker, P. (1989). *Famine Early Warning Systems. Victims and Destitution*. Earthscan, London.

A famine is not a single natural catastrophe: it has many stages. This book makes this very clear and explores the implications for a range of policy issues, including relief operations, early warning systems and development support to reduce vulnerability.

452. Watts, M. (1983). *Silent Violence: Food, Famine and Peasantry in Northern Nigeria*. California University Press, Berkeley, California.

Chapter Six

The Nutritional Value of Wild Foods

Sacred baobab tree, Louly Mba Faye, Senegal
Photo: Jules Pretty

6. THE NUTRITIONAL VALUE OF WILD FOODS

Wild foods are a part of rural people's diets not only during periods of food shortages, but also on a daily basis (90; 396; 398; 400a; 466; 490; 491; 493, 494; 545). Most dietary studies emphasize the value of calorific intake from staples. However, the amounts of wild foods consumed, their frequencies of consumption as well as their nutrient contents have also been explored (301, 316, 459, 462, 465, 466, 493, 504, 556). It is this daily consumption of wild products which contributes to overall nutritional well-being. Game and fish are major sources of protein and fat, while wild vegetables, fruits and seeds supply minerals, vitamins and fats. Even wild flowers, such as Fernaldia pandurata of Central America, are eaten (883). A range of studies provide evidence for the every day use of wild products as side dishes or snack foods and sometimes as replacements for staples. The chemical composition of some wild food sources has also been analysed demonstrating their nutritional significance (458; 467; 473; 475; 480; 481; 492; 507; 512; 516; 517; 529; 532; 534; 542; 559; 561; 568).

Dietary Diversity and the Role of Wild Products

It is access to a wide range of products and the resulting dietary diversity that contributes to nutritional well-being (398; 497; 498; 500; 508; 518; 526; 613). Better nutritional status is associated with proximity to forests or the presence of a home gardens or orchards (152; 493; 509; 545; 551; 613). An increase in the production of fruits and vegetables in Mexico helped to improve the nutritional status of villagers (502). In a study of two different ecological regions, in southern Zimbabwe, it was found that families in the zone in which species diversity was greater had a more balanced diet during the dry season (172). Dietary diversity is also crucial as these various nutrients interact with one another within the body. For example, fats enhance the absorption of vitamins A, D, and E (398; 399) or oxalic acid found in leafy vegetables may inhibit absorption of calcium (541). Non-dietary modifiers and anti-nutritional factors may also affect the nutritional impact of wild foods (505; 561).

The appearance of wild foods is seasonal for many products (140; 152; 504). Their presence

may coincide during times of food shortages, but their harvesting can also reflect the flexibility of farmers' procurement strategies which take advantage of the natural abundance of these species (518). In Newfoundland, for example, the plural economy of households comprises a mix of hunting and fishing with potato and vegetable cultivation. When the weather inhibits cultivation, it brings the cod close to the shore; when disturbs fish movements, it favours farming (429).

The Impact of Social Change

The collection of wild foods, however, appears to be diminishing as populations grow, with decreasing access to collection sites, and with more people participating in the cash economy (495, 509). Commercial foods and drinks are sometimes held in greater esteem than wild food equivalents which may be viewed as items only for consumption by the poor (429, 504, 533, 542). Likewise, new aversions may be adopted, for instance, the Yukpa no longer consume insects as regularly as in the past (356). As the daily activities of individuals change, so too does their knowledge of wild products plants. In Swaziland, now that young men spend more time working for wages rather than herding, they no longer recognise as many plants as other local people (111-113).

Dietary change is often associated with social upheavals caused by natural disasters or forced movements of populations (see 374-452 for literature on wild foods and drought/food security; 479; 484; 520; 523; 535; 557; 562; 564). Resettlement or refugee migrations often necessitate adaptations to a changed food base (456; 501; 554).

A range of wild animals are important in the nutrition of agriculturalists, pastoralists and forest dwellers. It is often small game (rodents, monkeys, small buck) that are nutritionally the most significant. Among the Amahuaca swidden cultivators of Peru, 40% of their food was obtained from hunting (181). In Botswana, all the meat consumed by bushmen was wild, while 80% of all meat consumed by livestock owners was wild (301).

Comparisons with Domesticated Food Sources

When the nutrient contents of wild foods are compared with cultivated foods, there is of course great variability. Some wild animals such as capybara and iguana (Lacerta iguana) can have similar protein, fat and energy contents as pigs, cattle and chickens (299). Other species, for example of ungulates, may have leaner meat and less fat (316; 534). Ants, grubs and caterpillars have similar energy, protein and fat contents as pork sausage and beef liver (54). Over 1,300 insects have been classified as edible (546, 547) and are sources of protein and fat (152; 487, 504, 545). Some insects can even have a higher iron and protein content than fish (152). During the rainy season, insects contribute 12% of the total animal protein to the diets of men and 26% to women of the Tukanoan Indians of Colombia (487). Children are often collectors (485). If game is in short supply, insects can substitute proteins and fats (49; 487). An important consideration is that wild game can have greater production efficiencies than domestic livestock. For example, the capybara is 3.5 times more efficient at converting food to meat than cattle (316; 354). Also such wild species adapted to the local environments are often better able to resist diseases.

Adults and children frequently consume leafy vegetables as a side dish. These vegetables are often wild or a weed of agriculture (148; 175; 476, 486, 494, 504, 516, 528, 531, 541, 528, 533). Nutritionally, they are high in protein, calcium, vitamin A and iron (494, 504, 510, 521, 522, 543,559, 563). Leafy vegetables, rich in lysine, are perfect complements to lysine-deficient maize (470, 471, 514, 541). Wild yams are often staples (48, 475, 504). Fruits are usually snacks consumed between meals or when out walking (48; 49; 111-113; 541). They are viewed mainly as children's foods (9; 170; see 608-630). The fruit of cultivated Bactris gasipaes is a source of protein and carbohydrates and can produce more macronutrients per hectare than maize (888). The mongongo (Ricinodendron rautanenii) wild fruit tree is a staple in the diet of the !Kung San bushmen (92-94; 566). Its fruits and kernels are sources of calories, protein and minerals. Other tree fruits are also known to be important for human nutrition (eg. 459; 465; 468; 472; 473; 513; 517; 529; 536; 537; 558; 564).

Wild plants can have higher fat, protein, mineral and vitamin contents than cultivated species

(464, 541). Wild grains may also be more nutritious than cultivated varieties. The wild rice Zizania aquatica has higher concentrations of protein, magnesium, phosphorous, potassium and vitamins B1 and B2 than cultivated Oryza sativa (532). The wild rice bean (Vigna minima) was also found to be of equal or greater nutritional value than the cultivated species (V. umbellata).

In Africa, the oil palm tree, Elaeis guineensis, is often protected and is an important source of fat, calcium, phosphorous and vitamin A throughout the year (457, 480, 504). Jessenia spp. are important oilseeds in South America providing oil and protein. The quality of this oil and protein is comparable to olive oil and animal protein (457, 888). Similarly, the jojoba plant (548) and other plants from arid lands (560) have potential for oil production. The wild sago palm (Metroxylan spp.) is a staple in parts of Southeast Asia (454; 474). In Northern Africa, a main source of fat is derived from shea butter produced form the kernels of Vitellaria paradoxa or Butyrospermum, spp. (673).

Malnutrition

Despite this great diversity and supply of nutrient-rich foods, malnutrition is commonplace in the Third World. Protein-energy malnutrition in which calories from staples and/or the body's amino acid building blocks from proteins are lacking is the most widespread form (506; 507; 544; 552; 553). Other deficiencies prevalent include iodine, vitamin D, vitamin B2, iron, calcium and fat (533; 551; 613). Vitamin A deficiency can result in blindness and affects approximately 6 million children in the world (496). Children and pregnant and lactating women are the most vulnerable to deficiencies.

To what extent can wild foods prevent such deficiencies? Can protein or energy-rich wild foods help to alleviate malnutrition? In light of the higher incidence of malnutrition among children, their foraging activities provide essential supplies of fats and proteins from insects and of vitamins and minerals from plants and fruits. Specific plants may even be able to improve milk production of mothers.

The presence of parasitic diseases and other illnesses means it is often difficult to link malnutrition to the lack of consumption of a specific food. Few such studies have been attempted. A notable exception is the increased incidence of goitre and cretinism among the Azanade of Central Africa as a result of the replacement of the home-produced ash salt from wild plants with purchased iodine-deficient salts (545). Benefits have occured after dietary change. In one example in India, the incidence of vitamin A deficiency declined in children following the increased consumption of mangoes (489). Similar changes occurred in Brazil after the increased consumption of buriti fruits (Mauritia vinifera) whose oil fraction which is also high in beta-carotene, a precursor to vitamin A (525).

There is a clear need to incorporate nutritional and dietary concerns into forestry and agricultural plans. Greater linkages in studies could be made between the nutrient content of *wild foods, dietary surveys of their consumption and anthropometric assessments.* Wild foods often provide key supplements to the main diet and are of great nutritional importance. Without the understanding of the complementarity between staple crop foods and wild food intake, agricultural planning will continue to be dominated by major crops to the exclusion of other, often nutritionally very important, wild products (466; 488; 490; 491; 499; 539; 540).

CHAPTER 6: THE NUTRITIONAL VALUE OF WILD FOODS

453. Ahmed, A.M. (1981). Forests as a source of food: Malaysia. *Tiger Paper, 8(3), 9-16.*

454. Anderson, A.J.V. (1977). Sago and nutrition in Sarawak. *Sarawak Museum Journal, 25, 71-80.*

455. Annegers, J.F. (1973). Ecology of dietary patterns and nutritional status in West Africa, 1: The distribution of starchy staples. *Ecology of Food and Nutrition, 2(2), 107-119.*

456. Autier, P. (1989). Migrations and nutritional status in the Sahel. *Disasters, 13(3), 247-254.*

> Migrations are an important response to the variability of Sahelian environments. This study shows that in settlements where households had been abandoned due to migration, malnutrition rates were significantly higher.

457. Balick, M.J. and Gershoff, S.N. (1981). Nutritional evaluation of the Jessenia bataua palm: Source of high quality protein and oil from Tropical America. *Economic Botany, 35(3), 261-271.*

> Jessenia bataua is a wild palm which grows in swamp and upland regions of the Amazon. The pulp of its fruits are high in protein and fats. It can be eaten ripe or processed into a milky beverage or oil. The fatty acid composition of the oil is similar to that of olive oil. The amino acid composition also compares well with animal proteins and is of a better quality than grain and legume proteins. When the fruit is in season, there is a marked gain of weight among individuals consuming it. The palm also provides fibres, household materials and medicinal. Jessenia bataua is a potential food high in protein and fats which can be grown in marginal areas to support growing populations. The quality of its oil could also be sold on national and international markets; however, further research on the cultivation and yields of the species is needed.

458. Balogun, A.M. and Fetuga, B.L. (1986). Chemical composition of some underexploited leguminous crop seeds in Nigeria. *Journal of Agricultural and Food Chemistry, 34, 189-192.*

> Seeds of 16 wild legumes (Mimosoideae, Caesalpinoideae and Papilionoideae) were studied. Most members of the Mimosoideae were rich in protein with Acacia senegal 38.9%, Parkia clappertoniana 29.4%, Prosopis africana 25.7% and Tetrapleura tetraptera 25.5%. Pterocarpus osun (Papilionoideae) had 28.1% protein. Ether extract, crude fibre and ash contents were fairly high. Generally the seeds seemed to be good sources of calcium, phosphorus and potassium, but were poor in sodium. Zinc and manganese contents varied widely.

459. Becker, R. (1983). Nutritional quality of fruit and leaves from the chanar tree (Geoffroea decoticans). *Ecology of Food and Nutrition, 13, 91-97.*

460. Beckerman, S. and Sussenbach, T. (1983). A quantitative assessment of the dietary contribution of game species to the subsistence of South American tropical forest tribal peoples. In: J. Clutton-Brock and D. Grigson (eds.), *Animals and Archaeology: 1. Hunters and Their Prey*, pp. 337-350, BAR International Series.

461. Behrens, C.A. (1986). Diet and activity patterns among the Shipibo. *Human Ecology*, 14(4), 367-396.

> Shipibo Indians in Peru are gradually depleting the local fish and game resources through the impact of settlement. Men who have ad opted rice as a cash crop tend to fish and hunt less than those who are relying on their subsistence gardens. Changes in cropping strategy result in changes in work patterns. This has a direct impact on diet. Quantitative data is presented from this community to illustrate this.

462. Berlin, E.A. and Markell, E.K. (1977). An assessment of the nutritional and health studies of an Aguarana Jivaro community, Amazons, Peru. *Ecology of Food and Nutrition, 6;69-81.*

> The Aguaruna are agriculturalists cultivating 46 food plants of 136 varieties. The main staples are manioc, bananas and plantains. Fish are the major source of protein; however, game are also hunted. Chickens and pigs have been introduced. This study combines anthropometric measurements and clinical evaluations of villagers to examine their food intakes and shows that most villagers are well-nourished.

463. Black, F., Hierholzer, W., Black, D., Lamm, S. and Lucas, L. (1977). Nutritional status of Brazilian Kayapo Indians. *Human Biology, 49(2), 139-153.*

464. Brand, J.C., Cherikoff, V. (1985). The nutritional composition of Australian Aboriginal food plants of the desert regions. In: G.E. Wickens, J.R. Goodin, and D.V. Field (eds.). *Plants for Arid Lands*. Proceedings of the Kew International Conference on Economic Plants for Arid Lands, 23-27 July 1984, pp.51-68. George Allen and Unwin, London.

> Information is given on the nutritional composition, palatability and seasonal availability of wild foods used by Australian Aborigines. These wild plants usually have a higher protein, fat and carbohydrate content than cultivated plants.

465. Bressani, R. (1977). Composition and potential use of some tropical fruits. *Arch. Latin Amer. Nutr., 24(4), 475-493.*

466. Brinkman, W. (ed.) (1989). *Why Natural Forests are Linked with Nutrition, Health, and Self Reliance of Villagers in Northeast Thailand: A Collection of Papers*. Royal Forest Department, Ministry of Agriculture and Cooperatives, UNDP, FAO, Swedish International Development Agency, Khon Kaen, Thailand.

> This collection of four papers is derived from a workshop on forestry and nutrition held at Khon Kaen University. The collection o f forest foods is placed within the context of nutrition and changes in villagers' livelihoods in the Phu Wiang Watershed of Northeast Thailand. Vulnerable groups to malnutrition include pregnant and lactating women and pre-school children. Within the watershed area, 47.1% of children aged 1-4 years and 13% aged 0-1 year of age showed signs of protein-energy malnutrition. Villagers depend upon rice cultivation and most seem to grow cassava within the forest reserve. They also collect fuelwood, vegetables, bamboo shoots, mushrooms, fruits, honey, medicine and hunt game from the forest. An appendix contains a list of these species along with their habitats, uses, and market price if available. In swidden fields eleven species are found and in paddy fields, nine. Other habitats include secondary forest, swamps, dry dipterocarpus forest, dry evergreen forest and mixed deciduous forest. Mushroom collection is a significant activity for households. Home gardens are also present and 27 species are listed. Participation in the cash economy, privatisation of natural resources and deforestation are all increasing. On the whole, availability of forest resources is

decreasing; however, game and vegetables are still obtained. These activities are most important for the poor and landless.

467. Brown, A.J.P., Roberts, D.C.K. and Cherikoff, V. (1985). Fatty acids in indigenous Australian foods. *Proceedings of the Nutrition Society of Australia, 10, 209-212.*

The fatty acid content of 27 native Australian foods is given (12 seeds, 5 nuts and 10 roots). The seed oils analysed included 9 different species of Acacia which had up to 70% linoleic acid. In general seeds and nuts had polyunsaturated: saturated fat ratios greater than 1, as had most of the roots.

468. Burger, A.E.C., De Villiers, J.B.M., and Du Plessis, L.M. (1987). Composition of the kernel oil and protein of the marula seed. *South African Journal of Science, 83, 733-735.*

469. Cadelina, R.V. (1983). Batak interhousehold food sharing: a systematic analysis of food management of marginal agriculturalists in the Philippines. *Dissertation Abstracts International, 44, 525*; Dissertation, University of Hawaii, 1982, 325pp.

The Batak, marginal agriculturalists of Palawan, Philippines, are faced with progressive food stress due to resource depletion. The stress is aggravated by the seasonal unavailability of foods. Food sharing assumes greater importance as they abandon their traditional mechanism of band fission-fusion and circular migration due to forest depletion. The data were collected on a bi-monthly basis for one year for seven households, representing the different life-cycle stages of the family. Cultural ecology and systems approaches were combined with analysis of interhousehold food sharing. The main conclusion is that interhousehold food sharing is an integral component of the Batak food management system and enables them to cope with cyclical food stress. Depending on the life-cycle stage of their families, some households have larger labour supply and lower food requirements; thus food (including wild foods) flows from them to households in other states with food deficit. The intensity of sharing food is affected by the manner of sharing, types of food, kinship, and geographical distance. Capital resources such as swidden plots, wild resin camps, labour, tools, and information are also shared.

470. Caldwell, M.J. and Enoch, I.C. (1972). Riboflavin content of Malaysian leaf vegetables. *Ecology of Food and Nutrition, 1, 301-312.*

471. Caldwell, M.J. and Enoch, I.C. (1972). Ascorbic acid content of Malaysian leaf vegetables. *Ecology of Food and Nutrition, 1, 313-317.*

472. Carr, W.R. (1958). The baobob tree: A good source of ascorbic acid. *Central African Journal of Medicine, 4, 372.*

473. Chauhan, B.M., Duhan, A. and Bhat, C.M. (1986). Nutritional value of ker (Capparis decidua) fruit. *Journal of Food Science and Technology, India, 23, 106-108.*

The ker tree (Capparis decidua) grows well in arid and semi-arid regions of India. This study examined unripe fruits for protein, fat, fibre and carbohydrate content. Beta-carotine, ascorbic acid, trace metal and calcium contents were also measured. The results show that the ker fruit has high nutritional value.

474. Chen, P.C.Y. (1984). Child nutrition among the Penans of the Upper Baram, Sarawak. *Medical Journal of Malaysia, 39, 264-268.*

Food sources of the nomadic Penan tribe in Upper Baram, Sarawak, Malaysia, include game such as

wild boar, deer and monkeys, small fish and prawns and edible plants, fruits and shoots. The staple food of the tribe is sago from which flour is extracted. Some families which had settled for 20 years or more are able to obtain 50 to 60% of their staple requirements by cultivating rice, tapioca or maize; they also grow small amounts of cucumbers, gourds and beans.

475. Cherikoff, V., Brand, J.C. and Truswell, A.S. (1985). The nutritional composition of Australian Aboriginal bushfoods. Corms, roots, tubers and yams. *Proceedings of the Nutrition Society of Australia, 10, 183.*

Four samples of corms, including the bush onion (Cyperus bulbosus) and prepared taro (Colocasia sp.) were analysed for nutrient content. The taro preparation was high in potassium, calcium and iron. Although higher in fibre the constituent proportions of 5 samples of roots and rhizomes were similar to those in turnip and parsnip. Tubers from species of Liliaceae, Compositae and Fabaceae were similar in nutrient composition to carrots and potatoes. The 13 native yam samples analysed were similar in composition to African yams.

476. Chweya, J.A. (1983). Identification and nutritional importance of indigenous green leaf vegetables in Kenya. In: *Ninth African Symposium on Horticultural Crops*, Mahe, Seychelles, 27-29 July, 1983, International Society for Horticultural Science, Wageningen, Netherlands.

477. Cmelik, S.H.V., Galloway, E. and Ley, H.E. (1976). Essential fatty acid content in some foodstuffs of plant origin used in Rhodesia. *Central African Journal of Medicine, 22(3), 42-45.*

478. Colson, E. (1959). Plateau Tonga diet. *Human Problems in British Central Africa, 24, 51-67.*

479. Corkhill, N.L. (1949). Dietary change in a Sudan village following locust visitation. *Africa, 19(1), 1-12.*

480. Cornett, J.W. (1987). Nutritional value of desert fan palm fruits. *Princeps, 31, 159-161.*

Fruits and seeds of Washingtonia filifera were known to be used as a food resource by the Cahuilla Indians of the southern California deserts. The nutritional analysis of W. filifera fruits was compared with analyses of other Indian and non-Indian food plants. W. filifera fruits have a higher carbohydrate content than other Indian food plants, but significantly less protein. Protein content was less than half that in Prosopis juliflora, a common oasis plant and food resource of the Cahuilla. Results suggest that W. filifera fruits have the potential to be an important dietary mainstay.

481. Creevey, C (1989). Aboriginal health data suggest wild foods beneficial. *Food-Australia, 1, 564.*

This brief discussion about the Aboriginal diet highlights the fact that even though the traditional diet is high in animal foods, coastal tribes eat plenty of fish and crustaceans which are high in polyunsaturated fatty acids and wild animal carcasses contain much less intramuscular and depot fat than do domestic animal carcasses.

482. Curry, J.J. and Huss-Ashmore, R. (1989). Diet, nutrition and the culture of agriculture in Swaziland. *Culture and Agriculture, 39, 2-5.*

483. Davis, T.A. (1986). Nipa palm in Indonesia: A source of unlimited food and energy. Indonesian *Agricultural Research and Development Journal, 8(2), 38-44.*

484. De Garine, I. (1984). De la perception de la malnutrition dans les societes traditionelles. *Information sur les Sciences Sociales, 23, 731-754.*

485. De Garine, I. (1980). Approaches to the study of food and prestige in savanna tribes: Massa and Mussey of northern Cameroon and Chad. *Social Science Information, 19, 39-78.* See also: 391.

486. Dirar, H.A. (1984). Kawal, meat substitutes from fermented Cassia obtusifolia leaves. *Economic Botany, 38(3), 342-349.*

487. Dufour, D.L. (1983). Nutrition in the Northwest Amazon: Household dietary intake and time-energy expenditure. In: R.B. Hames and W.T. Vickers, (eds), *Adaptive Responses of Native Amazonians, pp. 329-355, Academic Press, New York.*

> A study of food production and consumption of the Tatuyo Indians of Colombia was carried out in the months of November, 1976 and April 1978. Weights of food cultivated, gathered and hunted were recorded, as well as dietary intakes and the amounts of time allocated to these tasks. The most significant wild vegetable product during the study periods to diets was the oilseed Erisma japura. Wild plants contributed 1% of the total energy and 1.3% of protein consumed. The values for insects equalled 2% and 4.8% respectively. Insects were relied upon when game and fish were in short supply. Fish contributed the greatest amount of protein equal to 57.7% of the diet, and game only 8%. The author does note however that wild plant foods do probably supply significant amounts of fats and micronutrients, with fruits particularly important during the rainy season.

488. Ektin, N.L. (1986). Multidisciplinary perspectives in the interpretation of plants used in indigenous medicine and diet. In: N.L. Etkin (ed.), *Plants in Indigenous Medicine and Diet: Biobehavioral Approaches*, pp. 2-29, Redgrave, Bedford Hills, New York.

489. FAO (1984). *India, Malaysia and Thailand: A Study of Forests as a Source of Food.* FAO, Bangkok.

490. FAO (1989). *Forestry and Nutrition: A Reference Manual. Forests, Trees and People,* Swedish International Development Authority, and FAO, Rome.

> This reference manual is an important sourcebook to the literature on forestry and nutrition. It aims to highlight the significance of forest resources such as wild vegetables, nuts, seeds, oil, wild game and fungi to the rural poor. It begins with a discussion on their direct nutritional contributions (daily supplements, seasonal and emergency) and indirect contributions (income, medicines, fuelwood and fodder). An overview of the literature is given explaining where these studies may be found. It contains an annotated bibliography of 239 references drawn mainly from African studies. Subject and geographic indices provide for easy referral. The conclusion calls for a consideration of communities' nutritional needs in forestry projects.

491. FAO (1990). *Incorporating Nutrition Concerns into Forestry Activities. Field Guide.* FAO, Rome, Italy.

492. Ferguson, E.L., Gibson, R.S., Thompson, L.U., Ounpuu, S. and Berry, M. (1988).

Phytate, zinc, and calcium contents of 30 East African foods and their calculated phytate:Zn, Ca:phytate, and [Ca][phytate]/[Zn] molar ratios. *Journal of Food Composition and Analysis, 1, 316-325.*

Phytate was estimated in 30 staple Malawian foods, raw and prepared "as eaten" using an anion-exchange method, and for calcium and zinc were estimated by flame atomic absorption spectrophotometry. In general, leaves had the highest Ca content, followed by kidney beans, and dry pigeon peas. The content of other foods was relatively low. The Zn content of wild blight, cassava leaves and okra leaves was similar to that for the less refined cereals and legumes (more than 1.0 mg/100 g FW), but higher than that of highly refined cereals, pumpkin leaves, chinese cabbage and other foods. These results suggest that the bioavailability of Zn in the Malawian diet is probably low, due to the high phytic acid content of the staple foods.

493. Fleuret, A. (1979). The role of wild foliage plants in the diet: A case study from Lushoto, Tanzania. *Ecology of Food and Nutrition, 8, 87-93.*

Wild green leafy vegetables are not only emergency foods or "supplementary" in the sense of "peripheral" to diets, but are an essential part of every-day diets. Such leaves can be found in forests or along roads and paths. Three villages were studied during three different seasons. Householders were interviewed on what they had eaten the previous day. They were mainly small-holders growing maize, potatoes, bananas, vegetables and some cash crops such as tea and coffee. Vegetables were also sold. Most meals except breakfast were of a stiff porridge of maize, potato or cassava. Three-quarters *of these meals excluding breakfast were accompanied by a side dish of meat, fish, beans, nuts or most* frequently by green leafy vegetables. Frequencies of vegetable consumption are presented in tables. In one of the villages studied, 81.2% of the vegetable side dishes were composed of wild plants and 17.7% were of exotic, cultivated vegetables. In total wild plants appeared in 32% of all meals.

Although this village cultivated vegetables, they preferred wild leaves which are free and are seen as replacements for meat and fish. The cultivated vegetables, however, were sold. The village near to a forest reserve consumed a greater variety of vegetables than the other two. Quantities consumed or nutrient contents were not measured; however, other studies have shown that these wild leafy vegetables contain high amounts of protein, calcium and Vitamin A. In addition to supplying a significant portion of diets, wild greens can be sold in markets by women. Such women are often single or do not have enough land to sell cultivated foods. This sale enables them to earn two to three shillings per day (25-40 US cents). On the whole, cultivated vegetables have not replaced wild greens in diets in Lushoto.

494. Fleuret, A. (1979). Methods for evaluation of the role of fruits and wild greens in Shambaa diet: A case study. *Medical Anthropology (Spring).*

495. Flowers, N.M. (1983). Seasonal factors in subsistence, nutrition, and child growth in a central Brazilian Indian community. In: R.B. Hames and W.T. Vickers, (eds), *Adaptive Responses of Native Amazonians*, pp. 357-390, Academic Press, New York.

496. Francois, P. le, Chevassus-Agnes, S., Benefice, E., Dyck, J.G., Maire, B, Parent, G., Seymat, G., and Ndiaye, A.M. (1980). Vitamin status of populations in three West African countries. *International Journal for Vitamin and Nutritional Research, 50, 352-363.*

497. Getahun, A. (1974). The role of wild plants in the native diet in Ethiopia. *Agro-Ecosystems, 1, 45-56.*

498. Grivetti, L.E. (1978). Nutritional success in a semi-arid land: Examination of Tswana agro-pastoralists of the eastern Kalahari, Botswana. *American Journal of Clinical Nutrition, 31, 1204-1220.*

499. Grivetti, L.E. (1981). *Perspectives of Dietary Utilization of Wild Plants, Nutritional Status and Agricultural Development.* International Geographical Union Commission on Rural Development, Fresno, California.

500. Gura, S. (1986). A note on traditional food plants in East Africa: Their value for nutrition and agriculture. *Food and Nutrition, 12(1), 18-26.*

501. Harding, W.R. (1986). Dietary surveys from the Tokelau Island migrant study. *Ecology of Food and Nutrition, 19(2), 83-97.*

502. Hernandez, M., Perez H., C., Ramirez H.J., Madrigal, H. and Chavez, A. (1974). Effect of economic growth on nutrition in a tropical community. *Ecology of Food and Nutrition, 3, 283-291.*

This is a thorough study assessing the nutritional status and nutrient intakes communities in the State of Tabasco in Mexico. The studies were performed before and after a project of dams and drainage to improve the agricultural production in the area. Thirteen years after the initial study, it was found that the nutritional status of individuals improved. The people had maintained traditional diets and had increased their consumption of fruits and greens.

503. Hladik, C.M., Bahuchet, S. and De Garine, I. (1989). *Se Nourrir en Foret Equatoriale: Anthropologie Alimentaire des Populations des Regions Forestieres Humides d'Afrique (Food and Nutrition in the African Rainforest).* UNESCO/MAB, Paris.

504. Hladik, C.M., Bahuchet, S. and De Garine, I. (1990). *Food and Nutrition in the African Rain Forest.* UNESCO/MAB, Paris.

This report is a collection of essays presenting findings from the research of the French National Institute of Scientific Research (CNRS) "Anthropologie Alimentaire Differentielle" on food procurement in the African rain forests. Food consumption data is given for the hunter-gatherers and agriculturalists of the Central African Republic, Cameroon, Gabon and Zaire. The report provides an overview of very detailed and long-term studies in the region. Methodologies for measuring food consumption and energy are briefly described. Further references for these studies are provided.

Wild game and caterpillars are important protein sources throughout the African rain forest. Traps are placed around plantations to catch the cane rat Thryonomys swinderianus for both crop protection and food. Plant parts may also contain a high protein content; for example, the fruit of Anonidium mannii has a dry weight protein content of 12% and the leaves of Gnetum africanum 30%. Wild yams are found in sufficient quantities (5 tons/50 square kilometres) to support the Aka pygmies of the Central African Republic. Other groups cultivate cassava and maize in swidden fields taking great care to protect an indigenous oil palm tree, Elaeis guineensis from fire. As a result, a higher density of this tree is found than would occur in the natural forest. Its fruits are the main source of fat in diets as well as contributing calcium, phosphorous and vitamin A. Wine is also derived from its sap.

Food consumption data of four groups in southern Cameroon who have access to similar forest resources are presented. The Yassa eat more fish and the Kola eat more game, yet total animal food intake was similar, ranging from 206-307 g/day. The Mvae cultivators (two groups) consumed the most

leafy vegetables (59-76 g as compared to 7 g and 20 g for the Yassa and Kola respectively) and seeds and oil palm 75-83 g. The Yassa consumed 30 g/day and the Kola 10 g/day of seeds and oil palm. These groups have similar access to forest resources, but have distinct production systems linked by trade. Seasonal variations in food consumption are diagrammed for the Ntomba of Zaire who are divided into two groups: the Oto cultivator-fishermen and the Twa Pygmies descended from hunter-gatherers. Consumption of cassava and oil palm remain steady throughout the year. However, fish, game and caterpillar consumption vary according to rainfall patterns. Fish are most easily caught in the dry season, while most game hunting occurs during the rainy season. Caterpillars only appear at the beginning of the rains. During the rainy season a shortage of meat occurs. The health effects of a decrease in protein consumption at this time can be exacerbated by the presence of parasitic diseases.

505. Holmes, R. (1984). Non-dietary modifiers of nutritional status in tropical forest populations of Venezuela. *Interciencia, 9(6); 386-391.*

506. Homer, M.R. (1974). Anthropometric and dietary study of Miskito Indian children in rural Nicaragua. *Ecology of Food and Nutrition, 6, 137-146.*

507. Hongo, T., Suzuki, T., Ohtsuka, R., Kawabe, T., Inaoka, T. and Akimichi, T. (1989). Element intake of the Gidra in lowland Papua: inter-village variation and the comparison with contemporary levels in developed countries. *Ecology of Food and Nutrition, 23, 293-309.*

Intake of 17 elements was estimated in 4 villages of the Gidra in lowland Papua New Guinea. Inter-village variation of food intake was large. High Fe intake was due to region-specific foods such as sago, wild seeds and shellfish.

508. Huss-Ashmore, R. and Curry, J. (1989). Diet, nutrition and agricultural development in Swaziland. 1. Agricultural ecology and nutritional status. *Ecology of Food and Nutrition, 23, 189-209.*

Data is provided on the anthropometric measurements of women and children. Stunting or low height for age was identified as the most prevalent nutritional problem. Increased cash-cropping and increased herbicide use destroys the important edible weeds, Bidens pilosa and Chorcorus spp.

509. Hutanuwatr, K., Saowakontha, S., Tranfong, S., Sinsupan, N., Panomratanarak, B., Muktabhant, B., Hutanuwatr, N. and Uttam N. (1989). Factors influencing food habits and nutritional status of Northeast villages, Thailand. In: W. Brinkman (ed). *Why Natural Forests are Linked with Nutrition, Health, and Self Reliance of Villagers in Northeast Thailand*, pp. 61-74, Royal Forest Department, UNDP, FAO, SIDA, Khon Kaen, Thailand.

This paper examines the physical and socio-economic factors affecting food availability and consumption in three villages of Northeast Thailand. As forested areas decline and fishing areas become privatised, there is a decrease in collection of their products. In the past, a surplus of food existed and was generously shared. However, today subsistence needs are barely met and most food is traded. Food preferences are also changing with an increase in communication and education. Ready-made foods are being eaten particularly during the dry season when cultivated foods may be scarce. Electricity allows for the refrigeration of packaged foods and drinks. People's preferences relate to taste rather than nutrition. They are also affected by food prohibitions and by perceptions of foods eaten by the rich or poor. Malnutrition was not directly related to economic status; however, if a mother has to leave her family to find work, then the children may become undernourished. It was found that families who were undernourished grew fewer vegetables than other families. The authors recommend that existing food habits be studied in order to improve the nutritional well-being of

villagers. Natural resource conservation is necessary to ensure the availability of forest-foods and fish.

510. Imbamba, S.K. (1973). Leaf protein content of some Kenyan vegetables. *East African Agriculture and Forest Journal, 38(3), 246 -251.*

511. INCAP-ICNND (1961). *Tabla de Composicion de Alimentos para uso en America Latina.* Comite Interdepartmental de Nutricion para la Defensa Nacional, Institutos Nacionales de la Salud, Bethesda, Maryland, Instituto de Nutricion de Centro America y Panama, Ciudad de Guatemala.

512. James, K.W. (1983). Analysis of indigenous Australian foods. *Food Technology in Australia, 35, 342-343.*

Proximate constituents of about 60 indigenous Australian foods are tabulated. Vitamins were high in a number of wild foods: ascorbic acid in salty plum (Terminalia ferdinandiana); thiamin in cooked candle nut (Aleurites moluccana); thiamin in wild cucumber (Leichhardtia australis). The results suggest that bushfoods are a valuable food resource.

513. Jawanda, J.S. and Bal, J.S. (1978). The ber, highly paying and rich in food value. *Indian Horticulture, 23(3), 19-21.*

514. Joseph, S. and Peter, K. (1985). Curry leaf (Murraya koenigii), perennial, nutritious, leafy vegetable. *Economic Botany, 39(1), 68-73.*

515. Kamol Visuphata (1987). The role of bamboo as a potential food source in Thailand. In: *Recent Research on Bamboos: Proceedings of the International Bamboo Workshop*, October 1985, Hangzhou, China, IDRC, Canada.

516. Katiyar, S.K., Kumar, N., Bhatia, A.K. and Atal, C.K. (1985). Nutritional quality of edible leaves of some wild plants of Himalayas and culinary practices adopted for their processing. *Journal of Food Science and Technology, India, 22, 438-440.*

Proximate constituents of leaves eaten by inhabitants of the northwestern Himalaya are tabulated.

517. Kermasha, S., Barthakur, N.N., Mohan, N.K. and Arnold, N.P. (1987). Chemical composition and proposed use of two semi-wild tropical fruits. *Food Chemistry, 26, 253-259.*

The edible fruits of two native species of Southeast Asia, Baccaurea sapida and Flacourtia jangomas were analysed for sugars, amino acids and minerals. These fruits are useful as supplements to a balanced diet.

518. King, S. and Levey, A. (1982). Observaciones de la dieta de los Angotero-Secoya del Norte del Peru. *Amazonia Peruana III, (6), 27-38.*

The amounts of food eaten were measured for a member of the Antorre-Secoya during the wet and dry season. During the wet season, in addition to game and fish, the fruit of Jessenia polycarpa, a wild palm, was an important source of protein. In the dry season when meat consumption declined and Jessenia polycarpa fruits were unripe, the fruits of the cultivated peach palm (Bactris gasipaes) were harvested and provided an alternative protein source. This illustrates the ability which a variety of products has to provide for balanced diets throughout the year.

519. Kyle, R. (1987). *A Feast in the Wild.* Kudu, Kidlington, Oxfordshire, UK.

Although there are about 200 species of wild, large herbivores in the world, less than two dozen species have been domesticated to provide food for man. The best way to conserve a species is to manage it effectively for meat production. The first few chapters of the book deal with subjects such as domestication, game farming projects, multiple land use, and the extinction of species. Subsequent chapters look at: bison, reindeer, musk-ox, capybara, alpaca, wild Bovinae, deer, the saiga antelope, kangaroos, rodents, ratites and reptiles. Other chapters deal with New Zealand as a case study on the introduction of animals, harvesting of species, and cooking recipes for wild animal meats. Conclusions draw attention to the existence of two markets for the meat of wild animals - the high-price, luxury market for those with a taste for something different, and the subsistence market for areas where the animal protein supply of the human population from domestic species is grossly deficient. Game cropping and farming schemes sometimes fail because of *"insufficient market planning or disastrous over-cropping"*.

520. Leonard, W. R. and Brooke, T. R. (1988). Changing dietary patterns in the Peruvian Andes. *Ecology of Food and Nutrition, 21, 245-263.*

This article examines the effects of agrarian reform and the introduction of non-traditional foods such as wheat flour on diets in a Peruvian village. The agrarian reform appropriated large land-holdings and transformed them into government co-operatives. Diets have changed; however, the poor still rely on traditional foods during food shortages, for example, preceding the harvest. As a result, the energy intake of poor villagers varies through the seasons more than wealthier classes. Overall, the poor rely on traditional foods more and consume less energy and fat than better-off households.

521. Levy, L., Weintraub, D. and Fox, F. (1936). The food value of some common edible leaves. *South African Medical Journal, 10, 699-707.*

522. Lewis, O.A.M., Shanley, P.M.G. and Hennessy, E.F. (1971). The leaf protein nutritional value of four wild plants used as dietary supplements by the Zulu. In: J.W. Claasens and H.G. Potgieter, (eds.), *Proteins and Food Supply in the Republic of South Africa*, pp. 95-102, A.A. Blakema, Capetown, South Africa.

523. Loutan, L. and Lamotte, J.M. (1984). Seasonal variations in nutrition among a group of nomadic pastoralists in Niger. *The Lancet, 1984, 945-947.*

524. Malaisse, F. and Parent, G. (1985). Edible wild vegetable products in the Zambezian woodland area: a nutritional and ecological approach. *Ecology of Food and Nutrition, 18, 43-82.*

The composition of 184 edible wild vegetable products from a Zambezian woodland area of southern Zaire is given.

525. Mariath, J.G.R., Lima, M.C.C. and Santos, L.M.P. (1989). Vitamin A activity of buriti (Mauritia vinifera Mart) and its effectiveness in the treatment and prevention of xerophthalmia. *American Journal of Clinical Nutrition, 49, 849-853.*

The fruit of buriti (Mauritia vinifera), a palm tree that grows wild in some regions of Brazil, contains beta-carotene in its oil fraction in a concentration 10 times higher than that of red-palm oil. The results demonstrated that this natural food source of vitamin A can reverse clinical xerophthalmia and restore liver reserves.

526. Marten, G.G. and Abdoellah, O.S. (1988). Crop diversity and nutrition in West Java. *Ecology of Food and Nutrition, 21, 17-43.*

This article investigates the differences in crop diversity and nutrition between households due to economic status and proximity to markets. The ability of irrigated rice fields, trees in upland fields and home gardens to fulfill household nutritional requirements is examined. Upland fields can contain not only rice and cassava, but also fruit trees. Together, upland fields and home gardens provide calcium, iron, vitamin A and riboflavin which are not available from the rice staple alone. The poor produce and consume fewer nutrients than those well-off, mainly because they have less land. The home gardens of those well-off also produce more nutrients per unit area than the poor due to a greater crop diversity and the input of fertilizers and pesticides. Crop diversity is key in providing a range of essential nutrients. Given the nutrient content of specific species and the area of land they occupy an estimate of the optimal crop composition to produce a household's nutritional requirements on the least amount of land was made. Such an ideal would consist of a diverse cropping strategy of root crops for calories, legumes for proteins and green leafy vegetables for minerals and vitamins. This strategy is employed by the poor.

527. Masseyeff, R., Cambon, A. and Bergeret, B. (1958). *Le Groupement D'Evodoula (Cameroun).* Etude de l'alimentation. ORSTOM, Paris.

528. Martin, G. (1991). Cross-cultural analysis of edible plants of Oaxaca, Mexico. In: the *International Symposium on Food and Nutrition in the Tropical Forest: Biocultural Interactions and Applications to Development*, 10-13 September 1991, UNESCO, Paris.

Over 40 species of plants were identified which are not only eaten in accompaniment to a beans and maize diet, but are also sold in markets and to restaurants. These species may be semi-cultivated in forests, fields, or home gardens.

529. Mbiyangandu, K. (1985). Composition and proposed use of two wild fruits from Zaire. *Food Chemistry, 16, 175-178.*

The wild fruits kasongole (Strychnos cocculoides) and matungulu (Aframomum stipulantum) are common and edible imports of Zaire. The juice, used after diluting with water and adding sugar, can be bottled.

530. McLaren, D.S. (1961). Sources of carotene and vitamin A in Lake Province Tanganyika. *Acta Tropica, 18, 78-80.*

531. Messer, E. (1972). Patterns of wild plant consumption in Oaxaca, Mexico. *Ecology of Food and Nutrition, 1, 325-332.*

532. Murakami, T. (1988). The botanical position and food value of wild rice. *Agriculture and Horticulture, 63, 1353-1355.*

The botany of Zizania aquatica is discussed with reference to its relationship with other Zizania species. The chemical composition of wild rice grain was compared with that of Oryza sativa grain. The levels of protein, Mg, P, K and vitamins B1 and B2 were higher in wild rice than in O. sativa.

533. Mutiso, R.M. (1987). Survey of gathered wild foods and their nutritional value in Kathama: Literature review. In: K.K. Wachiira (ed.), *Women's Use of Off-Farm and Boundary Lands: Agroforestry Potentials*, pp. 114-126, Final Report, ICRAF, Nairobi,

Kenya.

This report reviews basic issues of nutritional well-being. Deficiencies of calcium and vitamins A and C occur in the Kathama area. The nutrient compositions of several wild fruits and vegetables of the region are given; for example the leaves of Amaranthus are high in vitamin A. It also has a high protein content of 27.8%. Another wild vegetable, Cucumis aculeatus, contains 6.2% calcium. There are, however, prejudices against these wild foods which need to be overcome if their consumption is to increase and improve the health of individuals.

534. Naughton, J.M., O'Dea, K. and Sinclair, A.J. (1985). Animal foods in traditional Aboriginal diets: polyunsaturated and low in fat. *Proceedings of the Nutrition Society of Australia, 10, 177.*

The fat content and fatty acid composition of various animal foods traditionally eaten by Aborigines in different regions of Australia were examined. Muscle samples of wild animals were uniformly low in fat (less than 2.5% wet weight) with a high proportion of polyunsaturated fat. The foods which are most readily available in the largest quantities for the hunter-gatherer are those which were lowest in fat. Foods high in fat (witchetty grubs, eggs and mangrove ray liver) were less readily available or present in only small quantities on the animal.

535. Nestel, P. (1986). A Society in transition: Developmental and seasonal influences on the nutrition of Maasai women and children. *Food and Nutrition Bulletin, 8(1), 2-18.*

536. Nicol, B.M. (1957). Ascorbic acid content of baobab fruit. *Nature, 180, 287.*

537. Nour, A.A.A.M., Ahmed, A.H.R. and Abdel-Gayoum, A.G.A. (1985). A chemical study of Balanites aegyptiaca L. (Lalob) fruits grown in Sudan. *Journal of the Science of Food and Agriculture, 12, 1254-1258.*

Two samples of the edible pulp of the fruit of Balanites aegyptiaca, a wild savanna tree, from two regions of Sudan contained, on average, moisture 10.9% ash 2.7%, protein 1.4%, oil 0.29%, total sugars 36.0% alcohol-insoluble solids 18.0% and, in mg/100g, calcium 93, iron 15 and phosphorus 57. The oil, 45.6% of the seed, is utilized by the local inhabitants. Values are also tabulated for seed composition, including fatty and amino acids.

538. Oficina Regional de la FAO para America Latina y el Caribe (1986). *Reunion Sobre Cultivos Andinos Subexplotados de Valor Nutricional, Informe Final, (Final Report of the Meeting on Underexploited Andean Crops of Nutritional Value). 7-10 October 1986,* Organ izacion de las Naciones Unidas para la Agricultura y la Alimentacion (FAO), Oficina Regional para America Latina y el Caribe, Santiago, Chile.

This final report of a meeting on underexploited Andean crops of nutritional value acknowledges that such crops have great potentials in contributing to human food supplies, but are being displaced by commercial crops due to urban preferences. In order to address these issues, the objectives of the meeting were to analyse the current situation of these crops, select certain crops based on their nutritional and social values and to identify strategies for their promotion. Grains, roots, tubers, fruits, and vegetables from Argentina, Bolivia, Colombia, Chile, Ecuador, and Peru are discussed.

539. Ogden, C. (1990). Building nutritional considerations into forestry development efforts. *Unasylva, 41(160), 20-28.*

This article provides a justification for taking nutrition issues seriously in the development of forestry projects and policy.

540. Ogle, B. (1989). *Nutrition in the Forests, Trees and People Project in Zambia*. Report on a Consultancy for GCP/ZAM/040/SWE, Uppsala, April, 1988 Arbetsrapport 99, Working Paper, Swedish University of Agricultural Sciences, International Rural Development Centre, Uppsala.

This report is in preparation for a Forest, Trees and People Programme in Zambia relating to nutrition and community forestry projects. It gives a brief review of the harvesting of wild resources and of the nutritional problems faced for example, due to firewood shortages or seasonal variations. It also lists a plan of study which involves the community and includes anthropometric surveys of children, types of foods and the frequency of their consumption and peoples' adaptive strategies in times of food shortages. The report ends with recommendations to incorporate nutrition studies, workshops and training programs into the Forest, Trees and People Programme. A list of references is included.

541. Ogle, B.M. and Grivetti, L.E. (1985). Legacy of the chameleon: Edible wild plants in the Kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study. Part IV - Nutritional analysis and conclusions. *Ecology of Food and Nutrition, 17, 41-6 4.*

Of the over 220 wild plants (table given) recognized as edible in Swaziland, the protein, moisture and nutrient content for 29 of these was analyzed for the most frequently consumed. The protein content for leaves varies from 1.3% to 7.5% of fresh weight. Bidens pilosa, a "weed" has a mean crude protein content of 4.19% of fresh weight. Wild vegetables were eaten with maize porridge in 39% of the meals. As these leaves contain high amounts of lysine, which is deficient in maize, they are an important complement to this staple by improving the absorption of protein by the body. Certain leaves such as Zantedeschia and Corchorus spp. had high iron contents: 45.6mg/100g and 42.7mg/100g of fresh weight respectively. In comparison to spinach, Bidens pilosa, Amaranathus spp. and Corchorus spp. all had a greater protein, calcium, phosphorous, and iron content. However, pumpkin leaves had a higher calcium content and had comparable protein content. Wild plants were more frequently consumed than potatoes, spinach and pumpkin, but less than tomatoes and onions. Wild fruit consumption was difficult to measure, as they are often consumed away from the homestead as snacks.

The availability of wild plants varied with ecological zone with more leaf species in the Highveld and more fruits in the Lowveld. More agricultural "weeds" were consumed in the Middleveld where much farm land existed. Although farm land was expanding within the Middleveld, collection of wild plants did not decrease; but the location from which they were collected changed from the bush to farm fields. This location also facilitates collection for busy farmers, mainly women. Although children spend more time in school than in the past, they did not lose the knowledge of edible wild plants. Their recognition of these plants is related to their travelling long distances to schools and/or attending schools in a different ecological zone than their homes. In conclusion the dietary diversity provided by wild edible plants promotes the nutritional well-being of people not only daily, but also at times when cultivated foods are in short supply as in the dry season.

542. Ohtsuka, R., Kawabe, T., Inaoka, T., Suzuki, T., Hongo, T., Akimichi, T. and Sugahara, T. (1984). Composition of local and purchased foods consumed by the Gidra in lowland Papua. *Ecology of Food and Nutrition, 15, 159-169.*

Moisture, protein, carbohydrate, fat, fibre, ash, and mineral content (Na, Mg, P, K, Ca, Mn, Fe, Cu, Zn, and Sr) were estimated in 70 local foods consumed by the Gidra in two inland, one river and one coastal village of southern Papua, and in eight purchased foods. Depending on district, diet was *provided by hunting or fishing, horticulture, wild plants and small animals, as well as sago, the staple* item, and coconut. Main purchased foods were wheat flour and rice. Some minor foods, such as tree

ants and sago grubs, lotus (Nelumbo nucifera) and cycad (Cycas circinalis) seeds, or leaves of joint-fir (Gnetum gnemon) and Ormocarpum orientale, were valuable sources of protein.

543. Oliviera, J.S. and De Calvalho, M.F. (1975). Nutritional value of some edible leaves used in Mozambique. *Economic Botany, 29, 255-263.*

544. Platt, B.S. (1962). *Tables of Representative Values of Foods Commonly Used in Tropical Countries*. HMSO, London.

545. Prinz, A. (1991). Ash salt, cassava and goitre: Change in diet and development of the endemic struma. In: *International Symposium on Food and Nutrition in the Tropical Forest: Biocultural Interactions and Applications to Development*, 10-13 September 1991, UNESCO, Paris.

Among the Azande of Central Africa (Zaire, Sudan and the Central African Republic), 80% have enlarged thyroid glands indicating iodine deficiency. The presence of goitre and cretinism was unknown in the 1920s. This great change is attributed to the introduction of cassava and the decline in the use of ash salt. The thiocyanate produced from the detoxification of cassava can cause goitre. Ash salt had been prepared from the burning of wild plants and contained sufficient amounts of iodine to protect against goitre. Currently table salt is purchased with little or no iodine.

546. Rai, S. and Rai S. (1987). Oils and fats in arid plants with particular reference to Capparis decidua L. *Transactions of Indian Society of Desert Technology, 12, 99-105.*

Capparis decidua, a wild plant of the Indian desert, has edible fruits rich in protein and minerals and a high seed fat content. Many of the plant parts have medicinal uses. The fruits, flowers and buds yielded 14% surface wax. The seeds and flowers contained 20% and 14% oil, respectively. The seeds also contained 1.7% sugar and 8.6% protein.

547. Ramos-Elorduy, J. (1991). Insects as Tropical Forest Peoples' Food. In: *International Symposium Food and Nutrition in the Tropical Forest: Biocultural Interactions and Applications to Development*, 10-13 September 1991, UNESCO, Paris.

It is noted that over 1,300 edible insects have been documented. Their seasonal collection requires little energy expenditure yet they include protein, vitamins, minerals and fats. The percent protein dry weight varies from 36% to 76% and fat content ranges from 30% to 45%.

548. Ramos-Elorduy, J. (1984). Edible insects in Mexico and their protein content. *Journal of Ethnobiology, 4(1), 61-72.*

549. Ranhotra, G.S. and Gelroth, J.A. (1989). Nutritional Considerations of Jojoba Oil. *Cereal Foods World, 34(10), 876-877.*

550. Richards, A. and Widdowson, E. (1936). A Dietary Study in North Eastern Rhodesia. *Africa, 166-196.*

551. Ross, H.M. (1976). Bush fallow farming, diet and nutrition: A Melanesian example of successful adaptation. In: E. Files and J .S. Friedlander (eds), *The Measures of Man: Methodologies in Biological Anthropology*, Peabody Museum Press, Cambridge, Massachusetts.

552. Saowakontha, S., Hutanuwatr, K., Kunarattanapruk, K., Uttamavatin, P., Muktabhant, N., Lowirakorn, S. and Panomratanarak, B. (1989). Roles of food gathered from the forest in self-reliance and nutritional status of villagers in Northeast Thailand: The case of Ban Nong Khong. In: W. Brinkman (ed.), *Why Natural Forests are Linked with Nutrition, Health, and Self Reliance of Villagers in Northeast Thailand*, pp. 39-57, Royal Forest Department, UNDP, FAO, SIDA, Khon Kaen, Thailand.

> The collection, consumption of forest foods by seven households within the Ban Nong Khong Village of Northern Thailand as surveyed along with the nutritional status of pre-school children. These households were classified as landless (poor), land-holders (moderate), or land-holders with a hunter in the household (moderate). Poor households collected forest foods 5-6 days per week; whereas, moderately wealthy households collected 3 days per week. On average, 3 kilograms per week of mainly animals and vegetables were collected. After rice, the forest provided the greatest weight of food consumed. Data on the amounts of forest foods collected are underestimates as foods consumed in the forest or field were not counted. Estimates were made of how much money households saved by collecting rather than purchasing forest foods. On average, collection from forest and fields saved a household 18.75 Baht per day. It was also found that villages living far from the forest spent three times more money on food (excluding rice purchases) than Ban Nong Khong. Of the pre-school children living near the forest, 44.4% were of a normal nutritional status, as compared to 46.9% and 39.5% for two villages far from the forest. Households in general had a low intake of calcium, vitamin A, B2 and fat. As bans on logging and cultivation in the forest reserve were enforced, household income declined and unemployment increased. One result was the increased harvesting of forest foods.

553. Selinus, R., Awalom, G. and Gobezie, A. (1971). Dietary studies in Ethiopia II: Dietary pattern in two rural communities in North Ethiopia. A study with special attention to the situation in young children. *Acta Societatis Medicorum Upsaliensis, 76(1-2), 17-38.*

554. Selinus, R., Gobezie, A,, Knutsson, K.E and Vahlquist, B. (1971). Dietary studies in Ethiopia: Dietary pattern among the Rift Valley Arsi Galla. *American Journal of Clinical Nutrition, 24(3), 365-377.*

555. Shack, K.W., Dewey, K.G., and Grivetti, L.E. (1990). Effects of resettlement on the dietary intakes of mothers and children in lowland Papua New Guinea. *Ecology of Food and Nutrition, 24(1), 55-70.*

556. *Shanley, M. and Lewis, O. (1969). The protein nutritional value of wild plants used* as dietary supplements in Natal (South Africa). *Plant Foods in Human Nutrition, 1,254-258.*

557. Smith, C. E. (ed.) (1969). *Man and His Foods: Studies in the Ethnobotany of Nutrition-Contemporary, Primitive and Non-European Diets.* Papers presented at the 11th International Botanical Congress, Seattle, Washington, University of Alabama Press.

558. Sofia-Mohamed-Giama (1988). Nutritional status of the Somali community: Role of the underexploited traditional crops. In: *Proceedings National Workshop on Promotion of Under-exploited Traditional Food Plants in Somalia*, 12-15 November 1988, pp. 92-105, Ministry of Agriculture, Mogadishu, Somalia.

559. Sood, D., Wagle, H., Nainawatee, J. and Srivastava, H. (1980). Quality attributes of some Ber (Zizyphyus jujube) strains. *Indian Journal of Nutrition and Dietetics, 17, 447-451.*

560. Sreeramulu, N. (1982). Chemical composition of some green leafy vegetables grown in Tanzania. *Journal of Plant Foods, 4, 139 -141.*

Analyses of moisture, ash, protein, fibre, ether extractive and carbohydrate are tabulated for foliage of 22 cultivated and wild vegetable species. Cassia tora, Gynandropsis gynandra, Solanum nigrum and Moringa oleifera contained the highest protein, followed by Basella alba, Amaranthus gangeticus and Celosia argentea. These 7 species had low fibre values; extraction of leaf proteins would be aided by this high protein:fibre ratio. Fibre was highest in Amaranthus viridis and lowest in M. oleifera. Most species were good sources of both carbohydrate and protein.

561. Thorn, K.A., Tinsley, A.M., Weber, C.W. and Berry, J.W. (1983). Antinutritional factors in legumes of the Sonoran desert. *Ecology of Food and Nutrition, 13, 251-256.*

Tepary beans (Phaseolus acutifolius var. latifolius) are indigenous to the Sonoran Desert and were an important food for the early civilizations. Pinto beans (Phaseolus vulgaris) were introduced by the Spanish. Palo verde (Parkinsonia aculeata) and feather tree (Lysiloma watsonii) have not been used locally as they are difficult to harvest. Tepary beans have the greatest potential as an important food for arid and semiarid regions of the south west USA and Mexico. They have sufficient crude protein, 19% to 25% of dry weight.

562. Waldemann, E. (1973). Seasonal variations in malnutrition in Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 67, 431.*

563. Walker, A., Walker, B. and Wadvalla, M. (1975). An attempt to measure the availability of calcium in edible leaves commonly consumed by South African negroes. *Ecology of Food and Nutrition, 4, 125-129.*

564. Wandel, M. (1989). Household food consumption and seasonal variations in food availability in Sri Lanka. *Ecology of Food and Nutrition, 22, 169-182.*

565. Wehmeyer, A.S. (1966). The nutrient composition of some edible wild fruits found in the Transvaal. *South African Medical Journal, 40, 1102-1104.*

566. Wehmeyer, A.S., Lee, R.B. and Whiting, M. (1969). The nutrient composition and dietary importance of some vegetable foods eaten by the !Kung bushmen. *South African Medical Journal, 43, 1529-1530.*

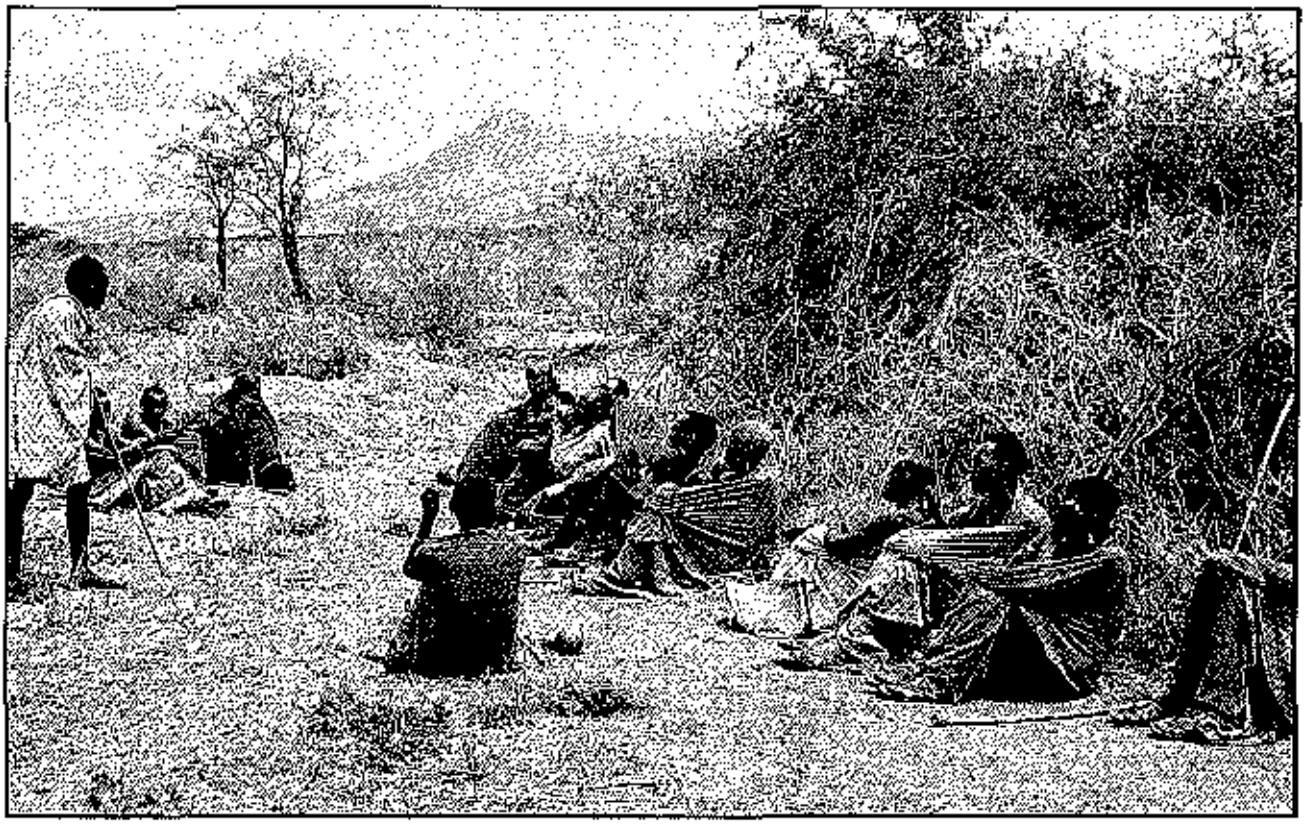
567. Williams, A.W. (1969). Dietary patterns in three Mexican villages. In: C.E. Smith, (ed.), *Man and His Foods: Studies in the Ethnobotany of Nutrition-Contemporary, Primitive and Prehistoric Non-European Diets, University of Alabama Press.*

568. Wolfe, W.S., Weber, C.W. and Arviso, K.D. (1985). Use and nutrient composition of traditional Navajo foods. *Ecology of Food and Nutrition, 17, 323-344.*

Samples of 92 traditional foods of the Navajo Indians were analysed for proximate composition. Use of those foods was assessed from results of a questionnaire completed by 86 Navajo women. Wild food plants included: wolfberry, sourberry and Navajo spinach. Nutritional requirements of the Navajo can be met using traditional foods if sufficient amounts are eaten, and present nutrient intake can be improved by increased use of some traditional foods.

Chapter Seven

Tenure and Local Institutions for Wild Food Resource Management



Barabaig elders meeting, Hanang District, Tanzania
Photo: Charles Lane

7. TENURE AND INSTITUTIONS FOR WILD FOOD RESOURCE MANAGEMENT

Access to the hidden harvest of agricultural systems is affected by property rights. The common property resources, held and managed as a public good, are often an important source of wild foods, particularly for the poor, the young and women. It is precisely these groups who have least access to private assets in many societies.

Common Property Resources

Common property resources are found in many different sites. In swidden agriculture systems, the forest beyond the cleared land represents an important source area (see 176-245). In settled agricultural systems, field boundaries, waterways, road or path edges and communal grazing or forest lands may be held in common (170; 628). Extensive pastoral systems are often based on regimes of common property resource management, where communal control of resource use is evident (see 246-279). But there is rarely a clear distinction between different tenure systems. Elements of private control over resources may be important within common property regimes. For instance, restrictions of access to fallows within swidden systems exist, allowing selective harvesting of wild products by those who originally cleared the land.

Tenure rules may change seasonally. In agricultural systems the cropped land may be held privately during the growing season but revert to common property in the dry season. Tenure rules may also differ according to the type of resource. For instance, particular fruit trees may remain exclusively private property, but leaf vegetables remain commonly owned, even on the same plot of land.

Tenure Patterns: Access and Control

A detailed understanding of tenure relations is central to understanding patterns of wild resource use. Tenure of land, of particular resources, ownership differentiated by gender, age and wealth and the seasonal dimensions of resource access need to be assessed. Few studies have tackled the question of wild food resource access in such detail, although there is a growing body of literature on tree tenure issues (571; 573; 574; 579; 586; 598; 602).

Recent important work in 82 villages of India's semi-arid tropics shows how the poor rely most on common property resources for food and other products (588-593). Some 14-23% of the sustenance of the poorest groups comes from common property resources. This rises to 42-57% in drought years yet the area of common property resources has declined by 31-55% during the last 35 years. This has had a disproportionate impact on the poor. Privatisation of land has had many further negative effects in rural India. Crops grown on land converted to private arable land yield poorly, and the productivity may be lower than the total returns from harvesting the former common land. Changes have increased inequities in rural societies with disadvantaged groups ending up with reduced access to resources. Changed tenure has resulted in increased environmental pressure on remaining common property resources, resulting in the disintegration of traditional controls over resource use.

This pattern is repeated in many other areas of India (571; 845). A survey carried out in forest regions of Gujarat showed that 22-27% of adults and 70-72% of children regularly go to forests for collection (577). More than a third of the earnings of tribals in Gujarat and in Madhya Pradesh are reported to be derived from common property resources. Women's contribution to cash income is higher in villages close to forests (577).

Case studies from Uttar Pradesh (625a), Maharashtra and Orissa (581) highlight the importance of so-called 'minor' forest products from common property forest land. There have also been changes in the communal management of forests in Africa (605a; 605b), changes in tenure policy in the Sahel (595b), and changes in ownership of minor forest products in East Kalimantan (587).

In Europe changes in tenure relations resulting from the enclosure movements of the 18-19th centuries resulted in huge social disruption (584). The promotion of extensification by government through thousands of enclosure acts destroyed the common property resources that were buffers against adversity for the poor. Their value was barely recognised, being called 'wastes', and represented to many a symbol of backwardness. Impoverishment greatly increased in the poorest groups, particularly for those living in the monocropped cereal lands compared with diverse landscapes (128).

Tenure Changes: Impacts on Wild Food Collection and Use

As land use patterns change, so wild foods availability also alters. In Kenya, as land became privatised the pattern of wild food collection switched from common forest land to an increasing reliance on more marginal hill sites, waterways and field edges (628). In densely populated sites, the availability of common land is restricted to road edges, gullies and disturbed land. With these changes there is a greater incentive for domestication of wild plants. In Zimbabwe, there are significant differences in the range of wild food species between private crop land and common grazing land that influence collection strategies (170-172).

In Latin America, Amerindian groups used to have common control over territories. However as land was expropriated many were forced to settle in reserves. With reduced access to forest resources, communities are no longer fully able to rely on wild food products (167; 204; 244) and have increasingly to rely on purchased foods (682). Conversion of rangeland expropriated for wheat farming in Tanzania has threatened the livelihoods of Barabaig pastoralists as they have lost traditional access to wild resources, salt licks and water (595a). Enforced resettlement to new areas results in the need to adapt to new food sources (204; 386a), which might lead to over-exploitation of resources (324b).

Changes in tenure may result in a new economic role for certain wild foods. In north east Thailand, as forest areas have declined and fishing areas privatised, so wild food collection decreased. Foods are no longer shared among households and are instead traded (509).

Legal Frameworks

The division of private and public lands in legislative frameworks and development plans imposes a false dichotomy on land-use. In swidden systems fallow lands may continue to be harvested after cultivation is over and in extensive pastoral systems a whole range of tenure settings from open access to private holdings are exhibited in notionally 'public' rangelands.

Legislation in many parts of the world acts to restrict access to state land. Forest reserves, state land and national parks have often been set aside. Such legislation derives from the *colonial period, where expropriation of land for commercial exploitation or forest* preservation was widespread. For instance, in Bungoma, Kenya, people are prevented from collecting products from Kenyan forest reserves, so travel across the border to Uganda in order to harvest wild foods (729). Such legislation undermines local people's traditional rights of forest products use.

In many Sahelian countries draconian legislation has restricted access, changing the status of wild food collectors to 'trespassers' or 'poachers'. However, in the Sahel the past Forest Codes are currently under review (595). The potential for allowing sustainable exploitation of forest products by local user groups is being explored.

In India, the colonial declaration of a forestry reserve did not affect the rights of people to collect forest products (606). This principle has since been maintained by State governments. However people may not benefit from such rights. This is because government has offered special industrial rights to forest resources and people are poorly informed about the rights that they can claim (577). Government nationalisation of forest products has had dramatic effects on their utilistation in India. Production of tendu leaves, lac and sal seeds have all fallen and the returns received by tribal collectors have dropped too.

In many parts of Latin America, Amerindians are fighting for control over their land (682). Tenurial rights that prevent settlement and allow access to traditional territories are their major demands. Governments are slowly recognising their demands and various institutional mechanisms for ensuring local livelihoods are being explored (eg. extractive reserves - 635;

658).

Institutions for Common Property Resource Management

Developing effective institutions for common property resource management represents a major challenge for policy makers. The harvesting of wild foods can potentially result in significant returns to local communities, but what form of institutions can effectively manage them for sustainable use?

Various traditional institutions exist for the management of wild food resources. Sacred groves of woodland, often associated with burial sites, can be important sources of tree fruit products in Zambia, Zimbabwe, Malawi and elsewhere (44; 273; 605a). Local restrictions on use rights may be imposed for particular sacred trees that ensure that they are not chopped down and fruits are harvested (171; 663 for Zimbabwe; 572; 597 for northern Kenya).

But pressures on common property resources often mean that traditional institutions are weakened. Increased social differentiation of the stakeholders in common property resources may means that key actors in local institutions become less committed. With greater pressure on limited common lands from local and external sources the ability of past rules and regulations to operate diminishes. This is widely documented (583a; 585 for semi-arid Gujarat in India; 576 for dry zone villages in Sri Lanka; 575 for Tamil Nadu, India; 605a, b for dry Africa).

In India effective attempts to manage communal resources have been reported in forest panchayats of the Uttar Pradesh hills (577; 625a) and in southern India (594; 607). The components of success include: small, relatively homogeneous community user groups with common goals, visible and defineable forest areas, a high value resource worth managing well and a system of enforceable rules supported by an enabling legal and institutional framework (569; 571; 577). Experiences of common property management in dryland Africa draw very similar lessons (603-605a-c).

Experiments with wildlife utilisation in Zimbabwe point to the potentials for the decentralisation of control over natural resource management for local communities (310; 346; 347; 349; 350; 373; 646; 647). The CAMPFIRE (Communal Area Management Programme for Indigenous Resources) scheme allows for co-management by the wildlife department, district councils and local communities and the return of revenues earned through safari hunting and tourism to local councils. Such monies are reinvested in community development projects, acting to compensate for wildlife damage incurred and increasing the incentive for local management of the resource.

Joint management schemes for forest use have had some notable success in India, West Bengal, Haryana and Gujarat, where communities given a stake in the protection of the forest area are gaining benefit from harvesting and selling products (571; 596; 600a, b; 675). Forest protection and exclusion through policing has not proved sustainable and resulted in considerable local resistance (72; 582). Similar experiences are reported for Indonesia (599).

Extractive reserves have been suggested as a route to more sustainable management of wild resources in Amazonia (658). Groups of rubber tappers and brazil nut collectors are allocated their own harvesting areas and granted rights to exclude others from settlement (635; 697).

CHAPTER 7: TENURE AND LOCAL INSTITUTIONS FOR WILD FOOD RESOURCE MANAGEMENT

569. Arnold, J.E.M. (1990). *Common Property Management and Sustainable Development in India. Working Paper 9, Forestry for Sustainable Development Program, Department of* Forest Resources, College of Natural Resources, University of Minnesota, St. Paul, Minnesota.

570. Arnold, J.E.M. and Campbell, J.G. (1987). *Collective Management of Hill Forests in Nepal: The Community Forestry Development Project.* Background paper from workshop on Common Property Resources, Sariska Palace, Rajasthan, 9-11 May, 1987.

571. Arnold, J.E.M. and Stewart, W.C. (1991). *Common Property Resource Management in India.* Tropical Forest Papers, 24, OFI, Oxford.

> This study reviews the state-of-knowledge regarding common property resource (CPR) use in India. The importance of CPRs is twofold. First, they fill crucial gaps in teh resource and income flows from other resources; providing complementary inputs into agricultural systems. Second, they are often a major source of support for the poor. The strong thrust to bring common resources under private or government control has often been based on an assumption that confuses degradation due to unregulated use under open access for the breakdown of CPR management arrangements. The examination of existing CPR regimes identifies a number of features of viable and sustainable CPR management. These centre around the control and management by the user group, securing rights to use the resources, and defend rights against intrusion, and investment in outputs that users can value and manage. The study notes that some recent interventions in India, such as most Social Forestry woodlot programmes, have not been consistent with this approach.

572. Barrow, E. (1988). Trees and pastoralists: the case of the Pokot and Turkana. *ODI Social Forestry Network Paper, 6b,* Overseas Development Institute, London.

> The traditional water and soil conservation strategies of the Pokot and Turkana pastoralists of Kenya are presented as important inputs into development and extension projects. Management of grazing is communal; however, there is private ownership of valuable tree species such as Acacia tortilis whose pods provide fodder. This ownership is most noticeable during the dry season when fodder is scarce. Trees also provide food, medicines, fuel, shade, and construction materials. Although trees are not planted, many are protected. For example: Acacia tortillis, Hyphaene coriacea, Cordia sinensis, *Zizyphus mauritiana*, *Dobera glabra* and *Acacia albida*.

573a. Berry, S. (1988). Property rights and rural resource management: the case of tree crops in West Africa. *Cahiers des Sciences Humaines (ORSTOM), 24, 3-16.*

573b. Berry, S (1989). Environment and access to resources in Africa. *Africa, 59, 18-40.*

575. Blaikie, P.M., Harriss, J.C. and Pain, A.N. (1984). *Public Policy and the Erosion of Common Property Resources in Tamil Nadu, India.* Workshop on Common Property Resources, Sariska Palace, 1987. Research proposal presented at a workshop on Common Property Resources held at ICRISAT Center, 19-20 January 1984, Hyderabad, India.

576. Bogahawatte, C. (1986). Erosion of common property resources: Evidence from

villages in the dry-zone districts of Sri Lanka. *Agricultural Administration, 23(4),191-200.*

This study was conducted in two districts of Sri Lanka to investigate the major causes of the erosion of common property resources. Tree felling, clearing of forest for cultivation and intensified use were all contributing factors. Common property resources were found to make significant contributions to local incomes, particularly in the drier districts.

577. Chambers, R., Saxena, N.C., and Shah, T. (1989). *To the Hands of the Poor: Water and Trees.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

This book explains how poor people can gain more from rural India's vast and often underestimated resources of groundwater and trees. The book explores the range of livelihood strategies employed by the poor and demonstrates how simple groundwater irrigation systems and tree growing can support rural livelihoods. The book explores the use of forest lands and the collection of minor forest products, including the institutional innovations for forest management by the people. The book provides a useful survey of the policy constraints faced, exploring in turn the reasons for poor performance of community forestry projects (poor diagnosis, bureaucratic implementation, species selection, rights and distribution policies) and why small farmers don't plant trees (ecological conditions, tenure, legal restrictions, marketing). The book proposes a new charter for the poor that tackles some of these policy constraints and paves the way for more sustainable livelihoods supported by local resources.

578. Cortez, F. (1988). Community forestry in customary lands: Lessons from Papua New Guinea. In: Y.S. Rao, M.W. Hoskins, N.T. Vergara and C.P. Castro (eds.), *Community Forestry: Lessons from Case Studies in Asia and the Pacific Region*, pp. 45-68, FAO, Rome.

579. Fortman, L. and Riddell, J. (1985). *Trees and Tenure: An Annotated Bibliography for Agroforesters and Others.* Land Tenure Centre, Madison, Wisconsin and ICRAF, Nairobi.

580. Francis, P.A. and Bulfeta, G. (1987). *Land and Tree Tenure in Humid West Africa: A Bibliography.* ILCA, Addis Ababa.

581. Guha, R. (1983). Forestry in British and post-British India. *Economic and Political Weekly, October 29.*

582. Guha, R. and Gadgil, M. (1989). *State Forestry and Social Conflict in the Himalaya.* Past and Present, No.123. (See also; 72).

583a. Gupta A.K. (1984). *Managing Common Property Resources.* Working Paper, Indian Institute of Management, Ahmedabad, India.

583b. Gupta, A. K. (1991). Why does poverty persist in regions of high biodiversity? A case for indigenous property right system. *Working Paper 938,* Indian Institute of Management, Ahmedabad, India.

583c. Gupta, A. K. (1991). Household survival through commons: performance in an uncertain world. *Working Paper 940,* Indian Institute of Management, Ahmedabad, India.

584. Humphries, J. (1990). Enclosures, common rights and women: the proletarianisation of families in the late eighteenth and nineteenth centuries. *Journal of Economic History,* 50,17-42.

The impact of enclosure on the livelihoods of families in rural England is documented. The impacts were felt particularly heavily by women who relied on products from the commons when access was secure.

585. Iyengar, S. (1989). Common property land resources in Gujarat: Some findings about their size, status and use. *Economic and Political Weekly 24(26):A67-A77.*

586. Jessup, T.C. and Peluso, N.L. (1985). Ecological patterns and the property status of minor forest products in East Kalimantan, Indonesia. In: *BOSTID-NRC Conference on Common Property Resource Management*, Annapolis, Maryland.

587. Jessup, T.C. and Peluso, N.L. (1986). Minor forest products as common property resources in East Kalimantan, Indonesia. In: Panel on Common Property Resource Management, BOSTID, NRC, *Proceedings of the Conference on Common Property Resource Management*, April 21-26, 1985, pp. 505-531, National Academy Press, Washington, DC.

This chapter by concentrating on three minor forest products (rattan, aloes wood and edible birds' nests) explores village and house hold property rights, and the interactions between villagers, traders and loggers. Aloes wood is used as a medicinal and is derived from the heartwood of diseased trees (Aquilaria spp). The birds' nests are made by swifts (e.g. Aerodramus maximus and A. fuciphagus) which produce a glue-like protein from their salivary glands in order to attach the nests to cave walls. This protein is claimed to give vitality to people. These nests are prepared in a soup. All three products are exported and data is given for their total export value (from 1967-1980) and for export prices (1970-1978 for rattan and birds' nests only). In 1979 one kg of birds' nests, equivalent to 100 nests, could sell for US$200-400. A major change in the area has been the granting of timber concessions. Rattans and aloes wood are common property resources, while the birds' nests are privatised. One reason is that the nests are more concentrated and therefore, more easy to guard than rattans or aloes wood.

Many changes have been occurring in the area. A new agrarian law in 1960 did not recognize traditional property rights and forest land was placed under the control of the government. As a result conflicts arise as settlers move in. Another major change in the area has been the granting of timber concessions. Although collection of minor forest products is allowed, swidden cultivation is not. This situation causes households to rely more heavily upon rattan collection than rice production. Participation to the market economy has led to specialisation and over-exploitation of forest products. Another consequence of the concessions has been the trespassing on villagers' territories and collection of minor forest products by loggers. In general, the authors note an overall decline in quantity and quality of the minor forest products. Timber concessions have also reduced villagers' access to products. The authors draw attention to the fact that it is very difficult for community organisations to manage forest resources when there are many outside groups with interests in collection; however, the communities should be involved in development planning.

588. Jodha, N.S. (1984). *Causes and Consequences of Decline of Common Property Resources in the Arid Region of Rajasthan: Micro-Level Evidence*. Economics Programme, ICRISAT, Andhra Pradesh, India.

589. Jodha, N.S. (1985). Population growth and the decline of common property resources in Rajasthan, India. *Population and Development Review, 11(2),247-264.*

590. Jodha, N.S. (1986). Common property resources and rural poor in dry regions of India. *Economic and Political Weekly, 21(27);1169-1181.*

This paper provides detailed evidence for the importance of common property resources to the rural poor. It is part of a long-term study of 82 villages in seven states in India. Comparisons are made between large farm households and the rural poor who include small farm households and the landless. It was found that 84% to 100% of the rural poor gather food, fuel, fodder and fibre products from CPRs, while only 10% to 28% of the large farmers do. One reason is that with a surplus of labour there is a low opportunity cost for the poor when they spend time collecting such products. The poor can obtain 15%-23% of their total income from CPRs as compared to 1%-3% for wealthier households. This income for the poor was sometimes greater than that derived from anti-poverty programmes. Despite these contributions, the land area of CPRs has declined 26% to 52% over the past thirty years mainly due to privatisation. Although the rural poor received more of this land on the whole, the area which they received on a per household basis was less than the rich. Some of this land was marginal and eventually the poor either sold, leased or mortgaged this land. The benefits to the poor are greater if these lands are kept as common property areas rather than as private property. However, if the potentials of CPRs are to be realized more attention must be paid to them by institutions and policy makers.

591. Jodha, N.S. (1987). *A Note on Contribution of CPRs and PPR-Based Farming Systems in Dry Tropical Regions of India*. Paper presented at the workshop on Common Property Resources 9-11 May 1987, Sariska Palace, Rajasthan, India.

592. Jodha, N.S. (1989). Market forces and erosion of common property resources. In: *International Workshop on Agricultural Marketing in the Semi-Arid Tropics*, ICRISAT, Hyderabad, India.

593. Jodha, N.S. (1990). *Rural Common Property Resources: Contributions and Crisis*. Foundation Day Lecture, May 16, 1990 International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal. Society for Promotion of Wastelands Development, New Delhi. Also: *Rural Common Property Resources: A Growing Crisis*. IIED Gatekeeper, SA24. IIED, London.

These cogent papers are a summary of the author's research which provides detailed evidence for the importance of common property resources to the rural poor. The studies covered 82 villages within seven of India's semi-arid states. Quantitative data is supplied in many tables. On the whole, 84%-100% of poor households relied on CPRs for food, fuel and fodder. They provided 31%-42% of agricultural inputs from the pre-sowing to pre-harvesting stages for farmers. CPRs can provide 14%-23% of the rural poor's sustenance incomes, which can increase to 42%-57% during times of drought. The crises facing CPRs include declines in total area, in productivity and in management. One of the main factors influencing these changes has been public policy. Land reforms in 1950-52 gave a larger percentage of poor households common property areas; however, in total they received less land than wealthier classes. From this time until 1982-84, common property areas decreased by 31%-55%. Concurrently, populations which are still dependent on CPRs have been increasing. As a result, fewer products are available and fewer trees are present. People's responses to these changes have ranged from over-exploitation to agroforestry. The author doubts whether the privatisation has been of greater benefit to the rural poor than if the land had remained as common property. For example, 78-96% of the former common property areas coming under cultivation had grain yields 50% or less than the same farmer's traditional fields. In order to reverse current trends of over-exploitation and open access he suggests membership in user groups to provide for the regulation of communal lands.

594. Kulkarni, S.D. (1984). *A Study of People's Rights over Forest Lands, Forest Produce and Village Grazing Grounds*. Research proposal presented at workshop on Common Property Resources, 19-20 January 1984, ICRISAT Center, Andhra Pradesh, India.

595a. Lane, C. and Pretty, J.N. (1990). *Displaced Pastoralists and Transferred Wheat Technology in Tanzania.* Sustainable Agriculture Programme Gatekeeper Series SA20, IIED, London.

595b. Lawry, S.W. (1989). Tenure policy and natural resource management in Sahelian West Africa. *Land Tenure Center Paper 130*, Land Tenure Center, University of Wisconsin-Madison, Madison, Wisconsin.

596. Malhotra, K.C. and Poffenberger, M. (1989). Forest regeneration through community protection: The West Bengal experience. In: *Proceedings of the Working Group Meeting on Forest Protection Committees*, Calcutta, June 21-22, 1989, West Bengal Forest Department.

This workshop report gives a history of forest management in West Bengal with examples of successful projects. Villagers have formed Forest Protection Committees in cooperation with the Forest Department to regenerate degraded forest areas. At the time of the report, 1,250 villages were participating in protecting 152,000 hectares of sal forests (Shorea robusta). The regeneration project began in 1972 when a Forest Officer tried to understand through dialogue with villagers why forests were being over-exploited. During lean periods of unemployment, the landless were forced to collect wood from the forest for cash. It was then agreed that in order to allow the degraded areas to regenerate, villagers would be employed during the lean period in the maintenance of the forests, be provided with fuel and fodder and be given access to all non-wood products. A committee was then formed, with all heads of households included and an agreement with the Forest Department made. The villagers are responsible for guarding the forest and fines are levied against any transgressors. After a 10-15 year rotation, they are to be given 25% of the yield of Sal timber. However, while waiting to harvest this timber, the villagers, particularly the poor and landless, still have immediate food and cash needs. These are met to some extent through the harvesting and of non-wood forest products such as fruits, leaves, seeds, mushrooms, fodder, fuelwood and medicinal. Women play a major role in the collection and processing.

The annual income reported from these products alone varies from Rs. 722 to Rs. 3272 per family. Such returns depend on the amount of land available to each household and perhaps more importantly on the diversity of useful species in the forests. After the harvesting of sal poles a household may earn Rs. 5,000 per hectare. This averages Rs. 500 per year per family, a significant sum. However, the sale of variety of forest products can earn a greater income for households. These figures are only for sales and give no indication of the extent to which these products are consumed by households. Such an estimate would greatly increase their worth. The West Bengal Joint Management of Forest Areas Project serves as a successful example of how local control and management over forest resources can both restore degraded environments and provide financial benefits to villagers, as well as the government.

597. Ostberg, W. (1988). *We Eat Trees: Tree Planting and Land Rehabilitation in West Pokot District, Kenya: A Baseline Study.* Working paper no. 82, Swedish University of Agricultural Sciences, International Rural Development Centre, Uppsala, Sweden.

There is brief mention of the desert date (Balanites aegyptiaca) being heavily relied upon during the hunger season and its leaves are used as a relish. Also there is protection of certain Acacia species in fields.

598. Panel on Common Property Resource Management, BOSTID, National Research Council (1986). *Proceedings of the Conference on Comm on Property Resource Management.* April 21-26, 1985, National Academy Press, Washington, DC.

This conference was convened in order to evaluate, through examples of successes and failures, the institutional structures necessary for the communal management of resources. These proceedings provide background information on the topic, as well as case studies covering water, fish, pasture land, agricultural land and forest resources. Such resources are important to the poor in diversifying the potentials for income earning. The Panel advises government and aid agencies to search out already existing "user group organisations" before establishing new organisations. More research is suggested in the knowledge of these local resource managers and the relationships between different common property forms such as water and pastoral resources. Actions to be taken must be tailored to each specific area, but generally should include training of donor agencies on CPRs, support for community institutions as managers, and the centralized collection and distribution of information,

599. Peluso, N. (1991). *Rich Forests, Poor People: The Political Economy of Indonesian Forestry*. University of California, Berkeley.

600a. Poffenberger, M (1990). *Joint Management for Forest Lands: Experiences from South Asia. A Ford Foundation Programme Statement, Ford Foundation, New Delhi.*

This paper examines three regions within South Asia where poor land management is causing environmental degradation and social and economic problems for rural communities. In each case an example is given of how a government agency is assisting in a joint management programme for forest use in partnership with community groups. Changes in the legal status of forest and communal lands has resulted in a large scale privatisation of common property. This has put further pressure on the remaining forest areas. Non-wood forest products are big business in India. In Madhya Pradesh alone, their value is estimated at $700 million annually during the late 1980s. The network of middlemen involved in marketing and regulation mean that forest dwellers and producers gain only a small proportion of this total value. This acts to undermine incentives for sustainable use. However a number of initiatives in Nepal (Nepal Social Forestry Programme) and India (Indian Himalayan Social Forest group; Shivalik Hills group; West Bengal Social Forestry group; and Gujarat Social Forestry group) have started to evolve joint management schemes where state support to local management is initiated. Recent experiences show that when communities are empowered and successfully organised to protect degraded resources, ecological regeneration can take place very rapidly. With the regrowth of the lost species, villagers regain lost productivity, further encouraging them to protect the forest. An enabling state support system through the forest service can provide the appropriate set of both economic and institutional incentives for sustainable management, if the programme is designed carefully and with the full participation of local populations.

600b. Poffenberger, M. (1990). *Forest Management Partnerships: Regenerating India's Forests*. Executive Summary of the Workshop on Sustainable Forestry, 10-12 September. Ford Foundation and Indian Environmental Society, New Delhi.

601. Pretty, J. (1990). Sustainable agriculture in the Middle Ages: the English Manor. *The Agricultural History Review, 38, 1-19.*

Manorial estates survived many centuries of change and appear to have been highly sustainable agricultural systems. Yet this sustainability was not achieved because of high productivity. It was promoted by the integrated nature of farming, the great diversity of produce, including wild resources, the divdersity of livelihood strategies, the guaranteed source of labour, and the high degree of cooperation.

Wild resources were important for food (fruits, nuts, herbs etc.), for fodder for livestock (leaves, acorns, beechmast), for green manuring, for meat (deer, birds, boar, fish) and for various household goods (baskets, roofing, fuel etc). These resources were carefully managed at the local level through by-laws that varied from village to village. These were designed to prevent long-term damage.

Examples included regulation of cutting and selling of wood; prohibition of lopping of oak, beech, apple; fines for owners of destructive pigs; manures not to be sold off the manor; and regular cleaning of waterways.

The expansion of agriculture into common property lands led to increased gross agricultural productions, but declining woodland, pasture and marshland resources, growing scarcity of meadows, growing conflicts between agriculture and forest sectors, and critically a loss of system components that acted as buffers for the rural poor. Ultimately this led to severe agricultural recession, greater human mortality and the decline of the manorial system.

602. Raintree, J.B. (ed.) (1987). *Land, Trees and Tenure. Proceedings of an International Workshop on Tenure Issues in Agroforestry*, ICRAF and the Land Tenure Center, Madison, Wisconsin

603. Scoones, I., Lane, C. and Toulmin, C. (1991). Land tenure in Africa's drylands: issues for savanna development. In: *Workshop on Economic Driving Forces and Ecological Constraints to Savanna Land-use*, Nairobi, 21-27 January, 1991.

This paper provides a broad overview of changing tenure relationships in Africa's dry areas. Various issues of tenure conflict are discussed - between peasant agriculture and pastoralism; between pastoralists and mechanised agriculture; between pastoralists, cultivators and wildlife management; and between cultivating herders and absentee herd owners. Systems of land management in dry pastoral areas are examined and some of the lessons for land tenure policy drawn out.

604. Shepherd, G. (1989). The Reality of the Commons: Answering Hardin from Somalia. *ODI Social Forestry Network Paper no. 6d*, Overseas Development Institute, London.

605a. Shepherd, G., Watts, J., Ifeka, A., and Blais, D. (1991). *Communal Management of Forests in the Semi-Arid and Sub-Humid Regions of Africa.* Report prepared for the FAO Forestry Department, Social Forestry Network, Overseas Development Institute, London.

This report reviews the management of communal areas and trees in Africa. It discusses tree and land tenure; traditional land-use systems, management tools for communal areas and trees; and the effects of change. Summaries of 111 studies from the literature are given. The authors strongly point out that if sustainable management of resources is to proceed, then ownership, either communal or private must be clearly defined. Traditional systems of tenure through lineage or labour inputs are described from the literature. Within traditional land-use systems, such as swidden cultivation, farmland and woodland are integrated and should not be separated. The pastoral system is similar, as the woodland provides fodder for livestock. Management tools include maintenance of sacred groves, use of fire, grazing by livestock, pollarding, and coppicing. Often woodland is viewed as detached from farmland and has been turned into state forest reserves. The effects include over-exploitation and degradation of remaining resources, farming of marginal areas, and the disincentive to maintain fallow periods, as any woodland might be confiscated. A further force behind environmental degradation is urban growth and the demands for fuelwood and low food prices. High demand for fuelwood leads to depletion particularly as members of the urban population take and have no responsibility for its management. Secondly, the low prices paid to farmers for their produce requires farmers to extensify agriculture in order to make a living.

In cases where community forests projects are initiated from outside, villagers may refuse to plant trees; the reason for such a response may not be a lack of regard for planting, but a defense mechanism to protect traditionally communal areas providing different benefits for the local villagers than perceived by the outside organisation. Also within this report, four participatory woodland management projects are analysed. What is most important for communal management is guaranteed

ownership in which villagers see themselves as directly benefiting. The report suggests further research on the following: the management of off-farm tree resources ("small CPRs") by small groups of farmers; the purpose and use of existing forest reserves; and the use of fire in woodland management. There are also recommendations for planting and management of trees under several specific land-use, CPR and physical scenarios.

605b. Shepherd, G. (ed.). (1992). *Forest Policies, Forest Politics.* Overseas Development Institute, London.

This book examines the political and institutional context of social forestry policy and its implications through an overview of case studies from Mali, Nigeria, Somalia.

605c. Shepherd, G. (1992). *Managing Africa's Tropical Dry Forests: A Review of Indigenous Methods.* Overseas Development Institute, London.

This book provides a forceful argument for forestry professionals to take indigenous knowledge and practice seriously in the design of forestry plans and programmes. The book stresses the localisation of management strategies and the need for tight forms of organisation for the successful management of forest resources on common property areas. It argues that the State's ability to protect and manage forest areas is diminishing and that the best solution is to pass the management and ownership to local people.

606. Singh, C. (1986). *Common Property and Common Poverty: India's Forests, Forest Dwellers and the Law.* Oxford University Press, Delhi.

607. Wade, R. (1985). Common property resource management in South Indian villages. *IBRD Discussion Paper Report ARU 36,* IBRD, Washington, DC.

Chapter Eight

Socially Differentiated Use of Wild Foods

Children eating bir (Zizyphus) berries whilst herding goats, Khartoum Province, Sudan
Photo: Jules Pretty

8. SOCIALLY DIFFERENTIATED USE OF WILD FOODS

Different types of wild harvest are used by different people at different times, and so contribute to livelihood strategies in a complex fashion. Understanding how collection, use and marketing of wild resource products is differentiated by wealth, gender, age and ecological situation is important.

Wild resources are particularly important for the poor, women and children, particularly at times of stress (drought, changing land availability, ecological change). With less access to land, labour and capital resources, these groups are particularly reliant on wild resource use. For instance, in parts of Amazonia over 80% of the population are landless and must rely on babassu palm products for their livelihoods; the associated trade in palm products is particularly important for poorer women (214; 612; 678). Similarly, trade in the Aguaje palm (Mauritia flexuosa) in Peru employs a significant part of the local population, particularly women (687; 903). In tribal areas in West Bengal, India, guaranteed use and sale of wild products as part of joint management schemes are central to the survival of disadvantaged tribal groups (596; 600; 675).

Differences Between Households

Many studies have demonstrated the greater reliance on off-farm income by poorer groups. Lower on-farm returns necessitate the diversification of income sources; this often includes the use of wild foods. There is extensive documentation of the role of wild product use from common property sources by the poor in dry India (588-593). Wild foods may account for 20% of the food supply among poorer groups in the dry season in parts of India (49); this increases significantly in times of drought (see 374-452).

The role of trees in the livelihoods of the poor is a recurrent theme of the literature (eg. 466; 551; 609; 625a; 626). In southern Zimbabwe, wild fruits are important as a dietary staple among poorer households (170; 172). In Mexico, households with smaller landholdings retain more trees in their fields (7). Wild fruit products are particularly important to those

households without established exotic fruit trees in their home compounds (98; 663)

It is the poor who are most affected by land use changes. Privatisation of common lands removes an important source of livelihood, establishment of forestry plantations often results in the exclusion of gatherers, deforestation has a particularly large impact on the poor who are reliant on local sources (577 for Indian case material; 128).

Ecological change will also be a source of difference in wild food use between households. Those households living close to still forested areas had a greater range of food sources to choose from in a case study from Tanzania (400). Similarly, nearby forest resources increase nutritional status in north east Thailand (466; 551). Ecological change within farming systems, particualrly the increased use of herbicides and changed cultivation techniques may also reduce access to edible weeds found within fields (111-113; 508 for Swaziland). Such changes will have differential impacts both between and within households.

Immigration and resettlement may also result in differences between households in wild food use. Recent settlers may be acquiring knowledge about the local wild food base, if they have moved from another ecological zone (111). For instance, initially transmigrants' gardens in Indonesia were less diverse (42). Settlers will also bring traditions of food collection with them (7) and recent settlers may be particularly reliant on wild products while they establish themselves in a new setting (554). In Sudan, groups of pastoralists from Darfur, displaced by droughts and now living close to the Nile, have different preferences and end uses of wild trees compared with farmers from the local community (622a).

Differences Within Households

Wild food use and collection is also differentiated within households. It is women who are particularly associated with wild product collection, use and marketing, especially collected products (eg. 825 and 49 for India; 90, 98, 139; 621; 622; 627; 628; 629; 729 for East Africa; 36; 113; 170-172; 612 for southern Africa; 116-119 for SE Asia; 140; 214 for Latin America).

Women are particularly associated with the collection and sale of wild vegetables (86; 90; 601). In Tanzania young unmarried or divorced women engage in the collection and sale of wild leaves in Usambara (400). In the northwest Amazon women have less access to game and fish products and therefore are more reliant on insects (54). Literature from Kenya provides extensive documentation of women's involvement in wild product management (621; 623; 628; 629). In West Africa, women are extensively involved in the marketing of bush meat in both urban and rural areas (284; 289; 291; 617).

Children are also closely associated with wild food use, particularly wild fruits as a snack food (49 for India; 90 for Tanzania; 149 for Sudan; 416 for West Africa; 140 for Amazon; 7 for Mexico). Regular, small meals of collected fruits or other wild products may be important components of overall diet (36; 172 for Zimbabwe; 98; 628; 729 for Kenya).

Men are also involved in wild food harvesting, and are particularly associated with hunting activities in many societies (342; 343 for Zambia).

Nutritional dynamics may be gender and age specific. Studies show a variety of gender specific food acquisition strategies (620 for equatorial Zaire; 619 for Maasailand, Kenya; 624 for Senegal; 616 for Africa). Undernutrition often shows particular patterns among children (608 for Bangladesh; 611 for Nigeria; 613 for Puerto Rico; 618 for Kenya; 252; 456 for the Sahel; 552 for Ethiopia). This may be compensated for, in many cases, by regular intake of wild food products.

608. Brown, K.H., Black, R.E. and Becker, S. (1982). Seasonal change in nutritional status and the prevalence of malnutrition in a longitudinal study of young children in rural Bangladesh. *American Journal of Clinical Nutrition, 36, 303-13.*

609. Chambers, R. and Longhurst, R. (1986). Trees, seasons, and the poor. *IDS Bulletin, 17(3), 44-50*, Institute of Development Studies (IDS), University of Sussex, Sussex, U.K.

> Trees play a significant role in poor people's livelihoods: this has been neglected due to the dual biases against understanding how the poor secure their incomes and ignorance of the role of multipurpose trees. Trees provide help to offset seasonal shortfalls in food and fodder and may be an important source of income for the poor. Policies need to be designed that reinforce this important role.

See also: Longhurst, R. (1987). Household food security, tree planting and the poor: the case of Gujarat. ODI Social Forestry Network Paper, 5d ODI, London.

610. Colfer, C.J.P. (1981). Women, men and time in the forests of East Kalimantan. *Borneo Research Bulletin, 13(2), 75-85.*

611. Collins, W. (1962). *On the Ecology of Child Health and Nutrition in Nigerian Villages.* Elsevier Publishing Co., Amsterdam, The Netherlands (Reprinted from *Tropical Geography and Medicine, 14, 201-229).*

612. Hunter, M.L, Hitchcock, R.K., Wyckoff-Baird, B. (1990). Women and wildlife in Southern Africa. *Conservation Biology, 4(4), 448-451.*

> Women as natural resource managers have been ignored in wildlife utilisation projects in Southern Africa. Such projects emphasize large game and men's roles. However, the large responsibility which women have for collection and management should be acknowledged. Women usually spot large game when they are on gathering trips and stop their activities to inform the men of its location. Otherwise, women fish, hunt birds and rodents, collect insects and wild plants. The collection is not always opportunistic, as often women decide from which areas to gather.
>
> The negative effects of large game management for women are that these animals often destroy crops and their presence makes women fearful of travelling too far from villages. Advantages include the income and community services which these products bring into communities. The authors recommend that income-generating activities from other forms of wildlife be developed so that women are brought into wildlife utilisation projects. For example, the mopane worm (Gonimbrasia belina) is important for women, not only as food for their families, but also for sale.

613. Immink, M.D.C., Sanjur, D. and Colon, M. (1981). Home gardens and the energy and nutrient intakes of women and pre schoolers in rural Puerto Rico. *Ecology of Food and Nutrition, 11,191-199.*

> This article investigates how the consumption of home garden produce can improve the nutrition of women and preschool children. Through the calculation of recommended daily allowances (RDA) of nutrients, women were found to be deficient in iron and calcium, while preschoolers lacked iron and vitamin C. Women who cultivated fruits and vegetables had higher intakes of vitamins A and C than those who did not, however there was little difference in energy intake. Preschoolers of households

growing fruits and vegetables, showed higher intakes of energy, protein, vitamin A and riboflavin than those from families who did not cultivate fruits. Home garden produce and the dietary diversity which they provide were important in improving the nutritional well-being of women and especially preschoolers. The authors recommend that projects encouraging the establishment of home gardens be carried out.

614. Kassogue, A., Dolo, J. and Ponsioen, T. (1990). Traditional soil and water conservation in the Dogon plateau, Mali. *IIED Dryland Networks Programme Issues Paper, 23. IIED.*

The paper documents how women supplement garden cultivation with collection of wild foods. Fruits (Lannea microcarpa, Butyrospermum parkii, Saba senegalensis, Hexalobus monpetalus and Zizyphus mauritania) are collected and sometimes sold.

615. Kumar, S.K. and Hotchkiss, D. (1988). Consequences of deforestation for women's time allocation, agricultural production and nutrition in hill areas of Nepal. *IFPRI Research Report 69*, IFPRI, Washington, DC.

616. Lawrence, M. (1985). Seasonal malnutrition in African women farmers. *The Epoch, 3(3&4), 16-19.*

617. Leach, M. (1990). *The Reciprocal Constitution of Gender and Resource Use in the Life of a Sierra Leonean Village.* Unpublished PhD Thesis, University of London.

Collection of minor forest products by the Mende of Sierra Leone as well as hunting and fishing are described. Gathering was much more common in the past, but still occurs adding diversity to daily diets and supplying foods during shortages. As trekking to the forest requires much time and energy, minor forest products are harvested from bush areas near the village and from cultivated fields. Hunting may also occur here. Ordinarily women collect such foods as they are responsible for their families' meals. From upland rice fields, mushrooms and leafy vegetables are gathered. Depending upon the season these vegetables are removed either as weeds or as food. Unlike men, women do not separate the farm from the bush and cultivated from wild products, as they see a gradual transition from farm to bush, both sources of a variety of products. The poor also collect forest products for sale. For example women sell fruits and seeds, while men sell honey and bamboo wine. Medicinal plants are also widely used. These men usually have no coffee or cocoa trees to market. Timber trees and oil palms may be protected in fields and shade cocoa and coffee. Men decide which trees are allowed to remain and women have no say in the matter. At times, they may cut trees from which women gathered fruits or seeds. Women comply with these decisions, as they view the income from the cash crops as more important than the minor forest products which can be gathered from other sites.

618. Muir, C.A. (1983). *East Pokot Agricultural Project: A Diet Study and Nutritional Assessment of Children in East Pokot [Kenya].* East Pokot Agricultural Project, Nginyang, Kenya.

619. Nestel, P. (1985). *Nutrition of Maasai Women and Children in Relation to Subsistence Food Production.* Unpublished PhD Thesis, University of London (KQC), London.

620. Pagezy, H. (1984). Seasonal hunger as experienced by the Oto and Twa women of Ntomba village in the equatorial forest (Lake Tumba, Zaire). *Ecology of Food and Nutrition, 15,13-27.*

621. Pope, E. (1986). *Importance of Indigenous Wild Food for Women in the Kathama area Machakos District, Kenya*. Paper presented in the KENGO Seminar on the Role of Indigenous Plants in Our Lives, 15 July, 1986. KENGO, Nairobi, Kenya.

622a. Pretty, J.N. and Scoones, I. (1989). *Rapid Rural Appraisal for Economics: Exploring Incentives for Tree Management in Sudan.* IIED, London and Institute of Environmental Studies, Khartoum.

> Different groups within the same community may put very different values on environmental functions. In Sudan, groups of pastoralists from Darfur, displaced by droughts and now living close to the Nile, have different preferences for trees according to end uses compared with farmers from the local community. Some of the criteria are strictly functional, such as value of fodder for livestock and wood for fuel; others are aesthetic, such as ornamental value and density of shade; and some are strongly cultural, such as value in funeral and marriage ceremonies. Each group has unique criteria: farmers are concerned with growing trees from seedlings, and so only they value Acacia nilotica for boatbuilding. Zizyphus was the most preferred tree in the displaced community, yet this was solely because of the central role that bark products play in funeral ceremonies. By contrast, farmers do not favour it in their home gardens because it attracts stone-throwing boys trying to steal fruits. For conflict to be avoided and interventions targeted towards the needy, it is essential that projects find and apply the methods to understand local values of resources according to different social groups.
>
> The displaced pastoralists have few options to sustain their livelihoods. One critical option is the collection of Cassia senna from the drylands. This brings 500-4000 Sudanese pounds per month (US $42-330 at official 1989 rates) for a 3-4 month period during the driest part of the year.

622b. Rocheleau, D. (1990). *Gender Complementarity and Conflict in Sustainable Forestry Development: A Multiple User Approach*. Paper presented to IUFRO World Congress, 5-11 August 1990, Hull, Canada.

623. Rocheleau, D.E. (1991). Gender, ecology and the science of survival: Stories and Lessons from Kenya. *Agriculture and Human Values, 8(1), 156-165.*

> The gendered nature of rural people's knowledge goes largely unrecognised. This paper presents a gendered perspective on survival strategies during the 1984 drought in Kenya. Approaches to survival may be differentiated by gender. For instance, 'one man's field becomes another woman's commons' during drought. As drought intensified wild foods became more important in the diet. This resulted in greater collection activity, largely by women. This was often carried out in field areas, owned by privately, but with communal access to wild products found in boundaries and along paths.

624. Rosetta, L. (1986). Sex differences in seasonal variations of the nutritional status of Serere adults in Senegal. *Ecology of Food and Nutrition, 18, 231-244.*

625a. Saxena, N.C. (1987). Commons, Trees and the Poor in the Uttar Pradesh Hills. *ODI Social Forestry Network Paper, 5f*, Overseas Development Institute, London.

625b. Saxena, N.C. (1990). *Farm Forestry in North-West India. Lessons from the 1980s.* Ford Foundation, New Delhi.

626. Shepherd, G., and Stewart, J.L. (1988). Poor peoples' forestry. *Appropriate Technology, 15(1), 1-4.*

627. Steenbergen, W.M. van, Kusin, J.A., Nordbeck, H.J. and Jansen, A.A.J. (1984). Food consumption of different household members in Machakos, Kenya. *Ecology of Food and Nutrition, 14, 1-9.*

628. Wachiira, K.K. (ed.) (1987). *Women's Use of Off-Farm and Boundary Lands: Agroforestry Potentials.* Final Report, ICRAF, Nairobi, Kenya.

Part One summarizes the results of an ICRAF survey of women's existing use of off-farm resources in Kenya. Many local students were involved in the study aimed at understanding the importance of gathered plants. Despite the availability of exotic crops, wild vegetables, fruits and medicinal are collected, usually on a daily basis. However, knowledge of these products is quickly disappearing between generations. Mainly women gather vegetables which are often mixed with exotic to increase the bulk of dishes for family meals. Children and herders are the most frequent collectors and consumers of fruits. Fruits are collected mostly during the long rains and dry season and vegetables mainly in the wet season. It was calculated that these gathered foods contributed 35% of the weight of foods consumed during the wet season. These foods on the whole contain greater concentrations of vitamins and minerals than exotic foods. Vegetables were mainly gathered from dry low plains, along waterways and in the hills. The types of land use from which vegetables were gathered included: crop lands, fence rows and grazing land. As land became privatised, a decrease in sharing of gathered foods was reported. Possibilities for domestication and incorporation of certain gathered plants and trees in home gardens is explored; however, there are difficulties in finding seedlings, as only a few trees may remain and are not reproducing. A reason given is the degradation of habitats from fire, clearing and grazing. Appendices contain the questionnaires and results of the survey.

This section is then followed by Part Two, containing students' individual reports, species lists ranked in order of importance and identification of species for possible domestication. In total, 17 leafy vegetables are gathered; 12 fibre; 55 fruits; and 112 medicinal. As a result of the survey, many men and primary schools wanted to become involved in nurseries and planting.

629. Wanjohi, B. (1987). Women's groups, gathered plants and their agroforestry potentials in the Kathama Area. In: K.K. Wachiira, *Women's Use of Off-Farm and Boundary Lands: Agroforestry Potentials,* pp. 61-104, Final Report, ICRAF, Nairobi, Kenya.

This paper discusses the advantages of wild food and medicinal plants along with their potentials for agroforestry. In the Kathama Area of Kenya, most people, with the exception of wealthier classes, believed these products to be important. The advantages of wild foods include: increasing the diversity of and supplementing diets; substituting meals when away from home and during times of famine; and preventing illnesses. Despite these advantages utilisation, as well knowledge of them, is decreasing. This decline is due to the adoption of exotic species; reduced time available for collection because of increased cash-cropping or formal schooling; farming improvements which provide a reliable food supply; loss of natural habitats and over-exploitation. Vegetables are more important than wild fruits as they appear quickly and are harvested during the rainy season when other cultivated vegetables may not be available. These leafy green vegetables have a high biomass productivity and are rich in proteins and vitamins. Women are responsible for their collection.

Over 120 medicinal plants are listed in this report with details of their local and scientific names, preparation, use, dosage and plant chemical constituents with pharmacological effects. These wild food and medicinal plants can be collected from a variety of areas such as cultivated fields, grazing areas, bush land, gullies, river banks, road sides and disturbed sites. Some examples of species found in these locations are given. Fruit trees are most often found in less disturbed areas. The greatest concentration of wild plants is found in gullies. Traditional agroforestry practices, such as protection of trees in fields and transplantation to gullies, hedgerows and woodlot do occur. Most often the species have multiple uses, such as fuelwood, fodder or fibre, in addition to food and medicine. Attempts to domesticate certain species and incorporate them in home gardens were made and have

been successful in increasing the amount of vegetables eaten in households. As many of the gathered products are found across a wide area, home gardens improve ease of collection by concentrating several species on one site.

630. Wheeler, E.F. (1988). *Intra-household Food Allocation: A Review of Evidence.* Occasional Paper No. 12, Department of Human Nutrition, London School of Hygiene and Tropical Medicine, U.K.

Chapter Nine

The Economic Value of Wild Foods

Medicines derived from wild products, Bihar, India
Photo: Ian Scoones

9. THE ECONOMIC VALUE OF WILD FOODS

Increasing attention is being paid to the assessment of the value of wild products (296; 700). Analysis of value must take into account the range of use and non-use values. Paying explicit attention to the economic value of wild products ensures they are taken into account in planning and policy decision-making. In the past they have been ignored. Forests have often been assessed simply in terms of timber extraction value, arable lands in terms only of the major crops, and wildlife areas only in terms of conservation or preservation objectives. In these processes other areas, such as field borders, gullies, home gardens and fallow lands have commonly been ignored in the analysis of resource value. This has biased conventional resource planning in favour of commercial outputs and undervalued the hidden harvest.

Valuation Techniques

Estimating economic value is not easy, and only a few quite recent studies have attempted this (308; 651; 653; 655; 664; 667; 681; 688; 689; 691; 692; 695; 700a, b). A range of values must be taken into account in any valuation. These include: direct use values (for consumption or sale), indirect use values (ecological and environmental functions) and non-use values (cultural, religious and existence values). A complete valuation of direct use must take into account both the marketed and subsistence benefits and costs. Attaching a monetary value to subsistence use is complex and requires adequate data to estimate what a replacement cost would be if the same product was purchased on the market. Other techniques use labour costs for product collection as a proxy, others relate people's perception of the value of the product to products that have a market price, others assess a 'willingess to pay' level (700a). Large divergences between estimates of value together with a lack of adequate shadow price data present many problems for the valuation of subsistence products.

Valuing the ecological or environmental functions of wild products is even more difficult. We do not necessarily know the potential impact of the loss of a particular wild product on

ecosystem functioning, and rarely, if ever, in sufficient detail to estimate the economic cost of its disappearance. The estimate of non-use values presents similar dilemmas. The cultural and symbolic value of a particular wild product (as a totem, a sign of spirit guardianship and so on) may be very important; assigning an economic value to this is impossible. Some attempts have been made to assess the 'existence value' of a particular species or habitat area. Even if people make no use of it, they may be concerned for its continued existence and preservation. Willingness to pay measures may be derived from the conservation movement's members, and now international markets in existence values are emerging in the context of debt for nature swaps.

In practice most valuation studies concentrate on direct use valuation. These can provide a rough assessment of the value of a particular product or a particular area. This may be important for planning and policy decisions. However simple valuations may also be misleading. Unless a differentiated analysis is carried out it is difficult to be precise about the different incentives for management and use of wild products (48). Values may change seasonally or interannually. For instance, in drought periods the value may increase significantly. Wild foods may become critical at such periods; the difference between life and death. What is their value then? For instance, during the 1984 drought in Darfur in the Sudan, people were surviving on Boscia senegalensis berries as a staple (392); even this did not avert starvation (for a wider discussion of food security questions see 374-452).

Wild foods have different values for different people. The incentives to collect, use and manage this resource is thus highly differentiated. Values of particular wild products may be highest for women and children, particularly in poorer groups (see 608-630 for a discussion of differentiated use).

The incentives to manage wild products will also vary in relation to where they are found and how access to them is controlled. Perceived values will differ accordingly. Common property resource areas may be highly valued by the poor, who are reliant on this resource for their livelihoods. For instance, in dry India common property resources provide between 14-23% of the rural poor's income, rising to 42-57% in times of drought (669). In northern Thailand households regularly save on expenditure (18 Baht/day) by collecting products from forests

and fields. Many agricultural communities rely on wild products for fertilising crops, such as fish and seaweed in Newfoundland (429), shellfish in France (643a), forest leaf litter in Britain (601) and various green plant matter on green manures in Nepal (600a; 701a) and Bhutan (401a).

Arable areas may be controlled by men and so the value of products may diminish for women. However there may be portions of field and home areas that women value highly and manage intensively, such as field edges, contour ridges etc (628; 629). These may be the areas where leaf vegetables, rodents, or fruits are found and harvested. Home gardens in Java are particularly important and provide 21% of net income to households (151).

As land use changes the range and value of products will also change. This will in turn affect the incentives for different people to manage the resource. For instance, as forest areas are cleared for agriculture high value trees are usually retained within fields. A mixed forest thus changes to an open parkland of fruit trees. Tenure thus shifts from communally managed access to woodland areas to quasi-private access arable fields. This produces a change from a wide range of wild products of different values available communally to a narrower range of higher value products available to a narrower group.

An economic assessment of the incentives to manage sustainably the hidden harvest must come from such a differentiated analysis of economic value, situated within an understanding of how patterns of use are differentiated according to season, year, ecology, tenure, gender, wealth and age. Aggregate analyses of value are insufficient. Unfortunately the literature to date does not offer such a perspective; this remains a big gap in our understanding of the importance and incentives for sustainable management of the hidden harvest.

Most literature on the economics of wild foods concentrates on the marketed value of the products. The following sections provide a brief review of some of the main themes.

Cash Income from Wild Products

Income derived from the collection and exchange or sale of wild products is particularly important for the rural poor. Gathering wild products may represent a significant proportion of total household incomes, particularly where farming is marginal. Collection, home use and marketing of wild products may represent a better option than wage labour or farming. In Botswana, gathering has a larger economic contribution than farming for many households (300; 301). In Ghana, the collection and sale of bush meat realises an income similar to that received by government workers (49). In Brazil, the sale of kernels from the fruit of the babassu palm, Orbignya martiana, supports over two million people (99). In the Philippines rattan and copal resin represent good daily returns year round (699). Rattan sales are particularly important in the household economies of the Filipino poor (656). In India, reafforestation efforts have acted to raise land values and the sale of fruit can earn a family between Rs 2500 and 5000 per hectare (125). In Sichuan, China, a wide range of wild products are sold, including more than 1100 tonnes of songrong (Tricholoma matsutake) mushroom, worth 100 million yuan, and 500 tonnes of fern (Pteridium aquilinum), worth 200-500 million yuan in 1990 (702b).

Many more wild products have potential economic value and are as yet unexploited (693; 777; 781; 791; 793; 797; 798; 837; 888; 889; 921; 928; 933; 938; 939).

The Value of Gums and Saps

Gum arabic is collected from Acacia senegal trees (other gums are derived from Acacia sayal) across the dry Sudano-Sahelian belt of Africa. Traditionally a long bush fallow system operated where gum collection was rotated. Today more permanent stands are tapped. Sudan is one of the largest producers of gum arabic and has a network of markets throughout the producing areas. Gum arabic is sold internationally to the confectionary and printing industries. It represents a significant proportion of Sudan's annual foreign exchange earnings. Problems of quality control, uneven supply due to drought and substitution for synthetics is currently undermining the market (631).

Babassu palm is cultivated in Brazil particularly for its wine producing sap (99). Palm wine from Raphia hookeri and Elaeis guineensis palms are also important in West Africa (828; 829). In West Africa the production of palm wine is an important income earning activity (771; 891 for the forest areas of Nigeria). Most households in palm growing regions make use of palm oil both for cooking and for sale on local markets (665; 680). Processing of palm oil provides an important source of income for women in West Africa eg. 641 for Cote d'Ivoire). Palm wine production is also important in southern Africa (648; 649).

The Value of Game Meat

Important markets exist for game meat in many parts of the world. The vibrant market for bushmeat in West Africa (289) is often controlled by women (353), both in rural and urban areas. Hunting is also an important supplementary income for many farmers in West Africa (280; 639; 657).

Markets for game meat in West African cities show higher prices for a range of game meats (hares, giant rat, grasscutter rat, duiker, bushbuck, bushpig, colobus monkeys and civets) than for beef or mutton (293; 396; 632). Small animals dominate game meat markets; they show both high productivity and high market demand. Urban bush meat markets are complemented by rural and roadside markets in southern Nigeria. Duikers, porcupine, giant snails and grasscutters dominate the trade (344). The consumption of bush meat varies considerably by household and community (318).

Expanding urban markets for bushmeat in West Africa poses a threat to the supply of wildlife products. Prices for bush meat are increasing at a faster rate than livestock meat products in in Nigeria and Ghana (396). Over-hunting has resulted in a decline in wildlife in most areas, especially of larger species (284; 293; 639). In Cameroun, the Yaounde market absorbs all available bushmeat meaning that little is traded in rural markets (660). As a result a wider range of species have entered the market (291; 396).

In southern Africa there as an increasing commercial market for dried game meat (biltong),

and an international market for trophy hunting and safari tourism (646; 647). Game ranching is now profitable in some parts of Africa and the practice of mixing livestock with game on ranches has expanded (659; 647). Many regard this as a positive development for conservation objectives (674).

Wildlife Products

The trade in wildlife products continues to grow, despite restrictions on certain products (700). There are convincing arguments that controlled trade is beneficial for long term conservation (296), although there are some who argue to the contrary (324a). Crocodile and ostrich ranching have expanded enormously in some parts of southern Africa over the past few decades (647). This has acted to reduce the impact of illegal hunting on wild populations.

Collected Fruits, Nuts and Vegetables

In southern Zaire (Upper Shaba), mushrooms (mostly Canharellus sp.) are collected annually by women and children. An estimated 20 tonnes are consumed annually by the 700,000 residents of the area. Mushrooms are gathered by women and children who spend several hours a day in the rainy season collecting. There is a plentiful supply of mushrooms to local markets, but also a high demand (121).

The market for wild tree products has been compared with cultivated products in Nigeria (892). Prices for wild products are comparatively higher, especially during the seasonal shortfall periods when other cultivated products are unavailable. The marketing of Irvingia gabonensis is particularly important in southern Nigeria (670). The trade is controlled by traders who even import fruit and seed from Cameroun.

Markets in collected fruits exist in most areas. In an area of southern Zimbabwe prices vary regionally depending on the proximity to forested areas, but all markets have a range of

fruits which are seasonally available. The reason for the widespread retention of the marulla tree (Sclerocarya birrea) in fields can be related to the economic value of the fruit products (fruits plus wine and beer). The annual return from these products (in sale and exchange value) over the productive period of a mature, fruit producing tree far exceeds the returns from felling the tree for wood useage (663).

Cola nuts are important in West African trade (396). Production in the humid zone is exported across the region. Production returns may be high compared to other cash cropping options, such as coffee. Cola nuts comprise between 5% and 37% of household's cash revenue in western Cameroun (643). The cola trade may also be an important income source for women traders in south western Nigeria providing sufficeint initial captital investment is made. Shea nuts similarly have an important role in women's income generation strategies in the Sahelian zone (671).

Incentives for the Sustainable Management of Wild Resources

Ensuring that local people have a stake in the future survival of wild resources is a central element in ensuring the long term sustainable management. Incentives must include enabling legislation that guarantees rights for local people over the use and benefits of wild products, institutional reforms that vests control and planning with local user groups and economic incentives that ensure that a significant proportion of economic benefits are received locally.

Providing economic incentives for sustainable management of wild products will be key to ensuring their continued existence. One way will be to encourage markets in wild products (653; 687). Various approaches have been discussed. Extractive reserves in Amazonia aim at providing a stable source of income for the forest dwellers and users (697 for rubber tapppers). In India, guaranteed markets assure an income for tribal peoples whose livelihood depends on the harvesting of forest products (596; 600; 675). In Zimbabwe, wildlife management programmes result in significant benefits returning to local communities (349; 350). Enhancing the economic value of wild resources through the exploitation of a greater range of products or the opening up of new markets offers potential (698). However the uncertainty of international markets in non-timber forest products may be a constraint (686).

CHAPTER 9: THE ECONOMIC VALUE OF WILD FOODS

631. Ahmed, M.B. (1989). Primary export crop production and the origins of the ecological crisis in Kordofan: the case of Dar Hamar. In Johnson, D. and Anderson, D. (eds.). *The Ecology of Survival: Case Studies from NE African History*. Lester Crook, London.

632. Ajayi, S. (1978). Pattern of bushmeat production, preservation and marketing in West Africa. *Nigerian Journal of Forestry, 8, 48-52.*

633. Akachuku, A.E. (1985). Cost-benefit analysis of wood and food components of agri-silviculture in Nigerian forest zone. *Agroforestry Systems, 3(4), 307-316.*

> *The costs and benefits of an agroforestry system in the Nigerian forest zone were estimated in this study.* Mixtures of hardwood species with yam/maize and cassava/maize cropping system were analysed. The paper concludes that agri-silvicultural practice acts to boost farmers' income. Unfortunately, the paper does not go on to value the benefits of an increased diversity of wild products derived from the integrated system.

634. Anadu, P.A., Elamah, P.O. and Oates, J.F. (1988). The bushmeat trade in Southwestern Nigeria: A case study. *Human Ecology, 16 (2), 199-208.*

635. Anderson, A.B. (1991). Extraction and forest management by rural inhabitants in the Amazon estuary. In: A.B. Anderson (ed.), *Alternatives to Deforestation: Steps Toward Sustainable Use of the Amazon Rain Forest*, Columbia University Press, New York.

636. Anderson, A.B. and Jardim, M.A.G. (1989). Costs and benefits of floodplain forest management by rural inhabitants in the Amazon estuary: A case study of acai palm production. In: J. Browder (ed.), *Fragile Lands in Latin America: The Search for Sustainable Uses*, Westview Press, Boulder, Colorado.

637. Arnold, J.E.M. (1991). *Production of Forest Products in Agricultural and Common Land Systems: Economic and Policy Issues*. A Forest Policy issues paper prepared for the Agriculture and Rural Development Department, The World Bank, Washington, DC.

> This paper discusses the production of forest products from on-farm and common property resources and the consequent policy implications. It briefly summarizes the ways in which forest products contribute to rural household economies through food, fuelwood, fodder and income. Traditionally common property areas have been a source of such products complementing agricultural production. The result of privatisation and government land expropriation has been diminished access to these areas and/or a loss of local controls over their maintenance. In response to decreasing access to these common property/forest resources, farmers begin to manage these forest resources on-farm. Another remedy has been the establishment of social forestry woodlots. However, their products are ofte n used for sale rather than providing food and fodder for communities as common property areas had in the past. In this way, the rural poor may still be unable to collect much needed products. It is recommended that forestry projects be directed to greater local control, less government intervention and guaranteed tenure.

638. Barbier, E., Aylward, B. and Bishop, J. (1991). Guidelines for applying environmental economics in developing countries. *LEEC Gatekeeper* GK 91-02. IIED, London.

639. Barde, J-P. and Pearce, D. W. (1991). *Valuing the Environment: Six Case Studies.* Earthscan Publications Ltd., London.

640a. Blanc-Pamard, C. (1979). Un jeu écologique differentiel: les communautes rurales du contact forets-savanes au fond du 'V Baoule' (Cote d'Ivoire). *Travaux Documents, ORSTOM, 107.* Paris.

640b. Blanc-Pamard, C (1980). De l'utilisation de trois éspèces de palmiers dans le sud du 'V Bouale' (Cote d'Ivoire). *Serie Sciences Humaine, Cahiers d'ORSTOM, 17 (3-4), 247-257.*

641. Boutillier, J. and Dupire, M. (1958). *Le Pays Adioukrou et sa Palmeraie (Cote d'Ivoire): Etude Socio-economique.* ORSTOM, Paris.

642. Browder, J.O. (1988). The social costs of rainforest destruction: A critique and economic analysis of the "hamburger debate". *Interciencia, 13(3), 115-120.*

> The social and private costs and benefits of cattle production in the Brazilian Amazon are analyzed. Government subsidies are high, yet ranches still operate at a loss. The sources of profit were through overstocking and sale of land. Considering the costs of the marketable timber wasted in land-clearing and the subsidies which could have been directed to social programmes the author estimates that the social costs of cattle ranching to be US$4.8 billion. These social costs equalled US$4,000 per metric tonne of beef; an amount which could have imported four metric tons of beef. In conclusion, the author acknowledges that with over 10 million people living within the Brazilian Amazon, the forest should be utilized, but in a non-destructive manner.

643a. Ceci, L. (1975). Fish fertiliser: a native North American practice? *Science, 188, 26-30.*

643b. Champaud, J. (1983). *Ville et Campagne du Cameroun de l'Ouest.* Memoires ORSTOM 98. Paris.

644. Christensen, B. (1983). Mangroves: What are they worth? *Unasylva, 35(139), 2-15.*

> With case studies from the Philippines, Thailand, Malaysia, the USA and Papua New Guinea, this article reviews the problems of valuing alternative land use options in mangrove areas.

645. Connelly, W. (1985). Copal and rattan collecting in the Philippines. *Economic Botany, 39, 39-46.*

646. Cumming, D. (1990). Wildlife products and the market place: a view from southern Africa. *Multispecies Animal Production Systems Project. Project paper 12.* WWF, Harare.

> In contrast to the animal welfare and conservation groups in Europe and North America, in most of Africa the use of wildlife is seen as culturally acceptable and the marketing of wildlife and its products is seen as a sensible economic enterprise and an effective means of promoting conservation. This paper traces the development of the wildlife conservation policy in Zimbabwe from colonial to present times. It shows how the marketing of wildlife products has become an integral part of productive land use in Zimbabwe and elsewhere in southern Africa.

647. Cumming, D (1990). Developments in game ranching and wildlife utilisation in east and southern Africa. *Multispecies Animal Production Systems Project. Project Paper 13.* WWF, Harare.

The present status of game ranching and wildlife utilisation in east and southern Africa is reviewed. Wildlife utilisation involving mainly ranching, safari hunting and photographic safaries is increasing on private land across the region, but especially in southern Africa. The most exciting development in Botswana, Namibia, Tanzania, Zambia and Zimbabwe is the growing interest in community based wildlife utilisation schemes. The relative benefits of such schemes as against more conventional crop or livestock based agriculture is unsure, as the relevant ecological and economic data does not yet exist.

648. Cunningham, A.B. (1985). *The Resource Value of Indigenous Plants to Rural People in a Low Agricultural Potential Area.* Ph.D. Thesis, Unpublished, University of Capetown, Capetown, South Africa.

649. Cunningham, A.B. *(1990). Income, sap yield and effects of sap tapping on palms in* south-eastern Africa. *South African Journal of Botany, 56(2), 137-144.*

Within the Natal region of South Africa, Hyphaene coriacea and Phoenix reclinata palms are tapped to produce wine. Palm wine tappers were interviewed to determine the number of palms tapped at a particular time and the yields obtained. The yields of one representative tapper were then followed throughout the year. He had tapped 712 palms to produce 4,846 litres of palm wine. Tables of total income and yields are given. Production does not vary with the seasons. After 10 months damage to palms was assessed and it was found that the majority recoppiced. Wine tapping is performed by those unemployed or to supplement incomes. Palm wine tapping is an important source of income for those with few alternatives in this area with marginal agricultural potential. This study is significant in that it actually measures yields in order to evaluate best sustainable management strategies and to improve production.

650. Cunningham, A.B. (1990). The regional distribution, marketing and economic value of the palm wine trade in Ingwavuma district, Natal, South Africa. *South African Journal of Botany, 56(2), 191-198.*

This study found that within the Natal region of South Africa, 980,000 litres of palm wine was harvested and sold from November 1981 to October 1982. The species tapped were Hyphaene coriacea and Phoenix reclinata. It was estimated that a total of US$145,113 (1982 US$) was generated as income from the tapping, transport and resale of palm wine. On average the yearly income for individual tappers and sellers respectively equalled US$359 and US$175 (1982 US$). In an area with marginal agricultural productivity, these activities are particularly important for the rural poor. The money earned can buy other goods, pay for school fees or pay for the assistance of herdboys. Palm wine is the beverage consumed most by the local people and is a source of nicotinic acid and vitamin C. Palm fibre is also used for basketry. Given these varied uses of palms and their significance to the rural community, the author recommends that land-use planning should combine palm tapping with pastoral activities and the cultivation of cashews and mangoes, rather than the promotion of Eucalyptus monocultures.

651. De Beer, J.H. and McDermott, M.J. (1989). *The Economic Value of Non-timber Forest Products in Southeast Asia with emphasis on Indonesia, Malaysia, and Thailand.* Netherlands Committee for the IUCN and WWF, Amsterdam.

An important non-timber forest products (NTFPs) review based upon literature, government statistics and interviews from Southeast Asia. It begins with a definition of NTFPs and a description of their

various uses. At least 27 million people in Southeast Asia live in forests and are dependent upon them. An overview of their value to household economies in Borneo is given. Their contributions include use as dietary supplements, famine foods and medicinals as well as sources of income. The export values of these products, with rattan being most important, is quantified from available government statistics to be US$23 million (1987), US$238 million (1987) and US$11 million (1986) for Thailand, Indonesia, and Malaysia respectively. Factors influencing their availability and use include deforestation, population increases and land tenure policies. Individual responses to these changes involve more time spent collecting, management in fallows and homegardens and abandonment of products. The purpose and methodologies of economic valuation are discussed. Overall there is a lack of quantitative data on the use of NTFPs by local communities and of accurate government statistics on their trade. The report proposes that NTFPs can improve the well-being of communities, promote the conservation of biological diversity and contribute to the national economy. It recommends that forestry, land use and development policies recognize NTFPs and the indigenous management strategies attached to them. These policies must be based upon site-specific studies which will take into account local needs and local ecology.

652. Dixon, A., Roditi, H. and Silverman, L. (1991). *From Forest to Market: A Feasibility Study of the Development of Selected Non-Timber Forest Products from Borneo for the U.S. Market.* Project Borneo and Cultural Survival, Cambridge, Massachusetts.

This report identifies products from the Bornean rainforest which have potential for export to the United States. Detailed information is given on six products and the infrastructure necessary for the marketing of these products.

653. Dobias, R.J., Thorani Tech, Vute Wangwacharakul and Nivand Sangswang (1988). *Beneficial Use Quantifications of Khao Yai National Park. Executive Summary and Main Report and Supplemental Annexes.* World Wide Fund for Nature, Project 3757. WWF, Geneva.

654. Doty, M.S., Caddy, J.F., and Santelices, B. (eds.) (1987). Case studies of seven commercial seaweed resources. *FAO Fisheries Technical Paper, 281.*

Case studies are presented of commercial seaweed resources including five on the wild crops: Ascophyllum nodosum, Chondrus crispus, Gelidium, Laminaria longicruris and Macrocystis.

655. Ehrenfeld, D. (1988). Why put a value on biodiversity? In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity, pp. 212-216, National Academy Press, Washington, DC.*

This essay outlines the dilemmas faced in valuation of such a complex concept as biodiversity. Is there value in diversity per se, or is value realised only in terms of specific species? What about 'undiscovered' species with unknown values? The author argues th at economic arguments may be insufficient to conserve species, and wider concerns of qualitative value need to be addressed. The case of the blue whale is cited, where it makes more economic sense (in purely financial terms) to kill all blue whales and reinvest the profits in high interest accounts.

656. Engel, A. (1985). *Promoting Small Holder Copping Systems in Sierra Leone.* An assessment of traditional cropping systems and recommendations for the Bo-Pujehun rural development project. Schriftenreihedes Fachbereichs Internationale Agarentwicklung, Technisches Universitat Berlin, IV, 86. Berlin.

This study was carried out in Sierra Leone and found that 18.6% of farmers onsidered non-agricultural income generating activities as most important in terms of labour investment and returns to the

household. Off-farm activities included: hunting, fishing, palm wine collection.

657. Faure, J. and Vivien, J. (1980). *Interet de Toutes les Ressources Ligneuses et Non-ligneuses Tirees de la Foret par les Populations Locales*. L'amenagement des forets littorales de Camp et Edea, Cameroun. SEDA, Yaounde.

658. Fearnside, Philip M. (1989). Extractive reserves in Brazilian Amazonia. *Bioscience, 40(6), 387-393.*

659. Field, C.R. (1979). Game ranching in Africa. *Applied Biology, 4, 63-101.*

660. Franqueville, A (1972). Les relations villes-campagnes sur la route au Nord de Yaounde (Cameroun). *Cahiers ORSTOM, Serie Sciences Humain, 9 (3), 337-387.*

661. Fujita, M. (1988). Flying foxes and economics. *Bats, 6(1),4-8.*

662a. Godoy, R. and Bennett, C. P (1991). The economics of monocropped and intercropped coconuts in Indonesia. *Human Ecology (in press).*

662b. Godoy, R. and Feaw, T. C. (1989). The profitiability of smallholder rattan cultivation in Central Borneo. *Human Ecology, 16, 397-420.*

662c. Godoy, R. and Dubowski, R. (1991). *How Much is the Forest Worth? Guidelines for the Valuation of Non-Timber Tropical Forest Products*. Unpublished mimeo.

663. Gumbo, D., Mukamuri, B., Muzondo, M. and Scoones, I. (1990). Indigenous and exotic fruit trees: Why do people want to grow them? In: R.T. Prinsley (ed.), *Agroforestry for Sustainable Production: Economic Implications*, pp. 185-214, Commonwealth Science Council, London.

> This paper presents case material from southern Zimbabwe that illustrates why, in the context of a community forestry project, people want to plant both indigenous and exotic fruit trees. Factors of taste, seasonality, gender and age preferences, market potential and ecological suitability are discussed. The reasons why certain trees are retained within fields are discussed. These are valued for their fruit, shade and nutrient enrichment properties. Their value is enhanced by their 'sacred' nature. The economic rationale for retaining Sclerocarea birrea within fields is discussed in relation to the value of its outputs - fruit, wine, wood products, nutrient inputs. The direct value of each of these products over time far exceeds the value realised by chopping the tree down.

664. Haneman, W. (1988). Economics and the preservation of biodiversity. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 193-199, National Academy Press, Washington, DC.

> The environment is treated as a marketed good, or an input to the production of marketed goods, or a non-marketed good of concern to people in its own right. This allows economists to begin to answer questions such as: what are the benefits of preserving a particular ecosystem? What value do people place on preservation? Questions of the first type are easier to assess, as they require anal ysis of market or proxy values of benefit. Assessing people's perceptions and values through economic analysis is more difficult. Preferences for uncertain and intertemporal outcomes are complex and may be individual to particular people at different times. Placing an economic value on such perceptions is fraught with dangers.

665. Hartley, C.W.S. (1988). *The Oil Palm.* Longman Scientific and Technical, Harlow, UK.

All aspects of the plant's growth and exploitation are covered, starting with the history of the African semi-wild palm groves, the early trade in palm oil and kernels, and the remarkable advances of recent decades. Chapters cover suitable climate and soils, research on oil palm botany and physiology, selection and breeding methods, cultivation practices, disease and pest control, and extra ction of palm oil and kernels by traditional and industrial methods.

666. Heinen, H.D. (1975). The Warao Indians of the Orinoco delta: An outline of their traditional economic organization and interrelation with the national economy. *Antropologica, 40, 25-55.*

A history is given of the production systems of the Warao Indians of Venezuela from hunting and gathering to subsistence agriculture to the current state of wage labour and participation in the cash economy. It is noted that as involvement in the cash economy increases, there is less time to grow or collect foods. As a consequence, foods such as canned goods and soft drinks are purchased which are detrimental to nutritional well-being. Also discussed are the marketing and loan services offered to the Warao by the go vernment and the difficulties that there are in providing benefits to the Indians.

667. Hueting, R. (1991). The use of the discount rate in a cost-benefit analysis for different uses of a humid tropical forest area. *Ecological Economics, 3(1), 43-57.*

668. Hunter, J.R. (1981). Tendu (Diospyros melanoxylon) leaves, Bidi cigarettes and resource management. *Economic Botany, 35(4), 450-459.*

669. Jodha, N.S. (1986). Common property resources and rural poor in dry regions of India. *Economic and Political Weekly, 21(27), 1169-1181.*

670. Johnson, E. and Johnson, T.J. (1976). Economic plants in a rural Nigerian market. *Economic Botany, 30, 375-381.*

671. Leplaideur, S. (1987). Shea nuts. *Inter-Tropiques, 21, 21-23.*

Shea nuts, used in Europe in the production of high value confectionary and cosmetic products, are generally harvested by African women from wild shea trees located on the drylands of the Sudan Zone. In Burkina Faso, where sheas constitute the country's third export product, the state-controlled marketing system provides no financial incentive to these women. It is argued that the state and processing firms in Europe make large profits at the expense of these farmers.

672. Longhurst, R. (1991). *Dependency on Forest and Tree Foods for Food Security.* A working seminar held by the International Rura l Development Centre, Swedish University of Agricultural Sciences, FAO/SIDA, Uppsala, Sweden.

This workshop report provides a number of case studies of how different research groups (eg. from Indonesia, Zambia) have tackled the question: how dependent are people on forest foods? Dependency can be defined in cash terms (cash income), in dietary terms (amount of food or nutritional importance), in seasonal or inter-annual terms (importance in a bad drought or the dry season) or in gendered or age specific terms. A discussion of methodological issues arising is included. This will provide input for a series of case studies to look at the question of forest food dependency.

673. Loszner, G. (1986). Importance of shea butter as a foodstuff and industrial raw material. *Beitrage zur Tropischen Landwirtsc haft und Veterinarmedizin, 24: 1, 29-34.*

Kernals from fruits of the wild shea tree (Vitellaria paradoxa or Butyrospermum sp.) contain up to 60% fat in DM. Methods of expressing or extracting the butter, similar in consistency and chemical composition to cocoa butter, are described. It is the main dietary fat of local populations in Burkina Faso and is used internationally in the production of chocolate, sweets, baking fat and non-dietary commodities.

674. Luxmore, R. (1985). Game ranching in South Africa as a force in conservation. *Oryx, 19, 225-231.*

675a. Malhotra, K.C., Deb, D., Dutta, M., Vasulu, T.S., Yadava, G. and Adhikari, M. (1991). *Role of Non-Timber Forest Produce in Village Economy: A Household Survey in Jamboni Range, Midnapore District, West Bengal.* Sponsored by the Ford Foundation in collaborat ion with the Government of West Bengal, Indian Institute of Biosocial Research and Development.

In West Bengal, villagers are working together with the Forest Department in the management of regenerating Sal (Shorea robusta) forest in degraded areas. The villagers, organized into Forest Protection Committees, protect the forest, while the forest department provides forestry and cash inputs. After a 10 year rotation, the villagers receive 25% of the profits from the harvesting of sal timber. However, while the forest is regenerating, the villagers are free to collect an assortment of non-timber forest products. Over 214 wild plant species are found in the regenerating sal forest, 155 of which are used for food, fodder, fuel, fibre, household items and medicinals. The mean annual income for a tribal and caste families equals Rs. 2,523 and Rs. 2,738, respectively. As of 1990, 1,611 Forest Protection Committees had been established and were managing over 191,000 hectares of degraded sal forests.

675b. Malhotra, K. and Poffenberger, M. (eds.). (1989). Forest Regeneragion through community protection: the West Bengal Experience. In: Proceedings of the Working Group Meeting on poorest Protection Committees, Calcutta. June 21-22, 1989.

676. Maundu, P. (1987). The importance of gathered food and medicinal plants in the Kakuyuni and Kathama areas of Machakos. In Wachiira, K. (ed.). *Women's Use of Off-farm and Boundary Lands: Agroforestry Potentials.* ICRAF, Nairobi.

677. May, P.H. (1991/2). Building institutions and markets for non-wood forest products from the Brazilian Amazon. *Unasylva, 165(4 2), 9-16.*

Drawing upon the Brazilian experience, this article discusses the institutional framework necessary for the sustained use and marketing of non-wood forest products. In order for communities to benefit from the sale of these products, they must first be given land rights. Progress is being made in this direction in Brazil through the establishment of 3 million hectares of extractive reserves. Additionally, grass roots organizations are essential to voice priorities and to implement management and marketing of these forest products. In Brazil this role is fulfilled by the National Council of Rubber Tappers and the Union of Indian Nations. Collaborations between local groups, universities and government agencies are beginning in order to investigate indigenous management of forest resources. Management training programmes are also being established. Increased participation in the market economy entails certain risks. Large land-holders and merchants may benefit more than the poor. Communities may grow and rely on only a few products for sale, reducing biodiversity and becoming vulnerable to market fluctuations. Products themselves may become over-exploited. The author suggests that these risks

may be reduced through local organizations controlling resources and working directly with universities, government and international businesses.

678. May, P., Anderson, A.B., Frazao, J.M. and Balick, M. (1985). Subsistence benefits from the Babassu palm (Orbignya martiana). *Economic Botany, 39, 113-129.*

679. McGrath, D.G. (1986). *The Animal Products Trade in the Brazilian Amazon.* Final report to the World Wildlife Fund-US, Washington, DC.

680. Moll, H.A.J. (1987). *Oil Palm in Cameroon. The Economics of Oil Palm.* Centre for Agricultural Publishing and Documentation, Wageningen, Netherlands.

The oil palm is indigenous in Cameroon and palm oil is produced from semi-wild oil palms and from improved planted palms on estates and smallholdings. Ecological conditions are moderately suitable for the oil palm along the coast. The rainfall distribution data show a distinct dry period from December to February/March and this limits production to 1.5-2.5/t of palm oil per ha. The oil palm became a major estate crop after 1960 and Cameroon is fourth largest producer in Africa with 7% of production. On a world scale, C ameroon is one of the medium-sized producers after Malaysia, Indonesia and Nigeria. Two state corporations, CDC and Socapalm, are t he main producers, with about 70% of the total area of 53 000 ha under improved oil palm. An estimated 30% of the total production of palm oil is from semi-wild oil palms harvested by farmers. Fruits are processed with hand-extraction methods or with simple ma chines. The government plays a major role in the oil palm sector as main producer, through determination of the prices for palm oil and kernels, and through control of exports. The government plans to expand the oil palm area on small holdings around existing estates.

681. Myers, N. (1990). *The Non-timber Values of Tropical Forests.* Working Paper 10, Forestry for Sustainable Development Program, Department of Forest Resources, College of Natural Resources, University of Minnesota, St. Paul, Minnesota.

682. Nations, J.D. and Nigh, R.B. (1978). Cattle, cash, food and forest: The destruction of the American tropics and the Lacandon Maya alternative. *Culture and Agriculture, 6, 1-5.*

683. Ogigirigi, M.A. (1985). An approach to development of the forest resources of the Sudano-Sahelian zone of Nigeria. In: *Proceedings, 15th Annual Conference of the Forestry Association of Nigeria,* Yola, 25-29 November, 1985.

A review is presented of current forestry development programmes in Nigeria, which concentrate on fuelwood and pole plantations, shelterbelts, and the production of tannin from Acacia nilotica and gum arabic from A. senegal. Some prospective areas of development are the domestication of wild fruits, production of vegetable oils and cultivation of forage species. Suitable species are noted, and implementation strategies are discussed.

684. Opala, I., Achola, E., Khasiala, P. and Wajuang, G.A. (1987). A study of economic uses and conservation of indigenous plant species, Bondo-Siaya District. In: K.K. Wachiira (ed.), *Women's Use of Off-Farm and Boundary Lands: Agroforestry Potentials*, pp. 105 -113, Annex II, pp. 127-139, Final Report, ICRAF, Nairobi, Kenya.

This paper describes the topography, soils and rainfall of the study areas of Sakwa and Uholo in Kenya, as well as the cropping and livestock systems. Interviews were conducted with womens' groups responsible for nurseries and other villagers including midwives and herbalists. An inventory of the

types of plants gathered, their uses, locations, and frequency of consumption was collected. A detailed list of species gathered appears in Annex II. It contains: 17 gathered leafy vegetables; 12 fibre plants; 55 gathered fruits; 112 medicinal plants. Some of these are ranked according to preference and importance. For all the above categories, candidates for domestication are given.

685. Padoch, C. (1987). The economic importance and marketing of forest and fallow products in the Iquitos region. In: W.M. Denevan and C. Padoch (eds.) Swidden-Fallow Agroforestry in the Peruvian Amazon, *Advances in Economic Botany, 5, 74-89.* The New York Botanical Garden, New York.

This article presents a review of, data on, and a thorough analysis of, the marketing of forest and fallow products in the Iquitos region of Peru. It begins with a historical background of the trade of such products as rubber, vanilla and sarsaparilla to North America and Europe. Marketable products were divided into ten categories consisting of intensively managed crops, fish and eight categories of forest products (e.g. cultivated fruits, forest fruits, firewood and construction wood, handicrafts and medicinals). Households in thirteen communities were interviewed regarding the income they received from these products. Villages could be divided into those whose households derived the majority of their income from staple crop production and/or fishing and those dependent upon forest product extraction. For the latter, household averages for annual income earned from forest products ranged from 6 1% to 86%. Households in the village of Tamshiyacu were reported to earn an income of US$1,200 per year from forest products. Even in those villages dependent upon staples and fishing, households could earn as much as 39% of their income from forest products. Within villages *differences in household income could be due to access to forest resources, as* well as the number of men in the family to carry produce. Transport costs as percentages of sale price were also assessed for eleven villages. In 1980 the production of just thirteen forest products in the Iquitos region was valued at US$952,780. The article is completed with a thorough analysis of the complexity involved in marketing forest products. This includes a description of the trade network of collectors, wholesalers and retailers. The influences of price fluctuations, government policies, transport and seasonal variations on supply and demand are explored.

686. Padoch, C. and De Jong, W. (1990). Santa Rosa: The impact of the forest products trade on an Amazonian place and population. *Advances in Economic Botany, 8, 151-158.*

This article chronicles the establishment of the village of Santa Rosa through a history of international trade in forest products from the 1930s to the present. In 1934 barbasco (Lonchocarpus sp.) was harvested for the manufacture of pesticides as it contains rotenone. With the introduction of DDT demand for barbasco fell. Afterwards Couma macrocarpa trees where tapped for their resins to make chewing gum and paint. In general, the collection of these products caused the men of households to move away from their home steads and at times the settlements were forced to relocate. This history of social upheavals should be taken into account when the harvesting of rain forest products for export is being promoted.

687. Padoch, C., Inuma, J.C., De Jong, W. and Unruh, J. (1987). Market-oriented agroforestry at Tamshiyacu. In: W.M. Denevan and C. Padoch (eds.) Swidden-Fallow Agroforestry in the Peruvian Amazon, *Advances in Economic Botany, 5, 90-96,* The New *York Botanical Garden, New York.*

The village of Tamshiyacu in the Peruvian Amazon is presented as an example of a successful agroforestry system providing an adequate income for households. These households are not composed of Amerindians, but of people of mixed descent. The production cycle begins with the clearing and burning of forest vegetation. Manioc, plantains and rice can be planted as well as fruit trees like umari (Poraqueiba sericea), peach palm (Bactris gasipaes) and Brazil nut (Bertholletia excelsa). Of the major sources of income, on average, 63% is derived from such cultivated fruits. Through weeding and

protection from livestock, the plots can produce for 25 to 50 years. Such success provides encouragement that managed long-term agroecosystems are possible in the tropical forests. A succession of products, mainly fruits, are collected during these 25 to 50 years. The final product is usually charcoal produced from the trees which are no longer yielding fruits. This succession and the variety of products in combination with the household having several plots of varying ages, ensures that products are available for sale throughout the year. When collection ceases, the forest is allowed to regenerate freely for approximately six years before the next clearance. One household earned as much as US$5,000 per year; although, on average, households earn US$1,200 annually from this cyclic agroforestry system. The villagers of Tamshiyacu are only 30 km away from the urban centre of Iquitos, a ready market for their products and an inland port on the Amazon River. The authors conclude that *"the economic viability of Tamshiyacu's agroforestry system appears indisputable"*.

688. Peters, C.M., Gentry, A. and Mendelsohn, R.O. (1989). Valuation of an Amazonian rainforest. *Nature, 339, 655-656.*

A hectare block of Amazonian rainforest in Peru was studied intensively. The value of all potential products was assessed in financial terms. The study concluded that the discounted financial returns from harvesting of fruit and latex plus selective cutting of timber far exceeded the returns from alternative options such as clear-cutting timber, plantation harvesting and cattle ranching.

689. Pinedo Vasquez, M., Zarin, D., Jipp, P. and Chota-Inuma, J. (1990). Use-values of tree species in a communal forest reserve in Northeast Peru. *Conservation Biology, 4(4), 406-416.*

This study quantifies the number of useful species within a communal forest reserve in Northeast Peru. Amerindians, as well as those of mixed ancestry, collect the reserve's forest products for home consumption or for sale. This is regulated by a set of guidelines. Within this reserve 60% of the tree species, representing 66.4% of the individual trees inventoried, were utilized. A relative ranking of their utility to people is also given. Food producing species totaled 28.2% of useful species. These included Jessenia spp., Inga spp., Iriartea deltoidea, Pithecellobium brenesii, as well as those species from which the beetle larvae of Rhynchophorus palmarum are collected. Some of these tree products are marketed depending upon the cost of extraction, transport and the sale price. The authors recommend that the communal management of forest areas can provide for their protection.

690. Prance, G.T. (1989). Economic prospects for tropical rainforest ethnobotany. In: J.O. Browder (ed.), *Fragile Lands of Latin America: Strategies for Sustainable Development,* pp 61-74. Westview Press, Boulder, Colorado.

This chapter is a general review of the economic potentials of many forest species in the Amazon. It lists tables of the number of useful tree species within one hectare which are utilized by Amerindians. The percentage of trees with food and remedy uses by each indigenous group are: the Chacoba of Bolivia, 40.4% and 35.1% respectively; the Ka'apor of Brazil, 34.3% and 21.2%; the Panare of Venezuela, 34.3% and 7.1% and the Tembe of Brazil, 21.8% and 10.9%. Additional information is provided on the monetary value of forest species and their potentials for extraction. Specific mention is made of those species which grow naturally in large aggregates for greater ease of harvesting from the wild or possible growth in monocultures. These species, such as babassu palm, the acaipalm and camu camu, have good market potential. The paper advocates the sustainable use of forest products as a method to conserve forests.

691. Prance. G.T., Balee W., Boom B.M. and Carneiro R.L. (1987). Quantitative ethnobotany and the case for conservation in Amazonia. *Conservation Biology, 1(4),296-310.*

The number of tree species utilised by indigenous groups in Latin America were quantified through

the inventory of one hectare plots of terra firme forests. The Amazonian groups studied were the Ka'apor and Tembe of Brazil, the Panare of Venezuela and the Chacoba of Bolivia. The percentage of tree species utilized were *76.8%, 61.3%, 48.6%,* and *78.7%,* respectively. Use categories were divided into food, construction, technology, remedy, commerce and other. Lists of the species utilised are provided along with a relative value of minor or major contribution. Those species found only within this dense primary forest are noted, as well as those for which there are no substitutes. Families of tree species were also ranked according to their value.

692. Randall, A. (1988). What mainstream economists have to say about the value of biodiversity. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 217-223, National Academy Press, Washington, DC.

Various valuation methods are discussed including 'implicit pricing' (where proxy prices such as travel costs are used) and 'contingent valuation' (where willingness to pay to avoid change are taken). These methods can be used in policy analysis through the application of modified cost benefit analysis, where utilitarian welfare changes are costed. Another approach adopts the minimum safe s tandard', the level of preservation that ensures survival, and estimates the costs of achieving such a level. The paper argues that the 'empirical cupboard is not bare' and that there is often sufficient data to support valuation exercises.

693. Rasoanaivo, P. (1990). Rain forests of Madagascar: Sources of industrial and medicinal plants. *Ambio, 19(8), 421-423.*

This article reviews thirteen medicinal plants of Madagascar. The periwinkle, Catharanthus roseus, is famous for its use in the treatment of leukaemia and other cancers. Two tons of leaves are necessary to produce one gram of alkaloids which provides treatment for six weeks. It had been harvested from the wild, but is now cultivated. Other medicinal plants described which are collected from the wild, include Centella asiatica for wound-healing; Rauwolfia spp. for hypertension; Vinca minor for cerebral vascular disorders; Pygeum africanum for prostatic adenomia and Drosera madagascariensis for respiratory tract infections. The amounts of these six plants exported and their on-board prices are given for 1979 to 1988. In 1988, the free on board price totalled US$101,340. Recently the amounts exported have decreased as the commercial extraction within Madagascar of plant compounds has been increasing. Th ese species illustrate the potential that plants have for the pharmaceutical development and revenue earnings. In Madagascar there are about 13,000 plant species with the chemistry of only 1% known. The great danger is that many plant species in Madagascar, and throughout the world, *are threatened and will become extinct before their usefulness is fully assessed.*

694a. Redford, K. and Robinson, J. (1985). Hunting by indigenous peoples and conservation of their game species. *Cultural Survival, 8, 41-44.*

694b. Redford, K. (1990). A research agenda for studies of subsistence hunting in the Neotropics. *Florida Journal of Anthropology, 6, 117-120.*

695. Robbins, S.R.J. and Matthews, W.S.A. (1974). Minor forest products: Their total value is of a major order. *Unasylva, 26(106), 7 -17.*

This article acknowledges the economic importance of forest products to rural communities. It concentrates on forest products for export or sale, such as gums, resins, essential oils and spices. It calls for a study on the effects of their price fluctuations on communities.

696. Robinson, J. and Redford, K. (1991). *Neotropical Wildlife Use and Conservation.* University of Chicago Press, Chicago.

697. Schwartzman, S. and Allegretti, M.H. (1987). *Extractive Production in the Amazon and the Rubber Tappers Movement*. Environmental Defense Fund, Washington, DC.

698. Sheikh, M.I. (1987). *Forest Based Rural Enterprises: Pakistan*. RAPA Publication, FAO Regional Office for Asia and the Pacific.

> A review on the use of raw materials derived from forests to create jobs and provide income for rural people. Topics covered include: minor forest produce; village carpentry; Magri (Nannorhops ritchieana, a palm) products and basketry; wild fruits and nuts; medicinal plants; mushrooms; Tannins, gums, shellac and essential oils; resin industry; sericulture; bee keeping; and Fodder and forage.

699. Siebert, S.F. and Belsky, J.M. (1985). Forest product trade in a lowland Filipino village. *Economic Botany, 39(4), 522-533.*

700a. Swanson, T. and Barbier, E. (1991) *Economics for the Wilds. Wildlife, Wildlands, Diversity and Development*. Earthscan Publications Ltd., London.

> An economics that properly values the resources of the wilds offers the best long-term security for their future. Most of the world's wild areas have always been used by local societies who have managed their resources sustainably; one important guarantee for their preservation is therefore the continued participation of those communities in harvesting the benefits of wild land production. The early chapters of the book provide an introduction to the economics of valuation of wild areas and wild resources. The next chapters examine the value of wild resources in the context of: community development in Africa, wildlife tourism, sustainable rainforest use, and poaching. The conclusion of this multi-authored book argues that a comprehensive utilisation strategy for wild resources in needed to ensure thair continue existence and the continuing flow of benefits from them.

700b. Swanson, T. (1991). The economics of wildlife utilisation: wildlife as a means of appropriating natural habitat. *LEEC Discussion Paper*, DP 91-03. IIED, London.

701a. Tamang, D. (1992). *Indigenous Soil Fertility Management in the Hills of Nepal: lessons from a East-West Transect*. Research Report Series No. 19, HMG Nepal Ministry of Agriculture - Winrock International, Kathmandu.

> The author records details of farmers' practices in districts of Nepal. Farmers rely on a wide range of wild products. 26 species of plants are used for making compost and enhancing soil fertility.

701b. Weidelt, H.J. (1988). Growing rattan in SE Asia - an ecologically adapted form of land use. *Forstarchiv, 59, 144-150.*

> A review of the uses of rattans, their taxonomy, distribution, morphology, site requirements, harvesting, standing volumes and yields. The traditional rattan gardens of the Benuaq dayaks of E. Kalimantan are described. This planting of old clearings has resulted in an agroforestry system well adapted to the mixture of rattan species (Calamus spp., and other genera), forest and fruit trees structured like a natural forest and yielding a great variety of products.

702a. Whitmore, T.C. (1980). Potentially economic species of Southeast Asian forests. *Tree Crops Journal, 1, 171-181.*

702b. Zhaoguang, L. and Ning, W. 1992. A local resource-centered approach to rural trnasformation: agro-based cottage industries in Western Sichman, China. In: Jodha, N.S.,

Banskota, M. and Partap, T. (eds.) *Sustainable Mountain Agriculture Farmer's Strategies and Innovative Approaches.* pp 636-650. Oxford and IBH Publishing Co, New Delhi.

The region is one of the richest in China for wild diversity. There are over 800 species of animals, 6000 of plants and 200 of fungi. The paper describes the agricultural strategies of farmers. Many formerly wild plants are cultivated. Wild pepper production, for example, has grown from 320 tonnes in 1965 to 1322t in 1985. There are important markets for various fungi, including songrong mushrooms (Tricholoma matsutaka). Over 2000 tonnes are produced yearly, realising a revenue of 100 million yuan on the 1100 tonnes sold and not consumed by gatherers. There are difficulties in marketing from remote regions. Demand for the vegetable fern (Pteridium aquilinum var latiusculum) has grown rapidly in recent years, and now realises a local value of 200-500 million yuan on the 500 tonnes sold.

Chapter Ten

Biodiversity and the Future of Agriculture

Diverse homegarden, Java, Indonesia
Photo: Jules Pretty

10. BIODIVERSITY AND THE FUTURE OF AGRICULTURE

Long term food security for the world's population will continue to be dependent on wild genetic resources. Genes from wild plants and animals have been the source of agricultural innovation since the beginnings of plant and animal domestication. They remain key to breeding attempts, both in the context of research carried out by scientists in laboratories and research stations around the world and breeding experiments carried out by farmers. Maintenance of biodiversity within agroecosystems is thus essential for the long term sustainability of agriculture (717; 933). New developments of biotechnology raise important issues about the use of germplasm for agricultural improvement (716).

There are increasingly powerful economic arguments for conserving the world's biodiversity (724; 734; 736-738; 743; 754; 768; 769). There are a range of products found in the world's undisturbed ecosystems that are of potential value, some are currently exploited on a small scale by local inhabitants; others' economic use are as yet unknown (693; 704; 708; 745; 888). Loss of species at rates estimated at between 5-10% of total species per decade (754) may result in significant lost potential for the future. Removal of this biodiversity, largely through conversion to agriculture, has potentially large, long-term economic costs (734; 747).

Crop Breeding

Wheat, rice, maize and barley make up almost 90% of global production of grain. All have benefitted from improvements from wild genetic resources (732 for wheat; 711 for rice; 767 for maize; 764 for oats). The same applies to root crops (721; 726 for potatoes; 758 for sweet potato; 739 for cassava), oil crops (727; 755 for sunflower), vegetables and pulses (766), cucurbits (740), fruits and nuts (731; 762; 763), multi-purpose trees (710), and commodity crops (708; 748). Indeed since crop domestication began ten thousand years in the Fertile Crescent of the Middle East, wild genetic sources have been central to the production gains that have been achieved.

Genetic improvement to crops comes through cross-breeding with wild relatives. Ensuring resistance to fungal diseases (eg. rusts of wheats), bacterial infection, viral attack, pests etc. is a continuous process, in which new genetic material must continually be sought to upgrade the resistance properties of crops (761). For instance, wild germplasm is incorporated into rice in order to increase resistance to the brown planthopper (730; 765). Yield or nutritional improvements may increase through breeding programmes. For instance, wild legumes often have higher nutritional quality compared with domesticated relatives (706).

Breeding for disease resistance in crops using wild genetic material has been a highly sucessful enterprise (757). Transfers of what are usually single dominant genes from wild to domestic cultivars is a relatively simple operation for the plant breeder. Breeding for other traits, such as yield, using wild genetic material is more complex, but most major breeding programmes have benefited from collections of wild genetic material (751-753 for sorghums and millets).

The opportunities for using wild genetic material in breeding programmes will depend both on the genetic linkages of the desired property in the wild cultivar and the breeding properties of the crop. Those disease resistant genes that are not linked to other undesirable properties may easily be crossed into the crop. However breeding becomes more complex if the desired gene(s) are linked to other properties or if they exist as a series of minor genes rather than a single dominant one. Most success in introducing wild genetic material has occurred in those crops that are inter-fertile within the crop. Those crops that are incompatible with wild relatives present more of a problem, although techniques of genetic manipulation and biotechnology offer potentials (748; 757).

Wild genetic resources are often a useful source of genetic adaptation to ecological change. As agriculture increasingly must be practised in marginal lands, in areas of degraded and disturbed soil and in cleared forest areas, wild crop relatives with 'weedy' properties (fast growth, low soil water and nutrient properties etc.) may be increasingly significant. For instance, wild, 'weedy' tomatoes have a number of important characteristics useful for genetic improvement of commercial varieties (725). Global climate change may also put new pressures on existing crops. Wild relatives that can cope with uncertain and variable

environmental conditions found in natural environments may be more suited to new *conditions*.

Animal Breeding

Improvement of livestock through breeding with wild relatives has had less success than with crops (718). A number of reasons exist. First, sources of wild germplasm are rarer for animals as many close relatives of domesticated livestock are very rare or extinct; second, disease and pest resistance and control in animals has biologically different characteristics compared to plants; and finally maintenance of a stock of wild animal genetic resources presents greater problems (748). Despite this, the process of domestication of wild animals for economic use remains important (744). For instance, the cross between beef cattle and North American bison (the 'beefalo') is reputedly hardier, while retaining the same meat quality and productivity (748).

Maintaining Biodiversity

Much of the genetic diversity on which the improvement and future sustainability of agriculture must depend is found in the Third World - in and around farmers' fields, in village forests, in grazing lands (702b; 703a, b). The Vavilov centres of biological diversity include China, India/Burma/SE Asia, South-central Asia; west Asia, Ethiopia; Middle America and South America (703b and 766 for cases in China).

Although some of this vast resource exists in forest reserves and national parks, the most important component is managed by local farmers or pastoralists. The development, management and control of this resource is an important current policy concern (729; 734; 746). In situ conservation of wild genetic resources will be key to the maintenance of economically important biodiversity (702a; 703a; 709; 756). For instance in a site in Mexico only 12% of the original forest cover remained, but small homegardens were the site of the greatest biodiversity and the source of most available wild species (7).

The question of who owns this heritage, who has control of it, and who will profit from it, is increasingly being asked (719; 735). Food and pharmaceutical companies and conservation organisations from the north recognise the value of the resource, albeit for different reasons. There are increasing attempts to 'save' this genetic diversity in gene banks and repositories for future use (712; 722). For instance, the International Board for Plant Geneitc Resources (IBPGR) has a number of regional germplasm collections and an programme of genetic conservation (723; 724). Other international agricultural centres are similarly engaged (741 for cowpea germplasm at IITA; 750; 752 for pearl millet at ICRISAT).

But some argue that the existing legal frameworks are insufficient to protect the rights of the current resource managers - farmers, forest dwellers and pastoralists. Removal of germplasm and its subsequent patenting and commercial use potentially results in the loss of value of wild products to local people (729). The management of wild genetic resources through in situ conservation programmes, supported by legal controls, is likely to be the most effective approach in the long term.

Economic Value of Biodiversity

Provision of economic incentives for natural resource management are increasingly seen as central to the sustainable management of resources use. Effective valuation of wild genetic resources and the design of appropriate incentives for resource management by local communities must be key to future strategies for the in situ management of biodiversity (296; 733; 747).

The value of diversity can be seen as distinct to the gross value of biological resources, as the maintenance of diversity itself may have intrinsic value (296; 664; 705). Valuation of biodiversity - genetic, species and ecosystem - has to take into account the direct use values, the indirect use values, the option values and the existence values of diversity (see also 631-701) for a comprehensive assessment.

CHAPTER 10: BIODIVERSITY AND THE FUTURE OF AGRICULTURE

702. Altieri, M. and Merrick, L. (1988). Agroecology and in situ conservation of native crop diversity in the Third World. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 361-369, National Academy Press, Washington, DC.

This chapter argues strongly for practical applications of in situ conservation of crop genetic resources. If the conservation of crop genetic resources is to succeed among small farmers, the process must be linked to rural development efforts that give equal importance to local resource conservation and to food self-sufficiency and market participation. A shift in agricultural development priorities is needed towards a focus on local knowledge systems, the use of internal resources and low external inputs to enhance sustainable production. Incorporation of indigenous crops and other native plant germplasm in the design of self-sustaining agroecosystems should ensure the maintenance of local genetic diversity available to farmers. This approach contrasts with that being carried out by many international centres, which currently concentrate on ex situ conservation of relatively few species. This approach runs the danger of eroding genetic diversity in the long term. If farmers are to participate in international biological diversity conservation programmes, they must be compensated for their efforts and they must have access to seeds and genetic resources in gen e banks. This requires a shift in emphasis of biodiversity programmes towards farmers' needs and rights and towards a more integrated view of agroecological development.

703. Altieri, M.A., Merrick, L.C. and Anderson, M.K. (1987). Peasant agriculture and the conservation of crop and wild plant resources. *Conservation Biology, 1(1), 49-58.*

Through a review of the literature, this paper explains how traditional farming systems are composed of not only of cultivated fields, but also the natural ecosystems which surround them. Characteristic of these agroecosystems is both intraspecific and interspecific variety. This variety, along with farmer management of the total agroecosystem, provides an opportunity for the conservation o f wild and crop plant genetic resources. In situ conservation allows for the adaptation of plants to the constantly changing environment and for the crossing of wild and weed species with cultivars.

In Mexico, the "weed" generas, Amaranthus, Chenopodium and Brassica are relied upon as food during the four months prior to the maize and bean harvests. These "weeds" also are an emergency food supply if hail storms should destroy the crops. In addition to these weeds in fields, examples are given of the hundreds of plants collected from natural ecosystems for food, fuel, medicinal and household items by agricultural and pastoral peoples throughout the tropics. However, local knowledge about wild resources is being lost with increasing agricultural modernisation. Although, as farmers become pushed onto marginal lands, they try to revert from modern varieties and inputs back to their traditional diverse systems and varieties for better food productivity. Unfortunately, this return is hindered by the loss of traditional crop genetic resources. It is therefore recommended that a farmer-curator system be established where farmers are responsible for the conservation of genetic resources on-farms in conjunction with the preservation of natural ecosystems. They should be compensated for any loss of productivity due to the maintenance of these native varieties. Such funding may come from developed countries who benefit particularly from these genetic resources.

704. Arkcoll, D.B. and Clement, C.R. (1989). Potential new food crops from the Amazon. In: G.E. Wickens, N. Haq, and P. Day (eds.), *New Crops*, pp. 150-165, Chapman Hall, London.

705. Aylward, B. (1991). *The Economic Value of Ecosystems: 3. Biological Diversity.* LEEC GK 91-03, IIED, London.

This paper argues that the maintenance of biodiversity may have intrinsic value; it is therefore necessary to see this as distinct from the gross value of the resource. Valuation of biodiversity must take into account genetic, species and ecosystem aspects and examine direct, indirect and non-use values. A loss of a particular species must be assessed according to the substitution costs of replacing its direct use value. The impact of species loss on indirect use value may require the assessment of species loss on ecosystem processes. Option values are dependent on the assumption that future demands for wild products are certain, but supply is threatened. These values represent the unknown value of unexploited plant species for food, medicine, and other uses. Existence values may also be important in the valuation of biodiversity; this is where people intrinsically value the presence of endangered species or the existence of diverse forest resources, even if they have no immediate use.

707. Boom, B. (1985). Amazonian Indians and the forest environment. *Nature, 314, 324.*

A forest inventory recorded 649 individual trees occurring in a hectare of Bolivian forest. The Chacabo Indians had a use for 75 species (85% of the total) or 619 individual trees (91% of the total).

708. Brucher, H. (1989). *Useful Plants of Neotropical Origin and Their Wild Relatives.* Springer-Verlag, London.

This comprehensive reference text lists information on the ecology, morphology, production, pests and economics of over 170 neotropical plants. The book is divided into ten parts as follows: Carbohydrates from Roots and Tubers; Farinaceous Plants; Protein Plants; Oil Plants; Palms; Industrially Used Plants; Aromatics, Narcotics, Stimulants, Spices; Some Neotropical Timber; Tropical Pasture Plants; and Aromatic and Fleshy Fruits. The author stresses the fact that many major staple products of the world (eg. maize, cassava, potatoes) originated in the neotropics and that many other neotropical plants also possess great potentials for food production and pest resistance; however, such potentials are in danger due to deforestation.

709. Brush, S.B. (1991). A farmer-based approach to conserving crop germplasm. *Economic Botany, 45(2), 153-165.*

This article advocates a programme of in situ conservation of crop germplasm by farmers. Four categories of germplasm exist: wild crop relatives, semi-domesticated crop relatives, perennial species and land races of ancestral crop species. The final category is concentrated upon in this paper. Conservation by farmers is less expensive than storage in gene banks. Also while in fields the plants are able to evolve and adapt to the prevailing environmental conditions. Case studies from Mexico, Peru and Thailand illustrate that despite the introduction of modern varieties of crops, farmers still maintain traditional varieties. These traditional varieties continue to be cultivated because their taste is preferred and at times they earn a higher price in local markets. Guidelines for the implementation of in situ conservation are given. It should complement ex situ conservation; have minimal outside intervention; follow farmers' current conservation strategies; improve farm income; and cooperate with international, national and regional conservation programmes. Also described are the types of institutional and policy frameworks needed to develop in situ conservation.

710. Burley, J. (1985). *Global Needs and Problems of the Collection, Storage and Distribution of Multipurpose Tree Germplasm.* Science and Practice of Agroforestry 2, ICRAF, Nairobi, Kenya.

This book provides an introduction to multipurpose trees, germplasm conservation and social forestry. It lists the international and national institutions involved in research into multipurpose trees. Problems related to germplasm collection and storage are identified along with potential strategies to address them.

711. Chang, T. (1975). Exploration and survey of rice. In Frankel, O. and Hawkes, J. (eds.). *Crop Genetic Resources for Today and Tomorrow*. pp 159-165. Cambridge University Press, Cambridge.

712. Cohen, J.I., Alcorn, J.B. and Potter, C.S. (1991). Utilization and conservation of genetic resources: International projects for sustainable agriculture. *Economic Botany, 45(2), 190-199.*

713. Cooper, D; Vellvé, R. and Hobbelink, H. (eds.) (1992). *Growing Diversity. Genetic Resources and Local Food Security*. Intermediate Technology Publications, London.

Farmers have managed genetic resources for as long as they have cultivated crops. But the farmers' role in the management of genetic resources has been undermined by the 'Green Revolution' approach to agricultural development. New varieties have displaced many of farmers' traditional varieties, and their own local knowledge about genetic resources has been eroded too. While the public imagination in industrialised countries is dominated by concern for the biological diversity of the tropical rainforests, that in farmers' fields is at least as significant, as it underpins our basic food security. This book compiles NGOs' and activists' experience of managing plant genetic resources, together with farmers from across the world, and argues that biodiversity and genetic conservation must be seen in combination with the basic issues of sustainable agricultural development.

714. Ehrlich, P.R. (1988). The loss of diversity: Causes and consequences. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp . 21-27, National Academy Press, Washington, DC.

This essay provides a short description of the major issues surrounding species and population extinctions, elaborating the conservationist concerns for species loss.

715. Farnsworth, N.R. (1988). Screening plants for new medicines. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 83-97, National Academy Press, Washington, DC.

Approximately 119 pure chemical substances are derived from higher plants and are used in medicine throughout the world. In 1985, U.S$8 billion was spent in community pharmacies for prescriptions whose active constituents are extracted from plants. Many of these plants are wild.

716. Farrington, J. (ed.) (1989). *Agricultural Biotechnology: Prospects for the Third World. Overseas Development Institute, London.*

Advances in biotechnology hold many promises for the future of agriculture, yet many potential dangers. This short book provides an overview of the issues, ranging from institutional arrangements for biotechnology research, questions of property rights and patenting and the technological potentials of emerging scientific techniques.

717. Frankel, O. and Hawkes, J. (eds.) (1975). *Crop Genetic Resources for Today and Tomorrow*. International Biological Programme, 2. Cambridge University Press, Cambridge.

718. Frankel, O. and Soule, M. (1981). *Conservation and Evolution*. Cambridge University Press, Cambridge.

719. Gupta, A.K. (1991). *Why Does Poverty Persist in Regions of High Biodiversity? A Case for Indigenous Property Right System*. Indian Institute of Management Working Paper No. 938, Ahmedabad, India.

720. Harlan, J.R. (1976). Genetic resources in wild relations of crops. *Crop Science, 16, 329-333.*

721. Hawkes, J. (1945). The indigenous American potatoes and their value for plant breeding. 1. Resistance to disease. 2. Physiological properties, chemical composition and breeding capabilities. *Empire Journal of Experimental Agriculture, 13, 11-40.*

722. Heywood, V. (1991). Conservation of germplasm of wild plant species. In: *Conservation of Biodiversity for Sustainable Development*, Norwegian University Press and Cambridge.

> This chapter reviews the conservation of wild plants' germplasm. Of the 250,000 species of higher plants, humans have utilized about 100,000. There has been very little collection of wild, underexploited and medicinal plants. Due to the lack of seed stocks of indigenous species, often exotic species are planted for reafforestation projects. Over 25,000 species are used for medicinal. Their efficacy is very much dependent upon the conditions under which they grow. As such medicinal plants disappear, substitutes may not be available for local communities. In addition to improving the presence of these species in gene banks, greater research into in situ conservation is needed.

723. Hoyt, E. (1988). *Conserving the Wild Relatives of Crops.* IBPGR, IUCN, WWF, Rome and Gland.

724. Hoyt, E. (1990). Wild relatives. *Wilderness, Summer 1990, 45-54.*

725. Iltis, H. (1988). Serendipity in the exploration of biodiversity: What good are weedy tomatoes? In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 98-105, National Academy Press, Washington, DC.

> This paper tells the story of two important discoveries of wild populations that have helped improve domesticated cultivars - a wild weedy tomato species from Peru improved sweetness of domesticated varieties and a wild maize species (teosinte) from Mexico was found in a small remnant population. Both these cases illustrate not only the economic importance of wild genetic resources, but also the need to conserve relict populations.

726. Jackson, M.T., Hawkes, J.G., Male-Kayiwa, B.S., Wanyera, N.W.M. and Kayiwa, B.S. (1988). The importance of the Bolivian wild potato species in breeding for Globodera pallida resistance. *Plant-Breeding, 101, 261-268.*

> Screening for resistance to G. pallida in potatoes from Bolivia was carried out in 1983 and 1984, using a mixture of 4 nematode populations. From the 66 accessions of 17 species and subspecies evaluated, highly resistant genotypes were identified in 21 accession s from 7 species. Two wild species, S. brevicaule and S. leptophyes, showed the best resistance. The geographical distribution of resistant populations and the evolution of resistance in wild populations are examined.

727. Jain, S., Oliveri, A. and Fernandez-Martinez, J. (1977). Serpentine sunflower, Helianthus exilis, a genetic resource. *Crop Science, 17, 477-479.*

728. Jong, K.E.O. (1973). Malaysian tropical forest: An under-exploited genetic reservoir of edible fruit tree species. In: E. Soepadmo and K.G. Singh (eds.), *Proceedings of the Symposium Biological Resources and Natural Development*, pp. 113-121, Malayan Nature

Society, Kuala Lumpur.

729. Juma, C. (1989). *The Gene Hunters.* Zed Press, London. See also: 88.

730. Jung-Tsung, W., Heinrichs, E.A., Medrano, F.G. and Tsung, W. (1986). Resistance of wild rices, Oryza spp., to the brown planthopper, Nilaparvata lugens (Homoptera: Delphacidae). *Environmental Entomology, 15, 648-649.*

> The resistance of wild rice to 3 biotypes of Nilaparvata lugens was evaluated in greenhouse studies in the Philippines. Of 36 wild rices screened, 19 accessions were resistant to at least one biotype of N. lugens.

731. Kokaya, Ts.D (1987). Wild citrus species and their use for breeding purposes. *Rastitel'nye-Resursy, 23, 513-520.*

732. Levy, A.A. and Feldman, M. (1989). Location of genes for high grain protein percentage and other quantitative traits in wild wheat Triticum turgidum var. dicoccoides. *Euphytica, 41, 113-122.*

733. McNeely, J. (1988). *Economics and Biological Diversity: Developing and Using Economic Incentives to Conserve Biological Resources.* IUCN, Gland, Switzerland.

734. McNeely, J., Miller, K., Reid, W., Mittermeier, A. and Werner, T. (1990). *Conserving the World's Biodiversity.* WRI, CI, WWF-US, World Bank, IUCN, Gland.

735. Mooney, P. (1979). *Seeds of the Earth: A Private or Public Resource?* Canada Council for International Cooperation.

736. Myers, N. (1983). Tropical moist forests: Over-exploited and under-utilized? *Forest Ecology and Management, 6, 59-79.*

737. Myers, N. (1983). *A Wealth of Wild Species.* Westview Press, Boulder, Colorado.

738. Myers, N. (1984). *The Primary Source: Tropical Forests and Our Future.* W.W. Norton, London.

739. Nassar, N. (1978). Conservation of the genetic resources of cassava (Manihot esculenta) determination of wild species localities with emphasis on probable origin. *Economic Botany, 32, 311-320.*

740. Nee, M. (1990). The domestication of Cucurbita (Cucurbitaceae). *Economic Botany, 44 (Supplement), 56-68.*

> The genus consists of 13 species or species groups. Squashes have been domesticated independently from 5 species. Wild ancestors were identified in the 1930s and 1980s, but progenitors of 2 domesticates remain unknown.

741. Ng, N.Q., Goli, A.E., Padulosi, S. and Osunmakinwa, A.A. (1987). *Exploration for Land Races and Wild Species of Food Crops.* IITA Research Briefs, International Institute

of Tropical Agriculture, B:1987.

Since 1985, a total of 1460 samples of Vigna germplasm have been collected in the course of missions to various African countries. These include 97 samples of wild subspecies of V. unguiculata and 201 of other wild Vigna species, such as V. nervosa.

742. Norgaard, R.B. (1988). The rise of the global exchange economy and the loss of biological diversity. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 206-211, National Academy Press, Washington, DC.

This chapter argues that the conventional economic approach to assessing biodiversity leads to extinction, as the neo-classical assumptions used are inappropriate.

743. Oldfield, M.L. (1989). *The Value of Conserving Genetic Resources.* Sinauer Associates Inc., Sunderland, Massachusetts, USA.

This book focuses on the extrinsic (societal and economic) value of natural biota The chapters of the book include: Gene resource conservation: a socioeconomic necessity, emphasizing the need for in situ conservation by protecting ecosystems; Plant resources and food production, detailing the economic importance of genetic diversity, the conservation of gene centres, the use of wild relatives to improve crop plants and the possibility of developing new crop species; Animal resources and food production, dealing with the genetic improvement of domesticated animals; Medicinal plant and animal resources; *Tree resources, with emphasis on the situation in the USA; Natural rubber, giving an account of the* narrow genetic base of rubber (Hevea brasiliensis) and its possible diversification, and the use of other plant species as sources of latex; Natural sources of industrial oils and waxes, with the examples of plant oils such as jojoba; Wild biota and other economic activities, emphasizing the value of wild species for the fashion, souvenir and pet or garden industries; Economics and extinction, examining the economic trade-off between the cost of conservation and the cost of allowing species to become extinct; and Conclusions: effecting global conservation.

744. Peel, L.E. and Tribe, D.E. (eds.) (1983). *Domestication, Conservation and Use of Animal Resources.* World Animal Science A1, Elsevier; Amsterdam, Netherlands.

This volume consists of 15 chapters, each by a different author or authors. The first four chapters deal with the domestication and use of indigenous animals in different regions of the world. The next five chapters deal with among other topics, conservation of genetic resources and the rational use of wild animals. Of the remaining six chapters, five deal with specific aspects of animal production in a world context.

745. Plotkin, M. (1988). The outlook for new agricultural and industrial products from the tropics. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 106-116, National Academy Press, Washington, DC.

746. Plucknett, D.L., Smith, N.J.H., Williams, J.T., Anishetty, N. and Murthi-Anishetti, N. (1987). *Gene Banks and the World's Food.* Princeton University Press, Princeton, USA.

Chapter 1 provides the rationale for gene banks; the reasons for loss of genetic diversity are briefly described, and examples of drastic productivity losses due to genetic simplification are given. Chapter 2 explores the rapid replacement of varieties, breeding strategies employed to make varieties more resilient to environmental challenges, and seed-production systems. Chapter 3 covers the history of germplasm preservation and exchange, from botanical gardens to modern cold-storage units. Chapter 4 considers the principles of germplasm collection and preservation of natural areas for wild relatives

of crops. Chapter 5 outlines recent advances in recombinant DNA technology and their impact on agriculture and value to gene banks. Chapter 6 provides information on germplasm holdings of cereals, root crops, pulses, vegetables and industrial crops (including data on wild relatives). Chapter 7 gives example s of how gene banks have been used to improve crops. Chapter 8 considers the importance of wild relatives of cultivated species. Chapter 9 gives an account of the production of the important high-yielding rice variety IR36. Chapter 10 summarizes the advances made in germplasm conservation and outlines challenges for the future, including improved evaluation of accessions and further duplication of collections.

747. Prescott-Allen, R. and Prescott-Allen, C. (1982). *What's Wildlife Worth? Economic Contributions of Wild Plants and Animals to Developing Countries.* Earthscan, IIED and WWF-US, London.

This book reviews the literature on the contributions of wild animals and plants to household and national economies in developing countries. Evidence is provided for their importance; for example, although official statistics show that national per capita consumption of wild game is only one percent of total meat consumption, this figure in rainforest communities can be as high as 70%. Rodents with high reproductive rates are most often caught. Taking into account aquatic animals, data from FAO's provisional food balance sheets (1972-1974) show that 62 countries receive at least 20% of total per capita animal protein consumption from wild animals. Data for specific countries and regions are provided. Wild plants and their uses are also described including their medicinal value. The World Health Organisation estimates that 70-80% of the population in less developed countries rely on traditional plant remedies. Also of 54 drugs listed in a UN survey for use in developing countries, 20 were derived from wild species, with another 20 also wild, but able to be cultivated. An additional benefit of wild species is as a genetic resource to improve crop yields or to provide disease and drought resistance. Many examples are given including Oryza nivara, a species of wild rice resistant to grassy stunt virus. This virus at one time damaged 116,000 hectares of rice in Asia, but because of crosses with the wild species, this disease no longer exists. Wild species however are threatened by overexploitation and habitat destruction. The book argues that the conservation of wildlife is necessary for sustainable economic development.

748. Prescott-Allen, R. and Prescott Allen, C. (1988). *Genes from the Wild. Using Wild Genetic Resources for Food and Raw Materials.* Earthscan, London.

749. Prescott-Allen, R. and Prescott-Allen, C. (1990). *How Many Plants Feed the World? Conservation Biology, 4(4), 365-374.*

From data on per capita food supply contained within the FAO's Food Balance Sheets 1979-1981, the authors found that 103 species comprise 90% of the recorded nations' food supplies. Previous estimates had listed a maximum of 30 species. Although the species are predominantly cultivated staples, fruits and vegetables, wild species, such as the Brazil nut, Bertholletia excelsa, are listed. The authors point out that this list of species is an underestimate, as those species grown in homegardens or sold in local markets are not included in national accounting systems. Other species missing include those with little weight, protein or fat and with few calories, but are significant in that they make the staples more palatable. This study provides evidence that species diversity is important to food supplies. This species diversity must be conserved, as well as the genetic variations within a species, in order to improve world food security.

750. Rao, E.V.V.B. (1989). Plantation crops genetic resources research in India. *Journal of Plantation Crops: Supplement, 303-312.*

Major germplasm maintenance centres in India are listed. Crops covered include coconut, arecanut, cashew, cocoa, oil palm, nutmeg, black pepper, ginger, turmeric, cloves, cinnamon, cardamom, tea,

coffee and rubber. Germplasm holdings consist of 182 exotic, 1610 local and 87 wild accessions of these crops. Priority areas for collection of exotic and indigenous material are given.

751. Rao S.A., Mushonga, J.N. and Appa-Rao, S. (1987). *A Catalogue of Passport and Characterization Data of Sorghum, Pearl Millet and Finger Millet Germplasm from Zimbabwe.* International Board for Plant Genetic Resources, Rome, Italy.

Following a general account of germplasm collected in Zimbabwe in 1982 under the auspices of ICRISAT, IBPGR and the national research organization, information is presented on passport data on genetic variation in Zimbabwe, wild relatives and utilization for Sorghum bicolor, Pennisetum americanum and Eleusine coracana.

752. Rao, S.A., Mengesha, M.H. and Reddy, C.R. (1986). Pearl millet (Pennisetum americanum) germplasm from Senegal. *Indian Journal of Genetics and Plant Breeding, 46, 413-422.*

This collection at ICRISAT includes 258 cultivated, 43 intermediate and 3 wild accessions. The early maturing (souna) type is adapted to low (350-600 mm) rainfall regions of northern Senegal, while the late maturing (sanio) type is adapted to the high (900-1200 mm) rainfall regions of the south. The thiotande type gives large grains with starchy endosperm and is generally grown in backyards.

753. Rao, S.A., Mitawa, G.M., Felix, J. and Mengesha, M.H. (1988). Collecting pearl millet germplasm in Tanzania. *Plant Genetic Resources Newsletter, 75-76, 40-41.*

A total of 299 samples of pearl millet (Pennisetum americanum), 261 of sorghum, 7 of groundnut, 4 of chickpea, 1 of pigeonpea and 15 of finger millet (Eleusine coracana) were collected from various regions in Tanzania. Pearl millets from Dodoma, Igunga and Singida differed markedly in tillering and spike size. Variation in field crops was high as farmers tended to grow mixtures of various types. Variation within populations was higher in Singida than in Dodoma. Landraces with red or brown grain were preferred by farmers as they were said to be bird resistant.

754. Reid, W. and Miller, K. (1989). *Keeping Options Alive: The Scientific Basis for Conserving Biodiversity.* World Resources Institute, Washington.

755. Richardson, D.L. and Chavez, C. (1986). Oil palm germplasm of Tanzanian origin. *Turrialba, 36, 493-498.*

Yield, vegetative and bunch quality characteristics are presented for a collection of open-pollinated progenies, derived from seed lots collected among wild palms in the Simbo and Kwitanga areas of the Kigoma District of Tanzania.

756. Roche, L. and Dourojeanni, M. (1984). *A Guide to In Situ Conservation of Genetic Resources of Tropical Woody Species.* FAO, Rome.

757. Russell, G. (1978). *Plant Breeding for Pest and Disease Resistance.* Butterworths, London.

758. Sakomoto, S. (1976). Breeding of a new sweet potato variety, Minamiyutaka, by the use of wild relatives. *Japan Agricultural Research Quarterly, 10, 183-186.*

759. Schachl, R. (1988). Genetic resources of crop plants in the alpine region.

Kulturpflanze, 36, 107-119.

The Alps has an abundance of habitats harbouring genotypes which have been displaced elsewhere. Examples of wild crop relatives an d landraces are provided; some have survived in alpine ecological niches, whereas others are known only through historical records. A large degree of diversity still exists in certain crops such as fruit, certain vegetables, condiments and medicinal plants.

760. Schultes, R.E. and Raffauf, R.F. (1990). *The Healing Forest: Medicinal and Toxic Plants of Northwest Amazonia.* Dioscorides Press, Portland, Oregon, USA.

This book draws together information on over 1,400 species and variants of medicinal and toxic plants based upon research in Northwest Amazonia and experience in phytochemistry. In addition to botanical descriptions, details are given of their uses and chemical compositions. Families of these species are arranged alphabetically for easy reference. Photographs and illustrations are also contained within the book. The tremendous knowledge of these species originally derived from Amerindians and the authors emphasize the importance of recording and conserving this understanding of the plant world.

761. Simmonds, N. (1979). *Principles of Crop Improvement.* Longman, London.

762. Soedpadmo, E. (1979). Genetic resources of Malaysian fruit trees. *Malaysian Applied Biology, 8(1), 33-42.*

763. Spiegel Roy, P. (1986). Domestication of fruit trees. In: Barigozzi, C. (ed.). *The Origin and Domestication of Cultivated Plants.* Elsevier, Amsterdam, Netherlands.

Fruit tree domestication probably began in the 4th millenium BC with collection from the wild and the domestication of those specie s most easy to propagate vegetatively, such as grape, olive, date, fig and banana, or those which exhibit polyembryony, such as citrus fruits and mango. This was followed by domestication of some seed propagated types such as almond and self-fertile Prunus spp. Further species were domesticated with the development of budding and grafting techniques.

764. Valentine, J. (1987). Breeding cereals of high nutritional quality with special reference to oats and naked oats. *Aspects of Applied Biology, 15, 541-548.*

Improvement of oats through breeding is considered and strategies such as the use of wild relatives Avena sterilis and A. maroccana for introducing genes for quality traits are examined.

765. Velusamy, R. (1988). Resistance of wild rices, Oryza spp., to the brown planthopper, Nilaparvata lugens (Stal) (Homoptera: Delphacidae). *Crop Protection, 7, 403-408.*

Of 128 wild rices (Oryza spp.) screened for resistance to Nilaparvata lugens in greenhouse tests in India, 83 were resistant to the pest.

766. Wang, M. and Sun, Y.W. (1987). Fruit tree and vegetable germplasm in arid and semi-arid areas of northwest China. *Plant Genetic Resources Newsletter, 72, 17-19.*

Attention is drawn to the rich reservoir of fruit tree, vegetable and cucurbit germplasm (including wild species) to be found in the arid and semi-arid regions of north-west China and Tibet. These include Diospyros, apricot, peach, walnut, almond, melon, Allium, Hemerocallis and Lilium species, the last 2 *being eaten as vegetables.*

767. Wilkes, H. (1972). Maize and its wild relatives. *Science, 177, 1071-1077.*

768. Wilson, E.O. (1985). The biological diversity crisis. *BioScience*, 35(11), 700-706.

769. Wilson, E.O. (1988). The current state of biological diversity. In: E.O. Wilson and F.M. Peter (eds.), *Biodiversity*, pp. 3-18 , National Academy Press, Washington, DC.

This opening chapter of this multi-authored book sets the scene for a wide ranging discussion in the following 57 chapter and 500 pages. Wilson reviews some of the current thinking on the magnitude of biodiversity. By concentrating on tropical moist forests, the most species rich of habitats, the threats to biodiversity are outlined.

Chapter Eleven

Non-Timber Forest Products

Venezuelan forest
Photo: Mary Melnyk

CHAPTER 11: NON-TIMBER FOREST PRODUCTS

This section compiles a range of material under the broad heading of Non-Timber Forest Products (NTFPs). This is a catch-all term for the huge range of products that are derived from forest or woodland systems, that are not timber products - the conventional concern of forest. This range of products has been widely discussed in the previous sections of this bibliography. This section concentrates on broad overview pieces and area specific listings.

Much of the research documented in this section concentrates on taxonomic descriptions and listings of the range of NTFPs. This gives an indication of the huge diversity of products available in forest systems. This contrasts dramatically with the conventional concentration of agriculture or forestry on a very limited range of species. The Victorian taxonomic tradition is insufficient to explain the key issues of the social role of forest resources, the economic contributions of NTFPs or the ecological relationships between different components of a forest, woodland or agricultural ecosystem.

As Professor John Lawton of Imperial College has commented: *"If you collected all the species from a hectare of forest, you'd go bankrupt, and all you would have would be a list; not even a shopping list. You wouldn't be able to trace an economy through it; it would be like trying to reconstruct how a city works from a residential telephone directory"*. In other words, it is insufficent to know only about species diversity, we must begin to understand interconnections and functional processes of ecology and economy.

This chapter includes papers covering a wide range of issues relating to the availability and use of NFTPs. It includes a wide range of country-based resource inventories and catalogues eg. Jordan 772; Pakistan 773; Egypt 843; Burkina Faso 831; Ghana 770, 859; Egypt 793; Philippines 795, 860, 875, 922; Bangladesh 810; Ethiopia 830; Poland 839; Zimbabwe 840, 929; Finland 867; Ukraine 866; Venezuela 853, 854; India 845, 876, 918, 920, 923; Uganda 842; Canada 869, 936; Chile 881; Cote D'Ivoire 882; Gambia 925; Vanuatu 901; Nigeria 891; Cameroun 890, 934, 935; Botswana 884; Malawi 940). There are also general regional overviews of NTFPs (eg. for Africa 792, 898, 90; for Amazonia 930, 931; West Africa 798; Malay Peninsula 797; Southern Africa 804; East Africa 846; S E Asian Forests 805; Andes

806; Latin America 822, 862).

Some focus more on traditional food uses (822, 824, 827, 914, 915) and others on economic aspects of wild plants (782, 791, 888). Many studies combine ecological and ethno-botanical aspects with respect to particular plants (eg. Balanites in Rajasthan 774; figs in Kenya 783; palms in Brazil 801; African breadfruit 814; palms in Indonesia 834; wild mango in Indonesia 789; wild cucurbits in Nigeria 900; Aguaje in Peru 903; Ameranthus in Tanzania 927). One notable study comprises a world compendium of forest institutions (851).

Yet these simple listings of NTFPs give little indication of importance or function. Does it matter if a particular species goes extinct in any area? Will this affect ecological relationships and the production of other NTFPs or forest resources? Is a particular NTFP economically valuable, now or potentially in the future? Is it worth investing in conservation for all species or only certain key species?

These dilemmas are difficult questions to answer. Research on NTFPs must therefore combine thorough taxonomic work of available resources with ecological studies of functional ecosystem interrelationships and economic analyses of the role NTFPs play in people's livelihoods.

CHAPTER 11: NON-TIMBER FOREST PRODUCTS

770. Abbiw, D.K. (1990). *Useful Plants of Ghana: West African Uses of Wild and Cultivated Plants*. Intermediate Technology Publications and The Royal Botanic Gardens, Kew, UK.

> This is a compilation and discussion on a large number of plants; some 2500 scientific names are included in the index. Uses are de scribed in the 12 chapters under the headings: Forests and conservation (forest reserves; timber trees; minor forest products; protective functions); Food and fodder (cereals, roots, tubers, etc.; legumes; vegetables; fruits; beverages; spices, etc.); Industrial or cash crops; (cocoa; coffee; palms; fibres; sugar; rubber; spices); Building and construction; Furnishings; Fuel (fuelwood; charcoal); Tools and crafts (including musical instruments); Potions and medicines; Poisons, tannin, dyes, etc.; Amenity landscaping and gardening; Weeds; and Plants and soil nutrients. Four indexes are provided: local (Ghanaian) names, common (English) names, scientific names, and general.

771. Adekunle, A.O. (1971). The non-timber forest resources of the high forest areas of Nigeria. *Nigerian Journal of Forestry, 1(1), 12-16.*

772. *Al-Eiswi, D.M and Takruri, H.R. (1989). A checklist of wild edible plants in Jordan. Arab Gulf Journal of Scientific Research, B: Agricultural and Biological Sciences, 7, 79-101.*

> A checklist of 142 species of edible wild flowering plants has been prepared on the basis of specimens collected from different parts of the country and information on local food habits. The taxa recorded belong to 84 genera and 28 families. English names, Arabic names and the edible parts of the plants are given.

773. Ali, S.I. (1986). Under-exploited economic plants of Pakistan. *Journal of Arid Environments, 11(1), 17-25.*

774. Amalraj, V.A. and Shankarnarayan, K.A. (1986). Ecological distribution of Balanites roxburgii Pl. in arid Rajasthan. *Journal of Tropical Forestry, 2, 183-187.*

> The tree occurs wild and is common on roadside and on fields. Fruits are an important source of food. Yield measurements from four areas are recorded.

775. Anon. (1949). Utilization abstracts: Indigenous food plants of West Africa. *Economic Botany, 3, 436-444.* Reprinting of text from F.R. Irvine, *Journal of the New York Botanical Garden, 49,225-236.*

> The wild and cultivated species native to Africa and their uses are reviewed. The species are categorized as follows: edible fruits and seeds; cooked fruits and the like; edible legumes; foliage crops; cereals; root crops; spices and beverages.

776. Arenas, P. and Giberti, G.C. (1987). The ethnobotany of Odontocarya asarifolia (Menispermaceae), an edible plant from the Chaco. *Economic Botany, 41, 361-369.*

> This medium-sized liana grows in semi-arid woods of the western central Chaco region of Argentina and Paraguay. Sharply contrasting with the well-known medicinal and toxic properties of many taxa in the family, the stems of this plant are cooked and consumed as a vegetable by several Amerindian

ethnic groups of the region (Mataco, Choroti, Toba-Pilaga, Chulupi and Pilaga). Collection, preparation and consumption of the plant are described. Vernacular names, a summary of local myths concerning the origin of this creeper, an illustrated anatomical description of the stem, and some ecological and morphological data are provided.

777. Arnold, T.H., Wells, M.J. and Wehmeyer, A.S. (1985). Khoisan food plants: Taxa with potential for future economic exploitation. In: G.E. Wickens, J.R. Goodin, and D.V. Field (eds.). *Plants for Arid Lands*. Proceedings of the Kew International Conference on Economic Plants for Arid Lands 23-27 July 1984, pp.69-86, George Allen and Unwin, London.

Sixty-six species of plants collected by the Khoisan are presented for development as foods in arid areas. Their nutritional composition, parts used, yields and potential for domestication are described. The following research needs are identified: further descriptions of species their nutritional content, growth requirements and studies for domestication.

778. Awasthi, A.K. (1991). Ethnobotanical studies of the Negrito islanders of Andaman Islands, India - The Great Andamanses. *Economic Botany, 45(2), 274-280.*

This ethnobotanical survey of the Great Andamanese lists 89 species as well as their uses. Thirty-three are food plants, while 20 are medicinal.

779. Balick, M.J. (1979). Amazonian oil-palms of promise: A survey. *Economic Botany, 33(1), 11-28.*

780. Balick, M.J. (1984). Ethnobotany of palms in the Neotropics. *Advances in Economic Botany, 1, 9-23.*

781. Balick, M.J. (1985). Useful plants of Amazonia: A resource of global importance. In: G.T. Prance and T.E. Lovejoy (eds.), *Key Environments: Amazonia*, pp. 339-368, Pergamon Press, New York.

782. Balick, M.J. (1986). Systematics and economic botany of the Oenocarpus-Jessenia (Palmae) Complex. *Advances in Economic Botany, vol. 3*, New York Botanical Gardens, New York.

783. Beentje, H.J. (1988). Fig trees (Ficus, Moraceae) of Kenya. *Journal of the East Africa Natural History- Society and National Museum, 76, 53-76.*

An illustrated account is given of 31 wild Ficus species, with a key to identification, descriptions and distribution maps. Many of the wild species are sources of edible fruits, timber and fibre; some have medicinal uses.

784. Benk, E. (1987). Information on some lesser-known wild fruits. *Gordian, 87, 226-227.*

Information is provided on the origin, botanical character and uses of Sorbus torminalis, Vaccinium macrocarpon (cranberry), Rubus chamaemorus (cloudberry), Mahonia aquifolium, Sorbus aria, Prunus padus, Prunus avium, Malus purpurea, Choenomeles japonica (Japanese quince), and Cotoneaster integerrimus.

785. Berlin, B. and Berlin, E.A. (1983). Adaptation and ethnozoological classification:

Theoretical implications of animal resources and diet of the Aguaruna and Huambisa. In: R.B. Hames and W.T. Vickers, (eds.), *Adaptive Responses of Native Amazonians*, 301-325, Academic Press, New York.

786. Berlin, B., Breedlove, D.E. and Raven, P.H. (1974). *Principles of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan-Speaking People of Highland Chiapas*. Academic Press, New York.

787. Bhatt, D.D. (1977). *Natural History and Economic Botany of Nepal*. Longman, Ltd.

788. Biswas, S and Bhuyan, T.C. (1983). On the identity of some food plants of Garo Hills, Meghalaya. *Indian Journal of Forestry, 6, 208-213.*

> Twenty-eight food plant species are listed including: Dillenia pentagyna (leaves and flower buds), Bauhinia malabarica and B. purpurea (leaves), Stereospermum personatum (leaves), Premnalatifolia (leaves), Artocarpus heterophyllus (fruit and seed), A. chaplasha (fruit), Bambusa balcooa (shoots) and Dendrocalamus hamiltonii (shoots).

789. Bompard, J.M. (1988). *Wild Mangifera Species in Kalimantan (Indonesia) and in Malaysia*. Report prepared for IBPGR and IUCN-WWF, Gland, Switzerland.

790. Boom, B. (1989). Use of Plant Resources by the Chacoba. *Advances in Economic Botany, 7, 78-96.*

791. Boom, B.M. and Moestl, S. (1990). Notes on economic plants. Ethnobotanical notes of Jose M. Cruxent from the Franco-Venezuelan expedition to the headwaters of the Orinoco River, 1951-1952. *Economic Botany. 44, 416-419.*

> Fifty-three plant species for which J. M. Cruxent obtained plant use data during his expedition to the sources of the Orinoco River in 1951-52 are listed under the headings: food, fuelwood, medicinal/bioactive and technology, together with local names and, in most cases, indications of their particular use.

792. *Booth, F.E.M. and Wickens, G.E. (1988). Non-Timber Uses of Selected Arid Zone Trees and Shrubs in Africa.* FAO Conservation Guide 19, FAO, Rome.

> This guide compiles the available information on 27 species of arid zone trees and shrubs. The following information is given for each species: botanical and vernacular names, distribution, description, main uses, other uses, economic importance, climate found, site, life cycle, pests and disease, seed supply, agronomy, yield, sociological factors, production potentials, processing, development constraints, recommendations for research and references. Illustrations of some species are also included. These species are multipurpose and the majority are wild. Many contribute to the nutritional well-being of communities and some are famine foods. Various tables are given for nutritional values, chemical compositions and amino acid contents. It is noted that five Faidherbia albida trees produce more crude protein than a hectare of groundnuts. Further research on these species is strongly recommended because of the contributions they make to households and of their ability to grow on marginal lands.

793. Boulos, L. (1989). Egyptian desert plants with promising economic potential. *Arab Gulf Journal of Scientific Research, 7, 91-108.*

A general survey of the desert plants of Egypt was carried out based on available literature and field observations. An annotated list of species (by family) is presented comprising edible, forage, medicinal, fibre, fuel, oil, resin, wax and tanstuff plants.

794. Brenzinger, M. (1990). Trees and grasses as rudiments of life. Use of wild plants in Kenya. *Mitteilungen der Deutschen Forschungsgemeinschaft, 1, 10-14.*

An important indirect use of flowering plants is in beekeeping and honey hunting. Yaaku and Mukogodo beekeepers know 93 nectar sources, and can recognize the taste of honey from them. In the Mukogodo district, 48 pollen sources are known, and here honey is used to make beer, or is eaten as a food.

795. Brown, W.H. (1918-21). *Minor Products of the Philippine Forests.* Bureau of Forestry Bulletin, Manila.

796. Brucher, H. (1989). *Useful Plants of Neotropical Origin and their Wild Relatives.* Springer Verlag, Berlin.

This book examines the origin, history of domestication and morphology of over 160 species of neotropical origin currently grown for food, fodder, timber and industrial purposes. Root and tuber crops, cereals, grain legumes, oilseed plants, palms, fibre and latex crops, aromatic, narcotic, stimulant and spice crops, timber crops, tropical forage grasses and legumes and aromatic and fleshy fruit crops are considered in turn. Biotechnological methods for improving their productivity are also discussed.

797. Burkhill, I.H. (1935). *A Dictionary of Economic Products of the Malay Peninsula.* Crown Agents for the Colonies, London.

798. Burkhill, F. (1985). *The Useful Plants of West Tropical Africa.* Royal Botanic Gardens, Kew, England.

799. Burley, J. (1983). *Bibliographic Sources of Lists of Multi-purpose Trees and Shrubs.* In: Resources for Agroforestry Diagnosis and Design, ICRAF, Nairobi.

800. Carlowitz, P.G. von (1986). *Multipurpose Trees and Shrub Seed Directory.* ICRAF, Nairobi, Kenya.

801. Cavalcante, P.B. (1977). Edible palm fruits of the Brazilian Amazon. *Principes, 21(2), 97-98.*

802. Chin, S.C. (1986). *Traditional Uses of Forest Products.* Paper for UNESCO-MAB Workshop on Advances in Tropical Forest Ecological Research and Relevance to the Management of Forest Resources in Southeast Asia, Kepong, Malaysia.

803. Chuntanaparb, L., Sri-Aran, and Hoamuangkaew (1985). *Non-Wood Forest Products in Thailand.* FAO, Bangkok.

804. Coates-Palgrave, K. (1988). *Trees of Southern Africa.* 5th edition, Struik, Cape Town, South Africa.

805. Cobban, J.L. (1968). *The Traditional Use of Forests in Mainland Southeast Asia.*

Papers in International Studies (S.E.A. series No. 5), Center for International Studies, Ohio University.

806. Correa Q., J.E. and Bernal, H.Y. (1989). *Especies Vegetales Promisorias de los Paises del Convenio Andres Bello.* Tomo I y II, Programa de Recursos Vegetales del Convenio Andres Bello (PREVECAB) Secretaria Ejecutiva del Convenio Andres Bello (SECAB), Ministerio de Educacion y Ciencia Espana, Bogota, Colombia.

These volumes are an incredible collection of information on promising plant species native to the Andes. A total of twelve volumes of these plant inventories will be produced by the member countries of the Andres Bello Agreement (Bolivia, Colombia, Chile, Ecuador, Spain, Panama, Peru and Venezuela). The majority of the species contained within the volumes are wild, underutilized, little-known and have economic potential. From existing documents and interviews with experts, the following information on the plants is given: botanical family, scientific and common names, geographical distribution, ecology, food, medicinal and economic uses, chemical composition, pharmacological properties, toxicity and bibliographic references. The above is also contained within a computer database. For species which have been more thoroughly researched, separate monographs have been written.

807. Crofts, T. (1987). *The Return of the Wild.* Friendly Press, Stonesfield, UK.

808. Dalziel, J.M. (1937). Useful plants of West tropical Africa. In: J.M. Dalziel and J. Hutchinson (eds.), *The Flora of Tropical West Africa,* Crown Agents for the Colonies, London.

809. Danin, A. (1972). A sweet exudate of Hammada: another source of manna in Sinai. *Economic Botany, 26, 373-375.*

This article explores an explanation of the biblical manna. On shrubs such as Hammada salicornica, Anabasis setifera, and Tamarix nilotica appear sweet droplets with an insect's exoskeleton attached. This species of insect is not identified; however it is thought that the insects Trabutina mannipara and Najacoccus serpentina produce the secretions which crystallize in air. The manna appears during the rains, occurring every five to ten years.

810. Das, D.K. (1987). *Edible Fruits of Bangladesh Forests.* Bulletin Plant Taxonomy Series, 3. Forest Research Institute, Chittagong.

Descriptions are given of 60 plants (canes, climbers, palms, shrubs and trees) with edible fruits, with information on habit, distribution, and fruit appearance, preparation for eating and ripening times. Common and scientific names (with indexes to each) are included.

811. Duke, J.A. (1970). Ethnobotanical observations on the Choco Indians. *Economic Botany, 24(3), 344-366.*

812. Duke, J.A. (1975). Ethnobotanical observations on the Cuna Indians. *Economic Botany, 29, 278-293.*

813. Dunn, F.L. (1975). Rainforest collectors and traders, a study of resource utilization in Modern and Ancient Malaya. *Monographs of the Malaysian Branch Royal Asiatic Society,* No. 5, Kuala Lumpur.

814. Ejiofor, M.A.N., Obiajulu, O.R. and Okafor, J.C. (1988). Diversifying utilities of African breadfruit as food and feed. *International Tree Crops Journal, 5, 125-134.*

The African breadfruit tree, Treculia africana subsp. africana, is well known in Nigeria as a source of food, fodder, fuelwood, pulp and paper. The tree is grown in compound farms near homesteads and around fields as well as growing wild in tropical rain forests. Data is given on proximate analysis of nutrient contents for processed seeds, husk and pulp.

815. Fanshawe, D.B. (1967). The vegetable ivory palm Hyphaene ventricosa its ecology, silviculture and utilization. *Kirkia, 6, 105-116.*

816. FAO (1967). *Lists of Foods Used in Africa.* FAO, Rome.

817. FAO (1982). Fruit-bearing forest trees. *FAO Forestry Paper No. 64, FAO, Rome.*

818. FAO (1983). *Food and Fruit-Bearing Forest Species. 1: Examples from Eastern Africa.* FAO Forestry Paper 44/1, FAO, Rome.

Monographs of 40 wild food species are given. Common and botanical names are given along with information on these species' habitats, abundance, uses, collection, cultivation, nutritional values and economic potentials.

819. FAO (1984). *Food and Fruit-Bearing Forest species. 2. Examples from Southeastern Asia.* FAO Forestry Paper 44/2. FAO, Rome.

The ecology, uses, nutritional values and propagation of 70 Southeast Asian food species are detailed.

820. FAO (1985). *Broadening the Food Base With Traditional Food Plants.* Expert Consultation on Broadening the Food Base with Traditional Food Plants. Harare, Zimbabwe, 16-23 November 1985, Food Policy and Nutrition Division, FAO, Rome.

821. FAO (1985). *Non-Wood Forest Products in Thailand.* Field Document 5, RAPA, Special study on forest management, afforestation and utilization of forest resources in developing countries. FAO, Bangkok.

822. FAO (1986). *Food and Fruit Bearing Forest Species. 3. Examples from Latin America.* FAO Forestry Paper 44/3, FAO, Rome.

This volume introduces 74 Latin American food species which are utilized by rural communities. Their uses, ecology, nutritional composition, cultivation and economic potentials are presented along with photographs and illustrations.

823. FAO (1986). *Yearbook of Forest Products, 1974-1985.* FAO, Rome.

824. FAO (1986). Focus on traditional food plants. *Food and Nutrition, 12, 2-57.*

This issue features articles based on a selection of the papers presented at a consultation on traditional food plants and their role in broadening the food base (see 820). (1) Introduction: promotion of *traditional food plants; (2) Broadening the food base in Africa; the potential of traditional food plants;* (3) A note on traditional food plants in East Africa: their value for nutrition an d agriculture; (4)

Socioeconomic factors in food production and consumption: a study of 12 households in Wedza Communal Land, Zimbabwe; (5) The importance of wild fruits for peasant households in Zimbabwe; (6) Processing and preserving traditional plant foods in Zambia; (7) Some issues in feeding African urban areas. The review focuses on food crops adapted to arid, semi-arid and subhumid environments of eastern Africa.

825. FAO (1987). *Restoring the Balance: Women and Forest Resources.* FAO, Rome, Italy.

This publication provides a general introduction to the dependence of women on forest resources. Women are responsible for the collection and management of tree resources for food, fodder, fuel, household items and income more so than men. A study in Uttar Pradesh, India found that 33% of women's income was derived from forest and common land. For poor women, these areas are relied upon for 45% of total income. Men, on the other hand, rely upon off-farm employment for 59% on their income and only obtain 13% of it from forest and common land. However, access to tree products is diminishing due to deforestation, new technologies and development projects which ignore women's use of such resources. In order to remedy such situations, it is recommended that women be consulted on their needs and knowledge of the local resources for the planning and implementation of forestry development projects. Examples of women's participation in forestry and reforestation projects from 10 countries are given.

826. FAO (1987). *Promoting Under-exploited Food Plants in Africa: A Brief for Policy Makers.* Food Policy and Nutrition Division, FAO, Rome.

827. FAO (1988). *Traditional Food Plants.* FAO Food and Nutrition Paper 42. FAO, Rome.

This is an important reference manual for those working in Eastern Africa. It provides information on 110 species of staples, legumes, vegetables, fruits and oilseeds regarding their uses, ecology and cultivation with emphasis on their nutritional value. In addition to the descriptive material on plants, an introduction to human food and nutrition is given placed in the context o f the conditions found in Eastern Africa. There is a comprehensive annex of important "Research Contacts and Germplasm Sources" throughout the world and another which arranges the 110 species according to food group, habitat and degree of domestication.

828. FAO (1989). *Utilization of Tropical Foods: Trees.* Food and Nutrition Paper 47/3. FAO, Rome.

829. FAO (1990). *Utilization of Tropical Foods: Fruits and Leaves.* Food and Nutrition Paper 47/7, FAO, Rome.

830. Floc'h, E. Le, Lemordant, D., Lignon, A. and Rezkallah, N. (1985). Ethnobotanical practices of the Afar populations of the middle valley of the Awash (Ethiopia). *Journal of Ethnopharmacology, 14, 283-314.*

One hundred and nine plant species (in alphabetical order of families) are listed with their medicinal, edible and other uses. Local names and the plant parts used are given.

831. Ford, R.E. 1991. Ethnobotany of the Kurumba, Mossi, and Fulbe/Rimmaaybe in Sahelo-Sudanian Northern Yatenga, Burkina Faso. Submitted to *Economic Botany*, 1991.

This paper examines the uses of wild plants by five ethnic groups (pastoralists and farmers) in Yatenga, Burkina Faso. In this area populations had been increasing, village areas grew and overlapped with

one another. The result was a loss of bush areas and wetlands from which wild plants were collected. Most villagers were acutely aware of the disappearance of many wild species which they had collected for purposes ranging from practical to spiritual. They were particularly important during the pre-harvest hunger season and during famines. As rainfall in the area had been declining over the years, many of the famine foods were becoming scarce. Wild plants were also relied upon for medicines and were not always distinguishable from food species. Plants also served the purpose of "ecological indicators" allowing the people to identify specific soil and water conditions. When asked, villagers preferred multi-purpose tree species such as Acacia albida, Butyrospermum parkii, and Adansonia digitata. The author emphasises the urgent need to preserve these wild species and local knowledge of them and argues that such knowledge can be applied to agricultural development.

832. Fox, R.B. (1952). The Piratubo Negritos: their useful plants and material culture. *Philippine Journal of Science, 81(3-4), 173-414.*

833. Fox, F.W. and Norwood Young, M.E. (1982). *Food from the Veld: Edible Wild Plants of Southern Africa.* Delta Books, Johannesburg.

834. Fox, J.J. (1977). *Harvest of the Palm: Ecological Change in Eastern Indonesia.* Havard University Press, Cambridge, Massachusetts.

835. Foxworthy, F.W. (1922). Minor forest products of the Malay Peninsula. *Malayan Forest Records, 2, 151-217.*

836. Gbile, Z.O. (1983). Indigenous and adapted African vegetables. In: *Proceedings of the Sixth African Symposium on Horticultural Crops,* Ibadan, Nigeria, 19-25 July 1981, the Horticultural Society of Nigeria (HORSTON) and the Federal Ministry of Science and Technology (Acta Horticulturae, 123, 7).

837. Ghate, V.S., Agte, V.V. and Vartak, V.D. (1988). Promising economic potential of shemul (Bombax ceiba L.) as a tuber crop. *Indian Journal of Forestry, 11, 158-159.*

The shemul tuber compared well with several of the other species in moisture, carbohydrate, protein, fat, mineral and energy contents. A high Ca content, beneficial for rural or tribal communities, is noted. The species has abundant natural regeneration, leaves palatable as fodder and high rates of seed production.

838. Gianno, R. (1981). Notes on some minor forest products. *Malaysian Forester, 44(4), 566-568.*

839. Glowacki, S. (1988). The basic raw material of forest fruits in natural stands and plantations in Poland. *Norwegian Journal of Agricultural Sciences, 2, 151-159.*

An assessment is made of the resources of wild bush and berry fruits, their geographical distribution, their productiveness and export potential. Vaccinium myrtillus is the principal export species at present (producing over 30,000 t/year). Other crops, listed in descending order of production, include Rubus species other than raspberry, Sorbus aucuparia, Sambucus nigra, Prunus spinosa, Rosa species, Crataegus species, Vaccinium species, Oxycoccus quadripetalus and Fragaria vesca.

840. Gomez, M.I. (1988). A resource inventory of indigenous and traditional foods in Zimbabwe. *Zambezia, XV(i), 53-73.*

Given the diversity of food species traditionally used in Zimbabwe and the disappearance of many of these species, the author provides an inventory of food species which are currently in use.. This resource inventory of species and their preparation and uses comprises: cereals, legumes, nuts, oilseeds, vegetables, mushrooms, wild fruits, fish, game, insects and processed and composite foods. Of these species, 20 species are wild vegetables, 42 species, wild fruits, 29 insects; 4, edible grasses and one wild finger millet. The author notes that when fruits disappear, villagers often cannot afford to buy substitutes in the market. The paper recommends that these species be conserved, their production be improved, and that indigenous knowledge be documented.

841. Gomez-Pompa, A. and Kaus, A. (1987). *The Conservation of Resources by Traditional Cultures in the Tropics*. Paper presented at World Wilderness Congress, September, 1987, Estes Park, Colorado.

This article highlights the Mayan Indians who have been able to support populations of 500 people per square kilometre while maintaining biological diversity. The authors argue that humans can utilize forests while maintaining biodiversity. As evidence they point to the number of economically useful species which are found near ruins and which grow in clumps suggesting their management. These same species are still in use by Mayans today. Hypotheses for the abundance of these useful species near ruins and in clumps include: the stands are natural, arose by accident or deforestation, or were man-made or a mixture of these. The authors support the man-made hypothesis because of the many present day management strategies of the Mayans. Such strategies include: selection, protection and introduction of useful species. Twenty-six species with their principle uses and the method of management are listed with references.

842. Goode, P.M. (1989). *Edible Plants of Uganda: The Value of Wild and Cultivated Plants as Food*. FAO Food and Nutrition Paper 42 /1, FAO, Rome.

This guide for local agricultural and extension workers provides information on the traditional and wild foods of Uganda (cereals, roots, green leafy vegetables, fruits and legumes). Vegetables are emphasized with details of their growth in home gardens, consumption, preparation, distribution and folklore. An inventory of species is listed and further descriptions are provided of selected species.

843. Goodman, S.M. and Hobbs, J.H. (1988). The ethnobotany of the Egyptian Eastern Desert: a comparison of common plant usage between two culturally distinct Bedouin groups. *Journal of Ethnopharmacology, 23, 73-89.*

844. Gunatilleke, N.I.A.U. (1991). Underutilized food plant resources of Sinharaja rain forest in Sri Lanka. *In: International Symposium on Food and Nutrition in the Tropical Forest: Biocultural Interactions and Applications to Development*, 10-13 September 1991, UNESCO, Paris.

The Sinharaja rain forest of Sri Lanka is a world heritage site. Previously, neighbouring communities used at least 53 species for food, medicines and household items. Many of these plants are threatened. Ten of the wild species were identified for domestication for management in buffer zones and home gardens.

845. Gupta, T. and Guleria, A. (1982). *Non-Wood Forest Products in India. Indian Institute of Management,* Ahmedabad and Oxford and IBH Publishing Company, New Delhi, India.

846. Gura, S. (1986). A note on traditional food plants in East Africa: their value for nutrition and agriculture. *Food and Nutrition, 12(1), 18-26.*

847. Hammermaster, E.T. (1981). *Village Forest Inventory of Bangladesh.* FAO Field Document, No. 5. FAO, Rome.

848. Hashim Bin Mohammed Noor (1986). Wild fruit tree species: A lesser known and under-utilized forest resource. *Prosid. Simp. Buah-buahanan Keb., 154-169,* Serdang.

849. Heinz, H.J. and Maguire, B. (1974). *The Ethno-Botany of the Iko Bushmen. Their Botanical Knowledge and Plant Lore.* Occasional Paper, 1, Botswana Society, Government Printer, Gaborone, Botswana.

850. Hill, J. (1944). *Wild Foods of Britain.* Third Edition, Adam and Charles Black, London.

851. Hilmi, H.A. (1986). World Compendium of Forestry and Forest Products Research Institutions.

852. House, A.P.N. (1983). The use of palms by man on Siberut Island, Indonesia. *Principes, 27(1), 12-17.*

853. Hoyos F.J. (1989). *Frutales en Venezuela (Nativos y Exoticos).* Sociedad de Ciencias Naturales La Salle, Monografia 36, Caracas, Venezuela.

854. Huber, O. (1990). Estado actual de los conocimientos sobre la flora y vegetacion de la region Guayana, Venezuela. In: F. Weibezahn; H. Alvarez and W. Lewis, Jr. (eds.), *El Rio Orinoco Como Ecosistema,* pp. 407-430, Electrificacion del Caroni, C.A., Fondo Editorial Acta Cientifica Venezolana, C.A., Univ. Simon Bolivar, Caracas, Venezuala.

855. Hyndman, D.C. (1984). Ethnobotany of Wopkaimin Pandanus: Significant Papua New Guinea plant resource. *Economic Botany, 38(3), 287-303.*

856. Ibadan University (1986). Proceedings: Inter-Country Seminar on Promotion of Traditional Food Crops in West Africa. *Inter-Country Seminar on Promotion of Traditional Food Crops in West Africa,* 15-17 December 1986, Department of Human Nutrition, Ibadan University, Nigeria.

857. Instituto Boliviano de Tecnologia Agropecuaria (1991). *VII Congreso Internacional Sobre Cultivos Andinos, Resumens (Summaries of the VII International Congress on Andean Crops).* 4-8 February 1991, CIID, ORSTOM, Ministerio de Asuntos Campesinos y Agropecuarios, Instituto Boliviano de Tecnologia Agropecuaria, La Paz, Bolivia.

This report presents the summaries of the papers presented at the VIIth International Congress on Andean Crops. The crops discussed include: Quinua (Chenopodium quinoa), Canihua (Chenopodium pallidicaule), Amaranthus caudatus, Lupinus mutabilis, roots and tubers.

858. Irvine, F.R. (1956). The edible cultivated and semi-cultivated leaves of West Africa. *Qualitas Plantarum et Materiae Vegetablis, 2, 35-42.*

859. Irvine, F.R. (1961). *Woody Plants of Ghana with Reference to Their Uses.* London

Crown Agents, London.

860. Jacalne, D.V. (1973-74). Edible fruit-bearing trees and other plants of the Philippines. *Forestry Digest, 2(1), 59-72 and 3(1), 65-69.*

861. Jackson, J.K. and Boulanger, F. (1978). *The Forest of the Mae Sa Valley Northern Thailand as a Source of Food.* Paper presented at the Eighth World Forestry Congress, Jakarta, Indonesia.

862. Jacobs, M. (1984). The study of non-timber products. The *Environmentalist, 4, Supplement No. 7.*

863. Johns, T. and Kokwaro, J.O. (1991). Food plants of the Luo Siaya District, Kenya. *Economic Botany, 45(1), 103-113.*

> This ethnobotanical survey of the Kenyan Luo identifies 52 cultivated species and 69 wild species. The collection of wild foods is most important in areas prone to drought.

864. Kabuye, C.H.S. (1986). Edible roots from wild plants in arid and semi-arid Kenya. *Journal of Arid Environments, 11(1), 65-73.*

865. Kessler, J.J. (1987). *Common Plant Species of the Dhamar Montane Plains: Notes on Colloquial Names, Distribution and Local Use (Yemen Arab Republic).* RLIP Communication No. 12, Ministry of Agriculture and Fisheries, Agricultural Research Authority, Yemen Arab Republic and DHV Consulting Engineers, Amersfoort, Netherlands.

866. Kornev, Y. (1985). The food resources of the Carpathian forest. *Ekonomika Sovetskoi Ukrainy, 6, 59-64.*

> The Carpathian forest produces a considerable amount of foods as well as timber. These include forest products such as: wild fruits, medicinal plants, honey and fish. The extent, development and organization of this utilization of woodlands to produce food is described. There is already a considerable unmet demand for the foods being produced.

867. Kujala, M. (1988). Ten years of inquiries on the berry and mushroom yields in Finland, 1977-1986. *Acta Botanica Fennica, 136 , 11-13.*

> Annual incomes of collectors of wild berries and mushrooms were M35-93 million. The most important commercial berries were lingonberry (Vaccinium vitis-idaea) and bilberry (V. myrtillus). The most important mushrooms were milkcaps (Lactarius spp.).

868. Lasschuit, J.A. and van Eerd F.A.C.M. (1983). *Minor Forest Products and Non-Timber Products of the Forest.* University of Wageningen, Netherlands.

869. Lepofsky, D., Turner, N.J. and Kuhnlein, H.V. (1985). Determining the availability of traditional wild plant foods: an example of Nuxalk foods, Bella Coola, British Columbia. *Ecology of Food and Nutrition, 16, 223-241.*

> Forty-two plant foods known to have been used in the past by native people of the Nuxalk Nation,

Bella Coola, British Columbia, Canada, were studied. Assessments of accessibility, abundance and frequency of food species were made. In addition, harvesting efficiency of 24 species was determined. Twenty species were selected as being the most readily available food resources, and therefore good candidates for nutritional research and promotion. These included the trees Populus trichocarpa, Pyrus fusca, Tsuga heterophylla; the shrubs Amelanchier alnifolia, Ledum groenlandicum, Ribes divaricatum, Rosa nutkana, Rubus idaeus, Rubus parviflorus, Rubus spectabilis, Sambucus racemosa, Vaccinium ovalifolium, Vaccinium parvifolium, Viburnum edule; and the herbs Cornus canadensis, Epilobium angustifolium, Heracleum lanatum, Majanthemum dilatatum, Potentilla pacifica and Trifolium wormskioldii. It was concluded that the variety and quantity of plant food resources of the Nuxalk are substantial.

870. Levi-Strauss, C. (1950). The use of wild plants in tropical South America. In: J. Steward, (ed). *Handbook of South American Indians*, pp. 465-486, Vol. VI, Bureau of American Ethnology, Bulletin 143, Washington, DC.

871. Lewington, A. (1990). *Plants for People*. Royal Botanic Gardens, Kew and World Wide Fund for Nature, Natural History Museum Publications, London.

872. Lewis, G.P. (1987). *Legumes of Bahia*. Royal Botanic Gardens Kew, Surrey, UK.

Information is given on 741 species in 132 genera of legumes in the state of Bahia in Brazil. Although this is a botanical inventory containing many details on individual species, it is noted that many of these legumes are used by the rural poor.

873. Lewis, G.P. and Owen, P.E. (1989). *Legumes of the Ilha de Maraca*. Royal Botanic Gardens Kew, Surrey, UK.

This monograph provides descriptions of the legumes found on the uninhabited Ilha de Maraca, one of the world's largest riverine islands located within the Urariquera River in Brazil.

874. Lum-Kong, A. (1989). The potential of Pomacea urceus as a culture species in Trinidad. In: Slugs and Snails in World Agriculture. *Monograph British Crop Protection Council, 41, 33-39.*

Investigations on the reproductive biology, life cycle and growth were undertaken on the ampullariid snail Pomacea urceus to assess its potential for culture as a food source. The snails are eaten in Trinidad, and are reported to be eaten in Guyana. In Trinidad, present demand is met by collecting snails from the wild. Qualities which make the snail attractive as a culture species include its large size, rapid growth rates, herbivorous and amphibious habits, together with its ability to aestivate.

875. Madulid, D.A. (1979). *Rare and Vanishing Fruit Trees and Shrubs in The Philippines*. IUCN, Gland.

Throughout the Philippines, there are about 200 species of fruit trees and shrubs. Of these 40-50% are currently minor fruits, yet have potential for greater use. Those species which are in danger of extinction in the Philippines are surveyed in this paper. Local names, geographical distribution, uses and conservation status based on IUCN categories are given. Of the species listed, one is endangered, 15 are vulnerable as their disappearance is increasing and 10 are rare with a small population. The author strongly urges that immediate action be taken to conserve these species.

876. *Mahanta, P.K. and Gogoi, P. (1988). Ethnobotanical studies in Assam: survey of* unusual vegetables. *Advances in Plant Sciences, I, Supplement, 329-334.*

Seventy-two species of plant used as vegetables by the rural population in the district of Sonitpur are reported. A key is provided to indicate which parts of the plant are edible (rhizomes, corms, tender-shoots or leaves, leaves, petioles, calyxes, flowers, fruits, inflorescences or whole plants).

877. Malleson, R. (1987). *Food Survey of Mundemba Town and Ndian Estate.* Paper Number 1 of the Korup National Park, Socio-Economic Survey, World Wildlife Fund, Godalming, UK.

878. Martin, F., Campbell, C. and Ruberte, R. (1987). *Perennial Edible Fruits of the Tropics.* Agriculture Handbook No. 642, Agricultural Research Service, United States Department of Agriculture, Beltsville, MD.

This is a concise reference text on edible fruits of the tropics. Within the text, the fruits are divided into three categories: major, minor and citrus. Major fruits are those which are well-known, are grown in many areas and can be marketed. Minor fruits, then, are those less well-known and found in only certain regions. The major fruits are arranged alphabetically according to family. Descriptions are given as well as information on their origins, distributions, cultivation, and uses. Minor fruits are listed with parts used and distribution. In total, these minor fruit chapters contain 2,800 species. The book concludes with a discussion of t hose species which have potential for greater use.

879. McGlothlen, M.E., Goldsmith, P. and Fox, C. (1986). Undomesticated animals and plants. In: A. Hanson and D.E. McMillan (eds.) *Food in Sub-Saharan Africa.* pp. 222-238. Lynne Rienner Publications, Inc., Boulder USA.

The importance of undomesticated animals and plants as food sources in Africa is discussed, highlighting the need for additional research, and the integration of the findings into national food planning and development. It is noted that for most rural Africans, undomesticated animals and plants provide foodstuffs, energy, monetary income, and useful materials that complement cultivated crops and livestock.

880. McKell, C.M., Blaisdell, J. R. and Goodin, J.R. (eds.) (1971). *Wildland Shrubs: Their Biology and Utilization.* An International Symposium, Utah State University. Logan Utah. Intermountain Forest Range and Experiment Station. Forest Service, USDA, Ogden, Utah.

This book is a collection of papers from an international symposium on wildland shrubs. The potential of shrubs to increase the productivity of arid and semi-arid areas is emphasized as they are able to survive under these harsh conditions. The chapters cover arid and semi-arid regions throughout the world. Throughout the book, plant species and their uses are identified. These uses include food, fuel, fodder and medicines. There is a section on the nutritive quality of shrubs, mainly with respect to herbivores. The potentials of these shrubs is discussed along with biological and social constraints.

881. Medel, S. (1986). Species and cultivars of fruit crops for southern Chile. *Agro-Sur, 14, 57-65.*

Fruit crop cultivars from the temperate region of southern Chile are listed for a range of species. Several species of possible commercial interest which exist wild or naturalized in Chile are mentioned.

882. Montoliu, M. (1988). *Non-Timber Forest Products in Cote d'Ivoire: Findings and Policy Implications.* World Bank, Washington, D C.

883. Morton, J.F. (1987). *Fruits of Warm Climates.* J.F. Morton, Miami, Florida.

884. Moss, H. (1988). *Under-Exploited Food Plants in Botswana.* FAO, Rome.

Twenty-four food species of Botswana were selected for possible increased cultivation based upon several criteria such as their nutritional and cultural values, drought tolerance, seasonality and growth rates. These species are either wild or are not commonly cultivated within Botswana. The knowledge to date regarding the availability, yields, use, nutrient composition, cultivation and marketing of these species is reviewed.

885. Myers, N. (1983). *A Wealth of Wild Species.* Westview Press, Boulder, Colorado.

886. Nabhan, G. (1985). *Gathering the Desert.* University of Arizona Press, Tucson, Arizona.

887. Nabhan, G.P. and Felger, R.S. (1985). Wild desert relatives of crops: their direct uses as foods. In: G.E. Wickens (ed.) *Plants for Arid Lands.* Royal Botanic Gardens, Kew, UK.

Brief notes are given on the potential value of several species from semi-arid subtropical scrub of W. Mexico. Ceiba species produce large tuberous roots that may be of value as a perennial crop. Coppicing might maintain plants as shrubs and allow annual harvesting of young tubers. The seeds are edible and the floss has occasionally been harvested from fruit of C. acuminata.

888. National Academy of Sciences (1975). *Underexploited Tropical Plants with Promising Economic Value. National Academy of Sciences,* Washington, DC.

Thirty-six tropical plants which have often been neglected but which have the potential to improve livelihoods in the tropics are described. Both wild and domesticated species of cereals, roots, tubers, vegetables, fruits, oilseeds and forage are included with their requirements for growth. Further research needs are discussed as well as reasons for their neglect.

889. National Research Council (1989). *Lost Crops of the Incas.* National Academy Press, Washington DC.

This book draws together information on species of roots, grains, legumes, vegetables, fruits and nuts still grown by rural people of the Andes. These crops were among those with which the Inca Empire was able to feed 15 million, people as well as storing an additional 3-7 year supply. They have been neglected yet they have tremendous potential for wider cultivation, as they can grow on marginal lands and are very nutritious. An example is the lucuma fruit which is high in starch, iron and vitamins. The tree fruits year-round and its deep roots enable it to withstand droughts. For each species information is given about its origin, uses, nutrition, and cultivation. Also its prospects as a food throughout the Andean region is discussed. Research needs and limitations of production are identified. The appendices contain references; lists of centres of Andean crop research and research contacts.

890. Nonveiller, G. (1984). *Catalogue of the Insects of Agricultural Importance of Cameroon.* Memoires de l'Institut Pour la Protection des Plantes, 15, Institut Pour la Protection des Plantes, Belgrade.

891. Okafor, J.C. (1977). Development of forest tree crops for food supplies in Nigeria. *Forest Ecology and Management, 1, 235-247.*

892. Okafor, J.C. (1980). Edible indigenous woody plants in the rural economy of the Nigerian forest zone. *Forest Ecology and Management, 3, 45-55.*

893. Okafor, J.C. (1983). Horticulturally promising indigenous wild plant species of the Nigerian forest zone. *Acta Horticulturae, 123, 165-176.*

894. Okafor, J.C. (1989). *Agroforestry Aspects.* World Wide Fund for Nature, Surrey, UK.

Villages near the Oban National Park in Nigeria were studied to give an account of traditional farming and agroforestry systems; to identify tree species of local importance and economic potential; and to make recommendations on the development of agroforestry systems in the area. Bush fallowing plantations and some livestock keeping were practised in the area. The local people collected over 150 species of wild food plants from the forested areas. Within their fields, they also planted and protected fruit trees such as pear (Dacryodes edulis), oranges, coconut and bush mango. Irvingia gabonensis var. gabonensis and Irvingia gabonensis var. excelsa are two varieties of bush mango which are mainly harvested from the wild, but are also retained in fields. A variety of medicinal species, parts used and ailments treated are also listed. The production and potential for bush mango and chewing sticks (Garcinia mannii and Massularia acuminata) along with revenues earned are discussed. In addition to the forests, useful species are collected from the following: home gardens; fields close to the homestead; on-farm; boundary areas; yam barns; and livestock enclosures. The constraints that the poor villagers face in agricultural development include a shortage of cash, shortening of fallow periods, poor roads and inefficient transport. Eight agroforestry interventions along with the species to be *incorporated are recommended to address specific constraints.*

895. Okafor, J.C. (1991/2). Improving edible species of forest products. *Unasylva, 42 (165), 17-23.*

In addition to providing a general overview of the uses of forest products, this article gives specific information on the success to date of the propagation of wild species in Africa. Twenty-six species have been vegetatively propagated through bud grafting, and 21 from adult stem cuttings. Propagation from seed and growth in nurseries have begun for the wild mango (Irvingia gabonensis), and the african pear (Dacryodes edulis). These same techniques are useful in the evaluation of germplasm stock. When collecting germplasm, the author recommends that samples of individual species be collected from different ecological zones; for example from forests and farms to investigate the effects of selection. He also suggests that intraspecific variation be studied in more detail to improve production of useful species. For example, there are two varieties of the bush mango: one which fruits in the dry season , the other in the rainy season. Research on both could lengthen the period of time which they are available. Both in situ and ex situ conservation, along with collaboration with research institutions on under-utilized crops are important for the improvement of forest products for home consumption and sale.

896. Okigbo, B.N. (1975). Neglected plants of horticultural and nutritional importance in traditional farming systems of tropical Africa. *Acta Horticulturae, 53, 131-150.*

897. Okigbo, B.N. (1983). Fruits and vegetable production and extension services in Africa. *Acta Horticulturae, 123, 23-27.*

898. Okigbo, B.N. (1986). Broadening the food base in Africa: the potential of traditional food plants. *Food and Nutrition, 12(1), 4-17.*

899. Okiy, G. (1960). Indigenous Nigerian food plants. *Journal of the West African Science Association, 6, 117-121.*

900. Okoli, B.E. (1984). Wild and cultivated cucurbits in Nigeria. *Economic Botany, 38(3), 350-357.*

901. Olsson, G. (1991/2). The socio-economic importance of non-timber forest products in the South Pacific: Focus on Vanuatu. *Unasylva, 42 (165), 24-30.*

> The islands of Vanuatu are still extensively covered with natural vegetation. Forest products are utilised for a variety of purposes such as foods, medicines, handicrafts and fuelwoods. This use, however, has been declining due to habitat loss caused by logging and reliance upon purchased foods. Not all products can be replaced by purchased goods and the poor, old and women are still heavily dependent upon the collection of non-timber forest products. It is recommended that forestry development projects include these products and that more research on their roles in people's livelihoods be performed.

902. Ong, H.C. (1988). Useful plants of Temuan community. *Wallaceana, 53, 7-10.*

903. Padoch, C. (1988). Aguaje (Mauritia flexuosa) in the economy of Iquitos, Peru. *Advances in Economic Botany, 6, 214-224.*

> The trade networks revolving around the collection, processing and sale of aguajo (Mauritia flexuosa) products are explained. The fruits of this palm are predominantly collected from the wild; however, some palms are grown near homes. Its raw fruits are mainly marketed, but also its dried petioles are made into screens as room dividers. Beetle larvae of Rhynchophorus palmarum are also collected from fallen logs and fetch a high price. The fruits are sold either raw, mashed, or prepared into drinks, frozen treats or ice cream. The fruit of the aguaje is very popular in Iquitos. About 15 metric tons of fruits are brought into Iquitos for its population of 250,000 every day. Its demand is so great that when it is out of season, its price can rise as much as 100%. Although rural collectors earn an income from the sale of raw fruits to wholesalers, this article concentrates upon the benefits to the urban community of Iquitos. The trade of aguaje fruits employs about 500 people mainly women and the poor. In fact, the trade is dominated by women, as five out of 8 wholesalers are women as is every retail vendor. The case of aguaje is unique: it is a fruit which is marketed locally with very few exports, yet, is a substantial source of income for a large number of people. It also illustrates the importance of a forest fruit to urban communities. Yet, as with any product marketed, there is always a danger of over-harvesting which is occurring to a degree in the areas around Iquitos as the number of fruit-bearing trees is declining.

904. Paroda, R.S. and Mal, B. (1989). New plant sources for food and industry in India. In: G.E. Wickens, N. Haq, and P. Day (eds.), *New Crops*, pp. 135-149, Chapman Hall, London.

905. Passerini, E. (1986). Food for everyone? Yes, from trees. *Agriculture and Human Values, 3(3), 15-20.*

906. Pearce, K.G., Luna Amen, V., and Jok, S. (1987). An ethnobotanical study of an Iban community of the Pantu Sub-district, Sri Aman, Division 2, Sarawak. *Sarawak Museum Journal, 37(58), 193-270.*

907. Pegler, D.N. and Pearce, G.D. (1981). The edible mushrooms of Zambia. *Kew Bulletin, 35, 475-491.*

908. Peters, C.R. (1987). Ricinodendron rautanenii (Euphorblaceae): Zambezian wild food plant for all seasons. *Economic Botany, 41 (4), 494-502.*

> This paper presents a review of the literature and of botanical specimens of Ricinodendron heudelotii

and R. rautanenii commonly known as mongongo or manketti. It is found in the Kalahari and its fruit had been used as a staple among the !Kung bushmen. The flesh is rich in carbohydrates, potassium and thiamine while the kernel is rich in fat and vegetable protein.

909. Phenglai, C. and Khamasi, S. (1985). Some non-timber species of Thailand. *Thai Forestry Bulletin, 15, 108-148.*

910. Poulsen, G. (1982). The non-wood products of African forests. *Unasylva, 34(137), 15-21.*

This article notes that wood forest products, as well as others which can be traded on international markets, have received the bulk of attention from development planners. It aims to raise awareness of the many other products from forests which are neither wood nor extensively marketed, yet are significant to the well-being of rural people. For example, caterpillars are likened to vitamin tablets because of their high vitamin B12 content. General descriptions are given of fodder, fibre, food, drug and chemical products. If one is interested in trade figures, then shea butter produced from Butyrospermum parkii tree and utilized as a cooking oil reduces the need to import a substitute. The question is raised of how is the livelihood value of these non-wood products to be assessed. It is suggested that forest management concentrating upon wood and industrial uses be amended to take into account those products which contribute to the well-being of rural communities.

911. *Powell, J.M. (1976). Ethnobotany. In: K. Paijmans (ed.), New Guinea Vegetation,* pp. 106-213, Elsevier, Amsterdam.

912. Prance, G.T. (1972). An ethnobotanical comparison of four tribes of Amazonian Indians. *Acta Amazonica, 2(2), 7-27.*

913. Prance, G.T. and Kallunki, J.A. (1983). *Ethnobotany in the Neotropics.* In: Proceedings of the Ethnobotany in the Neotropics Symposium, Society for Economic Botany, 13-14 June 1983, Oxford Ohio, USA, Volume 1, Advances in Economic Botany, New York Botanical Gardens, New York.

914. Redhead, J. (1984). *Broadening the Foodbase with Traditional Foods.* Report of a Mission to Ethiopia, Kenya, United Republic of Tanzania, Zimbabwe and Zambia, Nutrition Consultants Reports Series no. 74. FAO, Rome.

This is a report on the outcome of a consultancy contracted to identify individuals and institutions in Ethiopia, Kenya, Tanzania, Zambia and Zimbabwe who would carry out national case studies on the use of under-exploited food plants. Criteria for the selection of specific plants according to nutritional value are given. Those selected cereals, starches, legumes, oilseeds, nuts, green leafy vegetables and fruits are listed.

915. Redhead, J. (1985). Decline and revival of traditional food plants in East Africa. *Food and Nutrition, 11(2), 17-22.*

916. Rosengarten, F., Jr (1984). *The Book of Edible Nuts.* Walker and Company, New York.

917. Royal Botanic Gardens Kew and Threatened Plants Unit World Conservation Monitoring Centre (1990). *World Plant Conservation Bibliography.* IUCN, UNEP, WWF,

Royal Botanic Gardens Kew, Surrey, UK.

This bibliography lists over 10,000 references both specific and general to plant conservation covering such topics as threatened plants, plant genetic resources, habitat loss, protected areas, forestry and legal aspects of conservation. References are arranged under the categories of general, regional and country with indices on plant families and species and cross-references.

918. Sas-Biswas, Ahmed, A. and Biswas, S. (1987). Ethnobotanical studies on some plants of Burnihat Valley, Assam/Meghalaya. *Indian Forester, 113, 634-639.*

The botanical names, local names, morphology, uses and distribution of 26 species of medicinal and food plants used by the local in habitants of the Burnihat valley (mostly Mikirs, Kacharis, Garos and Khasis) are given.

919. Saw, L.G., LaFrankie, J.V., Kochummen, K.M. and Yap, S.K. (1991). Fruit trees in a Malaysian Rain Forest. *Economic Botany, 45 (1), 120-136.*

A survey of fruit trees with diameters greater than 1 cm was conducted over 50 one-hectare plots in primary rainforest in order to ascertain the diversity and abundance of edible wild fruit trees. Seventy-six of 820 species were found to yield edible fruits. The median number of fruit tree species was 3 per hectare. Although only one species, Parkia speciosa was regularly collected and sold (approximate value US$20/ha/yr), the authors see the greatest values in the forest as a genetic resources.

920. Saxena, S.K. (1981). Economic plants of Indian arid zone. *Man and Environment, 5, 32-41.*

921. Schultes, R.E. (1979). The Amazonia as a source of new economic plants. *Economic Botany, 33(3), 259-266.*

922. Science Education Center (1980). *Plants of the Philippines.* Science Education Center, UP Diliman, Q.C., Philippines.

923. Sen, D.N. and Bansal, R.P. (1979). Food plant resources of the Indian Desert. In: J.R. Goodin and D.K. Northington (eds.), *Arid Land Plant Resources,* pp. 357-370, International Center for Arid and Semi-arid Land Studies, Lubbock, Texas.

924. Strudwick, J. and Sobel, G. (1988). Uses of Euterpe oleracea Mart. in the Amazon estuary, Brazil. *Advances in Economic Botany , 6, 225-253.*

925. Szolnoki, T.W. (1985). *Food and Fruit Trees of the Gambia.* Stiftung Walderhaltung in Afrika und Bundesforschungsanstalt fur Forst und Holzwirtschaft, Hamburg, Germany.

926. Tapia, M.E., Moron, C., and Bacigalupo, A. (1990). *Cultivos Andinos Subexplotados y Su Aporte a la Alimentacion (Underexploited Andean Crops and Their Contributions to Food).* Organizacion de las Naciones Unidas para la Agricultura y la Alimentacion (FAO), Oficina Regional para America Latina y el Caribe, Santiago, Chile.

This book begins with a history of agriculture in the Andes, followed by a chapter on current cultivation systems and ecological issues. Botanical descriptions, physical requirements, uses, the nutritional value, amounts consumed of Chenopodium quinoa, Chenopodium pallidicaule Aellen,

Amaranthus caudatus, Lupinus mutabilis and tuber and root crops are given. Their potentials for greater use in agriculture and the pricing policies, technical assistance and research are also explored.

927. Tarimo, H.M. and Huxley, P.A. (1979). A preliminary note on the growth of Amaranthus spp at Morogoro, Tanzania. *East African Agriculture and Forestry Journal, 44(3), 183-186.*

928. Thomas, D.W., Thomas, J.M., Bromley, W.A. and Mbenkum, F.T. (1989). *Korup Ethnobotany Survey*. Final Report to The World Wide Fund for Nature, World Wide Fund for Nature, Surrey, UK.

Twelve villages in and around the Korup National Park, Cameroon were surveyed for their use of wild and cultivated plants. An inventory of medicinal species is contained in a 35 page appendix. Lists of seeds, green vegetables, fruits, spices, roots, edible mushrooms, and cultivated crop varieties were compiled along with their local names. Their uses are discussed as well as the locations from which they are harvested. The ailments treated by medicinal plants are described. Of the 50 most important medicinal plants, 46 % were found in areas of secondary growth; 18% from forest and ruderal areas and 20% were cultivated. Ethnography and village systems of administration and tenure are discussed. The report ends with recommendations such as the integration of traditional medicines with primary health care and the further analysis of medicinal plants. The survey methodology involved not only walking out with villagers, but also showing them a herbarium of 260 plant specimens.

929. Tredgold, M.H. (1986). *Food Plants of Zimbabwe*. Mambo Press, Gweru, Zimbabwe.

930. Uhl, C. and Jordan, C. (1984). Succession and nutrient dynamics after forest cutting and burning in Amazonia. *Ecology, 65, 1476-1490.*

Plant establishment, plant mortality, vegetation productivity, nutrient accumulation and nutrient leaching were studied during the first five years of succession following the cutting and burning of a forest plot in the upper Rio Negro region of the Amazon Basin. The speed and vigour of forest regeneration following disturbance provides a measure of the recuperative potential of this ecosystem.

931. Uhl, C., Buschbacher, R. and Serrao, E.A.S (1988). Abandoned pastures in Eastern Amazonia I: Patterns of plant succession. *Journal of Ecology, 76, 663-681.*

Vegetation composition, structure and biomass accumulation were studied on 13 forest sites that had been cut, burned and used as cattle pasture and later abandoned in the eastern Brazilian Amazon. Under light use, regeneration resulted in both higher biomass and higher species richness than under heavier pasture use. However these Amazon ecosystems generally can recover from large-scale pasture disturbance, although the regrowth will not necessarily have the same physiognomic and species characteristics as the original forest.

932. Unruh, J. and Alcorn, J.B. (1987). Relative abundance of the useful component in old managed fallows at Brillo Nuevo. In: W.M. Denevan and C. Padoch (eds.). *Swidden-Fallow Agroforestry in the Peruvian Amazon.* Advances in Economic Botany, 5, 67-73, The New York Botanical Garden, New York.

933. Vietmeyer, N.D. (1986). Lesser-known plants of potential use in agriculture and forestry. *Science, 232, 1379-1384.*

This review of some underexploited tropical crops, based on the results of a research programme

carried out by the National Research Council, USA, highlights some promising food crops such as the oil palm, Jessenia polycarpa, the grain amaranths (Amaranthus spp.), quinoa (Chenopodium quinoa) and oca (Oxalis tuberosa) which have been largely overlooked by research resources in the temperate zones. Among the legumes discussed are: groundnuts (Apios americanum and Voandzeia [Vigna] subterranean), yam beans (Pachyrrhizus spp.), winged beans (Psophocarpus tetragonolobus) and adzuki bean (Vigna angularis). Notes are given on the potential of some tropical fruits, including those belonging to the Solanaceae and Annonaceae, arid zone crops including tepary beans (Phaseolus acutifolius) and marama beans (Tylosema esculentrum), valuable resource shrubs and such N-fixing trees as Leucaena leucocephala, Acacia mangium, Mimosa scabrella and Calliandra calothyrsus.

934. Vivien, J. and Faure, J.J. (1988). Wild fruit trees of Cameroon. Apocynaceae. *Fruits, 43: 7-8, 465-471.*

Twenty species bearing edible fruits are described. Their local names and distribution in tropical Africa are also given.

935. Vivien, J. and Faure, J.J. (1988). Wild fruit trees of Cameroon. *Fruits-Paris, 43: 9, 507-516.*

This is one of a series of papers giving descriptions of fruit-producing trees (having edible fruits or seeds) of Cameroon, with information on their local names, distribution, utilization and morphology.

936. Walker, M. (1984). *Harvesting the Northern Wild: A Guide to Traditional and Contemporary Uses of Edible Forest Plants of the Northwest Territories*. The Northern Publishers, Yellowknife, Northwest Territories, Canada.

937. *Wickens, G.E. (1991/2). Management issues for development* of non-timber forest products. *Unasylva, 42(165), 3-8.*

Given the importance of non-timber forest products to livelihoods, recommendations are presented for their management. These forest resources have often been ignored in the development process and as a result, their importance to livelihoods is not realized until they are lost. Such neglect must be remedied by incorporating such products into land-use and forestry policies. In order to supply growing populations and avoid over-exploitation, management of these resources is required with improvements in their productivities, harvesting, transport, processing and marketing. Other suggestions include handing over control of these resources to local peoples, integrating of non-timber product management with timber and domesticating species. Management systems will need to be tailored according to national priorities and local conditions.

938. Wickens, G.E., Goodin, J.R. and Field, D.V. (1985). *Plants for Arid Lands.* Proceedings of the Kew International Conference on Economic Plants for Arid Lands, 23-27 July 1984, George Allen and Unwin, London.

A collection of conference papers with the aim of drawing together the research which has been done on economic plants of arid lands, as well as making recommendations for further research. The potential uses of wild plants as food, along with their nutritional compositions are described. Other purposes of these arid land plants include: medicinal, fodder, timber, fuel, soil and water conservation and nitrogen fixation. National case studies for India and Botswana are given.

939. Williams, L.O. (1981). The useful plants of Central America. *CEIBA, 24(1-2), 1-342.*

940. Williamson, J. (1974). Some edible fungi of Malawi. *The Society of Malawi Journal,*

27(2), 47-74.

941. Zambia Alliance of Women (1985). *Food for Africa: the Promotion of Traditional and Under-Utilized Foodstuffs.* Regional Workshop on the Promotion of Traditional and Under-Utilized Foodstuffs, 12 May 1985, Zambia Alliance of Women, Lusaka, Zambia.

942. Zambia Government (Ministry of Agriculture and Water Development) (1983). *Zambian Local Vegetables and Fruits.* Handbook for Agriculture Field Workers, Lusaka, Zambia.

A: REGIONAL INDEX

This index is included as a guide to the use of this bibliography. It does not represent a fully comprehensive cross-referencing of all occurences to regions, countries, ethnic groups and themes contained in all 971 references. Readers are advised to cross-check in all three of the indices.

B: ETHNIC GROUPS INDEX

This index is included as a guide to the use of this bibliography. It does not represent a fully comprehensive cross-referencing of all occurences to regions, countries, ethnic groups and themes contained in all 971 references. Readers are advised to cross-check in all three of the indices.

C: THEMATIC INDEX

This index is included as a guide to the use of this bibliography. It does not represent a fully comprehensive cross-referencing of all occurences to regions, countries, ethnic groups and themes contained in all 971 references. Readers are advised to cross-check in all three of the indices.

The Sustainable Agriculture Programme

The Sustainable Agriculture Programme of IIED promotes and supports the development of socially and environmentally aware agriculture through research, training, advocacy, networking and information dissemination.

The Programme emphasises close collaboration and consultation with a wide range of institutions in the South. Collaborative research projects are aimed at identifying the constraints and potentials of the livelihood strategies of the Third World poor who are affected by ecological, economic and social change. These initiatives focus on indigenous knowledge and resource management; participatory planning and development; and agroecology and resource conserving agriculture.

The refinement and application of Participatory Rural Appraisal methods is an area of special emphasis. The Programme is a leader in the training of individuals from government and non-government organisations in the application of these methods.

The Programme supports the exchange of field experiences and research through a range of formal and informal publications, including RRA Notes, aimed at practitioners of Rapid and Participatory Rural Appraisal, and the Gatekeeper Series, briefing papers aimed at policy makers. It receives funding from the Swedish International Development Authority, the Ford Foundation, [illegible] and other diverse sources.

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