Dryland Networks Programme

ISSUES PAPER

The Harvesting of Wild-Growing Grain Crops in the Gourma Region of Mali

A. Maiga
P.N. de Leeuw
L. Diarra
P. Hiernaux

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The authors of this paper form part of the research team of the International Livestock Centre for Africa (ILCA) in Mali.

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Preface

Fluctuations in the availability of food sources, both seasonally and interannually, are characteristic of Sahelian agroecosystems. Under periods of stress, such as during drought, people collect or purchase wild foods ot supplement their diet, or indeed replace major staples. The major importance of wild foods in food security has been widely documented from the Sudan (De Waal, 1989) to Botswana (Fleuret, 1986).

This case study, from the Gourma region of Mali, demonstrates the high potential productivity of wild grains. Research carried out in the same area shows how nutritionally significant wild foods are in local pastoral diets (Berge and Pederson, 1990). Wild fonio (Panicum laetum) and cram-cram (Cenchrus biflorus) were found to be the most important wild grains in the local diet. These are complemented by the fruits of Boscia senegalensis which are stored for staple 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.

A dietary study carried out in the dry season of 1990 showed that wild plants are the most used component of the diet amongst all households studied. Only 3 out of 167 households did not consume any wild foods. Most of the products were collected from the wild, although cram-cram was largely purchased. Wild foods were found to complement milk products during the dry season and cultivated agricutural foods were not consumed to any degree.

This Issues Paper highlights the high productivity of wild grain production, particularly Panicum laetum, in terms of absolute grain production and returns to labour. The importance of wild grain production sites is also highlighted. These are identified as 'key resources' within the pastoral landscape. The nutritional studies show that access to and control over these resources is vital for sustaining livelihoods in this area. Issues of tenure rights and management regulations are central. It remains unknown the degree to which different pastoral groups can assert control over particular 'fonio areas' (often low lying parts of the landscape) and how pastoral movement strategies are adapted to pass through areas where wild grains are abundant. These are areas for further research.

Haramata would be keen to hear from other people living and working in dryland areas of the world on the subject of wild food use and management. Please send notes, articles, reports to the editors.

THE HARVESTING OF WILD-GROWING GRAIN CROPS IN THE GOURMA REGION OF MALI

INTRODUCTION

Several pastoral groups in the Sahel collect wild cereals for home consumption or for sale. According to Niamir (1990, p 41), wild cereal collection is often the domain of women, either collectively or individually, especially as an economic activity. In many areas, there are strict rules covering the frequency of collection, territorial boundaries and the prohibition of livestock and other users into areas with fonio-type grasses.

According to Barral (1977, p 56), Tuareg agro-pastoralists in Burkina Faso adapt livestock movements to pass through low-lying areas where Panicum laetum is abundant to harvest grain during August to October. They use round baskets that are flung through the crop thereby dislodging the seeds from the grass panicles (Grouzis 1988, p 13). Other modes of harvesting include 1) cutting the grass before seeds fall, letting them dry, after which the grain is removed by threshing and winnowing, and 2) cutting (or burning) the standing crop after the seed has fallen, sweeping the residues into piles and extracting the grain by winnowing.

Since 1984, ILCA has been engaged in ecological research in the Gourma to study the dynamics of this ecosystem. To this end, more than 20 sites have been monitored over 7 growing seasons including areas where fonio-grasses (Panicum laetum, Echinochloa spp) are dominant. Data collected include rainfall, biomass yield of the herbaceous and woody strata, species composition, seed stocks etc (cf Hiernaux et al, 1989). In addition to this intensive monitoring, experiments are conducted to determine the effects of grazing, trampling, nutrient status of soils on plant productivity.

In view of the importance of fonio-producing areas for the local economy, the effects of seed stocks and their removal for human consumption on subsequent herbage yield was included in the research project. This led to a special study aimed at measuring the grain yields of fonio areas that were harvested by local people. This paper summarises this research with special emphasis on the relationship between yield and labour inputs.

SITES

Five fonio sites were monitored during 1987 and 1988. They were located in two general areas in the vicinity of Gossi and similar in rainfall and herbaceous biomass yield, even though area 2 was 60 km further to the north (Table 1).

Both areas represented lower slopes along valleys in alluvial plains and were usually intermittently flooded during the growing

season. Due to run-on moisture, these sites can be highly productive even in years of low rainfall. The major species are grasses, the most important of which are Panicum leatum, Echinochloa colona and E oryzetorum, all of which are harvested for grain; Echinochloa spp usually occur closer to the permanently flooded lakes found in the centre of the valleys.

Rainfall in 1987 was much lower than in 1988 (Table 1) which however did not affect herbaceous biomass yield: average yields in areas 1 were 3.3 and 3.7 t/DM/ha, and 1.4 and 1.5 t DM ha-1 in area 2 respectively. These yields represent the averages over 1-km long transects and therefore include lower and higher yielding areas in addition, these transects are usually heavily grazed during the growing season, unless they are destined as grain harvesting sites and protected.

Out of the 5 sites, only site 2 (in 1987) had a cover of Echinochloa spp; all others were P leatum swards. Only site 1 was monitored in both years (Table 2). However, sites 3, 4 and 5 were located in the same general area (Table 1).

Table 1
General Characteristics of the Monitoring Sites

	Area 1	Area 2
Location	15 44' N 01 20' W	16 12 N 01 40 W
Sites	1, 2	3, 4, 5
Mean Rainfall, mm (CV%) 1984-90	158 (59)	153 (60)
Rainfall 1987, mm	37	113
1988, mm	334	221
Mean yield, kg DM/ha (1984-90)	2280	2030

Source: Hiernaux et al, 1989

METHODS

The sampling methods were adapted to monitor the harvesting procedures employed by the local people. The monitoring was carried out in September/October 1987 and 1988. In general, highly productive areas within each site were selected. Usually, these were used regularly for this purpose and protected against grazing by livestock throughout the growing season.

The harvesting consisted of two principal activities:

- sweeping material and piling it in a central place
- beating and winnowing these piles to separate grain from straw, soil and other debris.

First, the standing straw was cut when necessary or when already disintegrated to litter it was simply swept into a central pile. The surface areas from which the material was collected were measured. When areas were square or rectangular, the boundaries were measured with a tape; when circular, longest and shortest diameters were recorded. The heaped material was weighed and is referred to as gross yield. In 1987, 15 collecting areas were monitored and ranged from 70 to 750 m^2 in size. In 1988, 17 areas were sampled varying in size from 16 to 360 m^2. In total, 6400 m^2 were sampled (Table 2).

Table 2
Details of the Monitoring of Wild Cereals Gathering in Gourma

Year	Site	Sample Areas (N)	Area Sampled (m^2)	Yield (Kg) Gross	Net
1987	1	3	288	64	33
1987	2	6	1096	141	87
1987	3	6	1709	116	23
Total	3	15	3693	321	143
1988	1	6	700	1045	103
1988	4	5	1172	320	94
1988	5	6	803	172	95
Total	3	17	2675	1537	292
Overall		32	6368	1858	435

The second phase of the harvesting consisted of a combination of repeated threshing, winnowing and sweeping until a pure residue of grain was achieved. This end product was weighed and called net yield. Weights were usually determined in total. However, occasionally when quantities were large or sampling time became limited, net yield was based on sub-sampling to determine net/gross ratios. Time spent on this phase was added to that of the first phase and expressed as net yield/hours of total work

(Table 3).

Time worked was determined by adding working periods of individual team members together, while subtracting temporary absences or time spent on activities not related to grain harvesting. Over the two seasons, total sampled quantity was 1860 kg gross and 435 kg net involving close to 200 working hours (Table 3).

Table 3
Summary of Yield Parameters by Site for 1987 and 1988

Year	Site	Yield g/m² Gross	Net	Ratio: Net yld (:) gross yld	kg/hour Gross	Net	Ratio: Gross hrs (: total hrs
1987	1	223	113	0.51	10.4	2.9	0.86
1987	2	83	52	0.63	3.8	1.7	0.54
1987	3	68	14	0.20	7.9	1.3	0.74
Mean*		87	39	0.45	5.5	1.8	0.74
1988	1	1493	146	0.10	75.2	2.7	0.37
1988	4	273	80	0.29	8.1	1.9	0.79
1988	5	215	118	0.55	8.6	3.5	0.74
Mean*		574	109	0.19	20.9	2.5	0.64
Overall*		292	68	0.23	14.1	2.3	0.68

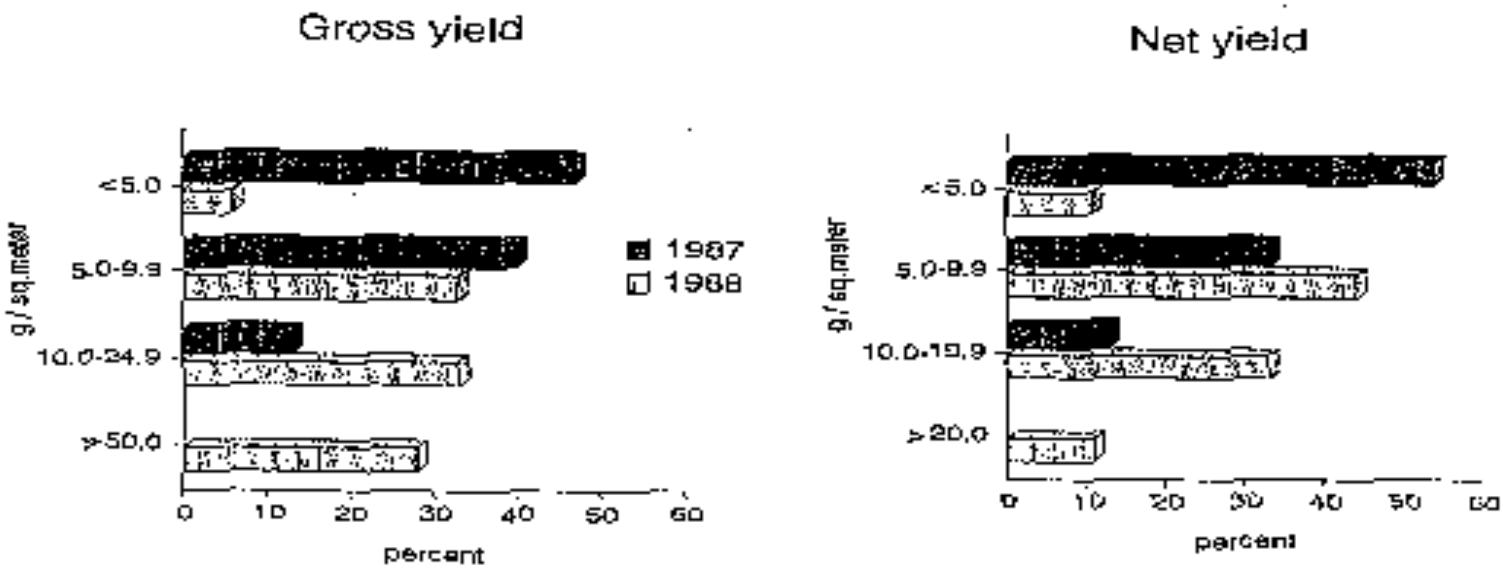
*Weighted mean

RESULTS

Yields

Gross yield represented material after the sweeping phase varied substantially between sites: two sites produced less than 100 g/m² (or 1 t DM/ha); three sites were similar showing a range of 215-273 g/m², while site 1 in 1988 had accumulated material close to 15 t DM/ha (Table 3). Gross yields in 1988 were much higher than those in 1987: 60% of the individual samples yielded more than 250 g/m² as compared to only 13% in 1987 (Figure 1)

Figure 1
Frequency Distribution (%) of Gross and Net Yields in 1987 and 1988



Gross yield did not always include plant material. In the sweepings done in 1988, soil and debris were important components as shown in data from small sub-samples. On site 1 plant cover was uprooted and swept away by floods and gross yields were mostly soil deposits left after the flooding (Table 4).

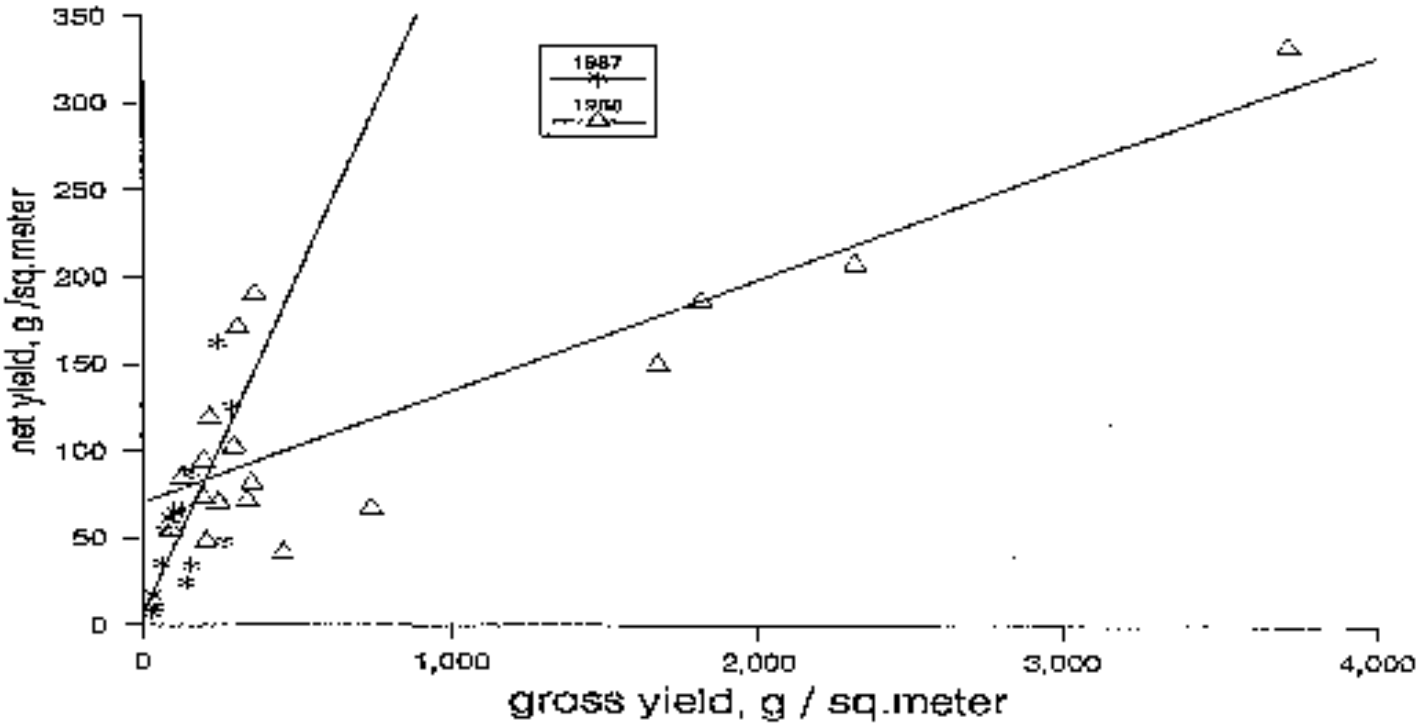
Table 4
Composition of Gross Yield in 1988
(% of total)

Site	Grain	Straw	Debris	Soil
1	5		23	72
4	14	46		40
5	15	32	53	53

This heterogeneity of gross yields is also reflected in the absolute net yields and the percent grain recovery. Net yields in 1987 were lower than in 1988 and their overall variability was much less than that of gross yields (Figure 1). Due to high recovery rates (50-60%) in sites 1 and 2 in 1987, mean rates were

double those in 1988. While mean gross yields in 1988 were more than 3-fold those of 1987, net yields were only 80% higher (Table 3). Rate of recovery was lowest (10%) in the flooded site (1) in 1988. In both years, regressions of gross on net yield were highly significant (Rs = 0.53, p = 0.002 in 1987; R2 = 0.71, p = 0.0001 in 1988), the slopes of the equations showing the differences in recovery rates between the 2 years (Figure 2).

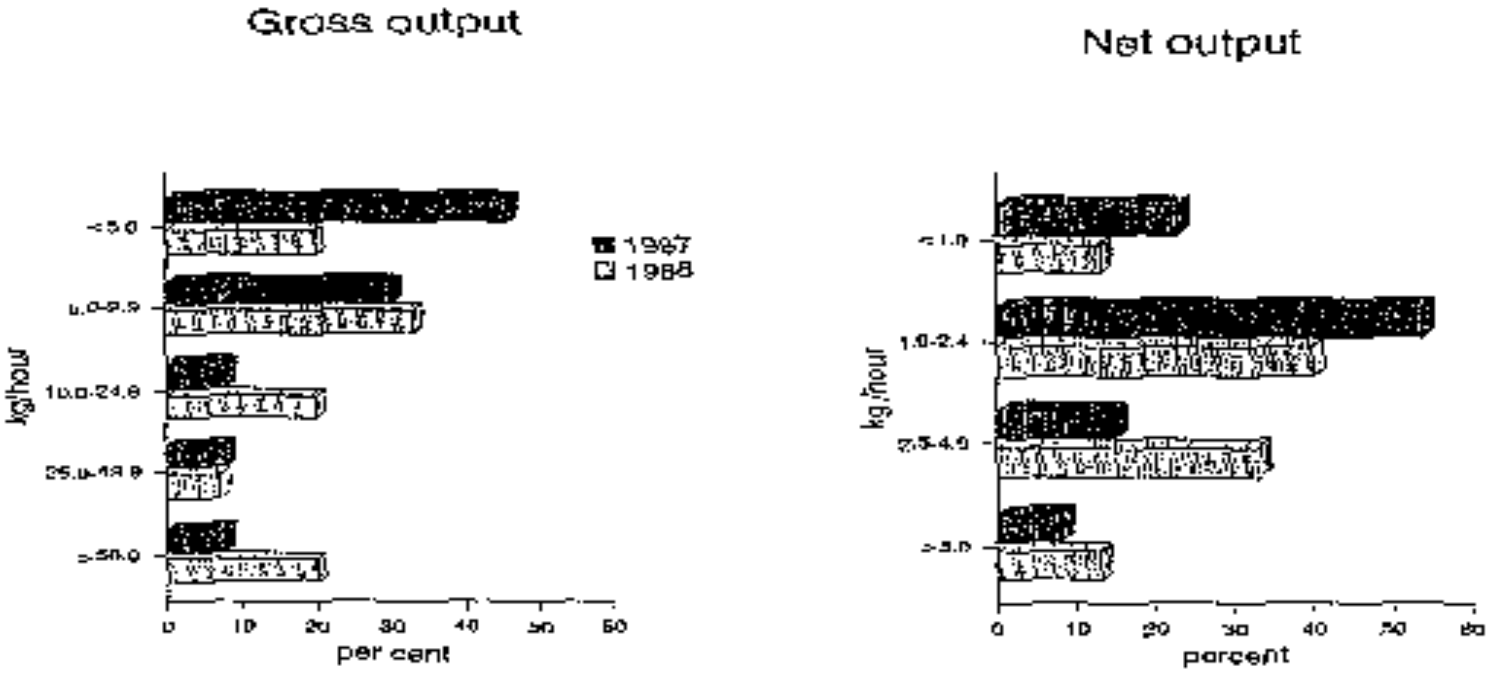
Figure 2
Relationship between Gross and Net Yield
in 1987 and 1988



Labour Productivity

Labour output during the sweeping phase varied from 4 to 75 kg/h with a mean of 14 kg/h for all sites combined (Table 3). Due to higher biomass yields and more flooding, swept quantities per hour were much higher in 1988 than in 1987, rates of more than 25 kg/h representing 27 and 16% of the total (Figure 3). Rates of net yield per total hours of work differed much less between sites and years, ranging from 1.3 to 3.5 kg of grain per h (Table 3). Thus frequencies of net output/h were similar between years despite the differences in gross output (Figure 3).

Figure 3
Frequency Distribution of Labour Productivity of Cereal Gathering (kg/h) in 1987 and 1988



Initially, it was assumed that labour used for cleaning gross yield would decrease with increasing grain content of the swept material; or in other words the ratio between net and gross yield would be positively related to the ratio between sweeping hours and total hours spent. Inspection of Table 3 shows that time spent on sweeping was not related to the ratio between net and gross yield. In spite of the net/gross yield ratios of 0.45 and 0.19 in 1987 and 1988 respectively, 74% and 64% of total time was spent on sweeping. The reduction in 1988 was primarily due to site 1 where flooding caused extremely high gross yields mainly consisting of baked clay, which took a lot of threshing and winnowing to dislodge the grain.

Although teams consisted of men and women, the latter were mostly responsible for the second phase and partitioning of time spent on the two phases may be less influenced by overall efficiency than by the labour availability of the two sexes. It is also clear that the overall efficiency as expressed in kg grain/hr is not linked to the phase on which most time is spent. Mean output seems to be determined mostly by initial site selection and herbage productivity, causing somewhat better net outputs/hr in 1988 than in 1987 (Figure 3).

Potential grain yields were determined in 1987 and 1988 near site 1 for P leatum and near site 2 for Echinochloa spp. These results showed the higher yields in 1988 due to high plant density and grain yield per plant in P leatum and to the latter parameter for E oryzeterum (Table 5). Although harvested grain yields did not approach these potential yields, site 1 produced net yields of 113 g/m² in 1987 and 146 g/m² in 1988; this seems a satisfactory output, considering the various losses that are likely to affect end-of-season yields.[1]

In another trial in October 1988 standing biomass was cut and subdivided in straw and grain. Of a total production of 3.91 t/ha (SD, 0.84), grain yield was 470 kg (SD 20) or 12% of the total. This low proportion of grain indicated that site selection and collection techniques are geared to produce a much higher grain content in the gross product (Table 3) than is normally found in natural standing biomass at the start of the dry season.

Table 5
Potential Grain Yields of Panicum Leatum and Echinochloa spp in 1987 and 1988

Species	P leatum		E colona	E oryzeterum	
Year	1987	1988	1988	1987	1988
Plants/m²	105	278	282	1094	262
Panicles/plant	6	12	14	2	10
Grains/panicle	136	166	163	95	171
Grains, 1000/m²	86	554	644	208	448
g/m², grain (1)	120	775	257	491	1057

1) 1000 grain-weight: P leatum: 1.4 g; E colona 0.4 g; E oryzeterum 2.36 g.

Source: A Maiga (unpublished data)

[1] These "losses" may include grain harvests earlier in the growing season before grain shedding. During this period, seeds are removed from the standing crop by swinging baskets attached to strings through the sward. Few output data are available on this harvesting system; Grouzis, (1988, p 14) in NW Burkina Faso reported a daily yield of 3.75 kg of grain.

DISCUSSION

Land covered with fonio-type grasses is only a minute proportion of the total land area of the Gourma. Most sites lie in alluvial plains which comprise about 11% of the Gourma or about 9,400 km² in total (IEMVT, 1989; de Leeuw et al, 1990). Within a 10 km radius from towns like Hombori and Gossi, where demand for fonio is high and labour may be available, alluvial plains covered 17 and 21% respectively (Bouba-Kaou, 1990; Dembele, 1990).

Actual depressions and lower slopes to permanent or temporary lakes and ponds occupy a fairly small proportion of the land mapped as alluvial plains. Inspection of aerial photographs provided an estimate of about 20% of land as potentially suitable for "fonio" grassland. (L Diarra, personal communication). If this estimate is applied, 190,000 ha qualify as potential sites or 2.2% of the total land area. These fonio-sites would embrace all habitats where fonio species could potentially grow, including those portions where potential grain yields are too low to justify labour-intensive harvesting. If it is assumed that 20% of the total potential fonio habitats are worth harvesting and produce on average of 400 kg grain/ha, total potential output would be 15,000 t of grain for an area of 38,000 ha.

One crucial question can not be answered: "what percentage of all potential land is presently covered with this type of herbaceous cover? or has the combined impact of lower rainfall, of more violent flooding (due to lower vegetation cover in the watersheds surrounding depressions and valleys) and of intensive grazing made many of these habitats unsuitable for "fonio-grasses"? Use by livestock is certainly intense; around Hombori where there is a large sedentary livestock population, stocking rates in "fonio-areas" averaged 2 TLU/ha from early August to late September (Bouba/Kaou, 1990). Similarly around Gossi, from July to October 1990, cattle spent 75% of their grazing time at the edges of Gossi lake and in depressions (Dembele, 1990). Apart from indicating that intensive grazing may have contributed to the decrease in actual "fonio-land", these data also illustrate the importance of these areas for livestock grazing in competition with grain harvesting.

There is little doubt that "fonio" harvesting is an important survival strategy yielding a high output per unit of labour. Yields of 400-1100 kg of grain per ha (Table 3) are much higher than those of cultivated millet. Millet yields south of Hombori from fields cultivated by Fulani and Rimaibe agro-pastoralists ranged from 20-300 kg/ha with a medium value of about 100 kg (Hosse et al, 1985). Labour costs in a similar environment in Central Mali were 5 and 15 kg of grain respectively (Fulton and Toulmin, 1982, p 157). In comparison, to produce 100 kg of fonio on average required 50 h of labour, but only 10 hours in the best-yielding fields (Figure 1).

Although reliable statistics on the current extent and productivity of *fonio* areas is lacking, it is evident that they are a key resource for the local human and livestock population and their long term food security and sustainability. In this context, it seems worthwhile to better assess their key role within the overall ecosystem, to investigate the economic and social merits of improved management and to seek potential avenues to increase their productivity. More information on current modes is required if balanced use is sought to modify the apparent opportunistic utilization en vogue at present.

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Dryland Networks Programme
INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT
3 Endsleigh Street, London WC1H 0DD, England
Tel: (44-71) 388.2117 Fax: (44-71) 388.2826
Telex: 261681 EASCAN G