

OILSEEDS

Post-harvest Operations

 INPhO - Post-harvest Compendium



Food and Agriculture Organization
of the United Nations

OILSEEDS: Post-harvest Operations

Organisation: International Development Research Centre, Canada ([IDRC](#))

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Edited by AGSI/FAO: Danilo Mejia (Technical), Beverly Lewis (Language & Style),

Last reviewed: 14/10/1999

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1 Introduction

Sub-Saharan Africa is a net importer of edible vegetable oil, protein cake and meal required for the dairy, poultry and pork industries. The entry of private-sector interests into post-liberalisation economies in African countries has highlighted the importance of production of annual oilseeds. When recent surpluses of palm oil pushed the commodity near discount prices, it became the interest of those holding the oil-surplus to sell their edible oil wherever they could.

There is a growing understanding that the national requirements for edible oil and protein cake can be met by engaging smallholder farmers in the production of annual oilseeds. Such production would make full use of the capacity of the domestic processing industry. In turn this activity would create or sustain jobs to produce both oil and the feed cake.

A cursory examination will show that many countries have weak or non-existent dairy and animal products industries, an effect of the overriding policy to make sufficient cooking oil available to the urban consumer. This policy ignored the potential of involving the domestic farmer in oilseed production, thus providing the domestic protein cake for the dairy and meat production industries.

At the same time, it is known that the region has a great agro-climatic potential for increased production of annual oil-bearing seeds like sunflower seeds and soybeans, which have substantial market demand especially in South Africa.

On average in the Eastern and Southern Africa region, only Zimbabwe has demonstrated long-term self-sufficiency in oilseeds, with a mix of sunflower seeds and soybeans. Only in years of drought does the country have to import both edible oil and protein cake. Preferably, Zimbabwe would buy the right quantities of the oilseed to ensure that the local processing industry is fully utilised.

1.1 Economic and Social Impact

Oil-bearing plants offer a range of opportunities for small holder farmers, particularly in Sub-Saharan Africa:

Manual processing near the farm gate as a small scale enterprise, and home utilization of the co-products-the edible oil is consumed in food for body energy to counter protein-energy malnutrition or under-nutrition; the protein-rich cake (sunflower, Niger seed, sesame) is fed to cattle for increased milk production, to poultry and to pigs.

Consuming the whole oil-bearing seed as a snack (e.g. groundnuts), or baking the oilseed (sesame) into a snack food such as biscuits.

The sale of farm surplus to the domestic crushing and refining industries (sunflower, sesame, Niger seed, mustard, rape).

The sale of high-grade farm surplus for export to the confectionery industries in the industrialized nations (groundnuts and sesame) (Makoko, M.S. and H.R. Balaka. 1991).

1.2 World trade

The annual oil-bearing crops of most importance to Sub-Saharan Africa, each with its own agro-climatic zone, include:

Groundnut (or peanut) (*Arachis hypogae*)

Sesame (called simsim in East Africa) (*Sesamum indicum*)

Sunflower (*Helianthus annuus*)

Rapeseed (Turnip rape, or Polish canola) (*Brassica rapa*, formerly *campestris*)

Rapeseed (Argentine rape, or Argentine canola) (*Brassica napus*)

Safflower (*Carthamus tinctorium*)

Niger seed (*Guizotia abyssinica*) has particular importance in Ethiopia, where it is called noug. Mustard seed (*Brassica carinata*) and linseed (*Linum usitatissimum*) also have special importance in Ethiopia particularly.

Two additional annual crops must be mentioned, though neither is technically considered an oilseed. Cotton (*Gossypium spp*) is not planted for its edible oil, but rather for the fibre, for use in the textiles industry. However, substantial tonnage of cotton seed are a by-product; and the oil, after crushing and refining makes a substantial contribution to the supply of national vegetable oils in most countries of Eastern and Southern Africa. As well, the press-cake is an important raw material for animal feeds.

Similarly, countries which have solvent extraction capability make use of the germ from maize (*Zea mais*) removed in roller milling in order to improve the shelf life of the maize meal (flour) by reducing its tendency to become rancid. The oil recovered from the germ can also make a substantial contribution to domestic supplies of vegetable oil.

Soybean (*Glycine max*) represents a special opportunity in many countries. The world-wide demand for soybeans is driven by the demand for protein meals for the dairy and meat production industries. Containing only 18 percentage by weight of oil, it cannot be crushed easily by manual or mechanical means to extract the oil. It requires expensive and sophisticated solvent extraction methods (or extrusion followed by motorised expelling). In the industrialised world, the oil is viewed nearly as a by-product, important to make the high-protein feed cake. In Eastern and Southern Africa, only South Africa, Zambia, Zimbabwe and Kenya have real solvent extraction capacity, which sends specific price signals to small holder farmers. There is substantial demand for soybeans from South Africa alone, whose representatives have travelled as far north as Uganda to seek contracts for the production of surplus for export.

In the rest of the region, and in Sub-Saharan Africa, soybeans are an exotic crop to most small holder farmers. It has been found that farmer adoption of the crop is strongly enhanced when home level utilisation is taught along with production practices. In this way, soybeans have a strong potential role as nutritional intervention, with resultant changes in household level food patterns.

The coconut palm (*Cocos nucifera*) and the oilpalm (*Elaeis guineensis*) (perennials) are concentrated along the eastern coast (coconut), and certain high-rainfall areas on or near inland lakes (oil palm). Oil palm is also found in some islands within Uganda's portion of Lake Victoria, along the northern shore of Lake Malawi and on the shore of Lake Tanganyika. (Research documentation on coconut palm production and postproduction can be obtained from National Coconut Development Programme, PO Box 6226, Dar es Salaam, Tanzania).

The annuals, with the exception of soybeans, have high levels of edible oil content and protein in the press-cake.

Table 1. Oil and protein content of selected oilseeds (% content on a per weight basis) (from Zulberti, C. 1988)

Oilseeds	Oil	Cake	Protein	
			In cake -----	In seed
Groundnut	40	52	50	26
Rapeseed	40	56	52	29
Sesame	44	40	40	22
Sunflower	44	37	43	16
Soybean	18	79	46	36

1.3 Primary product

After crushing or expelling annual oilseeds yield edible vegetable oils, fats, soapstock and the protein-rich presscake. Edible oil in liquid form is preferred by consumers and known as cooking oil in Southern Africa. The same oil after hydrogenation becomes solid white cooking fat the preference of consumers in Kenya and a portion of the population in Tanzania and Uganda.

Household level soybean utilisation

Home-processed soybean has the potential of making a significant impact on the chronic undernutrition of children in Sub-Saharan Africa:

Soybeans are an excellent and affordable source of protein and of dietary fat (still the lowest cost per kg of protein in comparison to cowpeas, milk powder, poultry, pork and beef) (Osho, S.M. 1995a);

Home processing is easy and is feasible with inexpensive, common household utensils; Soy protein has a good combination of the major essential amino acids required by the body; and daily consumption of a cereal/soybean based food will provide the amino acid complement of legumes and cereals.

Home level processing can be scaled up to small-scale manufacture, which can later grow into medium-size food processing plants.

Case study

IDRC supported two phases (phase I, 1987-1990; Phase II, 1991-1994) of collaborative work among the International Institute of Tropical Agriculture (IITA, PMB 5320, Ibadan, Nigeria) in Ibadan, the Nigerian Institute of Agricultural Research and Training (IAR&T) in Ibadan, the National Cereals Research Institute (NCRI) in Badeggi, and the National Agricultural Extension Research and Liaison Services (NAERLS) in Zaria. (see Osho, S.M. 1995a; Osho, S.M. 1995b: detailed project reports can be requested from IITA).

The project aimed to achieve the following:

- Document the status of soybean utilisation in Nigeria;
- Develop household level processing technologies for soybeans;
- Develop small scale processing technologies for soybeans using the extruder and oil press; and
- Disseminate results of the technologies to extension workers.

The key ingredients in the strategy for achieving project results included: the baseline survey, product development research, training and extension programs, and continually assessing the project impact.

Major results achieved include:

- The home level processing and small scale processing technologies developed can remove the anti-nutritional factors which are contained in the raw bean, improving taste and nutritional absorption;
- 1993 had trained over 67,000 people trained on uses of soybeans;
- The United Nations Children Fund (UNICEF) funded a wider implementation of the IDRC-supported results with a project The Dissemination of Soybean Processing and Utilisation Technologies in Nigeria.
- The establishment of a soybean utilisation centre at one of the country's busiest markets for buying and selling agricultural produce, in which upwards of 3000 people conduct business activities daily;
- By 1994, the number of small and medium size food processing plants had grown to 50, from 3 in the late 1980's;

IITA has been developing plans for sharing its experiences and expertise with national research and extension programs in other countries in West Africa, and in Eastern and Southern Africa.

Case Study in Zambia

"Results of surveys carried out by the National Food and Nutrition Commission (NFNC, PO Box 32669, Lusaka, Zambia) with FAO/UNDP assistance indicate a high prevalence of malnutrition in Zambia, particularly in the children aged 0-4 years. High prices and the present economic situation of the country make the animal protein a scarce commodity for the average man. Soybeans can help the situation a great deal because..." (Jahaveri, F. and D. Wynne, 1985).

Two years after the publication of that initial set of home level recipes, efforts at influencing the production of soybeans in the small holder sector were augmented by a training program for agricultural extension personnel with explicit emphasis on household level utilisation of soybeans. A manual finally reached publication in 1990 (Jahaveri, F. 1990). By then, there were upwards of 40 non-governmental agencies active in the promotion of the growing and home-level utilisation of soybeans. (More information can be obtained through the Integrated Crop Management/Food Legumes Project, PO Box 30563, Lusaka, Zambia)

Prior to the early 80s, soybean production was limited to commercial farmers. The development of naturally nodulating varieties made it possible for smallholders to participate. By 1990, almost 40,000 smallholder farmers were producing soybean, mostly for sale to the one solvent-extraction parastatal company, but with some retention as food for the household. APROMA (Association des Produits a Marche CEE/ACP, 52, Avenue Louis Lepoutre B-1060 Bruxelles, Belgique), a promotional arm of the European Union, began to show interest in soybeans in the early 90's, especially in relation to Southern Africa, and sponsored two regional meetings of agricultural scientists, economists, nutritionists, and marketers (APROMA. 1993, APROMA 1995).

APROMA funded a process to establish a data base on soyabean production, to be hosted by the Zimbabwe Commercial Farmers Union (Commercial Oilseed Producers Association (COPA), 7th Floor Agriculture House, 113 Leopold Takawira Street, PO Box 592, Harare, Zimbabwe). The intention was to begin with South Africa, Zimbabwe and Kenya, to add data from other countries as their soybean production rose, and to serve as a common source for the prediction of surplus and deficit countries, and thus serve as a tool for increasing inter-country trade in soybeans.

Case study on Kenya

Kenya has depended on locally hydrogenated fats from imported palm oil, at a cost of USD 60 million annually for 80 percentage of its vegetable oils and fats. Recognising that substantial imports of the oilseed meals required for dairy, poultry and pig feeds for its meat industries added to the size of the import bill, and kept local farmers from economic participation in this sub-sector, a GTZ/Government of Kenya project was initiated in the early 90s to promote soybean growing. Farmer-adoption of the new crop was inhibited by the lack of knowledge of home preparation of this potential food source yielding surplus quantities which could be sold to the three large scale industries which had solvent extraction capability. The project encouraged national extension agencies to train householders in home preparation, is championing the formation of the Kenya Soybean Association (KESA), and the use of the crop in child-feeding interventions (GTZ Soybean Project, PO Box 41607, Nairobi, Kenya).

The International Soybean Centre (INTSOY, University of Illinois, 169 Environmental and Agricultural Sciences Building, 1101 West Peabody Drive, Urbana, IL 61801, USA) is promoting the development of soybean products, and providing an invaluable repository of knowledge and teaching about soybean utilisation. INTSOY has had frequent and helpful technical linkages to the work in Nigeria, Zambia and Kenya.

1.4 Consumer preferences

Farmers of oilseeds want maximum income from the sale of their surplus crop. Their main customers, oilseed crushers, want maximum oil extraction per kg of oilseed bought. In few countries, at this time, are there well established standards of farmgate payment to the farmer by oil content, in part because a quick tool for establishing oil content does not yet exist. Users of cooking oil face a different problem. Pure oils from sesame, sunflower, Niger seed have different "boiling point" temperatures, at which the oil begins to smoke or vaporise. Cooking time varies for each type of oil. Thus, these pure oils are not easily substituted one for the other without adaptations to cooking times.

2 Post-Production Operations

Small to Medium Scale Processing of Oilseeds

In Tanzania, starting in the mid-80's, a manual press for sunflower oil extraction was developed, which in the next twelve years reached very high levels of dissemination in many countries. This was the technology, which spawned many rural enterprises and began to affect planting patterns. The US Appropriate Technology International (ATI, 1828 L Street NW, Suite 1000, Washington, D.C. 20036 USA) was the prime mover, attracting the interest and financial participation of other agencies, including IDRC.

In South Asia including India and Pakistan, IDRC funded work aimed at improving the efficiency and cost-effectiveness of the ubiquitous motorised screw expellers. This work contributed to a collaborative research and dissemination network.

Manual oilseed crushing-the Bielenberg ram press

In late 1984, ATI and Lutheran World Relief (LWR) initiated a program to help Tanzanian village groups to establish, own and manage small-scale sunflower seed oil extraction enterprises. A year later, ATI staff engineer Carl Bielenberg designed the ram press. In early 1989, a small workshop was convened to review the ATI progress to date, and to exchange experiences about the technology's manufacture, design and dissemination (ATI 1989).

A further workshop in September 1990, with a much larger number of participants, again took stock of progress with the technology (Kamau, John Mugeto 1990) and its dissemination (ATI 1990). By then, dissemination of the ram press was active in Zimbabwe (the ATI-led

Zimbabwe Oil Press Project, 132 Harare Street, P.O. Box 1390, Harare, Zimbabwe; Africare, PO Box 508, Harare, Zimbabwe), in Zambia (Africare, PO Box 33921, Lusaka, Zambia), in Kenya (Action Aid and ApproTech, PO Box 10973, Nairobi, Kenya). (See also Zulberti, C. 1990.; Navarro, L., J. Muthaka. 1990; Zulberti, C., O. Schmidt and J. Mugeto. 1990) Concurrently in Zimbabwe, the Intermediate Technology Development Group (ITDG, Gorland House, 7 Jason Moyo Ave., PO Box 1744, Harare) accrued valuable technical information and collected detailed business-performance on several pilot installations of the Tinytech mechanised systems applied to sunflower at the medium-scale enterprise level. ATI then developed the concept of a regional OILS project, to which IDRC made a financial contribution between mid 1993 and mid-1995. The regional project was to facilitate the interaction among national groups which were disseminating ram presses in their own countries, to enable support visits from the technical resource people, particularly those in the Tan-Press project of ATI's located at the Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC) in Arusha. (ATI June 1994; ATI 1995). A further regional workshop on the theme of small scale oil expressing technologies and enterprises was organised by AGROTEC (UNDP/OPS Programme on Agricultural Operations Technology for Small Holders in East and Southern Africa) 4-10 September, 1994, in Arusha, Tanzania. The proceedings of the workshop are extensive, and can be obtained from AGROTEC (P.O. Box BW 540, Borrowdale, Harare, Zimbabwe). By the time of that workshop, the number of ram press enterprises in Tanzania exceeded 1000, the low hundreds in Zambia and Zimbabwe, were just beginning to reach 100 in Uganda and numbered over 100 in Kenya.

One of the important features of that workshop was the declaration by the dissemination agencies that they were positioning themselves as midwives, not manufacturers, of the ram press technology. They gave descriptions of the kind of efforts being undertaken to devolve manufacture, sales and service of the ram press to indigenous companies and commercial agencies, to ensure maximum prospects of sustainability after the end of the short-term intervention projects.

In Kenya, ApproTech is pioneering a new approach to franchising the manufacturers of the ram press. The manufacturer is permitted to place a sticker from the Kenya Bureau of Standards (KBS) on each ram press built, as long as the workshop meets the qualifications and standards "policed" by ApproTech. At the same time, prospective buyers of the press are counselled to buy a ram press only if it carries the sticker of the KBS.

(Also, at the meeting the UK Natural Resources Institute (NRI, Central Avenue, Chatham Maritime, Chatham, Kent, UK ME4 4TB) provided an excellent keynote on technical issues of oilseeds processing. They proposed a protocol for systematic studies in Tanzania and Zimbabwe on protein cake-quality, and rural utilisation in feed for different farm animals. NRI was shortly going to publish a comprehensive manual on processing of oilseeds and utilisation of co-products in sub Saharan Africa. (See also Gordon, A. and A. Swetman, 1990))

Motorised expelling of oilseeds

The most common screw expeller being manufactured in South Asia is based on a design dating from 1906. Little change was made to the design by the many foundry and metal working shops building the machine. In the mid-80s, IDRC supported applied research work with the Pakistan Council for Scientific and Industrial Research (PCSIR) and with the Indian Council for Agricultural Research (ICAR), aimed at improving the performance of the technology. Other agencies began to show interest, and post-IDRC support led towards multi-country and interagency collaboration:

Improvement of the screw configuration in to increase the yield of oil while decreasing the energy consumption; reducing the machine's weight to make it more portable for the hills of Nepal, and other distant locales with few or no roads);

Improved heat treatment processes for the parts in order to reduce the operating costs;

Redesign of the cage lock and gear drive for weight reduction and facilitation of local manufacture;

Improvement of the cone adjustment mechanism in order to allow the processing of a greater range of oilseeds while avoiding jamming of the system.

The main collaborators were the Germany-based FAKT (Association for Appropriate Technologies in the Third World, Gaensheidestrasse 43, 1000 Stuttgart 1, Germany), the PCSIR of Pakistan, the Tinytech company in India (Tinytech Plants Private Limited, Rajkot--360 002, India). and the Nepalese Development and Consulting Services (DCS) in Butwal.

By 1990, substantial progress had been achieved (Dietz et al, 1990):

Machine weight reduced from 1000 kg to 230 kg while maintaining an hourly throughput of 20 kg of rapeseed;

Drive power requirement reduced from 6 kW to 5 kW;

Energy consumption reduced from 100 Whr/kg to 65;

Basic design of the machine had switched from foundry casting to welding.

Documentation can be obtained from FAKT, while the expelling machinery can be obtained from Tinytech (who have been marketing the equipment in Southern Africa, particularly in Zimbabwe).

2.1 Storage

A major rural problem is how to store the press cake produced by ram press operations on sunflower. If a buyer for the feed cake, containing the crushed hull is not easily found the product could become rancid. The buyer of the cake will also have to know which formulation to use to compensate for the high level of husk/hull fibre.

3. Economic and Social Considerations

Between 1975 and 1992, IDRC had supported 47 separately funded activities, for a total cost of over CAD \$14 million, aimed at improving oilcrop research and the vegetable oil and protein systems in Africa and South Asia. IDRC's support for this subsector has strong justification. Edible oils and fats are essential components of the human diet, but these countries were among the lowest in per capita dietary oil and fats intake; had low yields of oil crops; yet they have land and climate suitable for increasing oil crop production without displacing other crops. In addition, oilseed crop improvement was given low official priority in most of the countries in South Asia and Africa. The first 12 projects, funded from 1975 to 1980, largely focused on oilseeds production improvement.

In 1981, the Oil Crops Research Network (ORN), based in Ethiopia, was established. The initial intention was simply to provide better linkages among IDRC-supported oil crops projects and to provide technical support to make these projects more effective. This objective was subsequently expanded so that the Network could interact with all oil crop improvement programmes in the two regions. The original breeding focus in national programs and in the Network expanded to include agronomy, plant protection, and on-farm research. The network and its four sub-networks (Brassicas; Sunflower; Sesame; Other Oilcrops) provided an important on-going focus for production-oriented research, and served as an important and valuable vehicle of inter-country co-ordination and communication via an annual newsletter (Omran, Abbas. 1984-1993, vols 1-10 respectively).

By 1991, after 10 years of supporting the Oil Crops Network, it was clear that breeding, agronomic research, and even farming systems research (FSR) approaches alone would not

achieve the repeatedly stated goals of enhancing the subsector's contributions to improved nutrition and stimulation of the economy which countries in the region wished to see and believed to be feasible.

In part, because the Network had existed for ten years now and in part because of the relevance of the VOPS (K) work (described in the following sections) for defining a future strategy for the Network, a review process was initiated within IDRC in early 1991 (Zulberti et al. 1990).

3.1 Overview of costs and losses

The mid-1980 saw large surplus quantities of inexpensive palm oil becoming available from the Far East. The international price of palm oil dropped from a high of USD 750 per ton to below USD 300 within months, if not weeks. One impact of this palm oil surplus, taking Kenya, as a typical example, was a drastic reduction in the farm gate price being offered to sunflower farmers. The main refiner of edible vegetable oil in Kenya, through its subsidiary company established to promote oilseed production by smallholder farmers, adjusted the farm gate price of sunflower seed to match the international price of palm oil less the domestic crushing cost. Not surprisingly, in a period of 2-3 years, the number of small scale farmers participating in sunflower production plummeted from a high of 80,000 to around a tenth that number (Oilcrops Development Limited, Nakuru, Kenya). At the same time, many small to medium scale crushers, suppliers of oil to the giant refiner, saw their throughput (and the jobs of their workers) curtailed in similar measure as the refiner switched sourcing of raw vegetable oil from the indigenous crushing plants to importing palm oil from abroad. The fundamental question which IDRC felt it needed to address in the light of these circumstances was the following: since oilseed farmers had been rendered non-competitive by the volumes of cheap palm oil, should the focus of research support switch to helping these farmers to find and grow alternate crops? Was further investment in applied research on mainly annual oilcrops now inappropriate or ill advised? Would national economies, especially from the perspective of consumers of edible oil, be better off if they switched to importing the palm oil and found alternative competitive employment for the farmers and processors thus affected by international events?

A healthy, vigorous debate ensued within IDRC. One group argued that as the countries of Eastern and Southern Africa were perpetually short of foreign exchange, importation of palm oil was unaffordable at any low price because it would increase the foreign exchange debits. The rural economy would prosper in the long run if oilcrop production remained an integral part of national agricultural policy and strategy.

It was agreed within IDRC, therefore, to fund an initial study by one consultant of the vegetable oil/protein system (VOPS) of Kenya, as a representative example. The Social Sciences Division and several programmes within the Agriculture, Food and Nutrition Sciences Division (< biblio >) provided financial support for the study. This work was well publicised within Kenya and within the Oilcrops Research Network.

Inter-divisional support followed for three phases of the project Vegetable Oil/Protein System (Kenya) followed--the VOPS(K) project from early 1988 onward (Anonymous. 1989). Seven teams of researchers, and subsector stakeholders and key players did quick surveys of key aspects of the national sub-sector. (Figure 1 gives a schematic presentation of the aspects of the subsector examined, and underlines the importance of looking at both present consumption and at future demand for the various end-products from the vegetable oil/protein system.)

The results from the work were published by Egerton University (PO Box 536, Njoro, Kenya) (Oggema et al. 1988; Odhiambo et al. 1988; Bartilol et al. 1988; Karau and Namwamba, 1988; Gichohi et al. 1988a; Gichohi et al. 1988b; Gitu et al. 1988; China et al.

1988; Zulberti and Lugogo 1989---the series of 10 working papers from Egerton University), and were presented as well to the substantial membership of the Oilcrops Research Network (Zulberti, C. 1990).

These results were discussed at a workshop of sub-sector participants in Kenya. Annual workshops followed, for discussion of sub-sector progress or of special themes such as the policy environment (Anonymous. May 1991).

VOPS(K) steadily developed and increased the (public) knowledge base of the subsector's structure, behaviour and performance. VOPS(K) produced a newsletter to serve the subsector through information exchange and research publication. Also, additional resources have been attracted to the subsector (from the World Bank for the Agricultural Sector Management Project (ASMP, Ministry of Agriculture, Livestock Development, and Marketing (MALDM), PO Box 30028, Nairobi, Kenya) phase II, and from FAO for the Rural Oilseeds Production and Processing Project (ROPPP, same address)) for training and further applied research. These achievements have increased local ability and confidence to develop sound policies for subsector improvement.

3.2 Major problems

The most important signals to smallholders are producer price, and costs of inputs. A national enabling policy will encourage value-added processing near the farm gate and redistribution of the co-products to the farming communities. The liberalised economies are now presenting smallholder farmers with new problems and new opportunities. Smallholder farmers are having increased difficulty in affording the cost of high-yielding hybrid seeds, now being marketed by the new private enterprise companies. Thus, the small holders still require a relatively powerful yielding species, the seed of which they can retain for planting the next season. National agricultural research and extension systems have, in the last five to ten years, been less able to supply those needs because of funding cutbacks. As well, smallholder access to agricultural credit has been eroding in the newly liberalised economies.

3.3 Proposed improvements

The concept, inherent in the VOPS (K) project, of mobilising the sub-sector's key players and stakeholders, rather than hiring independent consultants, to delineate, characterise and "troubleshoot" the subsector, was promising. Thus, even as the VOPS (K) work was ongoing, the Oilcrops Research Capacity (Eastern and Southern Africa)-ORCESA--project was initiated in 1991. The burden of this complementary project was to seek to "replicate" the VOPS (K) approach in two additional countries of the region, Zambia and Tanzania (Mbwika et al. 1992; Mbwika and Theora 1992). The intention was to have ongoing interaction by this project's implementers, the Agricultural Research Foundation (AGREF, PO Box 39189, Nairobi, Kenya), with the VOPS (K) project, and the ORN.

Several years after initiation these projects achieved considerable progress and accomplishments.

From the VOPS (K) and ORCESA work, the potential was recognised that the ORN could explicitly incorporate into its future scope the PCSR (production to consumption system research) approach which would help to focus on a broader set of interventions in national programs, more likely to remove constraints to farmer uptake of the technical results from the ORN's work to date.

A series of co-ordinated technical evaluations of the work of the Oilcrops Research Network and its components (Thomas Development Associates, 1992, 1993), vigorous interaction between the Network and the VOPS (K) project (Omran, Abbas (ed) 1988; Omran, Abbas (ed) 1989a.; Omran, Abbas (ed) 1989b.), and a special consultancy (Riley, 1992) culminated in the suggestion that the focus of the network should shift to include a Production to

Consumption Systems Approach (PCSA). The PCSA framework emphasises a comprehensive understanding of the whole subsector as the basis for optimising its performance

However, IDRC's shrinking resource base coupled with its programmatic and structural reorganisation made it impracticable to achieve the recommendations agreed to in the last meeting of the Network in August 1992 (Navarro, 1995). Strenuous efforts to interest other donors to augment (and supplant) IDRC's waning support for the Network did not prove fruitful in the short lead-time available to the Network's Steering Committee.

The national oilcrops research programme in Nepal presented its own look at its complex vegetable oil/protein system at the meeting (Paudyal et al. 1992), and demonstrated that the PCSA was a tool useful to national agricultural research systems.

Although IDRC was unable to offer further substantial financial support to the ORN, progress in the PCSA based projects provided the impetus to apply the PCSA within another recent project, the Vegetable Oil and Protein System Improvement Network (VOPSIN).

VOPSIN was an IDRC-funded PCSA-based project for an integrated research and action endeavour to contribute to the sustainable development of the vegetable oil protein sub-sector in the Eastern and Southern Africa region. The primary recipient institution was the Preferential Trade Area (PTA) secretariat for Eastern and Southern Africa in collaboration with the Agricultural Research Foundation (AGREF). (In 1994, the PTA was renamed the Common Market for Eastern and Southern Africa (COMESA, PO Box 30051, Lusaka, Zambia). The project's purpose was improved performance and growth of the sub-sector. Its goals were improved human nutrition, rural employment and incomes, enhanced contribution to the economy and protection of the natural environment, with special attention to the numerous rural and poor populations who depend on the concerted collaboration of stakeholders and players in the sub-sector with the support of concerned governments and donors.

VOPSIN employed a PCS framework, which was developed from earlier project experiences in Kenya, Zambia and Tanzania. The PCS approach visualises the target Oil Crops Production to Consumption System as constituted by the groups of people, the resources and processes they command, and the interactions among themselves and with the environment, which affect the production, processing, movement, trade and final utilisation of the oil crops. This visualisation is the basis to understand the conditions and performance of the sector, and therefore to identify problems and opportunities to intervene in the sector and improve its performance.

The PCS approach calls for stakeholder participation and necessarily brings together multiple disciplines in an effort to impact the sector. It encourages the subsector participants to join in: Building the necessary knowledge base about the subsector;

Continuous critical examination of the accruing knowledge and identification of the limiting constraints and action gaps;

Developing priority agendas for research, policy and organizational adjustments plus investments aimed at improving the performance of the subsector;

Fostering interest and resources from within the subsector.

The project ran from mid-94 to the end of 1996. IDRC resources were applied to install, operate, and to help raise additional funds for the continued operation of VOPSIN. Progress was achieved in furthering national and regional attention and action in the subsectors of a number of countries, and knowledge about the respective national subsectors was accrued and disseminated (Anonymous. March 1997).

The VOPSIN project also collaborated with the agencies involved in the APROMA-funded process for the establishment of a regional soybean production database.

Work begun by the Junta del Acuerdo de Cartagena (JUNAC) in the early eighties (Dubois et al. 1984; JUNAC 1985; UNIDO/JUNAC 1985) led to UNIDO's collaboration and the formulation of an input/output model of production to consumption systems. UNIDO produced a computer-based simulation model, MEPS (method for the evaluation and assessment of production to consumption systems), using the Symphony spreadsheet software. This model was not fully achievable in many developing countries, because the required hard data were missing.

The IDRC-supported work in eastern Africa constitutes a mobilisation of sub-sector participants with the goal that they would ultimately be able to generate the data necessary for the more rigorous modelling. (such as MEPS and its successor, E-MEPS) Thus, the analyses of the systems research and the systems approach written by, primarily, IDRC staff at the time (Navarro et al. 1992; Navarro and Schmidt 1993) complemented the JUNAC/UNIDO work.

Further, IDRC also commissioned a useful and informative review of the methodologies useful to production-to-consumption studies (Sellen et al 1993).

In sub-Saharan Africa, the manual ram press appears to have the highest chance of success as a rural intervention to initiate small off-farm enterprises, a start for the evolution of more value added domestic activities. Edible oil, generated near the farm gate, and redistributed to households nearby, does not need to have long shelf life-it will be consumed quite quickly. Consequently, the oil needs to be only filtered, not refined, bleached and deodorised. The small-scale rural enterprises have a market niche, complementary to that of the large-scale crushers and refiners, which supply mainly the urban markets. Since on average, 80 percentage of the population is rurally located, the market niche is substantial in volume, and the number of potential rural enterprises is substantial in number.

While the total number of ram presses, in Tanzania as an example, are not sufficient yet to demonstrate a significant share of the national edible oil requirement, they do have substantial singular impact, on the rural economy of the smallholder.

Rurally located, off-farm processing adds value to the produce, and brings direct rural benefits, far more than the former "export" of the oilseed to distant (domestic) industrial installations and the costly redistribution of the co-products back to the rural areas.

Case studies on the profitability and viability of these enterprises

have been documented in Kenya, Uganda, Tanzania, Zambia, and Zimbabwe. The entrepreneur is limited by having insufficient cash supply to enable her/him to purchase enough oilseeds at harvest time so that the enterprise can run year-round. Commercial banks, and their interest and willingness to lend money for such off-farm processing businesses are vital to the process, especially since governments have ceased to administer rural credit.

From the view point of examining international competitiveness, a country has to first assess its niche for the domestic production of oilseeds and the total of their co-products, not of vegetable oil or protein cake separately. National planners will have to decide whether it is more cost-effective to fill national requirements and potential requirements from national production of oilseeds rather than from import of either edible oil or of protein cake.

Next comes the task of determining whether the country has a competitive edge for export of the oilseed, or its co-products to international markets, and the role which smallholder farmers can and will play in that export situation.

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