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Local Agro-Processing with Sustainable Technology:
Sunflowerseed Oil in Tanzania

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This Gatekeeper Series is produced by the International Institute for Environment and Development to highlight key topics in the field of sustainable agriculture. Each paper reviews a selected issue of contemporary importance and draws preliminary conclusions of relevance to development activities. References are provided to important sources and background material.

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LOCAL AGRO-PROCESSING WITH SUSTAINABLE TECHNOLOGY: SUNFLOWERSEED OIL IN TANZANIA

Eric L. Hyman

Introduction

"In 29 years of work in developing countries, I came across this year in Tanzania an NGO project more successful than any other I have ever seen, which deserves wider replication than it is already receiving due to the immense impact it is already having in village economies in some of the poorest areas of the country. The project I am referring to is the Village Sunflower Project sponsored by the Evangelical Lutheran Church in Tanzania and Appropriate Technology International" (Russell, 1990).

The ram press is a small-scale, manual technology for edible oil extraction. It was first disseminated in Arusha, Tanzania in 1986 through a project implemented by the Lutheran Diocese of Arusha with funding from Lutheran World Relief (LWR), Appropriate Technology International (ATI), and the U.S. Agency for International Development (AID). In 1990, the Tanzanian Small Industries Development Organisation (SIDO) began a follow-on project to extend the technology to other regions of the country, with funding from the same donors as the original project.

The ram press is inexpensive and can be manufactured and repaired in informal sector, rural workshops using labour-intensive methods. It is portable, durable, easy to maintain, and does not require diesel fuel or electricity. It is primarily intended for village-based production and consumption of vegetable oil. The ram press was designed for soft-shelled varieties of sunflower seeds with a high oil content, but it can also be used for some other oilseeds. Unlike simple screw-operated batch presses, it does not require the additional step of decortication before pressing soft-shelled seeds. The product is cold-pressed oil, which has a longer shelf life and tastes better than oil produced in a motorised expeller.

Small-scale manufacturers in several regions of Tanzania are now making this press. Owners of the press are using it to produce oil from sunflower seeds grown on their own farms or purchased from other farmers. Many also offer pressing services for other farmers. Press owners report sizable increases in income. As a result of project efforts, the ram press is becoming well established enough in Tanzania so that it can continue to spread on its own through market forces, bringing about a major transformation of the edible oils sector in the country.

The Context: Edible Oil Consumption in Tanzania

Inadequate consumption of dietary fat is a common health problem in most less developed countries. Per capita consumption of fats and oils is very low in East Africa, for example only 1.5 kg per year in Kenya (Zulberti, Schmidt, and Navarro, 1990). Local processing of oilseeds by the farmers themselves could increase production of edible oils, improving the diet in rural areas and boosting farm incomes.

When the Arusha project was designed in 1984, it was difficult to import edible oil into the country and domestically produced oilseeds were exported unprocessed. Modern technologies for oil extraction were largely unknown in rural areas. A few diesel-powered expellers had been introduced by an earlier AID project, but were out of service due to breakdowns or lack of fuel. As a result, it was difficult to buy cooking oil in either urban or rural areas and women's production of fried foods for sale along the roadsides had virtually disappeared.

Imported palm oil and solid shortening became available in 1986 after Tanzania liberalised its trade policies, but mainly just in urban areas. Still, the urban market for other domestically produced vegetable seed oils remained strong because consumers preferred them over the imported cooking fats.

In rural areas, the imported fats are too expensive for most households. Moreover, the domestically produced oils are more expensive in rural areas, due to high transport and distribution costs, if they are available at all. Ironically, little of the oil produced by the urban factories in Tanzania is consumed in the rural areas where the oilseed crops are grown. Thus, there is still a strong need to expand local production of low-cost, edible oil in rural areas. Locally produced oil has some advantages for low-income consumers. It can be purchased in small quantities in plastic bags or used containers and can be reused, whereas solid shortening can only be used once.

Unlike maize, sunflower seeds are well suited to farm-level extraction of oil. In addition, the seed cake left over after extracting the oil is a good animal feed. Sunflowers can be grown in soils that are marginal for many other crops and production costs are relatively low. Before the project, farmers had to sell sunflower seeds at a low price to parastatals through local cooperative unions. At some times, it was extremely difficult to sell the seed due to breakdowns and cashflow problems at the parastatal factories. With a low-cost technology like the ram press, farmers who grow sunflowerseed can process oil themselves, reducing their dependency.

The Origins, Objectives, and Strategy for Dissemination of the Technology

Arusha was selected as the target area for the first pilot project because of relatively good logistics and prospects for economic initiative, and ATI staff familiarity with the region. Sunflowers are grown in the region, but in recent years only three households were known to have processed sunflowerseed by the traditional method of heating and pounding the seed, boiling the flour, and skimming oil off the top of the kettle.

The project staff consisted of one expatriate director (Lynn Schlueter), one local field coordinator (Dallas Granima), one driver, and part-time secretarial and accounting services. Two all-terrain vehicles and one motorcycle were purchased for transportation. The original goal of the Arusha project was the establishment of 10 medium-scale sunflowerseed oil extraction enterprises in the region over a four-year period.

The ram press had not yet been invented when the Arusha project began. At first, the project was going to promote a different technology developed at the University of Tanzania's Institute for Production Innovation (IPI). The IPI technology consisted of a medium-scale, scissors-jack press and pre-pressing equipment, a decorticator, scorcher, and roller. After a small number of these machines were sold, it quickly became apparent that the IPI technology was not well suited to the needs of artisanal-scale producers of vegetable oil. It was too expensive and required extra labour in the production process. The scale of the technology was too large for micro-enterprises and the scissors-jack press was very susceptible to breakdowns.

As a result of the problems with the IPI technology, Carl Bielenberg, an ATI engineer, invented the ram press in late 1985. With soft-shelled varieties of sunflowerseed, the ram press does not require use of any auxiliary equipment. The project director strongly supported a switch from the IPI technology. By mid-1986, it became clear to all of the project partners that the ram press was more appropriate for village oil extraction. The project objective was amended to support the establishment of 40 small-scale ram pressing enterprises in at least 32 villages, yielding at least 24,000 litres of oil per year.

Initially, the Arusha project tried to work with a single manufacturer, which resulted in higher prices and mediocre quality control. Later, a different strategy was adopted to foster competition by providing training to multiple, informal sector workshops and giving them an incentive to begin production.

After successfully completing the training, the trainees are asked to submit a bid for producing a batch of 5-10 presses. If the bid is reasonable, the project places an order, guaranteeing the market for the batch by providing immediate payment to the manufacturer upon delivery of a press. As a press is sold, the project asks the workshop to produce another one if the quality, cost, and timeliness of the previous work was acceptable. In this way, an inventory is maintained so that potential customers can buy one when they want to. After a while, the manufacturer gains confidence in the marketability of the press and the project recovers the initial money it advanced from sales.

The project activities also included demonstration and promotion of technology, establishment of a loan fund for buyers, and provision of extension services and follow-up monitoring. Demonstrations of the press at village gatherings before the planting time for sunflowers proved important. The press was also displayed at agricultural trade fairs. Farmers were encouraged to switch from planting hard-shelled to soft-shelled, oil-rich varieties of sunflower. Initially, the project set up some demonstration plots for cultivation of suitable sunflower varieties, but later decided that was unnecessary. The Arusha project operated from May 1985 through December 1989 and the total amount spent was $418,000, plus some in-kind costs for staff time.

Sometimes the first demonstration in a village did not elicit any interest or the attitude toward a hand-operated machine was negative. In such instances, the project staff simply moved on to the next village. Later, several farmers in villages where no interest was initially shown in the ram press became enthusiastic owners after they had observed the presses in use in neighbouring villages.

The availability of loans was important in introducing the technology; loans covered up to 75% of the cost of a press. The repayment period was generally six months, but it was adjusted for borrowers who received a press late in the processing season. Those who operated their presses at a satisfactory capacity use level earned enough to pay back a loan within one pressing season.

Until 1987, the Arusha Diocese's Project Steering Committee limited loans to village groups of 10 or more and primarily targeted church members. These restrictions impeded dissemination of the press. In 1987, after strong pressure from ATI and the project staff, the Steering Committee allowed loans to be offered on a non-denominational basis to individual farmers and entrepreneurs as well as groups. The technology did not begin to spread rapidly until the criteria for participation were opened up.

All 52 of the borrowers who took out loans to buy a ram press under the Arusha project have repaid their debts. However, presses had to be temporarily repossessed from 16 delinquent borrowers just before the pressing season; this approach proved effective in securing prompt repayment. Many farmers were experiencing financial difficulties at that time because the parastatal did not have enough money to purchase maize in 1990.

However, some farmers who could have repaid on time preferred to hold onto the loan repayment money for working capital to buy more sunflower seeds to press. Timely repayment of loans was also hindered by the common perception that donor-funded development projects do not take loan collection very seriously.

The SIDO project followed the same strategy as the Arusha project did in its later stages, but placed more emphasis on working with NGOs involved in transferring technologies to women's groups. It was carried out by the same team as the Arusha project, with the addition of one new field coordinator (Robert Mollel) and another vehicle. The objectives of the project are to establish 150 small-scale, village oil enterprises, including 50 in the Singida Region, 50 in Iringa Region, and 50 in neighbouring regions. These enterprises are

expected to yield 250,000 litres of edible oil and 500,000 kg of animal feed supplement and generate additional part-time employment. The SIDO project has a total budget of $277,000 and is supported by the same donors as the Arusha project, plus in-kind contributions from SIDO.

The context in these two regions is slightly different from that of Arusha. Singida has only a small number of organisations that work with villagers and few established women's groups, while there are many organised women's groups in Iringa. The traditional process of sunflowerseed oil extraction is rarely practised in the Singida region, but is quite common in Iringa. Since Singida is a semi-arid area with scarce fuelwood resources, the traditional process, which requires more boiling, is less practical. Iringa has extensive forests although deforestation is proceeding rapidly. Forestry officials are interested in the potential to reduce fuelwood requirements in sunflowerseed oil extraction in Iringa by promoting the ram press as an alternative to the traditional process. Because the current model of the ram press, the CAPU version, is less than one-third of the cost of the original larger model, loan financing is less important for many buyers than it was previously. Nevertheless, loans are still available when needed, but for smaller amounts. Through mid-1991, 19 loans had been made under the SIDO project. The project also established a regional seed farm in Singida to supply farmers with suitable varieties of sunflowers.

A second phase of the SIDO project will extend ram press dissemination to four other major sunflower growing regions of Tanzania - Mbeya, Ruvuma, Rukwa, and Morogoro - and promote its use for other oilseeds. The objectives will be to establish a local manufacturing capability and sell a total of at least 40 presses in each of the four additional regions, plus another 20 presses for use with copra, sesame, or groundnuts. In addition to the existing funds allocated, the Food Industry Campaign Against Hunger has provided $60,000 for this phase in Tanzania and technical assistance in other countries.

The approach of information exchange is being used to promote ram press dissemination in other countries. In late 1990, an international conference was sponsored by ATI, LWR, and the Japanese foundation Global Action. ATI is publishing a manual with technical drawings for manufacturing the press (ATI 1991). The manual will be loose-leaf so that it can be updated to accommodate design modifications.

Evolution and Characteristics of the Ram Press

The ram press is a small batch press with automatic loading and unloading (Figure 1). It may be mounted on either a steel or hardwood base for portability or, for greater stability, fixed in place on a cement platform with bolts. Little additional equipment is needed for oil extraction with this press - just buckets, screens, plastic sheets, and containers for the oil. The ram press shears the seeds due to increased fracturing as the seed goes down the length of the cage, exerting a pressure of 200 kg/cm2.

The piston of the press acts as a valve that opens and closes for seed entry. Pushing the press handle forward forces seed into a perforated chamber that allows the oil to flow out. At the same time, the piston forces the pressed cake out of the cage end through an

adjustable restriction cone. When the press handle is moved back to the upright position, the piston returns to its rest position and the hopper refills the cage with seed. The ram press works best with soft-shelled varieties of sunflowerseed. Attempts to press hard seed result in a low oil extraction rate and may cause the press cage to burst if the pressure is increased too much. If only hard seed is available, it should be decorticated before pressing. The oil extracted from the seeds should be clarified either by allowing bits of seed and other impurities to settle out, filtering it, or boiling it in water and skimming the oil off the top.

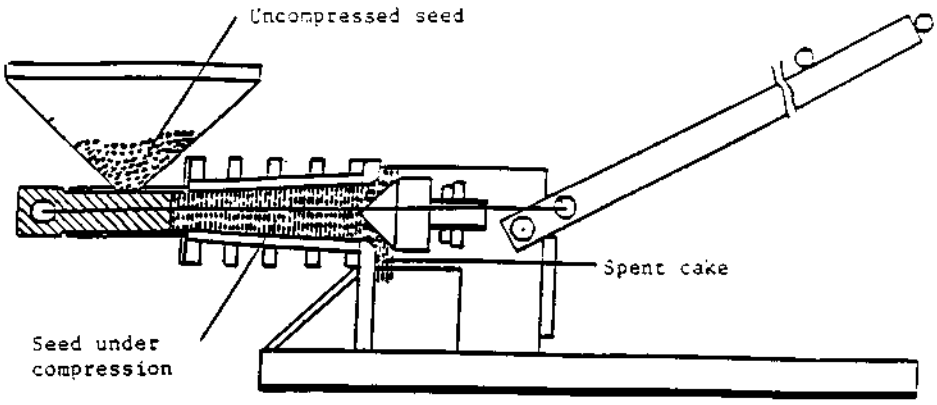
The press can extract 70-80% of the oil in the seed. About 100 kg of soft-shelled sunflowerseed can be pressed in 10 hours of work. The variety of sunflowerseed most commonly pressed in Tanzania, Black Record, yields 20-30 litres of oil per 100 kg of seed, depending on the time and condition of storage of the seeds, adjustment of the pressure of the machine, and the effort of the operators. The same amount of seed could yield up to 36 litres of oil from varieties with a high oil content, but only 12-14 litres from undecorticated, hard-shelled varieties. The difference in weight between the input seed and the extracted oil is accounted for in the seedcake.

As much as 25% more oil can be extracted when sunflowerseed is heated before pressing. This can be done by spreading the seeds out on a flat surface in the sun for a half hour or by carefully heating them over a fire without scorching. The oil yield will be reduced if seed is improperly stored. Seed with a high moisture content is more susceptible to rotting, germination, insect infestation, and aflatoxin formation than dry seed.

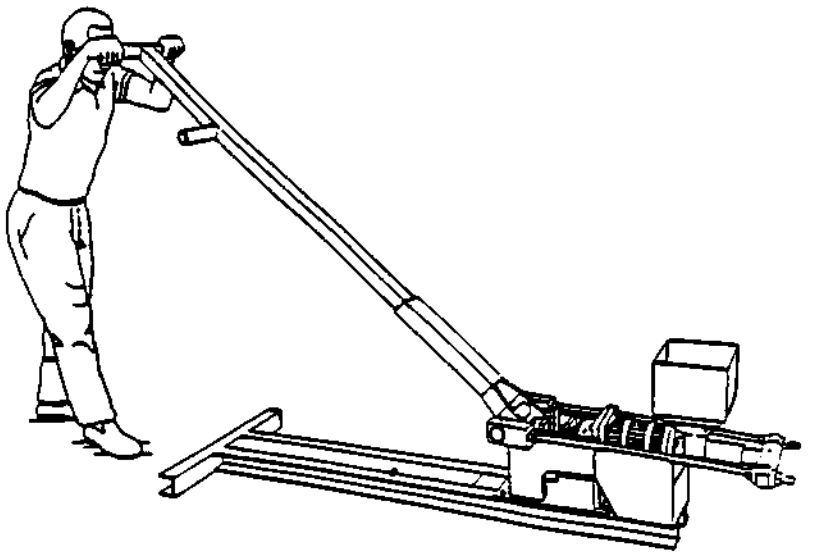
With other types of oilseeds, some minor modifications may be needed in the press for maximum efficiency. The ideal spacing of the cage bars is narrower for sesame copra than for sunflower seeds, but a cage spacing that is suitable for all three of these oilseeds can be used. Higher throughput and oil extraction rates can be achieved with these other oilseeds. Since copra has a high oil content and is very fibrous and compressible, it would be ideal to have a ram press with a large piston to take in a greater quantity of material at a time. Copra should be broken into small pieces before being fed into the press. The ram press is also suitable for rapeseed, mustard seed, and dehulled almonds, but other technologies are more productive for oil palm and groundnuts.

The design of the ram press has evolved over time. The original Bielenberg model was produced commercially for over a year. It had required a considerable amount of effort to operate, generally two workers at a time. In mid-1987, ATI hired Martin Fisher to test the original model and he developed a modified version. This model, known as the Bielenberg-Fisher press, was easier to use and more durable than the original model. Another model was designed by Hugh Allen, a former ATI employee working for CARE. The Allen press was designed to be stronger and easier to use than the B-F model; however, it is relatively large and requires more steel and machining than the earlier models.

Figure 1. Two Views of the Ram Press



Source: ATI 1991.



Source: Allen 1989a.

The CAPU model is the version now being produced by all of the manufacturers in Tanzania. Axel Utermohlen and Robert Kussage of the Craftsmen and Artisans Promotion Unit, a German church project, developed this small ram press. The CAPU press was designed to simplify manufacturing by artisans and to reduce costs. It is also easier to use. It uses half as much steel as the original press because it only weighs 65 kg, excluding the base. The CAPU press has a narrow cage bar spacing to accommodate either sunflower seeds, sesame, or copra. The price of the CAPU press ranged from $270 to $390 in mid-1991, depending on the manufacturer. The lowest price was charged by CAPU's own non-profit workshop. Further work is underway on the design of smaller versions of the ram press.

Impacts in Tanzania

By mid-1991, a total of 461 ram presses had been produced in Tanzania through the two projects. Of these, 368 had been sold and 93 were in the inventories of the manufacturers or distributors. To date, 12 manufacturers in 7 of Tanzania's 20 regions have sold ram presses commercially and 8 of these manufacturers are still actively producing the press.

Monitoring records were kept for the first 60 ram presses in the Arusha region through mid-1990. The individually owned presses in operation for a full processing season produced an average of 2,440 litres of sunflowerseed oil from July 1989 through June of 1990, compared to 1,070 for the group owned presses. Sunflowerseed harvests were lower the following year due to a severe drought. The twenty-two presses monitored in Arusha and Singida regions in 1990-91 produced an average of 1,440 litres of oil.

A sample survey of press owners in the Arusha region in mid-1990 revealed a high degree of consumer satisfaction with all of the ram press models. All of the presses sold in Arusha were in working order, including the first ones manufactured, which were harder to use and of only fair manufacturing quality. Owners reported only minor mechanical problems and had little difficulty in getting the necessary repairs or spare parts done locally and at minimal cost. A market has also emerged for sale of the seedcake as animal feed. Press owners paid farmers an average of $5.20-$6.20 per bag of Black Record seed at harvest time in 1990 when the oil sold at $0.91-$1.55 per litre in 20-litre tins. After the peak harvest season ended, the seed price rose to $7.80-$ 10.40 per bag. In comparison, the government buying price for sunflowerseed was $4.92 per bag, but most of the cooperative unions did not have money to buy any seed.

As a result of higher producer prices and the emergence of a reliable local market, the amount of sunflower grown in the Arusha region increased four fold from 1986 to 1989. Furthermore, a nearly complete shift in the type of sunflower planted from hard-shelled varieties to a soft-shelled variety that is easily processed with the ram press has been accomplished with little difficulty.

Ram press owners in rural areas can earn much more than typical urban salaries in Arusha town. At the average level of production and prices, the net present value of the machine

used for a combination of commercial and service pressing over a ten-year period is $5,500 at a 15% real discount rate. About seven-eighths of the respondents did service pressing for farmers in exchange for a share of the oil extracted. Per press, an average of 12 other households benefited from service pressing which also increases the capacity use rate of the press.

As a labour-intensive technology, the ram press creates employment for unskilled workers, most of whom are young men hired on a flexible, part-time basis. The press operators are paid a wage that varies with the amount of oil extracted and typically earn $0.91 to $1.37 per day. Sometimes, labour is also hired to clean the seed before pressing; this work is usually done by women.

Lessons Learned

Small-scale processing of an agricultural product for local consumption can be a viable alternative to the sale of raw products to parastatals or large corporations. Small-scale producers respond to economic incentives and will adopt new technologies where the benefits are large enough, the costs affordable, and risks manageable, but the characteristics of early and later adopters may differ. Government policies relating to imports of edible oils, purchase prices for oilseeds, and the ability of farmers to process oil themselves can have a large bearing on the incentives.

Flexibility in the type of technology promoted is important, but many of the problems that may lead to rejection of a technology can be anticipated or avoided if a thorough assessment of the social and economic factors affecting technology choice is done before implementation. The dissemination of new technologies to the rural poor in developing countries usually requires more than just the provision of information, especially in the initial stages. Manufacturers need accurate engineering drawings and a list of acceptable, alternative parts.

The ram press projects in Tanzania were able to achieve a significant impact because they concentrated on commercialisation of a single technology. Another important characteristic of the Tanzanian experience was the continuity, commitment, and perseverance of the project staff.

One of the main factors leading to the success of the Tanzanian efforts was a strong emphasis on getting the technology into the hands of farmers who can actually use it. Once field tests have shown that the cost and reliability of a technology are satisfactory, one of the best ways to identify areas for further improvement is to begin disseminating it to users. At that point, it may be best to keep the design constant for a certain period of time and then gradually change a few aspects so that the effects of the changes can be easily monitored. Over time, further improvements may be made by both manufacturers and users.

The ability to supply a new technology at a low price proved to be the key to widespread adoption in Tanzania. In general, it is important to have a simple design that is inexpensive

to produce and to foster competition among producers. However, in countries where local levels of skills in manufacturing and repairs are lower, some tradeoffs may have to be made in favour of greater durability over lower cost.

At first in Tanzania, too much reliance was placed on assistance to a single manufacturer. Faster progress can be made by working with multiple manufacturers because competition can keep prices down, stimulate design innovations, and encourage better quality control. By working with decentralised workshops, repair facilities were also closer to the buyers.

Large formal sector workshops have higher profit expectations and also higher production costs due to higher overhead, wage rates, and taxes. As competition from smaller, informal sector firms pushes down the prices, the large firms may lose interest in this product. Some informal sector firms may have difficulty maintaining product quality due to the use of inferior materials, lack of jigs and fixtures, and lower levels of skills. Nevertheless, many of these problems can be overcome through training, assistance in raw material sourcing, and monitoring of quality.

Development projects sometimes try to limit participation to village groups rather than individuals for ideological reasons, as was the case at first in Tanzania. Yet, the spread of a new technology can be much faster among individuals than groups, and individually owned enterprises often make more efficient use of a new technology than a community group.

In Tanzania, extension services for farmers were not needed because many were already familiar with growing this crop. However, adequate supplies of suitable varieties of sunflower had to be assured. Convincing farmers to switch to planting soft-shelled, oil-rich varieties of sunflower did not turn out to be difficult in Tanzania due to the availability of the seed and good quality extension services.

Financing can provide people with an opportunity to obtain profitable technologies that they could not otherwise afford. Strong collection efforts should be made to ensure prompt repayments so that participants can gain experience with banking practices and other borrowers can be given loans.

The strategy of ram press dissemination in Tanzania stands in marked contrast to previous approaches to technology transfer in the country, which relied on mass mobilisations, media campaigns, and village organisations. Technologies promoted in those ways, such as animal-drawn ploughs and cultivation of pyrethrum flowers for insecticides, were received with little enthusiasm. Where government is involved, it is important for them to work directly with farmers, rather than placing presses at rural extension offices to be operated by salaried workers.

Introducing and refining a new technology is often a slow process at first, but eventually the rate of adoption accelerates. The Tanzanian experience indicates the importance of a sustained, gradual approach to appropriate technology development with a time horizon of five years or more.

Significant testing, demonstration, or dissemination activities for the ram press have begun in Kenya, Lesotho, Uganda, Zambia, and Zimbabwe. To date, Tanzania is the only country where multiple manufacturers have sold sizable numbers of the presses. Elsewhere, ram press dissemination has not progressed as quickly because most of the activity has been in lab and field testing or making more design modifications instead of transferring the technology to farmers. It is likely that a significant number of the presses will only be introduced in these countries when some organisation takes an active role in the initial dissemination.

Note

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The Sustainable Agriculture and Rural Livelihoods Programme

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