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Visit by Dr S. Panigrahi to Zimbabwe to present a paper at a Seminar on Decentralised Agro-industries in southern Africa and to monitor activities in Project O0053 and C0633

Dates of visit: 25 November to 5 December 1996.

Project Numbers: R0201/O0053

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Background

1. Many non-governmental organisations have introduced small-scale oil milling technologies in developing countries for extracting cooking oil to meet local demand; a development that also contributes greatly to improving the sustainability of oilseed cultivation as a cash crop by smallholders. In Zimbabwe, the Intermediate Technology Development Group (ITDG) introduced the diesel-powered Tinytech Oilmill, while the Appropriate Technology International (ATI) has introduced the manually-operated ram press. Since these oil milling activities generate vast quantities of oilseed cakes which have, consequently, become available for livestock production in rural areas, the Natural Resources Institute (NRI) has promoted a concept for rural development based on efficient utilisation of these oilcakes.

2. In view of the NGO involvement, ODA's Advisory and Support Commission has part-funded two collaborative projects in Zimbabwe, one between NRI and the ITDG for activities (Phase 1: C0633, 1994-1996), and the other between NRI and the ATI (O0053). The proposed output of both projects are practical recommendations for small-scale livestock producers to improve their production systems.

3. The ITDG-Zimbabwe organised a seminar on 'small-scale decentralised agro-industries' on 28 and 29 November 1996, and invited the author to present a paper based on experiences in Project C0633. The visit was funded by ASC (Project No R0201); however, since the meeting was also to be attended by Mr A Swetman (NRI) and Mr A. deJode (of ATI) who along with the author were instrumental in setting up Project O0053, NRI's Project Manager

(Mr J. Wood) requested the author to participate in meetings with Mr B Mupeta (Head of Henderson Research Station) to review progress and draw up a tentative plan for livestock trials during 1997.

Seminar Proceedings

4. The seminar on small-scale decentralised agro-industries was of regional interest, drawing participants from Uganda, Tanzania and South Africa in addition to numerous Zimbabweans. The topics discussed ranged from the effects of the government's economic structural adjustment policies and minimum wage regulation on small enterprises, to reforms of credit and financial institutions that may encourage the small-scale sector, and specific technical issues that markedly affect the profitability of small-scale milling operations. The seminar was attended by a number of small-scale agro-processors who gave presentations discussing the problems that they encounter in successfully competing with large-scale oil millers and cereal millers.

5. The author's paper (Appendix 1) summarised the socio-economic considerations relating to the market for sunflower seed oilcake generated as a by-product of oil milling, and presented the approach adopted by NRI and ITDG to resolving the constraints through appropriate research and developmental activities (copies of the other papers presented at the seminar are available from the author).

6. The plenary session identified issues on which significant progress was deemed to be necessary for continued development of the small-scale agro-processing industry. Since the price realised by small-scale oil millers on the sunflower seed oilcake by -product is considerably lower (ranges between ZM$ 650-1300 per tonne) than that realised by large-scale soya oil processors for soyabean meal (ZM$ 2500 per tonne), this was considered a vital aspect that required attention. Significant progress had already been made to determine the nutritive value of sunflower seed oilcake produced by the diesel-powered Tinytech Oilmill. However, the support institutions (namely, ITDG, NRI and HRS) were urged to devote greater effort into translating the research findings into practical recommendations that will assist small-scale oil millers and livestock producers in rural areas.

Action Point: Author to hold discussions with ITDG to identify second phase project activities for implementation.

Project O0053

7. The ram press sunflowerseed oilcake poses very different problems to that produced by the Tinytech Oilmill because of the former's considerably higher residual oil content (of concern for dairy feeding systems), and because seed decortication (to improve oil extraction efficiency) but which reduces the fibre content of the oilcake is not an economically viable option (of concern for non-ruminant feeding systems). The nutritive value for different classes of livestock is, therefore, still uncertain. The findings from the current ATI/NRI/HRS project (O0053) will make an important contribution towards understanding the potential use of the oilcakes in local feeding systems.

8. During the visit the ATI consultant and NRI staff held joint discussions with staff at HRS, and a tentative plan for implementing the livestock trials was outlined for Mr J Wood's consideration.

Action Point: Mr J Wood to revise project work plan in collaboration with ATI.

S. Panigrahi
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Appendix 1. This paper is based on work conducted in ASC Project Code: C0633, 1994-1996. The paper was presented at a Seminar on Small-Scale Decentralised Agro-industries, Harare, Zimbabwe, 28-29 November, 1996.

RATIONALE FOR THE DEVELOPMENT OF SUNFLOWER SEED OILCAKE AS AN ANIMAL FEED IN SOUTHERN AFRICA, WITH PARTICULAR REFERENCE TO ZIMBABWE

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Summary

This paper summarises the major factors that have influenced the oilseed sector in southern Africa, and highlights the scope for the development of the small-scale oil milling industry.

The major oilseeds technically well suited to cultivation in the region are soyabean and sunflower, the former being capital-intensive in production and processing while the latter, in contrast, being particularly suited as a cash crop in smallholder farming systems and for small-scale oil extraction. Historically, the high demand for soyabean meal as animal feed has restricted the development of sunflower due to the limited demand for its oilcake (the oilseed residue from oil extraction); this has had a detrimental effect on resource-poor semi-subsistence farmers who grow this crop. However, in recent years the introduction of ram presses and small-scale screw press motorised oil expellers has reduced the dominance of soyabean. Further development of the small-scale sector requires effort to improve the revenue that oil millers derive from sunflower seed oilcake. Technical and socio-economic considerations indicate that the most promising way of achieving this would be for the oil miller to utilise the oilcake by developing integrated operations involving livestock production or by small-scale manufacture of animal feeds for sale locally; these options should prove more profitable than the disposal of the oilcake by sale to large-scale animal feed compounders.

Assisting the small-scale oil milling sector to improve its profitability through better utilisation of the oilcake is a desirable developmental objective not only from consideration of the efficient management of this resource, but also because it generates employment in small towns, increases the incomes of semi-subsistence farmers, and by enabling a higher price to be paid for the seed it stimulates the production of sunflower. Livestock production is also increased from the greater availability of animal feeds in a manner that assists small-scale livestock producers.

Introduction

Although oilseeds such as cotton and coconut generate a number of useful products which, thereby, pose taxing questions in deciding the optimal method of managing these resources, most oilseeds may simply be regarded as dual-purpose in that they provide cooking oil and a high-protein meal for feeding to livestock, with particularly attractive returns in poultry production. However, for small-scale agro-processing industries in developing countries the commercial management of even dual-purpose oilseeds often proves difficult due to lack of well-developed markets.

With increasing demand for livestock products in the urban areas of developing countries due to rising populations and incomes, there is greater awareness of the need for efficient post-harvest management of oilseeds. To achieve this it is essential to develop systems of utilising the residue from oil extraction to maximum financial advantage. This necessitates an approach that considers the oilcake as a genuine co-product of the oil milling operation, not simply a by-product (or even a waste product) that should be disposed of as quickly as possible because it occupies storage space. Efficient utilisation, however, requires the oil miller to be in full possession of information concerning the value of the oilcake in terms of its potential for generating income in different types of livestock production enterprises.

Improving the profitability of the small-to-medium scale agro-processing industries is a worthy developmental objective, particularly when the oilseed concerned is an important cash crop for vast numbers of resource-poor smallholder farmers, as is the case with sunflower in the communal areas of Zimbabwe. Availability of increased numbers of small-scale oil milling operations puts these farmers in a stronger position for negotiating the price they receive for the seeds. These enterprises generate employment in small towns, and since some of the additional profits are inevitably passed on to the farmer, they also increase rural employment and incomes, and provide an incentive for increasing seed production in subsequent years; this in turn, strengthens the relationship between the oil miller and the seed producer to develop a stakeholder economy. Economic development of this nature that improves the efficiency of resource utilisation with significant benefits to the resource-poor farmer is of interest to the governments of developing countries, to non-governmental organisations assisting the rural and urban poor directly, and to international aid agencies concerned with sustainable development.

Oilseeds of major significance in southern Africa

To assess the opportunities available to small-to-medium scale oil milling industries and, in indeed, to determine the oilseed developmental path of a country, it is essential to begin with a consideration of the supply side. The relevant questions here are: (1) which oilseeds can be grown sustainably in a region; (2) what quantities of seeds might become available for processing with current technology and prices; (3) what types of farmers are likely to be supplying the seeds, whether small-scale subsistence farmers growing oilseeds as a cash crop or large-scale commercial farmers, and (4) how the these activities might change over time with the availability of new agro-processing technologies and with any forecast changes in the macroeconomic environment. These considerations are of particular importance in countries with a long dry season where the major constraint on oil millers which limits profitability, at all scales of operation, is the adequate supply of seeds for extraction. In southern Africa, groundnuts, sesame, cotton, coconut and certain other minor oilseeds play important roles in various farming systems, but in terms of the supply of cooking oil to the market soyabean and sunflower stand out as the prominent oilseeds.

It is, therefore, useful to examine soyabean and sunflower cultivation in further detail. Tables 1 and 2 present the results of a soil survey and land evaluation exercise conducted over 15 mapping units in a farming area near Lusaka in Zambia (Chineme, 1992). The study showed that the minimum requirements of soyabean and sunflower in terms of land qualities such as moisture availability, nutrient availability, nutrient retention, oxygen supply to the root zone, land workability and water erosion hazard were similar so that both oilseeds could be successfully grown in eight to nine of the 15 mapping units examined. However, when gross margin analysis was used to ascertain the results of the physical land evaluation, sunflower was found to be unsuitable on all of these units, due to the low price for the seed in the market. The suitability class was consequently lowered from S1 (highly suitable) to Ne (not currently economic). On the other hand, not only did soyabean remain highly suitable on all eight mapping units, it was found to be more profitable than wheat and maize, which are grown primarily as human food.

These findings are likely to be repeated in other similar agro-climatic zones of the region. Soybean's dominance is also exemplified in the data for the marketed output of oilseeds in Zimbabwe (Table 3). Excluding cottonseed (a special case because of its cultivation primarily for textile fibre) soyabean accounted for more than 80 per cent of production until 1985, but saw a steady decline to about 63 per cent by 1992; on the other hand, sunflower production increased during the late 1980s and early 1990s.

Table 1. Land suitability of different mapping units to selected land utilisation types in a farm near Lusaka, Zambia (Chineme, 1992).

Mapping unit	Maize	Soyabean	Sunflower	Wheat	Potato	Rhodes grass
cCn	S3m	S1	Ne	S1	S1	S1
cCu	Ne	S1	Ne	S1	S1	S1
cCus	S3m,na	S1	Ne	S3,na	S3m,na	S1
xCo	Ne	S1	Ne	Ne	S2e	S1
cKw	S3m	S1	Ne	S1	S1	S1
bMi	Nna,m	S1	Ne	S3e	S1	S1
bMif	S2na	S1	Ne	S3e	S1	S1
cMp	S3m,na	S1	Ne	S3,na	S1	S1
bCg	Nf	Nf	Nf	Nf	Nf	S1
xKf	S3m,na,o	S2o	Ne	S3,na,o	S1	S1
fBz	Nm,o,f	Nm,o,f	Nm,o,f	N,o,f	Nm,o,f	S1
fCe	S3o,f	S3o,f	S3o,f	S3o,f	S3o,f	S1
bLo	Nna,o,f	Nna,o,f	Nna,o,f	Nna,o,f	Nna,o,f	S1
cNa	No,f	No,f	No,f	No,f	No,f	S1
fKs	No,f	No,f	No,f	No,f	No,f	S1

Suitability ratings: S1 = highly suitable; S2 = moderately suitable; S3 = marginally suitable; N = currently not suitable. **Nature of limitations**: f = flood hazard; m = moisture availability; na = nutrient availability; nr = nutrient retention; o = oxygen supply to the root zone; e = economic.

Table 2. Gross margins (US$/ha) of land utilisation types for five crops in selected mapping units (Chineme, 1992).

Mapping unit	Maize	Soyabean	Sunflower	Wheat	Potato
cCn	30	65	18	37	437
cCu	21	43	12	26	355
xCo	15	28	7	15	157
cKw	31	67	20	40	444
bMi	15	48	13	26	350
bMif	32	63	16	33	433
cMp	31	56	17	36	411
xKf	25	50	11	31	150

Least Acceptable Margin - US$ 25/ha. Land utilisation type defined according to practices on a high input farm.

Table 3. Marketed output of oilseed crops in Zimbabwe (tonnes).

Year	Cottonseed	Groundnuts	Soyabean	Sunflower	Soyabean (%)[1]	Sunflower (%)[1]	Total seed (*1000)	Total estimated oil equivalent (*1000)
1981-82	127500	16466	65300		80		209	42
1982-83	96700	15585	84400	-	84	-	197	40
1983-84	104840	9378	74400	4700	84	5	193	38
1984-85	155540	5378	89800	11715	84	11	262	50
1985-86	186636	7179	89400	13211	81	12	296	57
1986-87	155890	18143	83400	19849	69	16	277	57
1987-88	140010	14983	102600	23266	73	16	281	57
1988-89	200426	19062	122600	46403	65	25	388	81
1989-90	162085	19578	115800	50700	62	28	348	74
1990-91	116318	17765	105400	44190	63	26	284	61
1991-92	126801	14662	111500	51639	63	29	305	65
1992-93[2]	37200	213	42276	10000	80	19	90	17

1. Percentages calculated excluding data for cottonseed. 2. Drought year. Source of tonnage data: Takavarasha and Rukovo, 1994.

Whilst soyabean does have certain agronomically-desirable features, such as its drought tolerance that is made possible by a deep rooting system and its ability to utilise atmospheric nitrogen through nitrogen-fixing bacteria in root nodules, the relevant factor underlying its dominance in southern Africa is related to the fact that the oilseed is cultivated primarily for use as animal feed (the only cooking oil source that is!) with the oil generated representing the by-product. Lack of alternative high-protein animal feeds in countries without a coastline, which could have been a source of fishmeal (as for example, in South Africa and Namibia), places a premium on soyabean meal because of the high demand for its use in poultry (and to a lesser extent pig and dairy) rations for large-scale intensive production systems. For most feed compounders in these countries it is unthinkable to consider poultry feeds without soyabean meal.

Historically, the cultivation of soyabean for animal feed has had a major impact on the development of the vegetable oil sector, for four reasons. First, being capital-intensive in cultivation soyabean is only suited to large-scale farming so that in Zimbabwe it accounted for 97-99 per cent of the Grain Marketing Board's intake of this commodity in the late 1980s and early 1990s (Takavarasha and Rukovo, 1994). Second, it is not technically feasible to extract oil from soyabeans using simple manual presses or small-scale motorised screw-press extraction machines to meet the quality specifications required for the meal by the animal feed industry. This is because soyabean contains anti-nutritional factors known as trypsin inhibitors that need to be heat-inactivated during processing to render the meal suitable for feeding to non-ruminant animals. This inactivation can only be achieved in capital-intensive heat treatment cum oil extraction and processing operations that are normally only profitable on a large-scale, or by the use of extrusion technology that is also capital intensive. The low oil content of the beans (below 20 per cent) also means that solvent extraction is the most common method of oil milling employed. For these reasons, soyabean processing is highly dependent on imported technology for investment items as well as running inputs such as hexane; this represents a drain on a developing country's foreign exchange reserves. Third, the high profits generated by virtue of the high market price for soyabean meal and the economies of scale achieved in these operations place these operators in a formidable position in the vegetable oil market where they are able to reduce their margins on the sale of cooking oil. This was particularly the case in Zimbabwe where, in the absence of small-scale oil millers, these operators were also able to utilise spare capacity in the plant by processing sunflower seeds procured cheaply from resource-poor farmers in the rural areas; the latter supply 90 per cent of the marketed output of sunflower seeds, the remaining 10 per cent coming from the large-scale commercial sector (Takavarasha and Rukovo, 1994). The solvent-extracted sunflower seed meal so generated was used as cattle feed; however, it was not uncommon for some of this by-product to end up being simply discarded due to insufficient demand. Fourth, soyabean has also been promoted as a source of high-protein food for humans by the development of value-added products such as soya mince. It is, therefore, reasonable to conclude that the promotion of soyabean in developing countries retards the develepment of small-to-medium scale oil milling. This has a detrimental effect on the production of other oilseeds that may be grown primarily for cooking oil by resource-poor farmers, such as sunflower and sesame.

Notwithstanding this disadvantaged competitive position, sunflower persisted in southern Africa because it too is agronomically suited to cultivation in the region, and crucially, it has the necessary attributes for adoption into smallholder semi-subsistence farming systems as a cash crop. Resource-poor farmers prefer sunflower to soyabean because of its low capital intensity in cultivation; it can be grown in small pockets of land in or around cereal fields; and the de-seeded sunflower heads are a nourishing crop residue for feeding to any cattle or goats they may own. In some countries (such as Tanzania) an important factor was the ease with which the seeds could be pressed in rural areas using simple manual devices (such as the ram press) for a local supply of cooking oil which, furthermore, did not require refinement, as is the case with soyabean oil.

To summarise, the facts that soyabean is cultivated primarily for animal feed, is suited by and large to only large-scale farming, and processing is only viable using capital-intensive methods contrasts with the situation with sunflower which is grown primarily as a vegetable oil source, and is suited to small-scale operations in cultivation as well as in processing. The differences in demand for their processing products in different locations may explain why it is quite possible for the two oilseeds to co-exist. However, the depressive effect of the dominance of soyabean on the profitability of cultivating and processing sunflower and other oilseeds is unmistakable. It is also consistent with trends in the world market where soyabean oil accounts for 60-70 per cent of the edible soft oil marketed (FAO, 1994). Significantly, sunflower seed oil attracts a premium in the markets of modern developed countries due to the health benefits of its high content of unsaturated fatty acids. For farmers growing the crop, this partially compensates for the lower value of its oilmeal. In Zimbabwe there is currently no such premium, perhaps because people have acquired a taste for food cooked using soyabean oil as a result of a long period of use without alternatives. Thus, the disadvantage to sunflower owing to the lack of a well-developed market for the oilcake in comparison with soyabean for which there is an excellent market, constitutes a major issue in any consideration of the future development of the oilseed sector in southern Africa.

Market for sunflower seed oilcake

To assess the developmental potential of the oilseed sector in southern Africa, it is necessary to examine the market for the sunflower seed oilcake in some detail. In February 1996, the price offered for the sunflower seed oilcake by animal feed companies in Zimbabwe was ZM$ 1300 (US$ 144) per tonne (bagged and delivered to the company's gate) compared with a price of around ZM$ 2500 (US$ 277) for soyabean meal; the world market prices in 1993 being US$ 133 and 208, respectively (FAO, 1994). However, in some rural areas ram press oil millers may have to accept prices as low as ZM$ 650 per tonne.

The poor price of sunflower seed oilcake is caused by several reasons. First, there is a general impression that the high fibre content of this raw material renders it unsuitable for inclusion at high rates in poultry feeds - potentially the most profitable market for oilcakes in any country. Second, large-scale animal feed compounders (the major commercial outlet for oilseed meals) have complex feed milling operations for poultry feed production, which requires reliable and regular supplies of large quantities of different feed raw materials. The production process is not conducive to frequent changes of feed ingredients, which causes disruption and involves the company in additional costs related the maintenance of feed quality. Changes are, therefore, tolerated only when unusual raw materials are available at 'knock-down' prices. This is particularly the case when the raw material concerned is what might be termed as nutritionally-unconventional and is variable in composition from batch to batch, as is the case for sunflower seed oilcake. Furthermore, the current low state of development of the small-scale oil milling industry in southern Africa results in supplies to the feed mill being haphazard, so that an oil miller cannot expect to receive a 'fair' price in relation to the potential value of the oilcake, as measured, for example, by what it might be worth to a poultry producer mixing his own feeds. Third, due to its high content of unsaturated fatty acids, sunflower seed oilcake from small-scale oil expellers and presses are prone to fat deterioration during storage, which renders the feed unpalatable to livestock. Its soft kernel also renders it vulnerable to fungal attack pre- and post-harvest, resulting frequently in contamination with mycotoxins, which depress animal growth performance and may even cause mortality. These factors deter large animal feed companies, who for operational reasons may occasionally need to store feed. Fourth, in the absence of effective competition in the animal feed industry, the oil miller has no choice but to accept the price offered. This in turn raises the question of whether there is scope in Zimbabwe for the development of new small-scale animal feed enterprises that can successfully compete with the large animal feed companies in producing and supplying finished animal feeds.

It is relevant at this point to refer to two forecast changes in the macroeconomic environment in Zimbabwe which may affect decision-making in oilseed cultivation, oil milling and animal feed production activities. First, the economic structural adjustment policy being pursued by the government may lead to lower domestic prices for cooking oil as a result of the import of cheap vegetable oil. In such an eventuality the major threat to small-scale oil millers should come from imported palm oil, the world market price of which fell dramatically relative to soyabean and sunflower seed oils since 1993 (FAO, 1994). Second, if the government proceeds with the planned lifting its ban on soyabean exports, this could also affect relative prices in the domestic market, and hence, economic activity in the agricultural sector.

Recent developments in small-scale oil milling in Zimbabwe

Until recently, the vegetable oil industry in Zimbabwe was dominated by industrial scale plants which used a combination of screw-press expelling followed by solvent extraction of soyabeans and sunflower seed. These processing plants were located in the urban areas to which oilseeds had to be transported from the growing areas. Demand for the oil in the urban areas was high with the result that rural areas were often under-supplied and the price of oil was high. The low price offered for sunflower seeds by these processors was detrimental to a large number of resource-poor farmers and, significantly, did not provide them with the incentive needed to increase seed production by, for example, the use of high oil-content hybrid seeds and fertiliser inputs. The situation has been ameliorated since the mid-1980s, as reflected in the figures for marketed output (Table 3). This has been due at least in part to the introduction of small and medium scale oil milling operations in selected areas of the country, with the consequence that farmers now have a market option for their seeds. The decentralisation of the oil milling industry has been led by the Intermediate Technology Development Group's (ITDG) 'Tinytech Oil Mill Project' (see Sunga and Whitby, 1995 for a recent appraisal of this project) and the Appropriate Technology International/Zimbabwe Oil Press Project's 'Ram Press Project'. These developments have clearly exploited a market opportunity, and the continued proliferation of the oilmills and presses, particularly in the absence of a good market for the residual oilcake, is an indication that the opportunities have still not been exhausted.

When considering the future development of the small-scale oil milling sector, it is important to recognise the inter-dependence of the small-scale farmer supplying the seeds on the one hand, and small-scale oil millers on the other. The efficiency and profitability of this system may be improved by adopting an integrated approach comprising the cultivation of oilseeds (by contract with small-scale farmers, if necessary), small-scale oil expelling, and poultry production (COSEP) activities. Details of the major technical and socio-economic considerations associated with the COSEP system have been described (Panigrahi, 1995). The activities may be fully integrated in a single operation or only loosely integrated; the precise solution being tailored to individual circumstances. The fully integrated system involves the oil miller in growing sunflower seeds for processing, with additional procurement from local markets, and in operating a poultry production unit to utilise the oilcake.

In Zimbabwe, some innovative Tinytech Oil Mill operators have attempted various systems of integration. One oil miller who also operates a maize mill has developed rations that utilise the by-products from both operations (sunflower seed oilcake and maize bran) to feed to chickens for egg production in a nearby poultry house. Another case is that of a commercial crop-livestock farmer who has found it profitable to invest in a Tinytech Oil Mill to process the sunflower seed grown on the farm and any additional seeds procured from small-scale farmers, and to utilise most of the residual oilcake to feed farm livestock. Interestingly, consideration of the economics of the whole farm as the management unit has enabled this farmer to feed the sunflower seed oilcake to ruminants (sheep and cattle) instead of poultry. These oil milling-livestock systems utilise the oilcake soon after production which not only reduces the storage space occupied, but markedly reduces the scope for storage-related fungal attack and mycotoxin contamination of the oilcake. However, the essential point in promoting integrated operations of whatever nature is that for oil millers to increase profits, they need to find alternatives to selling their oilcakes to large animal feed compounders; this is simply because the price currently offered represents a gross under-valuation of the resource.

Future developments

National agricultural centres, international organisations funded by aid agencies, and private seed breeders have undertaken research programmes aimed at increasing the production of sunflower seed oil by the development of hybrids that yield larger quantities of seed per hectare and/or have a higher oil content. However, the complexities involved in conducting such research and promoting new varieties mean that these activities can only be relied upon to provide solutions in the medium to long term. In the short term, the relevant question is what is the scope for improving the profitability of sunflower seed cultivation and small-to-medium scale oil milling under current market conditions where these oil millers are price takers.

Clearly, an increase in the quantity of seeds that millers process will increase profits from the sale of vegetable oil, and may also assist the miller in negotiating a better price for the oilcake because of the larger quantities that will become available. Throughput can, however, only be increased by (1) inducing a larger supply of sunflower seeds, a situation that is likely only if farmers are offered a higher price (a chicken and egg situation - that is which comes first!); or (2) by securing alternative oilseeds to supplement the processing of sunflower seeds. In this respect, oilseeds such as groundnuts (for cooking oil), macadamia nuts (for salad oil), sesame (for cosmetics and therapeutics) and *Jatropha curcas* and drumstick (*Moringa oleifera*) seeds (for biofuel and other industrial oils) have already been considered in Zimbabwe.
Another possibility for improving profitability would be to maximise revenue from the sunflower seed oilcake through integrated operations involving livestock (such as those described above) that circumvent the need to sell it to animal feed compounders. But what options are available to those oil millers who for various reasons are unable to engage in livestock production? An approach worth considering is for oil millers to develop their businesses by diversifying into animal feed production at a small-scale in order to add value to the oilcake; alternatively, they could encourage local small-scale poultry producers to purchase their oilcake by providing them with advice on how it should be fed to livestock by appropriate blending with other raw materials available in their localities.

Small-scale livestock production

Small-scale poultry and dairy enterprises have potential for meeting some of the increasing demand for livestock products in developing countries. Livestock production is of particular interest to those concerned with sustainable agriculture when it is associated with crop farming. Well-considered dairy and poultry interventions can contribute to farm productivity by, for example, (1) utilising poultry litter as a feed ingredient for any cattle or goats on the farm or as a high-value fertiliser for horticultural crops; (2) utilising cattle manure to fertilise the fields, (3) utilising crop-residues such as maize and sorghum stover, sunflower heads and groundnut hay as feed for farm livestock; and (4, and arguably the most important) providing a source of regular income from the sale of milk, poultry meat or eggs so that farmers are then able to purchase inputs such as high quality seeds and/or fertiliser to increase crop production. The farming system can be further intensified by feeding livestock with agro-processing by-products, such as oilcakes and cereal brans, generated by local small-scale enterprises. This utilisation of rural resources in rural areas would also promote rural development and reduce the drain of soil nutrients, as is inherent in agricultural development that is dependent on large-scale agro-processing units located in urban centres.

Whilst the feeding of cattle with agro-processing by-products is relatively simple and farmers can normally learn the technique that is optimal for their needs quickly (with perhaps some extension guidance, or by trial and error methods), developing a feeding system for small-scale poultry systems is a complex task (as discussed below). The potential benefits in terms of uptake are, however, greater because, in comparison with the larger stock, poultry have characteristics that are particularly suited to acquisition and management by resource-poor and landless farmers with labour and time constraints. For example, poultry have a rapid reproductive cycle so that the time taken to become productive (that is to reach slaughter weight, to begin egg production) is short. Unlike cows, poultry do not require much land and do not consume large quantities of feed. Small-scale poultry units involving up to 150 birds run less of a risk of financial ruin from diseases when compared with the high capital investment involved in owning a single cross-bred or pure-bred dairy cow. In sub-Saharan Africa it is also necessary to consider whether the areas in which small-scale agro-processing activities exist are also tsetse-infested because trypanosomiasis spread by these flies can seriously affect the productivity of certain types of ruminant livestock. On the demand side, there is a much greater consumer demand for poultry meat compared with other meat or milk. Milk, in particular, does not representing an important constituent of the diet of most of the population of southern Africa, except in some urban and tourist centres and areas where pastoral livestock systems are the predominant form of animal agriculture. There is, therefore, considerable potential benefit in assisting resource-poor farmers with poultry rearing activities. Since the use of commercial feeds represents 60-70 per cent of the cost of poultry production, the area where developmental assistance is most required is on the formulation of cheap poultry rations.

Development of poultry rations in accordance with the objectives of increasing the oil millers' profits from the disposal of sunflower seed oilcake and of encouraging adoption by local small-scale poultry producers, underlies the COSEP system of integration referred to above. Clearly, its success depends on market conditions being such as to enable sufficient gains to be realised by both poultry producers and oil millers from the latter diversifying into animal feed production.

Integration of oil milling and poultry feed production: development through research

Integration of oil milling with small-scale feed manufacture is simple in concept, requiring the oil miller to invest in (1) a grinder to mill the feeds (this may not be required if there is a flour mill operating in the locality); (2) a 1 kg balance that can accurately weigh down to 100 g; (3) a balance to weigh up to 50 kg; and (4) a 50 kg mixer (a cement mixer may be suitable). However, as indicated above, it does require a major technical problem to be resolved, namely the development of ration formulae for different classes of poultry (mainly broiler chickens and egg laying hens).

To induce small-scale poultry producers to confidently adopt a ration, it needs to reduce their cash outlay on feeds and generate higher profits from the sale of the poultry meat and eggs than that achieved by commercial poultry feeds sold in the area; this objective necessitates a study of those commercial feeds. The ration formulation objective also needs to take account of the local market conditions for poultry products, for example, whether chickens are sold by weight or appearance of size and on whether there is a premium on certain carcass characteristics. Market conditions in rural areas may sometimes be different to those in the major urban centres where middle to upper classes and tourists represent the major consumers of livestock products. The ration should also be consistent with the production systems of small-scale poultry producers. Development of appropriate rations requires a knowledge of poultry nutrition, information on the nutritional value of each feed ingredient available, and a socio-economic study of the resources and constraints of poultry producers who will purchase the feed. In short, it is necessary to undertake feed developmental research and promotional activities.

It should be noted that the technical difficulties in developing such rations is one reason that feed compounders in developing countries are generally reluctant to change a 'winning formula', whereas such changes are common in developed countries where there is strong competition between feed compounders. This recognises that to maximise profits feed companies consider trade-offs between developing poultry rations that are nutritionally ideal (for maximal production) and that which is practical in relation to the marketing of large volumes. For example, in Zimbabwe a 42 per cent crude protein broiler concentrate is retailed with the advice that it should be mixed with maize at a ratio of 2:3 for the starter phase (0-3 weeks of age) and 1:2 for the finisher phase (4 weeks to slaughter). This feeding regime is not ideal in terms of providing the right balance of nutrients required by chickens at different ages to maximise growth performance overall. However, it is convenient for marketing in rural areas where farmers may prefer to use their own maize (when a surplus is available), or that purchased from the local market where maize is generally cheaper than it is the major urban centres in which the major feedmills are based. Marketing a complete broiler ration in rural areas would also require the cost of handling, mixing and transporting this additional maize along with the associated production and marketing margins to be included in the price of feeds; this would deter many small-scale rural producers from buying the feed.

The technical difficulty of developing rations is compounded in the case of sunflower seed oilcake because of its high-fibre content, which nutritionists are trained to believe renders the material unsuitable for feeding to poultry at high dietary inclusion rates. The situation is further complicated by the fact that (1) there are currently two types of sunflower being grown in southern Africa, the traditional open-pollinated varieties with a very high fibre and low oil content, and hybrid varieties with a thinner hull and, consequently, a lower fibre and higher oil content; and (2) the sunflower seed may be partially dehulled by the oil miller to improve extraction efficiency so that the fibre content of the resulting oilcake will be reduced in proportion. Another aspect of formulating animal feeds with sunflower seed oilcakes from small-scale oil milling operations is that these contain a high concentration of residual oil which, again, may vary depending on the extraction efficiency achieved in individual batches, and on whether the seed is double pressed for secondary oil recovery. Although the residual oil content is of considerable advantage in being a source of energy for chickens, it is generally difficult to estimate what nutritionists term the metabolisable energy (ME) value of such materials without conducting research in controlled laboratory conditions. If a reasonably accurate figure for ME is not available, the diet formulated will not be the cheapest possible relative to its production potential. Furthermore, differences in extraction efficiency from batch to batch adds to the uncertainty on nutritional value introduced by consideration of the fibre content. This in turn may lead nutritionists to consider analysing each batch of oilcake and formulating a separate ration; however, such an approach would be highly impractical and unsustainable in those developing country situations in which small-scale oil milling is an important component of agricultural systems.

Consideration of the socio-economic circumstances of poultry producers in the vicinity of the oil mill and the feed ingredients available that are complementary to sunflower seed oilcake in ration formulation are also vital aspects of designing the appropriate formula. This requires a survey of the resources and constraints of small-scale poultry producers and an analysis of all available feed ingredients. In addition to ME, an important component of this analysis is amino acid composition, which requires highly specialised equipment and trained personnel; it is, therefore, not generally available in the countries of southern Africa for routine use by poultry nutritionists.

Collaborative Project

The complexities discussed above explain why it may take a relatively long period of research and developmental activities before practical rations can be developed to assist oil millers in optimally utilising their sunflower seed oilcake. To assist this development, the Government of the United Kingdom, through the Overseas Development Administration's Advisory and Support Commission (ASC) funds, has enabled the Natural Resources Institute (NRI) to engage in a collaborative research project with the ITDG-Zimbabwe and the Henderson Research Station (HRS) in Zimbabwe. The objective of this project was to ascertain the feeding value for poultry of the Tinytech oilmill-expelled sunflower seed oilcake, and then to develop rations that give the oil millers the incentive to either (1) develop integrated oil milling and poultry production systems to utilise their oilcake; (2) produce complete poultry feeds incorporating the oilcake for sale to local poultry producers; or (3) simply provide such ration blending advice to local small-scale poultry producers purchasing the oilcake. The programme is also considering the use of the oilcake for feeding to other livestock, particularly dairy cattle, but at a lower priority. The findings of this research and developmental activities are expected to encourage the development of a local market for poultry feeds, thereby improving the profitability of oil milling and sunflower cultivation.

In view of the uncertainties discussed in this paper, a phased approach was adopted in the work plan. In Phase 1 (ASC Project No C0633, 1994-1996) studies were first conducted in NRI's environment-controlled poultry houses in the UK to determine the nutritional value of the sunflower seed oilcake obtained from a number of Tinytech operations in the field and some of the major raw materials generally available in Zimbabwe. A formal survey of 97 mostly small-scale poultry producers was also undertaken using a structured questionnaire for the typification of small-scale poultry production systems. This study categorised producers according to their objectives in relation to resources available and constraints operating, including an examination of marketing conditions. Based on these studies, tentative practical poultry rations were developed and tested at the HRS. Studies were also conducted to determine the optimal method of using sunflower seed oilcake for ruminant livestock. This was assessed using *in vitro* laboratory methods and an evaluation of practices already adopted by some commercial dairy operations in the field.

The results are most encouraging. These show that it is possible to develop broiler chicken rations incorporating sunflower seed oilcake at 25 per cent to match commercial feeds in growth performance but at a minimum of 18 per cent lower cost to the poultry producer whilst also increasing the price realised by the oil miller on the oilcake (that is the value added to it) by over 100 per cent. ITDG and NRI are, therefore, considering a Phase 2 project in which the objectives will be two-fold: (1) to develop least-cost poultry rations and dairy concentrates using the sunflower seed oilcake generated by a selected number of Tinytech oil millers evenly distributed across Zimbabwe; and (2) to develop a pilot integrated oil milling and animal feed production operation with one of these oil millers. The performance of this integrated operation will be evaluated in terms of its profitability as well as on the effect it has on local smallholder farmers growing sunflower and on small-scale livestock producers.

References

Chineme, V. R. N (1992) Land evaluation using the FAO framework: an example from Zambia. *Soil Use and Management*, pages 130-139. Blackwell, Scientific Publications.

FAO (1994). Market situation and short-term outlook for fats and oils, oilcakes and meals. ESC/Misc. 94/2. Basic Foodstuffs Service. Commodities and Trade Division. Food and Agriculture Organisation of the United Nations, Rome, 1994.

Panigrahi, S. (1995) The potential for small-scale oilseed expelling in conjunction with poultry production in developing countries. *World Poultry Science Journal*, 51: 167-176.

Sunga, I. and Whitby, G. (1995) Decentralised Edible Oil Milling in Zimbabwe: an evaluation report of the Tinytech Oil Mill Project. Intermediate Technology-UK. Myson House, Railway Terrace, Rugby CV21 3HT, United Kingdom.

Takavarasha, T. and Rukovo, A. (1994) A study of Zimbabwe's Oilseed Crops Sub-sector. Final Report. Analysis of the oil crops sub-sector using the production to consumption systems approach (PCSA). Follow up study to the first workshop on agro-industries for PTA Agricultural Division: oil crops, held in Nairobi, Kenya, 16-18 February, 1993; Ministry of Lands, Agriculture and Water Development, Zimbabwe.