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DEVELOPMENT OF PROTO-TYPE MOBILE SEED DRESSING APPLICATORS SUITABLE FOR AFRICAN COUNTRIES

XA/RAF/89/615

Technical report: Findings and recommendations*

Prepared for the Governments of
the Republic of Kenya, Republic of Malawi, United Republic
of Tanzania, Republic of Zambia and the Republic of Zimbabwe
by the United Nations Industrial Development Organization

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* This document has not been edited.

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1. ACKNOWLEDGEMENTS

Numerous people assisted in one way or the other to bring this project to fruition. To all of them in Vienna and the five PTA countries visited, (Zambia, Zimbabwe, Malawi, Tanzania and Kenya) the authors extend their sincerest gratitude for their assistance during this mission.

2. SUMMARY

This preparatory assistance assesses the situation of plant protection and seed dressing technology in five countries in the PTA subregion.

In particular, it assesses the existing capacities and capabilities of agricultural and engineering institutes to participate in R & D programme including design, fabrication and testing of a mobile seed dressing applicator.

The development of this applicator could be undertaken through collaborative R & D between countries in the PTA subregion and a developed country. This R & D will also result in the development and upgrading of skills of technical personnel in operation and maintenance of the mobile seed dressing applicator in addition to the production of a report containing description of the R & D work, together with techno-economic analysis and data on field trials conducted in selected PTA countries.

3. INTRODUCTION

The Preferential Trade Area (PTA) of Eastern and Southern African States is the largest subregional economic cooperation arrangement in the African region. It embraces a subregion comprising 20 countries with a total population of approximately 180 million.

The ultimate object of the PTA is the restructuring of the national economies and achieving accelerated self-sustaining and self-reliant development.

There are six main activities in the PTA's current programme:

1. Promotion of intra-subregional trade in commodities originating in the subregion, and creation of institutional mechanisms including monetary arrangements for facilitating intra-subregional trade.

2. Inter-country cooperation and specialisation in the nationalisation of existing national excess capacity and high cost industries, and the development of basic and strategic industries, using agricultural raw materials and minerals that are produced within the subregion which are now exported to developed countries for the production of consumer goods, capital and intermediate goods that will be traded among the PTA member states.

3. Inter-country cooperation and specialisation in agricultural development with particular emphasis on food security and production of staple food crops, livestock and fisheries; and on cooperation in the field of research in these subregions.

4. Cooperation in the improvement of existing inter-country transport links in all sub-sectors and where necessary, creation of new inter-country transport links to facilitate intra-PTA trade and economic integration of the countries of the subregion.

5. Cooperation in the development and exchange of technical and professional skills, including the creation of subregional consultative services in key sectors, based on skills available in the subregion.

6. Cooperation and collective action in the mobilisation of financial and material resources both from within and from outside the subregion for the implementation of PTA projects, identified and prepared by PTA governments, businessmen and development agencies; acting in concert.

The member countries of the PTA are Angola, Botswana, Burundi, Comoros, Djibouti, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.

The Agricultural Sector

The countries in the PTA of Eastern and Southern African States are characterised by low income per capita. They are mainly agricultural countries producing such crops as maize, wheat, soyabean, cotton, sorghum, coffee et al. Food production for a whole decade 1976 - 1986 was only about 1.5% per annum at a time when population growth in the subregion was increasing at an average rate of 2.5% per annum. The low agricultural productivity aggravated by drought, pre and post harvest losses has reduced the subregions's food self-sufficiency ratio and volume of agricultural raw material inputs to industry.

The Industrial Sector

The PTA subregion's industrial sector is at a low level. The development of the metal and engineering industries sector within the PTA region like many developing nations, is constrained due to a number of ratios:

1. The small domestic market
2. Relatively under-developed engineering sub-sector
3. Unavailability of all the necessary resources
4. Lack of skilled(indigenous) manpower

The PTA's largest and only integrated steelworks is the Zimbabwe Iron and Steel Co. Ltd. (ZISCO) at Redcliff, which is equipped with blast furnaces and oxygen converters with production capacity of 850,000 tones per year. There are 8 plants in the subregion which operate scrap-based meltshops for producing billets and/or ingots and sections.

Because 12 steel plants in the subregion are re-rollers and because the general tendency is to build rolling capacity in excess of what can be fed from their own billet/ingot capacity, the aggregate subregional rolling capacity of 1.72 million tones exceeds the liquid steel capacity by 57%.

If steel mills and rollers operated at maximum capacities, the PTA subregion would import billet/ingots of the order of 50% of local production. However, the national rolling mills have been running at well below capacity averaging about 30% of installed capacity. Thus imports of billets average about 0.8 million tones p.a.

The factors responsible for under-utilisation of installed capacity include:

1. Lack of spare parts
2. Lack of skilled manpower
3. Lack of foreign exchange to purchase feedstocks and spare parts

4. Shortage of scrap for those mills which make their own ingots or billets from meltshops based on scrap

Technical assistance is being provided by UNIDO and the Commonwealth Secretariat. Studies carried out indicated the manpower requirements and local training facilities .

The PTA has completed an exercise involving in depth studies for the rehabilitation and rationalisation of existing national steel plants. Remedial measures were implemented on the spot, where possible ; but a major rehabilitation programme still remains to be carried out.

The need for regular in-plant training courses tailor-made to suit the requirements of the industry were demonstrated after such training programmes were undertaken at ZISCO with the technical assistance provided by the Governments of Austria and Britain through UNIDO.

Metal forming and fabrication is, in general, well developed, although metal forming requires proper tooling equipment especially for high accuracies. As with many sectors of developing nations, most of the PTA countries need technical assistance and skilled manpower to exploit facilities and meet local demand on a commercial basis.

Whilst the subregions large-scale farming community has benefited from the use of heavy tractors and other large implements, small-scale farming, which accounts for the bulk of agricultural production, has lAgged behind in farm mechanisation. Many of the small-scale farmers operations are still undertaken by hand, making them labour intensive and tedious. Priority is accorded to the manufacture of hand tools, simple manually operated machines and animal drawn implements. However, productivity is 30% of installed capacity due to a number of reasons:

1. Domestic manufacturing units continue to depend on imports of raw materials, semi-manufactured inputs, machinery, equipment and spares. Imports of all these items can be restricted due to the acute scarcity of foreign exchange experienced in some subregional countries.

2. The inability to substitute locally available raw materials for the imported production inputs.

3. Poor industrial maintenance leads to plant and equipment in most industrial units experiencing frequent breakdowns and remaining shutdown due to lack of spares.

4. Little export promotion by domestic manufacturing units to alleviate their foreign exchange problems.

The production of pesticides may be broadly differentiated into the manufacture of active ingredients and the formulation of usable compounds by blending of solution with carrying agents, such as dust, wettable powders, or emulsifying agent. Most countries rely on importation of all pesticide material. The only subregional pesticide production plants are in Zambia and Zimbabwe, both producing approximately 2,000 tones of copper-oxychloride between them. Again, foreign exchange to purchase inputs is a limiting factor.

The rest of the subregions pesticide industry includes formulation plants with a total capacity of 36,500 tones per annum, relying on imports for supply of active ingredients and carrying agents. Promotion of production and application of pesticide is being undertaken in conjunction with research into development of resistant varieties, biological control and cultural practices.

PTA PLAN OR STRATEGY FOR AGRICULTURE SECTOR AND AGRO-ALLIED INDUSTRIES SUBSECTOR

Agriculture and food production have been accorded the highest priority in view of the need for the subregion to attain self-sufficiency in food. For the majority of PTA countries, agricultural commodities remain despite continued worsening terms of trade, dominant export items and carriers of foreign exchange, and above all, the major source of supply of basic foodstuffs and employment to both rural and urban populations.

The PTA plan for agriculture and agro-allied industries include the following *inter alia*.

To intensify production of each of the staples in the PTA areas most suited to their growth with regard to climate, agro-climatic factors and soil conditions.

To strengthen tne capacity of the countries to intensify production of the respective crops. This will entail intensification of the use of potential land by increasing the level of various material inputs and higher use of fertilizers together with improved seeds and rational use of pesticide made available with the necessary back-up of research and extension services to both small and large holder farmers, and training of relevant manpower to develop the necessary technology and implement the various programmes. Research programmes at National Universities should be integrated with those of the identified national research centres. The development of integrated pest management strategies which combine control techniques such as resistant varieties, cultural practices, introduction of natural predators and parasites and low selective use of chemical pesticides. A subregional project on prevention of food losses is to be undertaken to strengthen national capacities to process and preserve important food commodities.

Thus a number of programme aimed at developing production of chemicals and fertilizers, agricultural machinery and food processing and agro-allied industries have been identified for promotion through coordinated effort at the subregional level. Priority is accorded to the reduction of pre and post harvest losses.

The development of appropriate technological packages is being encouraged, involving as much as possible the utilisation of locally available raw materials and processing facilities.

Current PTA fertilizer consumption is 1.3 million tones per annum. This is expected to rise to 1.8 million tones per annum by 1995. It is envisaged that the development of a viable chemical and fertilizer industry would stimulate the development of agriculture, industry and other sectors whose viability could not be assured using imported chemical inputs.

With regard to agricultural machinery, priority is accorded to the manufacture of hand tools, simple manually operated machines, animal and tractor drawn implements, and simple power operated machines.

The PTA plan for industry

In terms of the metal and engineering industries, the primary objective is the implementation of a metallurgical industry capable of supplying the vital raw materials necessary in the industrialisation process.

It is against this background that the PTA member states have adopted the following strategy for the development of a PTA iron and steel complex.

To rehabilitate and rationalise existing national mills including utilisation, to the maximum extent of feedstocks from ZISCO.

To produce sponge iron to supplement scrap as feedstock for the meltshops to produce billets for the national rolling mills.

To develop other integrated iron and steel plants as and when it becomes feasible.

The immediate objective is to promote coordinated and integrated subregional projects for manufacture of machine tools, agricultural machinery and equipment, tractors, commercial vehicles, local transport equipment and spare parts. It is envisaged that these activities will eventually lead to rationalisation and integrated development of the engineering industries.

PROJECT JUSTIFICATION

Problem to be addressed; the present situation

The development of agro-industries is critical to the sub-regions attainment of self-sufficiency, however, efforts should be made to reduce pre and post harvest losses from pests and diseases which currently reduce food availability by 30-40% or more. Grain losses on its own may amount to over 2 million tonnes per year and exceed grain imports by several hundred thousand tonnes.

Many of the common crops such as maize, wheat, sorghum, barley, groundnuts, cotton, beans and vegetables in the subregion are prone to seed and soilborne pests, in addition to post emergent pests and dieases. Each crop is subject to about a dozen or so serious diseases and pests, some of which may cause the complete crop loss in some areas, nationally, or even regionally.

Fungi, bacteria, wireworms, rootworms, aphids, corn maggots, birds, nematodes and termites are some of the common pests for which seed dressing can be a useful method of protection. In general, farmers rely on pesticides which are usualy imported by chemical companies in ready to use forms, with the exception of copper-oxychloride which is manufactured in countries like Zambia and Zimbabwe. The demand for pesticides has been increasing at an alarming rate and since the development of the pesticides manufacturing industry in the subregion is in its infancy, valuable foreign exchange will continue to be spent on the importation of pesticides from the developed countries. In addition, since in some countries there is inadequate knowledge of the type of pesticides to be used, their quality, toxicology etc. pesticides are often misused by many in the rural farming community. In some countries the indiscriminate use of pesticides has led to pests developing resistance to pesticides and the breakdown of cropping patterns. Pesticide misuse can kill natural enemies (predators and parasites) of pests causing pest resurgence and infestations by formerly uneconomic secondary pests. Pesticides are also potential hazards to human and environment when farmers are untrained in the safe use, handling and application of pesticides. It therefore seems necessary that the small and medium scale farm holders will have to depend on an alternative and more efficient method of protecting crops from pests than blanket spraying.

Seed dressing over the years has proved to be one of the most effective and economic methods of plant protection. Wide varieties of fungal and bacterial diseases such as mildews, rusts, bunts, smuts, blasts and blights could be controlled in addition to a number of soilborne insects, nematodes and even birds.

Destruction of seed or seedling by pests and diseases may result in a plant stand that is insufficient to give an economic crop and in some instances there can be almost total crop failure. Also with seed dressing, smaller amounts of pesticides are used than when applied to furrows or broadcast, thus minimising pollu-

tion. Thus seed treatment as an important component in an integrated pest management strategy will be a formidable approach in Africa.

Seeds are treated for the following reasons viz. to minimise yield loss, to promote good seedling establishment, to maintain and improve quality and to avoid the spread of harmful organisms. Apart from seedborne and soil-borne organisms, pathogens and pests that attack the plant at a later stage of growth are also targets of attack from seed treatment.

Protection thus given at the early stage of growth of the plant, against these soilborne pathogens and pests thus promoting good seedling establishment is considered to be a healthy cost-effective pest control method, since they are cheaper, easy for the grower to use, and only small amounts are usually used.

For the seed dressing Kaptasan F, the insecticidal component, fenitrothion, is used at a rate of 0.4 g/ha, and the fungicidal component, thiram, at a rate of 32g/ha for maize.

In addition since these small amounts of pesticides are localised, their effects on non-target beneficial insects and soil micro-organisms are minimised.

Seed treatment is being carried out on an ad hoc basis in Africa. In the countries where this is being done e.g. Tanzania, Malawi and Kenya, the farmers have to depend on one or two suppliers for treated seeds and very often have to travel over long distances to get them. The applicators used, however, are mainly imported and not specifically designed for the traditional applications of plant protection products. Usually the physical properties, especially the shape, surface area, nature of the seed(whether it is smooth, hairly, wrinkled or hard) often determine the type of seed dressing methods to be used. The machinery used could, therefore, be sophisticated or simple, multiple or single application depending on the characteristics of the seeds.

It is proposed to carry out a research and development programme in developing viable prototype mobile seed dressing applicators which could be tested in many parts of Africa for their viability in supplying treated seeds to farmers living in places far removed from towns and cities. The project would take into consideration R & D work already tried in this area (lab. seed treaters and mini rotostats), quality of seed dressing being carried out, workers's safety, precautions being made for waste disposal etc.

However, before embarking on such a project, it is deemed necessary to assess the present situation in selected countries in the PTA subregion, in particular, the existing capacities and capabilities of some agricultural and engineering institutes. With a view to determining whether such institutions could be directly involved in the research and development programme and actually fabricate the design and develop mobile seed dressing applicators. Examples of such institutions are International Centre of

Insect Physiology and Ecology (ICIPE), the Tanzania Engineering Manufacturing Design Centre, The Kenya Institute of Technology and the Centre for agricultural Mechanisation and Rural Technology in Arusha (CAMETREC).

Thus two consultants, one biologist (Team leader) and one engineer were appointed by UNIDO to conduct a 1.4 m/m preparatory assistance as indicated below with duty station in Vienna and travels to Lusaka, Harare, Lilongwe, Dar-es-Salaam and Nairobi.

THE PROJECT

(a) Development Objectives
To increase agricultural production and achieve self sufficiency in food production by minimising the risks of pre-harvest losses due to pests.

(b) Purpose of Preparatory Assistance

i To carry out an initial assessment of the existing situation of plant protection and the seed dressing technology in the PTA subregion with a view to developing prototype mobile seed dressing applicators.

ii To assess the present status of existing agricultural/pesticide research and engineering design institutions in the subregions in terms of laboratory/testing, design and fabrication capacities and capabilities, manpower and staff training, equipment etc., potentials and constraints if any to participate in the proposed R & D work for the development of mobile seed dressing applicators.

iii To identify priority needs in terms of the nature and characteristics of seeds, areas to be covered and type seed dressing applicators that could be designed and developed for widespread use in the subregion.

OUTPUT

1. A comprehensive report containing findings of the preparatory assistance mission with recommendations on the viability of developing mobile seed dressing applicators for the PTA subregion.

2. A draft project document with the corresponding project formulation framework based on the findings of the preparatory assistance mission report and recommendations.

DETAILS OF ASSIGNMENT

Duties: In collaboration with the Director of Industry (PTA) and

Technical Staff/Management of the International Centre of Irsect Physcology and Ecology (ICIPE), The Tanzania Engineering Manufacturing Design Centre, The Kenya Institute of Technology and the centre for Agricultural Mechanisation and Technology (CAMERTEC)

1. Collect review and assess relevant information in the seed dressing technology in the PTA subregion.
2. Assess the importance of seed borne diseases in the region and recommend the type of seed treatment useful especially to the needs of small scale farm holders,
3. Recommend the type of tests that should be carried out to assess the efficiency of seed dressing in the field,
4. Identify safety precautions to be taken during treatment and storage prior to use in the field,
5. Prepare inputs required for R+D work and fabrication of design including costing taking into account the type of work that has already been done in this are both in Africa and outside Africa especially in the developed countries.
6. Assess the training needs of personnel to run and maintain a suitable mobile seed treaer in different in different countries of the region,
7. Prepare a comprehensive report and a draft project document in accordance with the new UNDP format.

Inputs

(a) Government Inputs

The PTA/Govts will provide office accommodation administrative support, transportation and counterpart staff. PTA will also make arrangements for site visit to existing Agricultural Research Insitutes and provide relevant background infomation.

(b) UNIDO Inputs

2 Consultants
Project Travel
Miscellaneous 1/

Follow-up

Upon completion of the preparatory assistance and submission of the report and draft project document, UNIDO (AREA/AFR) in collaboration with IO/T/CHEM will review the report including the recommendations and finalize the project document to be considered for IDDA funding.

1/ This includes typing of report and draft project document in the field.

4. METHODOLOGY

From the duties assigned, a work plan for the various countries to be visited was designed. The mission started at the UNIDO headquarters in Vienna, Austria (2 days briefing), then Zambia (7 days) where the PTA Secretariat is located, Zimbabwe (8days), Malawi(7 days), Tanzania (4 days), Kenya (7 days) and Vienna, Austria(5 days de briefing).

In each country visited discussions were held with relevant Government Ministries, Agricultural Research and Development Institutions, Engineering Institutions, Seed Companies, Agrochemical companies, Universities and other agencies. In addition the PTA Secretariat in Zambia and the ICIPE in Kenya were visited.

Site visits and assessment of agricultural institutions and engineering manufacturing and design institutions were conducted together with a survey of capabilities to undertake research work for seed dressing and other duties in the details of assignment. A draft project document in accordance with the new UNDP format and a comprehensive report were prepared.

5. RESULTS/

5.1 ZAMBIA

Agriculture in Zambia is highly dualistic with a modern, capital intensive sector handled by expatriates and indigenous commercial farmers on the one hand (20%), and a traditional subsistence sector on the other hand in the hands of the majority of indigenous Zambians (80%). Of the 42 million hectares of arable land, only 6.7million hectares i.e. 16% is under cultivation presently. The large scale commercial farmers (800) produce 40% of the maize and 55% of other produce, while the 22,000 medium scale farmers together with the thousands of small scale traditional farmers produce 60% of maize and 45% of the other produce. Subsistence production has concentrated mainly on maize, soyabean, fruit and vegetables while cash crops are mainly sunflower, tobacco, cotton, groundnuts and beans. The official crop estimates for 1984/85 to 1988/89 in terms of area under cultivation is given in table I.

TABLE I - OFFICIAL CROP ESTIMATES 1984/85 TO 1988/89

TOTAL AREA (ha) UNDER CULTIVATION IN ZAMBIA

MAIZE	-	904,873
SUNFLOWER	-	46,507
SOYABEANS	-	21,770
GROUNDNUTS	-	77,590
PADDY RICE	-	12,857
BEANS	-	18,904
SORGHUM	-	51,416
SEED COTTON	-	85,251
V.TOBACCO	-	4,219
B.TOBACCO	-	1,850
MILLET	-	46,313
CASSAVA	-	110,773
RAINFED WHEAT	-	305

The major crops of Zambia and tables of important seedborne diseases and insect pests are shown in Tables 2 and 3.

TABLE 2 - SOME IMPORTANT SEED BORNE ORGANISMS OF RELEVANCE TO ZAMBIA

CROP	ORGANISM	DISEASE
Maize	*Fusarium* spp.	Cob rot
	Diplodia spp.	Cob rot
	Erwinia stewartii	Bacterial leaf blight
	Sclerophthora macrospora	Downy mildew
Wheat	*Ustilago* spp.	Smut
	Tilletia caries	Common bunt
	Fusarium spp.	Head scab
	Helminthosporium sativum	Spot blotch
Sorghum	*Spacelotheca* spp.	Smut
	Claviceps microcephala	Ergot
	Claviceps purpureum	Ergot
	Fusarium moniliforme	Seed rot
Rice	*Pyricularia oryzae*	Blast
	Drechslera oryzae	Brown spot
	Xanthomonas oryzae	Bacterial blight
Sunflower	*Plasmopara halstedii*	Downy mildew
	Sclerotinia sclerotiorum	White rot, stem rot
	Verticillium albo-atrum	Wilt
Cotton	*Aschochyta gossypii*	Seddling blight
	Colletotrichem gossypii	Seddling blight/boll rot
	Verticillium dahlae	Wilt
	Xanthomonas malvacearum	Angular leaf spot
Groundnut	*Aspergillus* spp.	Seed rot
	Fusarium spp.	Seed rot
Beans	*Colletotrichum lindemuthianum*	Anthracnose
	Psuedomonas phaseolicola	Halo blight
	Xanthomonas phaseoli	Common blight
	Bean Common Mosiac Virus	
Soyabean	*Peronospora manshuria*	Downy mildew
	Sclerotinia sclerotiorum	Stem rot
	Phomopsis sp.	Seed rot
	Colletotrichum sp.	Leaf and stem blight
Pea	*Ascochyta pisi*	Leaf spot
	Mycosphaerella pisi	Leaf spot
Onion	*Alternaria porri*	Purple blotch

Lettuce		Virus
Tobacco	*Peronospora tabacina*	Mildew (Blue mould)
	Colletotrichum tabacum	Anthracnose
Tomato	*Corynebacterium michiganense*	
Cabbage	*Xanthomonas campestris*	Bacterial black rot
	Phoma lingam	
Carrot	*Alternaria dauci*	Leaf blight
	Cercospora carotae	Leaf blight
	Alternaria radicina	Black root rot
Cucumber	*Pseudomonas lacrymans*	Angular leaf spot
	Colletotrichum legenarium	
	Cucumber mosaic	Virus

TABLE 3 SOME INSECT PESTS OF SEED CROPS IN ZAMBIA

INSECT PEST	ORGANISM	MAIN CROPS
American bollworm	*Heliothis armigera*	Cotton, tomato, beans, peas, maize cobs, sorghum, wheat, sunflower & groundnuts
Aphids	*Aphididae*	
Armyworm	*Spodoptera*	Lucerne, ground nuts beans, sorghum, maize wheat, tomato, tobacco rice & okra
Bean fly (Bean stem maggot)	*Ophiomyia phaseoli*	Beans (*Phaseolus*)
Beetles (Ladybird)		Maize, wheat, Cucurbits

(Blister beetles or pollen beetles)	Mylabris sp.	Groundnuts,cowpea, beans,pasture legumes & okra
Bugs	Heteroptera sp.	Cereals especially rice, wheat,sorghum & sunflower
Cutworms	Agrostis sp.	Sunflower,wheat, lucerne,cotton tobacco,potato, carrot & cabbage
Diamond back moth	Plutella xylostella	Brassicas
Fruit fly or Melon fly	Dacus sp	Cucurbits
Grasshoppers	Acridoidea	
Leafhoppers	(Cicadellidae) (Jassidae)	Maize,cotton, rice & groundnuts
Mites	Tetranychida	Beans,cotton, groundnts, tomatoes,eggplant & cucurbits
Nematodes or Eelworms	Meloidogyne sp. Heterodera sp. Pratylenchus sp.	Beans, potatoes
Potato tuber moth	Phthorimaea operculella	Potatoes
Stem or Stalkborens	Busseola fusca Sesamia calamistris Chila partellus	Maize,sorghum & Wheat
Trips	Thripidae	Onions,groundnuts, tobacco,lucerne & grain legume
White fly	Bemisia tabaci	Tomato,eggplants cucurbits,tobacco, sunflower,cowpea, sweet potato, cassava

AGRO-ALLIED INDUSTRY

Zambia has a well developed manufacturing industry which has many problems similar to most countries in the P.T.A. subregion. Domestic manufacturing units depend heavily on imports of raw materials, semi-manufactured inputs, machinery, equipment and spares. Imports of all these items are restricted due to the acute scarcity of foreign exchange. The inability or unwillingness to substitute locally available raw materials for the imported production inputs does not help to relieve the problem. Zambia does have sizeble deposits of both iron ore and coal, and it is the P.T.A. strategy to use these deposits to produce sponge iron to supplement scrap utilised in the subsectors few meltshops for the production of billets.

Industrial maintenance is poor leading to frequent breakdowns of plant and equipment in many industrial units, prolonged shutdowns occur due to the lack of spares and replacements. There is, however, an increasing effort in export promotion by the domestic manufacturing units in a bid to alleviate their foreign exchange problems.

There are no steel production facilities in Zambia, heavy cash outlay is required for steel importation and foreign exchange is sold to the highest bidder. Even so, the foundry industry is well established in Zambia and metal forming and fabrication are well developed, although proper toolings are required for high quality precision engineering.

Zambia produces nitrogen fertilizer although none is exported. Nitrogen Chemicals of Zambia Limited produced 101,335 tones of fertilizer in 1986/87, an increase of 270% over 1985/86. The major problem which the company faced was the frequent breakdowns of the plant due to lack of adequate foreign exchange and poor liquidity position. The NCZ complex at Kafue was installed with the financial support of Japan and local financial institutions, the balance being provided by NCZ.

Pesticide production occurs in Zambia at one of only two such units in the P.T.A. subregion, the other being in Zimbabwe. Production of active ingredients is limited to copper-oxychloride, the current production figures for which suggest that output is far from adequate even at low levels of consumption. Total installed capacity for both plants is 2000 tones per annum owing to lack of foreign exchange to purchase inputs. All other pesticides are imported.

To increase production and encourage greater industrial development, Zambia, and most other countries in the P.T.A. subregion, will have to make considerable efforts in terms of domestic production in order to improve capacity utilisation through improved operational efficiency. There is a need to substitute local raw materials for imported inputs, ensure proper mainte-

nance of plant and equipment, and to vigorously promote exports of their production to earn foreign exchange for essential spares and components.

PLANT PROTECTION SITUATION IN ZAMBIA

Many plants in the Zambia are susceptible to a wide range of pests and diseases caused by insects, fungi, bacteria, viruses and nematodes, which attack the plant at different stages of its growth (pre-harvest) and after harvest (post-harvest).

Plant protection in the Zambia is characterised by the awareness of all forms of protection against pests and diseases, and most forms are practised to some extent. At the Ministry of Agriculture Research Station at Mount Makulu there is a plant disease and pest clinic which advises farmers on various plant protection strategies.

Plant varieties with heritable resistance to pests and diseases (resistant varieties) are usually recommended. Traditional varieties have evolved over the years with their pests, however most of the commodity research teams of the Ministry of Agriculture at Mount Makulu are engaged in breeding programmes aimed at increasing the level of resistance in several crops against various pests and diseases amongst other characteristics. Other methods of pest control recommended include the provision of good growing conditions such as adequate water, well drained fertile soil, and good management, since plants provided with these can resist pests and diseases better than those without. Good sanitation practices aimed at reducing all possible sources of infection can also go a long way in reducing incidence of pests and diseases e.g. all infested plant materials should be burnt routinely. Weeds, which are sometimes a source of pests and diseases especially of seed crops must be eliminated. Crop rotation is encouraged since they can reduce build-up of fungi, bacteria and nematodes - non-hosts crops tend to suppress build-up of parasite populations while susceptible crops on the other hand increase the population. Clean and graded seeds must be used.

To minimise the ravages of seed and soil inhabiting pests and diseases, seeds are dressed with chemicals, since it is extremely important to avoid seed borne diseases, whenever possible. Seeds are normally dressed with Thirasam M or Captasan (a mixture of the fungicide Thiram or Captan, an insecticide (1% malathion), 1% sodium molybdenate, and a red dye which serves as a warning agent). The insecticide is included to protect mainly against insect storage pests. Sometimes seeds are dressed with Vitavax or Baytan. In Zambia dressing is mostly done by the Commercial Seed Company, Zamseed, or by Commercial farmers to some extent.

Methods used for dressing vary from sophisticated Gustafson imported dressers, and concrete mixers (electrical, petrol or manual), to ordinary tins and plastic bags.

Certified seeds sold by Zamseed are already treated with seed dressing e.g. seeds of maize and wheat, (usually 250g/100kg seed). In addition, biological control using suitable natural enemies (parasites and pathogens) are used especially against the cassava mealybug.

TABLE 4 EXAMPLES OF PEST CONTROL STRATEGIES IN THE ZAMBIA

CROP	DISEASE/PEST	TREATMENT
Soyabeans	Sclerotinia stem decay	Use certified seeds. Rotate
	Bacterial blight	Varietal resistance
	Bacterial pustule	Varietal resistance
Cowpea	Blight (target spot)	Varietal resistance and benomyl deconil,dithane
	Maruca sp.	
	Heliothis sp. (American bollworm)	Azodin,endosulfan or synthetic pyrethroids
	Nematodes	Varietal resistance,rotation
Groundnuts	Crown rot Rosette virus	Seed dressing Insecticide vector
	Wilts	Crop rotation good drainage
Maize (Pests)	Fat John (Dereodus sp.) Diacoderus sp.	Aldrin Furadon(Carbofuran)
	Corn Rootworm	

	(Buphonella murina)	Aldrin
	Cutworm (Agrostic spp.)	Dursban(chloropyrifos)
	Stalkborer (Busseola fusca)	Thiodan(endosulfan) or DDT
	Black Maize beetle (Heteronychus spp.)	Dieldrin
(Diseases)	Maize Streak Virus	Avoid late planting in high rain Choose resistant varieties.
	Cob rots (Diplodia spp.)	No resistance Burn residues & employ crop rotation.
	(Fusarium spp.)	Seed dressing
	Leaf blight (Helminthosporium turcicum)	Varietal resistance. Seed dressing
	Rusts (Puccinia sorghi)	Varietal resistance.
Wheat(Rainfed)	Smuts	Baytan seeddressing Vitavax seeddressing or captasan or
Wheat(Irrigated)	Smuts	
Barley	Smuts	Thirasan
Rice	Stem borers	Carbaryl
	Beetles	Malathion
	Armoured crickets	Cultural practice
	Cutworm	Dursban(Chlorpyrifos)
Sorghum	Smuts	Seeddressings
	Stalk borers	Aldrin or dielrin
	Shootfly	Furadan endosulan & thiodan
	Pink borer	
	Stalkborers	
Soyabeans	Cutworm	Dursban(Chlorpyrifos)

	Looper caterpillar	Thiodan(endosulfan) or sevin (carbaryl)
	Stink bug	DDT
	Cercospora	Benomyl
		Thridan(endosulfan)
Beans	Bean stem maggot	Dieldrin seed dressing
(Phaseolus)	Root rots	Captasan seed dressing

Chemical pest and disease control using various spray techniques including the knapsack, with suitable insecticides, and fungicides exist. In the case of locust and army worm, the Ministry of Agriculture does the spraying free of charge. In the other cases, the farmers undertakes the responsibility. Extension workers assist in disease and pest identification in collaboration with the pest and disease clinic, and if necessary external institutions such as the Commonwealth Mycological Institute (CMI) Kew, UK.

Quite a lot of chemical pesticides from the major chemical groups which can be applied to the soil, seed or crop, are imported into Zambia as shown by the pesticide list of two such companies (Table 5 & 6). The list includes herbicides, insecticides, fungicides, seed dressing and soil fumigants. Only the fungicide oxycholride is manufactured in Zambia.

TABLE 5 SHELL CHEMICALS (Z) LIMITED - AGROCHEMICALS LIST

PRODUCT	
1. HERBICIDES	2. INSECTICIDES
BASAGRAN	AZODRIN 40% WSC
BASAGRAN	AZODRIN 40% WSC
BASAGRAN PL2	AZODRIN 24% EC
BLADES 50 SC	BLUE CROSS
BUCTRIL M	BLUE CROSS
COTOGARD 500 FW	DIMETHDATE 40 EC
DACTHAL 75% WP	DIMETHDATE 40 EC
DUAL 72% EC	DIMETHDATE 40 EC
ERADICANE 6E	DISYSTON 10 G
FARMAROX (ERADICANE)	DURSBAN 4E

GESAPAX
GESAPRIM 500 FW
GRAMEVIN/DALAPON
LASSO 48% EC
LEXONE 75 DF
M C P A
PARAQUART
PRIMAGRAM 500 FW
RAMROD 48% SC
ROUND UP
SENCOR 70% WP
STING
STOMP
TILLAM 6E
TRIFLURALIN 48%
USTILAN G

DURSBAN 4E
FASTAC 10% EC
FASTAC 10% EC
FURADAN 10G
FURADAN 10 G
MALADREX 50% EC
MALADREX 50% EC
MOCAP 10 G
OMITE
ORTHENE 75% WP
PHOSDRIN 24% EC
SUMICIDIN
SUMITHION 2% DUST
SUMITHION 2% DUST

3. FUNGICIDES
BAYLETON 25% WP
BAYTAN 15SD
BENOMYL 50% WP (BENLATE)
BENOMYL 50% WP (BENLATE)
BRAVO 500 FW
COPPER OXYCHLORIDE
COPPER OXYCHLORIDE
DITHANE M 45
DITHANE M 45
FENTIN OH (DUTER EXTRA)
FENTIN OH (DUTER EXTRA)
TRIAZINE 50% (DYRENE)
TOPSIN M

4. SEED DRESSING
THIRASIN M

5. GROWTH REGULATORS
ANTAK (N-DECANOL)
ANTAK (N-DECANOL)
CYCOCELL

6. SOIL FUMIGANTS
METHYL BROMIDE
METHYL BROMIDE
E D B MINIFUME
E D B 4.5
E D B INJECTOR GUN
METHYL BROMIDE APPLICATOR

TABLE 6 GROWELL CHEMICALS LIMITED - AGROCHEMICAL LIST

HERBICIDES

PRODUCT

Alachlor 384EC
Alanex 480 EC
Atrachlor 500FW

INSECTICIDES

PRODUCT

Cabofuran 10G
Diazol 60EC
Disyston 5G

Atrazine 500 FW
2,4-D Amine
48% EC
Gramoxone
MCPA 400 EC
Sencor 70WP
TRIF 480 EC

EDB 92% MO
Fenitrothion 60EC
Methyl Bromide
Mitigan 18.5EC
Monocron 40EC
Acephate 75SP
Thionex 35EC

FUNGICIDES AND OTHERS

PRODUCT

Bayleton 25EC
Baytan 15SD
Copper
Oxycloride
Dyrene 75WP
Nitrophoska/Curafeed
Royaltac
Solubor 20.55SP
Zinc Sulphate

Available on Request:

Dacthal 75WP	Mineral Oil
Dipterex 95WP	Baythroid
Dipterex G	Cycocel
Round up	Dithane M45

In recommending suitable pesticide treatments,the ministry is guided by the Commercial Crop Production Recommendation of the Department of Agriculture. However, pesticides are freely avail able for sale in shops and stores with no legislation in this regard, but the newly-formed association of plant protectionists is seriously addressing this situation in the country.
Seeds stored for consumption are treated with 1% Actellic or Blue Cross dust. Examples of some common pesticides used against various pests are shown in Table 5.

Phytosanitary legislation (International and National) designed to prevent the entry of plant pests and pathogens into Zambia does exist, e.g. the Plant Pest and Disease Act i.e. Chapter 346 of the Laws of Zambia.

Though most forms of plant protection are recognised, large losses in yields are incurred yearly as a result of pests and diseases. This is due to lack of proper use of these methods and their rational implementation. Thus there is great room for improvement in the existing plant protection strategies, so that it can reach the majority of the small scale farmers in the rural areas in an integral form while reducing any deleterious environmental consequences such as the development of resistance to pesticides resulting from irrational use. Also of importance is safe pesticide usage with precautions so that the chemicals do not affect man, his animals , wildlife and plants.

ZAMBIAN SEED TREATMENT

The current seed treatment situation in Zambia is in the control of one large seed company and a number of commercial farmers. This company, Zamseed (Zambian Seed Company Limited), supplies most of the farmers treated maize seed; estimates of total farmers supplied range from 40 to 80%.

Zamseed supplies a comprehensive list of seed products, and has cleaning equipment to match the requirements for the range of seeds sold.

Large scale:
- Air screen machine
- Grading cylinders
- Indented cylinders

Small scale:
- Air screen cleaner
- Specific gravity separator
- Grading cylinders
- Indented cylinders
- Band grader

Large scale machines are used for maize, cereals, etc; small scale machines for vegetable and other low volume seeds.

Chemical application is undertaken at the plant by one of two available methods: purpose built machine or cement mixer. The purpose built machine is a Gustafson S-600 SS stainless steel unit which is mainly used to apply slurries which are metered from an ancillary mixing tank. This machine is to be backed up with an Austrian built "Heide" unit before the next treating season commences. This is to increase treated seed output, and, by mounting the new treater on a lorry chassis, enable the unit to be mobile between seed producing farmers.

Two industrial cement mixers have been adapted to apply liquid and slurry treatments on a batch principle. Running from 3-phase electric motors, eight 90kg bags of seed are loaded into the drum, the chemical is applied as the drum rotates, and after a

suitable mixing time period, the seed is removed via a chute to collection. The system produces a visibly satisfactory result, although no single seed analysis is undertaken on any of the treated seed. Thus, loading deviation between seeds is unknown.

Some seed producing farmers are also contracted to supply treated seed to Zamseed. Only graded seed is treated, thus, only farmers who possess grading machinery are able to treat seed. Treatment is undertaken using cement mixers or farm-made "tumble drums" manufactured from 200L containers.

Treatment is usually Captasan, a fungicide with insecticide component. The 200 litre drum requires a minimum number of 100 revolutions to treat 100kg of maize seed.

The capacity of an ordinary cement mixer is about 120kg of seed per mix and about 400x50kg b gs can be managed in 2x6 hour shifts, applying the minimum recommendation agitation of 3 minutes per mix. The recommended rate of seed dressing per 50kg bag of seed is 75-125g depending on the product. Most growers mix this with half a litre of water. This controls dust production and helps chemical adherence to seeds. There were many safety problems associated with the use of "Vitavax" (broad spectrum fungicide) due to dust.

Other forms of treating equipment include tipping seed and powder together in a bag or sealed bucket.

It is difficult to assess the quality of seed treatment as no analysis of treated seed is undertaken. The treatment is visibly even with no blotchiness although this is not an accurate guide to seed loading.

Only certified seed is treated. Certification is undertaken by the Seed Control and Certification Institute (SCCI) at Mt. Makalu. Seed certification is aimed at maintaining genetic purity of valuable crop varieties at high standards of seed quality. Evaluation of seeds for certification include purity (% by weight), germination (%), weeds no. per kg (highest value), moisture content and defect seeds % by weight (highest value). Seed crops are inspected in the field at all important stages of crop growth (planting, vegetative, flowering, harvest). There has been compulsory certification for maize, soyabean, wheat, sunflower and sorghum seed since 1987.

There have been problems in the past with farmers supplying treated seed to Zamseed which has been overdressed. This affected germination in the field.

Zamseed purchase seed through the Zambian Seed Producers Association (ZSPA), prices are negotiated through the ZSPA and not with individual farmers. During the seed production phase, the SCCI inspect the crop for the required standards; Zamseed acts in an advisory role.

All of Zamseed's agricultural seed products are treated except for soyabean and sunflower. Soyabean is susceptible to germination reduction (phytotoxicity) when dressed, and sunflower is more valuable undressed as surplus can be sold for oil extraction.

Two varieties of non-hybrid maize are marketed and sold by Zamseed (MMV 400+ MMV600). The hybrid varieties are in much greater demand, production cannot match demand for hybrid maize. Non-hybrid maize has been produced in quantities estimated to supply demand but it has not sold and is currently being stored on the premises.

80% of farmers in Zambia are small scale farmers cultivating 1/2 - 1 ha (2-4 limas) each. It is estimated that 40% of seed used in Zambia is treated, it is mainly large scale (commercial farms of 10ha plus and emergent farms of 5ha plus that are supplied. Treated seed is available to anyone who is able to get to the distribution depots. Most small scale farmers are members of cooperatives which help primarily in the marketing of harvested crops, although inputs such as seed, fertilizers and packing materials are also brought in through the cooperatives system. Equipment sharing is not usually a characteristic of cooperative members; some are badly managed. Seed is sold through provincial cooperative unions.

Hybrid maize has a "floury" taste, and it is common for farmers to grow hybrid maize for sale whilst growing indigenous varieties for consumption. Urbanisation leads to acceptance of floury taste so hybrids are acceptable for processing and sale.

Indigenous (non-hybrid) varieties are less susceptible to periods of stress than the introduced hybrid varieties so hybrid maize has a greater "risk-factor" associated with it. The need to buy in hybrid seed each year is also a deterrent to small scale farmers who can regrow indigenous species for a few generations. Bought in treated hybrid seed can be as much as four times the price of farm saved seed especially if treated seed is not available locally.

Thus the reasons for continuing use of farm saved indigenous species seed are:

1) Cost
2) Palatability
3) Less associated risk factors
4) Ability to regrow seed
5) Availability of seed; There is improved access to hybrid seed but it is still not reaching the majority

WASTE DISPOSAL

Current seed waste disposal is not satisfactory. Waste seed and soiled equipment is burned on a site away form urban development and any remaining residue is then buried. This site is govern-

ment controlled and earth moving equipment is used for burial purposes.

Waste chemical and washings from the machinery are deposited straight into the drainage system at the Zamseed treatment plant on Buyantanshi Road, Lusaka,

The Zamseed plant itself is kept extremely clean; the floors are well swept, seed is stacked neatly in areas of access and the machinery is free from chemical spillage. Operators are issued with overalls, gloves and dust masks The actual treating process was not observed, although good agrochemical practice was assumed.

STORAGE

Rural farmers seed storage has remained unchanged for many generations . The practice was to store seed in containers (baskets, bags etc.) in the roof of the house where the smoke from the fire discouraged insect activity. Recent changes in housing and cooking practices have led to the necessity of investigating new methods of seed storage (charcoal used for cooking produces negligible smoke).

Much research has been undertaken in storage of grain for consumption at Mt. Makalu Research Station, using "Acetellic Dust" and "Blue-Cross" insecticidal powders in sealed storage vessels for pest control. Storage of grain for seed is an area of research which is urgently required especially if treated seed is to be stored in the home.

Treated seed presently comes in a variety of polypropylene bags (50kg, 10kg, 2kg maize, soyabeans 15kg(1 ha pack), groundnuts 40kg (1/2 ha pack) Sorghum 10kg (1 ha pack), and others in 15 kg packs), which are labelled with the following information.

1. Certifying agency
2. Reference number
3. Varietal name
4. kind and class of seed

The label also states that the seed is treated with a poisonous substance and should not be used for human consumption or animal feed. There have been various reports of people washing the treated seed in an attempt to remove the dressing prior to cooking and eating the maize. Some believed there had been fatalities in this way. The view of the problem was one of "if people are hungry, nothing will stop them eating".

The idea of the project is to take seed treatment to the rural farmers who, in general, have little education. It is an important part of the project to ensure treated seed is not responsible for casualties and a system must be devised to ensure households receiving treated seeds are aware of the dangers of pesticide abuse, and the needs for careful storage of seed products.

AGRICULTURAL AND PLANT PROTECTION RESEARCH IN ZAMBIA

Agricultural and related research are conducted mainly by the Ministry of Agriculture and Cooperatives, the University of Zambia and the National Council For Scientific Research.
An FAO project on pest management of food legumes in Zambia evaluated the following seed treatments:-
1)Dieldrin 2)Chlorpyriphos 3)Triazophos 4)Pirimiphos methyl and soil placement at planting, 1) Pirimiphos ethyl 2)Carbofuran
All significantly controlled stem maggot damage. Endosulphan as seed treatment (5-10g of 50% WP per Kg seed) compared favourably with dieldrin and was superior to pirimiphos ethyl. It was also more beneficial on plots with fertilizer application and was also highly cost effective. At Mount Makalu Research Station, Chilanga (one of the Research Stations of the Ministry of Agriculture and Cooperatives) near Lusaka, quite a considerable amount of information on agricultural production techniques has been generated and made available to the farming communities as practical recommendations.

Most of the commodity research teams have breeding programmes which include breeding varieties with increased level of resistance to important diseases and pests. In addition various plant pathology and entomology (Plant Protection) research projects are being conducted including biological control of the cassava mealybug. Research is also carried out at the regional research stations throughout the country. Crops of priority include maize, wheat, rice, sorghum, potatoes, soyabeans, cotton, pasture grasses and legumes, tobacco, sunflower, groundnuts, beans, cassava and a range of exotic and local vegetables.

The agricultural engineering section in conjunction with the food conservation and storage unit is undertaking an on-farm grain storage project in which shelled maize is stored in their newly developed solid walled grain storage structure (4 recommended structures). Research on the efficiency of different seed treatments against storage pests using the following are on the way i.e. 2% detamethrin dust (Kaothrin), 2% methacrifos (Damfin Zp) and 1% Pirimiphos methyl(Actellic). Research include seed moisture content determinations, insect pests and damage, seed germination, moulds and insecticide residues.

There is also an on-going project on the design of storage structures for dressed seeds intended for planting.

Also at Mt. Makulu, is the Government Seed Control and Certification Institute (SCCI) of the Ministry of Agriculture, the body charged with the responsibility for testing and certification as well as other declarations concerning seed. The SCCI is com-

pletely independent from plant breeding, seed production and marketing. Its seed inspectors sample seeds produced on the farm and carries out quality testing at the laboratory at Mt. Makalu, to ensure that the prescribed standards are met. The SCCI also has control plots for checking the genetic purity of the seed lots that have been certified. This is in keeping with the government legislation laid down in the Agriculture(Seeds) Act, Chapter 352 of the Laws of Zambia. This Act provides for the regulation and control of seed production, and distribution, and controls minimum standards for purity and germination in a certification scheme. Thus the seed certification system is a means used by Government through its Ministry of Agriculture, for securing production and distribution of genetically pure, high quality seeds of improved varieties. Parameters tested are: moisture content, weight, physical purity, genetical purity, germinability, vigour, viability, reference test, pesticide homogeneity(overloading)and phytotoxcity.

The Mount Makulu Central Research Station has the necessary basic infrastructure for seed dressing research in terms of personnel and facilities. There are basic core staff (plant pathologists and entomologists) and laboratory technicians. In particular, at the plant protection section there are two postgraduate trained entomologists (1 Phd and 1 MSc) and three plant pathologists (2 Belgians(Msc) and 1 Zambian(BSc)). Although these pathologists are mainly attached to a Belgian sponsored project on screening for resistance in sunflower and wheat, they could also participate in a seed dressing project. In addition, there are other plants pathologists and entomologists and agronomists attached to the various crop improvement projects who could also participate in the project if necessary.

At the SCCI, nine qualified staff (1 Phd, 1Msc and 7 Bsc (2 studying for Msc)) , and several technical staff are available.

The on-farm storage project possesses 2 qualified staff and several technicians including a gas liquid chromatography technician (analysis pesticide residues). There is however a need to train 1 or 2 technicians in 1 or 2 specialised areas(1 -3 months).

At the University of Zambia, Faculty of Agriculture, Department of Crop Science and at the Department of Biological Sciences, agriculturally related research is on-going. There are breeding and plant protection projects including breeding for wheat resistance at the Crop Science Department.

In terms of manpower in the plant protection discipline there is 1.5 Entomologist and 1.5 Plant Pathologist in the Crop Science Department and two plant pathologists, 1 Nematologist and two entomologists in the Biological Science Department.

FACILITIES

The relevant laboratories of the Mt Makulu Research Station are sufficiently equipped with the basic facilities. However, some of the equipments are apparently out of order. Repairs have not been done because of lack of spare parts e.g. the Gas Liquid Chromatograph which analyses pesticide residues has been out of order for some time due to lack of relevant spare parts. Consumables such as reagents, solvents, media, disposables, petri dishes etc. are grossly inadequate. Seeds for research purposes are usually supplied by Zamseed free of charge.

Although no research pertinent to seed dressing has been conducted, the University has the basic manpower capabilities to participate in this project - Agronomists,Plant Pathologists and Entomologists. The University has in the past collaborated with the Ministry of Agriculture the NCSR and with Zamseed, thus a similar collaboration will not be novel and would be desirable for this project, if well coordinated.

In terms of equipment, like the Ministry, the University possesses the basic equipments but will require expendables as well and would also require short term training for one (1) technician.

At the National Council for Scientific Research, work on pesticidal plants, resistance of ticks to acaricide and on acaricides from plants is being undertaken. In addition some work on mycotoxin incidence in poultry feeds and on pesticide residues have also been conducted. This statutory body of the government which coordinates research at the National level can participate in the project. Indeed, its laboratory at Chilanga which conducts pesticidal research posses two research personnel with MSc and 2 technicians and basic facilities but would need 1 more technician trained, and consumables for active and fruitful participation.

ENGINEERING DESIGN INSTITUTES

The department of agriculture are actively involved in R & D at Magoye Regional Research Station, especially implement design and maunfacture, both hand operated and animal drawn. Current manpower is 8 engineering staff, 2 Dutch MSc.Ag.Eng., 1 Zambian MSc. Mech.Eng., 1 British BSc.Ag.Eng and 4 Technical staff with Diplomas in Ag.Eng. The department is short of manpower, but between the Ministry and University of Zambia, manpower is sufficient. They are willing to cooperate with the project. although a technician trained in seed dressing technology would be required. Sending one of their technical staff for training in a

developed country for 3-6 months would be adequate.

The actual workshop facilities are limited and they are certainly not capable of fabrication in numbers; however, the testing of the machine in the field presents no problem.

The department already collaborates with number of commercial companies including LENCO (Lusaka Engineering Co.) SKF Zambia Ltd. and Northlands Engineering Ltd who have a prototype drum mixer seed dresser for use with powder applications.

One of the biggest drawbacks that the Agricultural Engineering Section has found in relation to the local manufacturing of agricultural tools and implements is the fact that imported finished agricultural implements are exempted from both duty and tax whilst raw material which is going to be used for manufacturing similar implements is not. This has resulted in locally manufactured implements being more expensive, hence a tendency of depressing local manufacturing.

The AES aims to research, develop and carry out extention work into appropriate rural structurs and devices which are designed to alleviate peasant and small scale farmers workload. The chief areas of involvement are mechanisation (manual, animal draught and tractors). farm structures (animal housing, crop storage,seed storage and human dwellings), storage and processing and village workshops (blacksmithing, carpentry, leatherwork and masonary).

The department works in conjunction with UNZA - TDAU (Technology Developemnt and Advisory Unit), School of Agricultural Sciences, Church Organisation, local manufacturers, private farmers, etc. Finance, technical expertise and advice come from SIDA, the Dutch Government, GTZ and NORAD. There is also limited support from the FAO/SIDA cooperative programme.

The School of Agricultural Sciences at the University of Zambia recently introduced a course in Agricultural Engineering leading to a B.Eng degree. The first students, ten in number, graduate in the 1989-90 session. The final year is applied agricultural machinery design. Other topics include agricultural machinery and power, structures, soil and water, surveying, earth moving and food processing.

The department has a small infrasturcture but collaborates and communicates with other faculties on the campus. There are five staff at present, another member joining in September 1989 to bring the total to 2 Ph.D's and 4 MSc's. There is nobody specifically trained in aspects of seed dressing technology, if the project were to be undertaken at the University, a technician conversant with seed treatment techniques would be necessary.

The department does already undertake research work; projects include a millet harvester using bicycle components, the developement of a de-huller in conjunction with SIDO in Botswana

and yoke development for animal draught. Currently consultancy work is being undertaken in the form of technical back-up to a Dutch project in land and water management controlling water level for paddy.

Fabrication facilities are excellent using the Engineering Faculties workshops which are manned by trained technicians who are involved in project prototype manufacture. A foundary is being incorporated into the workshop facilities which should be operational by 1990.

Engineering companies such as Gomeko and Northlands are already working with the department usually on an informal basis. For the project, collaboration with other University departments would overcome shortages in manpower (full staff strength should be nine), the designing could be shared with the Mechanical Engineering section which has excellent design facilities: draughtmen, AUTO-CAD and Lotus 1-2-3. The Mech.Eng.Dept. has five PHd. staff and one MSc. A 2-3 man design team is available for project work.

Metallurgical problems i.e. the interaction of the machine components with the seed treatment chemicals could be investigated by the School of Mining who are on campus. The University recommended that commercial companies should not be involved in the R & D section of the project,since profit is the primary concern of such companies. Final fabrication in number will have to come from commercial industries since material stocks on campus are limited, especially sheet steel.

Communications between institutes within Zambia is very good; however, inter-region collaboration between P.T.A. member states is difficult. The project could be undertaken in collaboration with the engineering faculties, crop science, Mt. Makulu Research Station, the SCCI, NCSR etc. Field trials could be undertaken at Mt Makulu, seed treatment analyis could be handled by the SCCI on the same site. There will be a need for an expert in field on the project. The crop science department at the University of Zambia already work informally with Zamseed. Although there is no official link, they are invloved in the wheat programmes research through varietal development. Communications between the University faculties, the Ministry of Agriculture and NCSR are good and they are willing to collaborate. The processing and storage manager at Zamseed, Mr Bo Hermannson is interested in evaluating any prototypes produced.

5.2 ZIMBABWE

Zimbabwe with a population of 8,200,200 and a growth rate of 3.0 percent in 1985, is bordered by South Africa on the South, Mozambique on the East, Zambia on the North and North West and Botswana and Namibia on the West. The land area is approximately 390,000 sq.km. About 56% of Zimbabwe's population consists of peasants who live in communal areas while 23% live in urban areas. Communal areas however account for 42% of the total land area. Only 25% of this land is suitable for intensive farming. Agriculture provides more than 90% of the food requirements of Zimbabwe and accounts for 41% of total merchandise exports.

Thus agriculture is an important sector in Zimbabwe. Approximately 75% of the total population derive their income from agriculture, which is rather complex, largely due to the agroecological diversity of the country. This sector is delineated into three distinct groups of producers - the large-scale white commercial producers (4,500 farms) utilising 15 million hectares under freehold title, cultivating maize, tobacco, cotton, wheat, coffee and soyabean. The other group is comprised of 8,500 small-scale African commercial farms on 1.5 million hectares under tenancy and freehold title. The farming systems and crop rotations in these are similar to those in the larger scale commercial sector, but the area under cultivation is considerably reduced and yields are lower. Thirdly, 850 - 950,000 African smallholders family farms exist on 16 million hectares in the communal areas based on traditional rights assigned by local chiefs. Over 70% of the rural population live in this area. Yields of crops in this area are generally low. Present government policy is to eliminate the pronounced segmentation of the agricultural sector, hence, although slow, resettlement of African smallholders and landless people on commercial farms is the main policy initiative in Zimbabwe.

Zimbabwe's major agricultural commodities are maize, tobacco, cotton, groundnuts, wheat, soyabeans, sorghum, sunflower seeds, coffee, sugar, milk and beef. The bulk of all marketed products and exports comes from the large commercial farms, however government is presently initiating policies that will give the communal farmers a more important role in marketed crop output especially cotton and maize.

The major crops of Zimbabwe i.e.
Maize,wheat, rice, sorghum, millet, barley, groundnut, soyabean, sunflower, cotton,vegetables (beans i.e. Phaseolus) cowpea, fruit, coffee and tea, are attacked by a large number of seed and soil borne diseases and insect pests.

The manufacturing industry is seen as the key sector for changing the productive structure of the Zimbabwean economy as well as for achieving rapid and sustained overall economic growth and development. To achieve this, there is active promotion in the development of an indigenous technological capability. The industrialisation strategy of the National Development Plan is based on the long-term objective of using locally produced raw materials in production.

Metal farming and fabrication industries are very well developed in Zimbabwe, second to that of the RSA in the region. There are numerous private companies capable of high precision engineering, the limiting factor is metal availability and cost. The foundry industry is well established. Forging and heat treatment facilities are available, but mostly for captive use. Although facilities for the manufacture of moulds and dies do exist, the industries that manufacture these do not produce them on commercial basis for want of skilled manpower. There are approximately 200,000 salaried workers in the manufacturing industry representing 8% of the total labour force. Future industrial development will require more skilled manpower at all levels of operation.

The only integrated iron and steelworks in the PTA region is located in Zimbabwe and combined with local rolling mills, bar and sections are produced for export and local use. ZISCO is among the country's leading exporters, 84% of the steel produced per annum is exported, only 16% is currently absorbed by the local market. The plan is to increase local share and utilise ZISCO products in manufacture of various machinery as well as greater use of these products in the construction of large scale industrial projects. This will allow for the maximisation of both forward and backward linkages in the capital goods sector as local engineering companies provide part of the machinery required for ZISCO's refurbishment and new downstream industries are set up to manufacture steel sheet plate, stainless steel, tin-plate, special steels, machine tools, etc.

Local production of fertilizer from ammonium nitrate supplies Zimbabwe's fertilizer needs. Two companies, the Zimbabwe Fertilizer Company (ZFC) and Windmill Zimbabwe, have 60% and 40% of the market respectively and exports are supplied to Zambia, Malawi, Mozambique, Angola and Burundi. Fertilizer is price controlled. The basic nitrogenous compound is supplied by Sable Chemical Industries and, formulation of the finished product is undertaken by the ZFC and Windmill. Pesticide production is limited, relying on importation for all commodities except copper oxycholride which is produced in quantities to fulfil local requirements.

PLANT PROTECTION IN ZIMBABWE

In Zimbabwe, the Plant Protection Research Institute of the Research Services Division in the Department of Research and Specialist Services of the Ministry of Lands, Agriculture and Rural Resettlement, is charged with the responsibility to conduct research on pests and diseases affecting agricultural crops. The main fields of research are entomology, plant pathology and nematology. In addition it provides phytosanitary services, a free advisory service for farmers and other interested bodies, and conducts pesticide screening and registration in addition to performing regulatory functions concerning plant pests and diseases. It also has an insect rearing and a virus unit.

All aspects of plant protection are practised from sanitation to biological control, as in Zambia.

Seeds in Zimbabwe are usually dressed with a slurry of Kaptasan (the fungicide captan 31.35%, an insecticide, fenitrothion 1%, and inert material, 67.65%) by the seed company, Seed Coop. Kaptasan occurs in three different formulations (1) Kaptasan Super, (2) i.e. (1) + 15% sodium molybdenate, (3) 1 +30% sodium molybdenate. This latter is used by Seed Coop on parent seed to produce seeds. While (2) is used if molybdenum concentration in seed is low. While the fenitrothion controls weevils the Captan controls seedborne pathogens. Members of Seed Coop who are invariably large scale farmers produce seeds for Seed Coop. Every farmer grades etc. and even dresses the seeds on-farm using either sophisticated dressers, concrete mixers or 44 gallon drum. Certification is on-farm as well. If the concentration of Sodium molybdenate in maize is less than 0.83 ppm, Kaptasan containing 15% sodium molydenate is recommended. Seed coop also dresses seeds especially the open pollinated varieties . Other dressings are, for wheat, Baytan (a wide spectrum seed dressing) or Vitavax + thiram. In this mixture the Vitavax controls smuts while the thiram controls the other diseases. The Vitavax-thiram mixture is however cheaper than Baytan. For the michigan pea bean, thiram or AFC, for sorghum (when requested only), thiram and for barley, vitavax or baytan. Companies such as the Zimbabwe Fertilizer Company Ltd (ZFC) which are private commercial companies import these chemicals from abroad. Some are formulated in Zimbabwe while others are imported in the formulated form. Pertinent research is conducted including trials necessary for Government Registration. This includes hazardous and toxicology research (Ministry of Health), biological efficacy etc. necessary before a registration number is granted. Trials are conducted by the Company and Government. Thiram is also marketed for rural farmers as ZFC-Kumeresa (50% Thiram and 50% Inert Ingredients) and demonstration plots in rural areas have shown its efficacy in these areas. Thiram is applied as a powder by rural farmers in bags, cement mixers or tilted drums to protect their seeds. It is sold as a dry seed dressing (90g packets) for the control of pre-emergence diseases on groundnuts, wheat and rice, smuts on sorghum and damping-off diseases on legumes and vegetables. Instructions including precautions, symptoms of poisoning and

first aid in both English and the local language are provided.

At present almost all maize seeds (90%) are provided by Seed Coop, hence mainly hybrids and some open pollinated varieties which are already dressed and certified. The remainder, invariably open pollinated and traditional varieties are probably not treated at all. Other crops e.g. Bambara groundnuts (Vigna subterranea), groundnuts, beans (Phaseolus vulgaris), soyabean, sorghum, finger millet, sunflower, cowpea may or may not be treated depending on financial position. Most cannot afford the pesticides, others are unaware of pest problems. In addition, the extension system does not reach many farmers. However organisations like the NFAZ (National Farmers Association of Zimbabwe) are working with Agrochemical Associations to teach farmers using the vernacular language, about pesticides, safety such as the use of masks and gloves etc. Since these are expensive, low cost gloves and helmets using local materials are being researched into presently. Hence, a kind of awareness campaign has been instituted.

Since present day farmers are rapidly becoming commercialised, they seem extremely keen to get into crops such as maize and sunflower whose seeds are already treated that they can sell and use the proceeds to purchase other commodities for the family. Infact the communal farmers presently contribute a significant percentage of sunflower and maize grain sales to the Grain Marketing Board(GMB). Other seed companies produce uncertified seeds.

In addition to seed dressing, other commercial pest control strategies include the use of insecticides, herbicides, fungicides as sprays and soil fumigants. All are imported with the exception of copper oxychloride which is manufactured locally.

Large scale farmers use modern sophisticated spraying machinery while small scale farmers rely on extension workers to provide sprayers while they provide the pesticides if they can afford them. Government and other agencies such as FAO, GTZ, however provide pesticides for locust and Armyworm control. For example sprays are used for cotton pests and spider mite control. Biological control is also practised in Zimbabwe against the mealybug on coffee since it was observed that synthetic pyrethroids destroyed the natural enemies. Nuclear polyhedroses virus is used against semilooper of soyabeans. In this case even the farmers can carry out the process themselves. Other biological control processes include use of viruses against the water hyacinth Eichornia (water weeds) use of the parasite, Copodisima sp against the potato tuber moth; Bacillus thuringiensis against lepidoptera spp. on vegetables; the weevil, Neochitina against the water hyacinth (aquatic weeds) Eichornia, and the Neohydronomos weevil against the water lettuce , Pistia. The biological control of nematodes, Meloidogyne spp. is being tested using the bacterium, Pastoria penetrans. Other methods of control in Zimbabwe include cultural practice (spacing, time of planting etc.), breeding for resistant varieties and international and

national phytosanitation methods. In short, an integrated pest management strategy is being practised. Post harvest control include use of methyl bromide for maize and wheat in stalks, or phosoene for oil seeds, wheat and maize in silos. Aluminium or magnesium phosphide (phostoxin) releases phosphine, usually in detia bags containing chemicals in stakes. Other chemicals used are malathion dust (1%), Actellic (1%), damfin, Tetrachlovinphos (Gardona) Ethrinphos, Graingard, BHC and DDT. Very few farmers use ash.

Other agrochemical companies in Zimbabwe include, Agricura, Shell, Windmill, TSA Ltd. Agricura produces another seed dressing called Calirus 50 W.P. containing the fungicide benodanil, 50% and inert ingredients, 50%. It controls Rhizoctonia in cotton and tobacco seedlings and is compatible with other pesticides except lime sulphur and bordeaux mixture. Other dressings registered for use are Monceren for damping off in cotton and promate, quintozine, rizolex and thiabenzadol. Trials conducted usually take cost effectiveness into consideration e.g. Actellic was found to be expensive. The insecticidal seed dressing for cotton, disulphoton (a fruminol product) although still registered was found to be inactive, as pest occur later in growing season. In addition it was also toxic to handle. The market is also found to be open for systemic seed dressings and nematicides.

Termites have been controlled by dressing with aldrin, or by slow release soil pesticides. The organophosphorus insecticide Carbaryl has also been used as a seed dresser against maize pests. Also, the insecticides, aldrin or dieldrin have been used as seed dressings against the bean fly but these are being phased out, hence the need to look for alternatives.

AGRICULTURAL RESEARCH

Agricultural research and related activities are largely conducted by the Department of Research and Specialist Services (DR&SS) of the Ministry of Lands, Agriculture and Rural Resettlement (MLARR); and the Faculties of Agriculture, Science, Engineering and Veterinary Science of the University of Zimbabwe. Some research is conducted by the private sector and international organisations.

The DR & SS was established in 1948 and is the most important agricultural research organisation in Zimbabwe conducting research in all disciplines of all commodities with the exception of tobacco, sugar, forest products, fish, pigs and animal diseases. It is also responsible for providing various services to plant and dairy inspections, meat and cattle grading, seed certification and pesticide registration. The research stations and institutes in the DR & SS serve one or more specific agroecological zones in the country, and they produce new agricultural technologies to priority problems in the agricultural sector in the country.

The Research Services based in Harare consists of the Plant Protection Research Institute (PPRI), the Seed Services Unit, the Chemistry and Soil Research Institute and others. The Plant Protection Research Institute conducts research on the entomological, plant pathological and nematological problems of crops of economic importance in Zimbabwe except sugarcane and tobacco, in addition to the other advisory services previously mentioned.

Research has been conducted on various insecticidal, fungicidal nematicidal and cultural control (spacing and time of planting), disease assessments, and on biological control especially for nematodes (*Meloidogyne* spp.) using the bacterium, *Pastoria penetrans*. The Seed Services Unit collaborates with the PPRI.

The Crop Breeding Institute of the Crops Research Division in Harare undertakes breeding programmes including breeding for resistance to various important pests and diseases.

The Chemistry and Soils Research Institute amongst other things, provides analytical services in the analysis of pesticides and aflatoxins in food, feed, soil and water.

At the University of Zimbabwe, Faculty of Agriculture, on-going research include plant pathological and entomological projects in the Crop Science Department. For example oil seed pathology (groundnuts and soyabean especially), phytoalexins in groundnuts, phytotoxins from plant pathogens and methods of detecting aflatoxins. Previous work include comparison of fungicides and sprayers, and fungicidal seed dressings for the control of *Rhizoctonia solani* on cotton. In this latter, several fungicides

were tested in seed dressings for the control of the seedborne disease of cotton caused by the fungus Rhizoctonia solani. Of the six seed dressings tested, chloroneb, 2- isoprophylsulphonyl -5-trichloromethyl - 1,3,4, - thiadiazole (STT) and benodanil w.p. were consistently better than the others, and had no adverse effect on seed germination. Thus all three were recommended at a rate of 2.5 a.i./kg seed for dressing cotton seed. Liquid seed dressings were found to be phytotoxic.

Entomological research include seed storage pests and their control with chemicals. The Department of Agricultural Engineering conducts research on post harvest problems, rural development technology needs and related areas. The Development Technology Centre (DTC), an autonomous multidisciplinary resource centre which originated from a small rural development project in the Faculty of Agriculture in 1986, is active in this latter appropriate technology project.

At the Department of Biological Sciences, Faculty of Science, both plant pathological, entomological and nematological research are being undertaken including Sclerotinia sclerotiorum of oil seeds e.g. soyabean (mycological work and biological control using Penicillum spp.); Fusarium diplodia toxins, and Amyllaria of pines and indigenous trees. Entomological research include biology of insect pests and biological control of insects using viruses, while nematological research include biological control of plant parasitic nematodes.

Other research orientated projects are conducted by the private sector e.g. Seed Co-op Company of Zimbabwe. This company is entrusted by government to produce all the crop varieties released by the state. Thus it is the major producer of seeds in the country. It owns a self-funded private research station conducting research relating to seed production including breeding, factors affecting yield of seeds, aspects relating to successful pollination and pollen contamination. In addition effects of molybdenum, nitrogen fertilizers and pest control have also been conducted e.g. the effect of applying the pesticide carbofuran on seed parents of maize.

PERSONNEL

In 1986, the DR & SS had 140 professional Zimbabweans and 16 expatriates. At the Plant Protection Research Institute there are now 4 plant pathologists (3MSc and 1 BSc); 8 Entomologists (1 PhD 6MSc and 1BSc). In 1986, there were 8 professional nationals at the seed services, and 21 nationals and 5 expatriates at the Chemistry and Soils Research Institute.

At the Crop Science Department of the University there is a plant pathologist (Phd) and 1 entomologist (Phd), while at the Depart-

ment of Agricultural Engineering there are three lecturers (MSc) and at the Development Technology Centre, two personnel while at the Department of Mechanical Engineering two relevant personnel (MSc). At the Department of Biological Sciences there are two entomologists (MSc), 1 Plant Pathologist and 1 Nematologist.

The Seed Coop Research Station (The Rattray Arnold Research Station) had a permanent staff of twelve people in 1987.

SEED TREATMENT

The seed supply industry is controlled by the Seed Coop Company of Zimbabwe Ltd. It was born out of the merger of the two biggest seed houses in Zimbabwe on the 1st April, 1983 and now forms one of the most essential parts of the Agricultural Industry in Southern Africa in general and Zimbabwe in particular. The company meets the Zimbabwean demand for seed and exports heavily. They have a 99% monopoly.

Although the Seed Coop is a private company, it is the only government approved seedhouse, and works in close conjunction with the seed services division of the Department of Research and Specialist Services (DRSS). The DRSS, a department within the Ministry of Land, Agriculture and Rural Resettlement, has free access to any part of the Seed Coop's production facilities.

Rather than having one large centralised treating unit for maize, the seed is graded on farm, certified by the seed services division, and dressed. Seed is then distributed according to requirement. De-centralisation enables transport requirement to be kept to a minimum, 1 million 50kg units of treated maize were produced for the 89-90 season.

Seed multiplication is carried out on 155 large scale farms; small scale farmers cannot meet the required isolation distances between adjoining crops. The farmers, members of the Seed Coop, produce seed and the Seed Coop sells it. Isolation requirement for maize are 350m from any point to any adjoining maize crop; sunflower isolation is 100m. Another reason for using commercial farmers is the amount which can be supplied - it is easier to work with one large scale farmer than with forty small scale farmers producing the same total amount.

Hybrid maize seed was introduced by the Zimbabwean Maize Seed Association (ZMSA) in 1940, and effective extension work has led to 90% of maize seed planted being improved varieties which have been treated. Open pollinated varieties are produced but these are mainly for export to Angola. The 1989-90 season will see an aggressive campaign to reach the 10% of farmers not buying treated seed maize - communication and education are needed to reach the few remaining farmers; women will be the focus of this attention, as farming is usually performed by women (the National Crop Farming Competition was won by a woman farmer in 1989).

It is envisaged that the Seed Coop will eventually produce enough

seed for the SADCC region, and be able to increase production relative to population growth. They are required by the government to carry a 20% reserve of seed.

Since groundnuts became a controlled commodity (i.e. harvested crops have to be sold to the Grain Marketing Board (GMB) for a fixed price), production has decreased dramatically. Groundnut production prior to independence was in excess of 70,000 tonnes. Current national production is approximately 5000 tonnes. The government has not increased the price for groundnuts so few farmers grow the crop. This leads to seed shortages as peasant farmers grow and store groundnuts for food rather than sell to the GMB. Seed is kept back and regrown (the black-market price for groundnuts is three times that offered by the GMB-2500-3000 Zim.$/ton), and the government has asked the Seed Coop to increase groundnut seed production to enable pre independence figures of production to be achieved. This scheme started in 1989-90 and it is envisaged it will be at full production within three years.

When the ZSC could not supply groundnut seed, the GMB would produce packets of seed enclosing a packet of Thiram dust dressing to enable the farmer to treat the seed on farm. Seed cleaning is undertaken using an LMC 8448 cleaner. The GMB used to treat seed prior to distribution, but felt the dust produced during application was damaging to workers health, so opted for the previously mentioned system. The dust was an 18% wettable powder, but application was performed dry using offset drum tumblers or by simple manual mixing with shovels.

Groundnut seed production by the GMB is standard, i.e. minimum 60% germination, whereas Seed Coop seed is certified, i.e. 72% germination.

Other seed types, unlike maize, are cleaned and treated centrally by the Seed Coop. Wheat and barley (grown under irrigation) are supplied 100% by the Seed Coop; 150,000 x 50kg units were produced in the 1989-90 season. Sunflower cropping has plummeted from 40,000 ha/yr to 10,000 ha/yr due to price control through the GMB of harvested product.

Sorghum is treated only on request; it loses viability in store otherwise. Treatment is only usually requested for export seed. White sorghum is preferred for human consumption, open and hybrid varieties are available.

Soyabeans are not treated as most are inoculated . 10,000 x 50kg units of soyabean were produced in the 1989-90 season.

Michigan pea beans are usually grown as a contract crop and are open pollinated, leading to a number of farmers saving their own seed.

Current treating machinery is Gustafson S- 600 SS (x2), a Gustafson copy (manufactured in Harare by Spray-Quip) and numerous

"Zimbabwe hybrid machinery" using Gustafson or rotating drum application principles. The central plant in Harare uses the two Gustafson machines for the application of slurries to a variety of crops, and a large continuous flow rotating drum for powder applications.

The "hybrid" machinery is built by Lane Engineering of Harare and is sold to members of the Seed Coop to treat maize seeds or to interested parties outside of Zimbabwe. The machine costs between $2650 -3000 (Zim), runs on 3- phase electricity, and is not mobile.

Farms not purchasing Lane Engineering treaters use concrete mixers or drum tippers to apply the slurry formulations. There is no single seed analysis, even visual colour coating is taken to mean even chemical loading. Germination testing after treatment is undertaken by the seed services division to ensure no adverse effects result from dressing. Testing is undertaken on each seed lot, where one lot is equal to 40 tonnes of seed or less.

The Zimbabwean Fertilizer Company (ZFC) used to produce a groundnut dressing kit which consisted of a 20 litre drum containing maize seed and a packet of dressing; the idea being to sprinkle the dressing onto the seed, seal the drum, shake, then plant the dusted seed. The idea did not catch on although ZFC still produce small packets of powder dressing with which rural farmers treat groundnut seed. The common method of application is shaking the seed and treatment together in a drum or plastic bag. Less practised methods using the dressing in slurry form (it is a wettable powder) is to apply to seed spread on the ground using watering cans or spraying equipment, and mixing with a shovel.

All chemicals used by the Seed Coop are wettable powders applied as slurries; maize treated with Kaptasan F, which is a mixture of captan and fenetrothion (fenetrothion is an insecticide for control of weevils during seed storage). Various formulations are used containing different percentages (by mass of product) of sodium molybdenate (15 or 30%). The chemical pack has concise notes on usage, dosage rates, safety precautions, storage instructions and composition. The label is clearly marked with a green triangle emphasising the harmful nature of the product. The dressing itself is of low toxicity, this is especially important for seed sales to peasant farmers where shortages of food could lead to seed being used as food.

Seed trials with groundnuts for research into insecticidal seed treatments undertaken on behalf of commercial companies interested in introducing such chemicals had to be stopped due to farmers complaining about excess seed being unfit for consumption. It was feared that people were washing off the treatment and consuming the seed, although no one was reported sick because of it!

Other chemicals applied include Thiram, Vitavax and Baytan. The use of vitavax is diminishing although the Seed Coop are investi-

gating the use of a vitavax-thiram mix which, it has been claimed, controls pests as well as baytan, at approximately half the price. The cost of treatment per ton of oats, winter wheat or barley are as follows:

Vitavax - Zim$60/tonne
Thiram - Zim$21/tonne
Bayton - Zim$159/tonne

The National Farmers Association of Zimbabwe(NFAZ) is the only association specifically for communal, resettlement and plot-holder farmers. Communal farmers are those which cultivate land which, prior to independence, was previously called tribal trust-land; resettlement farmers are those which resettled after independence (the government buys the land and gives it to families being resettled), and plot holders are farmers who own small areas within urban areas. All of these farmers are small scale, less than 10ha. The medium size and large scale farmers have their own associations, the ZNFU and CFU respectively.

The farmers join together at grassroots level in clubs; between 10 and 50 farmers in each club. It costs Zim$5 per annum for each member to join, the club is charged a one-off Zim $20 for registration. The NFAZ is 9 years old and has over 5000 clubs, but this is only a fraction of the 850,000 communal dwellers (approx.10% communal dwellers belong to NFAZ). The NFAZ is registered as a welfare association, the only one at present, the only other small scale farmer representatives being the government initiated marketing co-operatives.

Some members of the NFAZ produce groundnut seed for the GMB with advice from the Agri-Tex extension workers. Good extension work has led to major hybrid utilisation especially maize and sunflower. Groundnuts, if not sold to the GMB for a higher price as seed, are stored in the shell (for protection) and resown. Groundnut seed availability is poor; however, the Seed Coop expects seed supply to be adequate within 3 years. The vast majority of farmers are involved in production of food, not seed, most buy treated hybrid maize. Crops which are saved for seed include beans, millets and cowpea. Sorghum and soyabeans are grown, but seed is purchased from the seed coop who have depots and stores in rural areas. This enables even remote farmers to have access to good quality seed.

Farmer "awareness" is extremely good due to the extension service Agri-Tex. There is one extension worker for every 800 households, advising on agricultural practices, pest management etc. Although knowledge of chemical pest control is good, use of sprays etc is limited due to cost and poor rural availability of chemicals. Also there is a problem of misuse in chemical handling. The Agro-chemical Association (ACA) are undertaking measures to ensure farmers are aware of the dangers associated with chemical pesticides. Labels and posters have been produced in English and local language in a bid to educate farmers, and the ACA and NFAZ run joint courses in safe chemical handling.

A problem often overlooked is the cost of safety equipment necessary for use with pesticide applications. The price of gloves, masks, overall etc need to be taken into account when buying chemicals, if there is a choice between spraying with or without the added expense of safety gear, many will choose without.

Many small scale farmers are becoming more aware of economic value cropping. There is an increasing interest in return on investments which has a detrimental affect on nutrition, i.e. the farmer is more interested in selling his produce to raise school fees instead of growing enough food for his family. Cotton and groundnuts are popular cash-crops, although cotton has numerous input necessities, and farmers prefer to minimise inputs in an effort to save money and labour.

There are a number of problems associated with the introduction of a seed treater. The first problem is the seed forecasting at present by the rural farmer; he purchases seed when he sees the rain coming, thus treatment of saved seed would be a last minute affair. Secondly, farm saved seed costs next to nothing so why increase overheads by applying expensive chemicals? Thirdly, the use of a seed dresser is only creating more work for the farmer, and finally, the cost of using the equipment is again increasing overheads.

On the positive side, seed treatment is necessary as part of an integrated pest management regime, If farmers operate the machinery themselves, not only would the technology be more readily accepted but it would also enable skills and education to be diffused among the farming community.

The machinery could possibly be utilised in schemes similar to one of those for maize grinding mills. Here farmer groups of between 10 and 100 members purchase and install a mill within a community. Maize is brought to the mill and ground on request. Maize is ground by the tin, where 6 tins are equal to one bag (90kg), and one bag costs Zim$6 to grind.

AGRICULTURAL ENGINEERING INSTITUTES

The Institute of Agricultural Engineering is part of the Department of Agricultural, Technical and Extension Services, Ministry of Lands, Agriculture and Rural Settlement. The role of the institute is to provide agricultural engineering research, testing, development, training and extension services to meet the agricultural engineering needs of the agricultural and associated sectors within Zimbabwe. Priority target groups are communal and resettlement farmers.

There are a number of areas in which research, testing and development are undertaken; runoff control and soil conservation, tillage equipment development, reduction of human labour, reduction of post harvest losses, improvement of equipment suitability

and quality, and small scale irrigation equipment.

The training and extension aims of the institute are to disseminate results of R & D work to the farming community, to increase efficiency of draught animals and equipment; to increase small scale rural repair and production capabilities; to increase efficiency of powered machinery and to minimise breakdown; and to promote the use of appropriate technology to farmers.

Current work includes the development of an animal drawn crop sprayer, the evaluation of various tractor types and the testing of animal drawn planters for various crops. The R & D department of the institute is very good especially in the production of test-rigs and equipment; however, there is no facility for manufacture en masse. Tooling costs are high.

The workshop has basic fabrication equipment, but lacks casting and pressing facilities. Material availability is good except for plate and sheet which is not produced locally. Bearings are easy to come by at the present time.

Collaboration with local companies is good as is cooperation with the University. Local companies are always looking for new markets to develop, and the institute is keen for their ideas to be adopted.

The limiting factor in the institute is manpower. Only seven of the ten engineering posts are filled. There are four Zimbabwean engineers, 2 Germans and 1 Dutch.

The Development Technology Centre (DTC) is a multidisciplinary resource centre on the campus of the University of Zimbabwe. It was established officially in early 1986 with the approval of the University Senate and with assistance from UNESCO, GTZ/GATE and ITDG. The centre originated from a small rural development research project in the faculty of agriculture concerned with "community" or "rural engineering". It aims to improve low income rural and urban areas through improved technology transfer and by development of new technology.

There are numerous aspects to the work undertaken by the DTC, all of which benefit due to the staff research and facilities to be found on the university campus.

The centre is very much still in its infancy although it has already established itself in a number of areas, especially in the research and development of cook stoves, bake ovens, building alternatives, rabbit production, vegetable oil expressing, low cost printing, rural energy supplies and tools and equipment for small workshops.

Collaboration and cooperation occurs with a large number of organisations both within and outside of Zimbabwe. Topics of interest to this project which are already undertaken by the DTC

include rural workshops, food processing, transport, small scale manufacturing and environmental factors.
The Faculty of Engineering at the University of Zimbabwe has an agricultural engineering section. The department has a few of its own technicians as well as access to the engineering faculties workshops and technicians. Collaboration amongst all university departments is excellent and in the past work has been undertaken with the Agricultural Engineering Institute at Borrowdale. The department would like to improve links with industry and other sectors.

Current work includes the use of solar drying for horticultural and fruit products. Consultancy work is involved in soil fertility studies, farm machinery selection for rural resettlement, and food supply research with special emphasis on storage facilities.

To undertake the UNIDO project no special equipment will be necessary, although a technician trained in seed dressing principles would be required, preferably someone with "hands-on" experience of seed treatment technology.

The mechanical engineering department has excellent facilities including access to computer aided design (CAD) using DOGS software. There is also a full-time designer, Dr Madjzoub, as well as three mechanical engineers in the department.

Part of the course run by the department is crop processing technology, and research has been undertaken into maize shelling, oil extraction from groundnuts, crop winnowing and unfired bricks for storage, and other structures. The department is working in conjunction with the Agricultural Research and Development Association (ARDA) on a sorghum and millet dehuller.

The university is keen to participate in the R & D work although seed technology is already extremely advanced in Zimbabwe. Links with crop protection and biological science departments will enable machine development and field trials to be run within the same unit i,e, university campus.

The growing season coincides with the long vacation, hence the university can offer both the technical staff and the time required to the project. Single seed analysis and machine proving can be undertaken on campus as can some field trials. The cost of field staff and trial expenses would have to be met, i.e. land preparation, weeding etc, the limiting factor would be transport to and from the field trial sites. The university trial plots are based in Harare on soil classified as 2A, communal land is usually 3-4 and varies in height above sea level, enduring different metereological patterns accordingly. On-farm trials with the machine could be undertaken as part of the field trials, enabling farmer response to be evaluated.

Only registered pesticides may be used in Zimbabwe; a registered pesticide is one which has satisfied the DRSS and HSB (Hazardous

Substances Board) requirements. This process can take 3 to 5 years before import licensing is administered for the product.

A number of engineering companies who could participate in the production of prototype seed treaters were identified in Zimbabwe.

LANE ENGINEERING (PVT) LTD
P.O.BOX ST43
SOUTHERTON
HARARE

This company produces seed treatment equipment for members of the Zimbabwe Seed Coop, and for export. Costing approximately 2650-3000 Zim dollars, the machine is a "Gustafson hybrid" using an inclined auger to mix the seed and chemicals.

G. NORTH AND SONS (PVT) LTD
LOBENGULA ROAD
P.O.BOX ST 111
SOUTHERTON
HARARE

George North fabricates a range of milling and threshing equipment, forage cutters, crop processors and pumps. They, and the following companies, are high quality engineers capable of manufacturing prototype designs from drawings:

NEI COCHRANE ENGINEERING (PVT) LTD
TILBURY ROAD
WILLOW VALE
BOX ST 361
SOUTHERTON
HARARE

TINTO INDUSTRIES LTD
77 COVENTRY ROAD
P.O.BOX 2356
WORTHINGTON

5.3 MALAWI

The Agricultural sector is divided into two distinct subsectors, smallholder agriculture which accounts for 85% of the total output and concentrates on food crops (maize, beans, groundnuts, sweet potatoes and rice) also cotton and tobacco, and estate agriculture which contributes 15% but provides three quarters of the total export principally the main cash crops i.e. tobacco, sugar and tea.

Agriculturally Malawi is divided into eight Agricultural Development Divisions (ADDs), each with a fair measure of autonomy with respect to crop production. Each ADD is further subdivided into extension planning areas. A parastatal organisation, the Agricultural Development and Marketing Corporation (ADMARC) purchases and sells most of the smallholder surpluses although private traders also actively compete with them in buying crops from farmers directly. Private firms, some foreign owned, dominate trade in estate produce.

Maize, the country's major staple food is mainly cultivated by the smallholders. Thirty-five percent (35%) of these have less than 0.7 ha (hectares) and cannot with present technology satisfy their own subsistence requirements. Forty percent (40%) with between 0.7 - 1.5 ha, can with current technology normally satisfy their subsistence requirements and have the potential for modest cash crop sales. Twenty-five (25%) with over 1.5 ha and mainly involved in cash cropping.

In 1986/87, the agricultural season experienced both variable weather conditions and an outbreak of pest. Most places had less than normal rainfall, and mealy bug pest destroyed cassava in the northern region lake-shore districts, and people there had to switch to maize for their subsistence requirements. However the hectarage planted to hybrid maize was reduced. Earlier in 1980/81, of the 9,408,000 ha land of which 5.3 million ha was possible for cultivation, only 1,332,000 was actually under cultivation with 768,000 under maize cultivation. Also, of the 1,332,000 under cultivation 43.78 were cultivated with hybrid maize, 34.32 with composites and 689.89 with local and others in pure maize stands. In mixed maize stands, 52.90 groundnuts, 103.75 pulses, 13.31 cassava and 31.64 other crops.

Thus Malawi's development policies (1987-1996) dictate that the development of maize varieties of higher yields will continue to be a research priority, in its quest for reduction of poverty, ignorance and disease by the achievement of rapid and sustained economic growth.

The major food crops of Malawi are maize, sorghum, wheat, cassava, groundnuts, rice, beans and sweet potatoes while the main export crops are tobacco, sugar, tea, coffee and cotton. A catalogue of the major crop pests is presented in the UNDP/FAO Action Programme for Improved Plant Protection in Malawi - Report of survey on Plant Protection (1984). This catalogue lists over

100 pests and diseases of the major crops of Malawi, some of which are common to the other countries in this report. Quite a good number of these are soil borne, seed and seedling diseases and they include the following.

I. SOIL BORNE DISEASES:
   1. Southern blight or Stem rot - white mold
   2. Pod rot - Pythium causes pod breakdown
   3. Seed decay, pre-emergence and post - emergence damping off caused by Rhizoctonia solani
   4. Fusarium pod rots - ubiquitous in soil
   5. Charcoal rot - responsible for seed and seedling rots, wilt, root and stem rots.
   6. Botrytis blight - causes seedling blight and wilts.
   7. Aspergillus crown rot - Aspergillus niger causes pod and seed discoloration
   8. Yellow mold and aflatoxin - caused by Aspergillus flavus
   9. Bacteria wilt caused by a soil borne bacteria - Psuedomonas solanacearum

II. SEED AND SEEDLING DISEASES
   1. Rhizopus spp. -
   2. Aspergillus niger
   3. Pythium spp
   4. Rhizoctonia spp
   5. Fusarium spp
   6. Sclerotium rolfsii - blue damage causes discoloration of the testa. This is produced by a phytotoxin caused by this fungus.

MALAWIAN INDUSTRIAL SECTOR AND AGRO-ALLIED INDUSTRIES

The Malawian Government is pursuing a policy of increasing the manufactured component of the nations agricultural output and expanding manufactured exports. Malawi does not suffer from shortages in material as experienced in many other PTA member states. Steel is imported form Zimbabwe whenever possible and specialist steels (such as stainless and carbon spring steel) required in the manufacturing industry, from South Africa.

The industrial sector is broadly made up of three sub-sectors: a group of medium scale establishments concerned with the processing of tobacco, tea, sugar, etc. for export; a group of medium scale establishments concerned largely but not wholly with import substitution (cement, textiles, footwear, beverages); and a large group of small scale enterprises, many in the informal sector, concerned with the supply of goods to the domestic market (bricks, farm tools, kitchen, utensils, basketware). Employment in the formal segment of the sector is currently just under 50,000.

Domestic demand for manufacturing has been limited by the slow growth in agricultural incomes. Industrial expansion has also

been impeded by the lack of adequate long-term finance which, in the past, has largely been obtained through overdrafts and retained earnings. Ownership of all but the smallest ventures is highly concentrated among a small number of parastatal organisations and private companies many of which are partly or wholly foreign owned.

The main statutory body for the development of the agricultural, commercial, industrial and mineral resources of Malawi is the Malawi Development Corporation (MDC). Playing the role of a catalyst in the rehabilitation of numerous projects, the MDC's main role in the agro-allied industry is the production of agricultural implements (Agrimal) and foundry products (Malawi Iron and Steel Corporation).

There are no facilities for pesticide production in Malawi, the country relies totally on importation as it does for fertilizers.

The main supplier of agricultural inputs to the farming community is the Agricultural Trading Company (A.T.C.), a subsidiary of Auction Holdings Limited. Ten percent (10%) of total sales are pesticides. Other products sold include sprayers (knapsack), grain bags, soil injector guns, safety equipment etc. The small-scale farmer is a target group of the ATC. Bulk purchases of pesticides and fertilizers are repacked by the company into smaller units convenient for small farm use. The pesticides carry labels in English and local language to warn of any dangers and to instruct the purchaser into correct application techniques. The ATC has many branches throughout the farming community and could be utilised for the dissemination of seed treatment chemicals.

There are a number of companies involved in agricultural equipment manufacture. The Engineering Foundry (good workshop and foundry facilities), Brown and Clapperton (high quality engineers in any metals). Agrimal (Malawi) Ltd., (implements for the peasant farmer)and many others. Many companies will produce equipment from drawings which could be supplied from the team involved in the seed dresser design.

PLANT PROTECTION IN MALAWI

Like in other countries of the PTA region, Malawi cultivates a lot of plant spp. which are quite susceptible to various insect pests and diseases at various stages of the plant's growth.

Plant protection in the crop production section of the Ministry of Agriculture is only fairly developed in the country. The Ministry of Agriculture is thus responsible for plant protection.

The ADDs are staffed with an agronomist who gives advice to farm-

ers on obvious pest problems. In general, farmers are not readily aware of the degree of devastation by pests unless it is extremely obvious. However, all methods of plant protection are practised to some extent, from cultural practice to biological control.

The ADD's serve as the extension, the bridge between the farmers and the technical service researchers. In addition they also assist in the training and advice of farmers, and conduct adaptive research.

Chemicals used vary depending on the type of disease or pest. In maize for example, termites, stalk borers and armyworm are the major problems even in dressed hybrid seeds. Local varieties are also susceptible. At first aldrin and dieldrin were used but they have now been withdrawn since both are organochlorines and usually remain persistent in the soil where tobacco is rotated with maize. For armyworm, carbaryl is used and for stalk borers, diptherex (contains 10% of DDT). The Japanese donated sumicidin and sumithion (a pyrethroid) to Malawi for the control of armyworm. Daconil fungicide is used for leaf spot but is expensive and uneconomical. Sprayers are bought from ADD with medium term credit to individuals but this is now being replaced by loans to groups (minimum of 10 farmers). Extension was extremely important to demonstrate the usefulness of the technology. Chemicals are bought from various private companies including Shell and the Agricultural Trading Company which is mainly involved in distribution. The Agricultural Trading company target the small scale farmers, hence they purchase in bulk and package into smaller packages. They also use their staff to give back up and advice. Likewise, Shell company is also targeting the small scale farmers using their extension workers in collaboration with the government extension service to educate farmers on pests and diseases and safety aspects as well, using the local languages. Thus DDT has now been replaced by synthetic pyrethroid (Ripced). For example, cotton growers - farmers buy pesticides and treat themselves. Major problems of cotton include the cotton bullworm - controlled with carbaryl, ripcod and dimethrin (rogod). Other targets are the smal barley growers. Shell maintains the importance of proving t armers the monetary advantage relating to pesticide usage and the important role of ADD to sell the technology. Yields obtained from ADMARC were obtained and benefits of pesticide use were obvious. Government support is deemed necessary and the importance of working with Ministry personnel crucial.

New products are tested by government for approval e.g. for stored products, sumikombi (fenatrotrion and sumicidin) is presently awaiting government approval. Presently actellic on to corn on the cob is used. Large organisations hire pest control agents for fumigation. Tea is sprayed using planes, and knapsack is also common, while tractors are used in large estates.

As far as seed dressing goes, the National Seed Company used Fernasan D for seed treatment and Actellic (2% dust) for storage.

Thiram and Captan plus an insecticide (formerly lindane) have also been used in the past as a seed dressing. Furadan is also being investigated since it protects the crop when most people do not bother e.g. the early seedling stages.

Small scale farmers do not dress their seeds at all. For beans and others, ADMARC fumigates with methyl bromide and the storage methods used are traditional, making use of ash and smoke. Pathological problems in groundnuts include aflatoxin production. ASIDA project on a possible pesticide formulation plant is being discussed.

At present there is no pesticide legislation hence no restriction on import, sale or use of pesticides in Malawi. It is however hoped that this situation will be remedied soon, even though a gentleman's agreement exist with the chemical companies that new chemicals are not marketed until the MOA has given approval.

Specific strategies for the control of soil and seedborne diseases are as follows:

1. SOIL BORNE DISEASES:
   1. Crop rotation
   2. Ploughing or ridging
   3. Plant none host
   4. Avoidance of infected fields
   5. Fertilisation in areas where recommended
   6. Fumigation with chemicals

II. SEED BORNE DISEASES
   1. Proper drying of seed after harvest
   2. Proper storage in shell
   3. When shelling never moisten seed
   4. Plant after effective rainfall after 3 inches (80.0mm) rainfall. Avoid planting when there is drought
   5. Never soak the seed prior to planting
   6. Seed dresser may be used when the seed is going to be stored already shelled - use a fungicide and insecticide seed dresser or seed dresser may be used when poor quality seed happens to be used as seed

CHEMICALS USED AS SEED DRESSERS:
1. Prentasan plus - Thiram + GAmma BHC
2. Thiram
3. Captan
4. Actellic dust
5. Methyl bromide fumigant or Phostoxin fumigant
6. Vitavax - U.S.A.
   - Systemic fungicide seed dresser

MALAWI SEED TREATMENT

The National Seed Company of Malawi (NSCM) is the only commercial company which produces treated agricultural crop seeds in Malawi. It is estimated that 80% of arable land is put down to maize, 8% of which is seeded with NSCM treated seed. Ninety percent (90%) of treated seed is hybrid, 10% is composite.

The NSCM has only one centralised depot using Gustafson machinery. Presently there is one machine but within the year another machine will be installed to cope with demand in production during the peak season. Both machines will apply slurry or powder, although slurry application is the norm due to reasons of better chemical adherence, less dust and better distribution than with powders. All chemicals are imported; there is no local formulation.

Ninety percent (90%) of seed produced is maize, other crops such as tobacco, beans, groundnuts, sorghums, modegrass and other species make up the remaining 10%. The company occasionally supplies pigeon peas, cowpeas, rice and cotton. There is no dressing undertaken at any other level. Many have the opinion that if a small scale farmer could afford to buy dressing to treat his seed, he would buy dressed seed which has the advantage of certification over his own saved seed.

The NSCM reckons that it is reaching 10% of the farming population in total. It is hoped that this figure will increase to 50% in the next 5-10 years. Presently, there are no field trials undertaken to see if the applied chemicals are actually advantageous to the farmer: the use of fungicide is assumed to be beneficial and treatment with such is routine rather than proven requirement. The company works alongside the Ministry of Agriculture and makes use of the governments extension service. As the company grows, it is envisaged that seed demonstration plots and field trials will be used to justify treatment and to disseminate knowledge of correct seed practice to small scale farmers.

Maize seed multiplication is undertaken on large farms, usually tobacco estates, due to the need for isolation from other maize crops. Sixteen (16) ha is required for isolation around the seed crop. The Government extension service is utilised for distribution of treated seeds to the farmers via the ADD.

The centralised positioning of the NSCM seed plant is advantageous in that chemical and seed storage is safer in one large unit than in many small spread out plants. The main advantage of diverse treatment operations (such as Zimbabwe seed treatment industries) is that transport is minimised; the NSCM feel that the small area of Malawi does not necessitate the distribution of numerous treatment plants.

Current maize hybrids are grown usually on cash-crop basis; the soft dent hybrid varieties do not store well, are difficult to prepare with traditional village implements, and do not appeal to

the farmers palate as much as traditional flint varieties. Adoption of hybrid seed utilisation would be greatly increased if a flint hybrid was introduced, i.e. a high yielding variety with hard grain characteristics for better milling properties. Food preparation in Malawi (and Tanzania) is different from that in Zimbabwe and Kenya, hence the greater adoption of hybrid seed in the latter two countries. If 30% of the current maize hectarage in Malawi yielded 3 tones/ha, the country would be self sufficient in maize; 3 tones/ha is achievable with hybrid seed use.

Seed treated by the NSCM is packaged in woven polypropylene bags in a range of sizes between 1 and 10 kg. Germination tests after treatment are undertaken to ensure there are no adverse affects on the seed due to the chemical application. All seed testing is carried out by the seed technology unit of the Chitedze Agricultural Research Station, although there is no testing for homogeneity in chemical loading on the seed; an even colour coverage is taken to indicate an even application rate.

The actual use of hybrid treated seeds is increasing, the demand outweighs supply, and seed has to be imported from Zimbabwe to supply the market that the NSCM cannot meet. Hybrid seeds enable greater productivity per unit area of land and Malawi needs improved productivity: in 1964 the population was 4 million, now, in 1989, the figure is 8 million. Land pressures have been increasing with the result that the average family plot has been getting smaller and fewer areas left fallow. There is little scope for bringing further land into economic use, smallholder development now depends on intensive production and ensuring that the land under cultivation does not deteriorate.

Great quantities of hybrid dent maize varieties are grown by commercial farmers and sold to ADMARC. When food is scarce due to drought etc, the people buy the dent maize from ADMARC as they have no choice. During times of plenty, dent varieties are eaten by urban dwellers and the refugees from Mozambique who have no choice in what is supplied.

Recent policies introduced as part of Malawi's structural adjustment programme have had mixed results for many smallholders. Increased maize prices have led to increased aggregate production, but again the benefits have gone to farmers with large holdings since they tend to be net sellers of maize. Most smallholders are infact net food purchasers and have therefore been adversely affected by the price rise.

Promotion of seed products is undertaken by the NSCM and Ministry of Agriculture, although not aggressively. Advertisements on radio broadcasts and discussions on "making better farmers" help to disseminate the advantages of growing improved variety crops.

There are a number of reasons why hybrid seed is not adopted by small scale farmers, the first being the limited supply. The soft nature of hybrid maize makes it prone to attack from pests in store and, combined with the fact that the floury taste of the

hybrids does not appeal to the farmers palate, indigenous hard varieties are preferred. Buying hybrid seed is seen as an expensive input compared to saving seed from the previous harvest. The pricing of maize means that sale of excess is not inviting; the farmer grows enough maize to feed the family then puts the remaining land into cash crops (cotton, groundnuts etc.). Thus the pricing policy retards development of self sufficiency in maize.

Another problem with the adoption of hybrid maize seed is the increased requirement of further inputs which are not necessary with indigenous traditionally cropped varieties. Relatively few smallholders use fertilizer, partly because, until recently, it was not being packaged into small enough units for them to use. The government implemented a Fertilizer Subsidy Removal Programme over several years. As prices increased between 1983-84 and 1986-87, consumption of fertlizer decreased by 7%, and the area planted with hybrid maize declined by 50%. In 1987-88, however, fertilizer use did go up by 24.4% and by 4.2% in 1988-89, mainly due to the retention of the subsidy.

Until seed production is increased to meet the country's needs, dressing of "farm saved" seed will be an economical alternative to importation of treated seed. Due to the monocropping practices incurred on the majority of smallholdings with no manuring and no organised integrated pest management, soil fertility declines and soil-borne pests and disease increase. Seed treatment will enable at least part of the problem facing small scale farmers to be addressed.

Farmers are being discouraged to save their own seed due to poor storage conditions leading to poor germination results; however, since supply is limited, saving part of the previous reasons crop is necessary for the small-scale farmer. Cleaning and grading of such seed would be advantageous, and could be included as part of the seed dressing project.

SEED STORAGE

Traditional methods of seed storage include hanging cobs in the house above the fire, threshing millet and keeping it in a woven basket (chikwa), and keeping beans in a muddied basket. Another popular storage method is the mixing of seed with ash. Groundnuts and pumpkin seeds are dried and kept in sealed tins.

Surveys have revealed that smoke protection of seed is not a good control of insects due to the intermittence of smoke production through the day. Once the insect enters the cob it tends to remain there; storing the whole cob complete with its protective sheath of leaves further prevents insect attack. Large cob sizes of new varieties tend to have their tips uncovered due to the shortness in length of the sheathing leaves, this leaves the cob

open to attack from insects.

The Chitedze Agricultural Research Station designed and built a cheap drum mixer especially for the application of powders to stored grain. The idea was for the farmer to dress his grain with actellic/bluecross etc before storing. The drum was successful in achieving its aim, i.e. dust application to grain, but the concept was not adopted by the rural farmers for a number of reasons.

1. The machine treated shelled maize - the farmer stores his maize on the cob, shelling enough for food as and when required. The shelling of all his maize before treatment would not only be extremely time consuming, but would also require special storage structures for containment and transport difficulties would be increased. The farmer would need to have access to good quality grain bags.

2. The small scale farmers are aware of insect damage but know soft hybrid varieties are more susceptible to weevils than indigenous types. Thus any hybrid produce is immediately sold to ADMARC, the farmer keeps the flint types in store.

Actellic dust is used to protect cobbed maize, applied at a lower rate than for shelled maize. It is sprinkled on to the cob between the leaf sheath. Maize is then shelled for food as and when required.

AGRICULTURAL RESEARCH

Agricultural and related research in Malawi is mainly undertaken by the Department of Agricultural Research of the Ministry of Agriculture, the Tea Research Foundation, the Tobacco Research Authority and the University of Malawi. The National Research Council is the government body mandated to coordinate all aspects of scientific research as well as development of technology in Malawi. Its terms of reference include; to develop appropriate agricultural machinery and structures for the smallholder farmer; control of insects and other pests and diseases of various crops and trees; breeding for high yields and for resistance to pests and diseases; use of cultural practices, product development and quality improvement research activities.

At Chitedze Agricultural Research Station, Lilongwe, various research projects are conducted in cereals, grain legumes,, oilseeds and fibres, livestock and pastures, soils, land husbandry and agricultural engineering, horticulture, adaptive research and technical services (seed technology *et al*).

The plant protection laboratory identifies pests and diseases attacking crops in the field and gives appropriate advice on control measures. Plant pathological research including breeding

for resistance is also conducted on maize, groundnuts, oilseeds, potatoes and cassava. In particular, a seedling project on groundnuts was conducted using thiram or thiram and BHC dust formulations. Seeds were treated by merely exposing seeds to pesticide in a seeddressing cardboard box and manually shaken for a while.

Field trials were conducted in the plateau regions of Malawi and the following parameters measured. Seedling emergence, standard count at harvest and yields (grades A,B, & X). Results suggested that there was no need for seed dressing in good quality seeds, but for poor quality seeds i.e. smaller seed.

However, it must be borne in mind that trials were conducted in the plateau region where there are lots of rain hence less soil borne disease and more foliar diseases. Experiments have now been repeated in drought prone areas where there are more soil borne diseases, using thiram and baytan (50g/50kg seeds). Preliminary analysis of data has indicated that while thiram protected the groundnut seeds, baytan was phytotoxic.

At the other research station (Brumbe ARS) there is a plant protection service and a crop storage unit and at Makoka an armyworm and cotton pest control. Some adaptive research is conducted by ADDs, Shell Chemicals and the FAO. The Seed Technology Unit at Chitedze is a quality control service, which works closely with the National Seed Company to produce high quality seeds which are free from pathogens. For seeds to be certified they have to meet the seed certification standards of both purity (freedom from pathogens) and germinability. Farmers who are seed producers have their crops inspected regularly.

At Bunda, projects have emphasised cultural control for small holders viz. intercropping and trap-crop projects, local methods of grain preservation e.g. storage of dry beans mixed with pod ash, and chemical pesticide screening.

PERSONNEL

At the Chitedze Agricultural Research Station there are 51 professional officers (BSc, MSc, PhDs) only two of these are plant pathologists, and no entomologist. Also, at the Seed Technology Department there are presently only two professional officers. At the University of Malawi, Chancellor's College in Zomba there is presently only 1 plant pathologist and i entomologist,while at Bunda Agricultural College in Lilongwe there is 1 entomologist, 1 plant pathologist, 1 nematologist and 4 agricultural engineers presently, while at Makoka there are two entomologists.

ENGINEERING DESIGN INSTITUTIONS/COMPANIES

Agrimal (Malawi)Ltd
P.O.Box 143
Blantyre

Agrimal is jointly owned by the Malawi Development Corporation (40%) and the U.K. firm of Chillington International (60%). They are geared for production of agricultural implements required by the peasant farmer; from basic hand-held cultivation equipment to animal drawn ploughs, ridgers and cultivators.

The recent addition of two electric furnaces will increase output of forged ring hoes to approximately 200,000 per year although, at present, production is at a standstill due to compressor failures. Stocks are diminishing, currently 18,000 tools are available. Production will be restarted before the end of September.

The company exports equipment to eight countries, and works in conjunction with UNHCR to equip farmers in Mozambique. Although the factory is currently being extended to increase production facilities, the company is restricted in its diversification due to limitations of machinery.

Steel is imported from Zimbabwe (Zisco Steel) but special steels, sheet and plate are brought in form R.S.A. Carbon spring steel plate, which is necessary for mouldboard plough shares and other soil-interacting components, cannot be produced in Zimbabwe so is subsequently purchased from South Africa.

Design and research within the company is good, and is mostly undertaken at the Chitedze Research Station near Lilongwe. Recent developments include the design of a tool carrying frame (animal drawn) adapted for use as a plough, ridger, cultivator or groundnut lifter and does away with the need for four different pieces of equipment. The combined cost of the newly developed tool bar and its attachments is approximately half the price of the combined costs that would be incurred if all the tools were purchased separately.

There is a drawing office at Agrimal's factory and simple implements can be fabricated from drawings. The production of a combined seed drill and fertilizer placement machine is currently being investigated with emphasis on the adaptability to sow various seed types.

Agrimal (Malawi) Ltd and Zimplow Ltd (Bulawayo, Zimbabwe) have the same background in terms of development, and as such produce a similar range of products.

Brown & Clapperton Ltd.
Engineering
Gomani Road
P.O.Box 1582
Blantyre

B & C Ltd. designs and fabricates a wide range of products from their different departments; from simple furniture and door/window frames in the light engineering division, to pressure vessels and storage tanks in the industry unit. Most material is imported from the R.S.A. or U.K. and they have no problems with supply of steel or of components such as bearings etc. One limitation is that spinnings have to be brought in from RSA as they lack this facility. All types of steel are used including stainless.

It is the largest company of its kind in Malawi with branches throughout the country to distribute the finished goods. Apart from producing basic commodities a number of products are manufactured to serve the farmer: maize hammer mill electric or diesel powered, ox-carts (MK1800, would be MK1000 without tax at 35%), and specialist equipment such as fluid bed driers, graders, presses and industrial wood pulp machinery. Mixing machinery is also produced for the tea industry. Anything fabricated in metal could be produced.

The main problem facing B + C is the surtax on finished goods. Industrial equipment has a 10% surtax levied upon it, all other products have 35%. Thus the hammer mill which should retail for MK 13,000, costs approximately 17,550.

Another advantage of B + C is that they are the importers and assemblers of bicycles from India and as such can supply complete bikes or various spares from stock. They recently reduced the price by price fixing from MK 580 to MK 296 to enable the bicycle to reach all levels of the community.

The factory has a full-time drawing office and can engage in R & D or produce from drawings supplied. Quotes from drawings can be given as a close estimate to final production cost.

FARM MACHINERY UNIT
CHITEDZE AGRICULTURAL RESEARCH STATION
P.O.BOX 158
LILONGWE
MALAWI

As a department of agricultural research in the Ministry of Agriculture, Chitedze offers a wide range of service. The farm machinery unit is active in a number of practical R & D areas, including fabrication and evaluation of appropriate technology equipment.

The aims of the department:
1. To develop and test appropriate technologies which could be used or the farm.

2. To assist manufacturers and users on equipment design, production, distribution and spare parts availability.

3. To design technologies which relieve labour and energy bottlenecks.

4. To assist on farm machinery extension within the country.

R & D in conjunction with Agrimal has led to the adoption of a tool bar with various attachments for manufacture. The new system comprising tool bar, plough share, ridger body, groundnut lifter and cultivator, eliminates the need for four individual pieces of equipment, saving approximately MK 270 ($107.60).

Work is also undertaken in conjunction with the University of Malawi, Bunda College of Agriculture. Collaboration is increasing now that an earlier individualist approach by each department has reduced.

Much use of wood has been evident in many projects, due to its greater availability and cheapness over steel. A wooden groundnut sheller has been designed and developed to reduce the labour requirement for this process. Costing MK 50 ($20), the unit is robust and easily maintained. Other projects include steel rice weeder (MK 100 or $40) and cereal thresher (wooden) for rice, wheat and sorghum. A price for the thresher was not available and work is under way to improve throughput from 60kg rice/h to 100kg rice/h.

A small revolving drum tipper was also viewed, differing from many designs in that all the parts (except the 20 litre drum and the connecting nails) were wooden. Designed in conjunction with the crop storage section, it is principally used for actellic dust application to shelled maize for storage. Maize is placed into the drum with the required amount of dust, rotated ten times, then emptied into a bucket placed beneath the machine.

Other projects include a small grain de-huller (for use with grain sizes from maize to sorghum using a 10-15 hp motor (electric 3-phase or ic), ox-carts, planters and yokes.

The department has seven team members(1 MSc, 1 BSc and 2 Diploma plus three others who are on study leave overseas) and are willing to participate in the project.

University of Malawi
Bunda College of Agriculture

The agricultural faculty consists of five main schools; crop production. rural development, animal science, human nutrition and agricultural engineering. The agricultural engineering section has four areas of study; farm power and machinery, structures, soil and water, and processing.

The department is short of staff with only 5 of the 8 teaching places filled. The current staff consists of 3 PhD and 2 MSc; two people being trained will return in 2-3 years time. The immediate manpower situation looks limited although the near future looks better. The department is willing to participate in the project, although a technician trained in seed treatment technology would be a necessity. There is a PhD in seed technology within the University.

The department undertakes projects both individually and with other institutions (notably Chitedze and Zomba) and cooperation is continually improving. Consultancies have included bio-gas utilisation (project awaiting government funding), ox-cart design (current), improved grain storage facilities and improved livestock housing. Work has also been undertaken on oil expressing from sunflower seeds.

Fabrication facilities are good although they are certainly not geared for any manufacture or full-time fabrication. Basic machine shop equipment is available on campus; off-site industries can be used if the workshops cannot cope with the designs.

5.4 TANZANIA

As in the other countries, Tanzania's agricultural sector which is the most important sector of the economy is dominated by small scale farmers who contribute 83% of the agricultural production on privately owned plots averaging 2.2 hectares. They rely mainly on manual and hand implements. Private estates are important in tea and sisal, and government estates contribute significantly to rice, sisal, wheat, sugar and meat production.

The major food crops include maize, rice, wheat, cassava, millet, beans, sorghum, bananas, vegetables, fruits, potatoes and other root plants. Export crops comprise coffee, cotton, sisal, tobacco, tea, cashewnut and pyrethrum which together account for 75% of the total foreign exchange earnings.

Of the estimated 40 million hectares of fertile and arable land available only 6 million hectares are under cultivation and most farming is rainfed. Agriculture grew by 4.5% in 1987 and 1987/88 was generally a good year for all major food crops.

AGRO-ALLIED INDUSTRY

Tanzanian industry suffers from shortage of raw materials, spare parts, unreliable water and electricity supply and transport. Materials are always a problem, especially steel, which is presently being imported from Italy. The actual distribution of steel when it arrives at Dar-es-Salaam is less of a problem since the industrial area is very close to the port. Small scale industry employs 24,500 people in 1600 enterprises, 50% of which are in Dar-es-Salaam. 21.5% of manufacturing employment is within the small scale sector. Massive investments in the industrial sector during the 1970's led to a doubling of the installed capacity between 1974 and 1984; however, this was accompanied by a decline in capacity utilisation due to the shortages mentioned above.

There are two parastatal agricultural implement manufacturers producing hoes, hand held tools, ox-drawn cultivation equipment etc; Ubungo Farm Implements (UFI) in Dar-es-Salaam and Zana Zana Kilimo (ZZK) in Mbeya, receiving aid from China and Sweden respectively.

There are a number of companies who could be involved in the design and manufacture of seed dressing equipment, although agricultural machinery cannot be fabricated unless it satisfies the Ministry of Agriculture's standards. Testing of such equipment could be undertaken in Arusha at the centre for Agricultural Mechanisation and Rural Technology (CAMERTEC).

The actual manufacturing industry is well developed in terms of metal fabrication. Machine tools are assembled in Tanzania but only a small number are produced per annum (approximately 600 in 1988) The demand for machine tools in PTA countries, considering

only metal and woodwork machines is estimated at 6900 per annum.

Large scale farming mechanisation requirements are met by the local assembly of a number of tractor makes and types. Peasant farmers still rely on hand tools and animal drawn implements, the demand for which is growing. SIDO, the small industry development corporation, is active in helping the establishment of local manufacturing to boost production of smallholder implements.

The assistance of SIDO for the manufacture of seed treatment equipment could be sought; other companies include National Engineering Company (NECO), and Nguru Engineers, the latter of which produce cotton ginning equipment.

There is no known local production of fertilizers or pesticides, thus importation of requirements is undertaken.

PLANT PROTECTION SITUATION IN TANZANIA

The major crops in Tanzania are attacked by a large number of pests and diseases including seed and soil borne insects and diseases. Thus pests and diseases account for substantial pre and post harvest losses every year.

As with most other countries plant protection comes under the Ministry of Agriculture (MOA). Problems relating to plant protection are either reported to the MOA Extension Officers by the farmers or are identified by the officers in the first place. Recommendations are made immediately or after consultation with the Plant Protection Department. Most methods of plant protection are used to a greater or lesser extent, from cultural practices to biological control . For example biological control of the cassava mealybug is undertaken.

Chemical control is commonly used at all levels. Farmers of primary societies for example can buy sprayers etc. and after the sale of their produce deduct cost of sprayers. Knapsack sprayers are quite popularly used, although ULV and aircraft are also used especially on large farms. For epidemics, the government takes all responsibilities while for the cashew powdery mildew, sulphur motor sprayers are commonly used. Storage pests can be a real menace in Tanzania, and methods for their control include use of natural insecticides such as ashes, plants like the Neem, Crotolaria and Schinos sp.; Fumigation with phosphine, use of contact insecticides (liquids and dusts) applied by hand with gloves or with shovel; pyrimiphos methyl and permitrim used together. An on-going FAO project is on the control of the large grain borer.

As far as seed dressing is concerned, the Tanzania Seed Company (Tanseed) dresses their certified seeds as follows: For wheat, vitavax is used while for maize and the other crops farnasan D, using Gustafson Seed treaters. Sometime ago in remote areas, farmers utilised hand operated drums for treating seeds or

grains. Presently the Ministry of Agriculture produces the foundation seeds in their foundation seed farms for supply to Tanseed and also dresses these seeds using Gustaffsons as well Because of unavailability of the seed dressers (e.g. Farnasan D) foundation seeds and seeds from tanseed are sometimes sold undressed.

SEED TREATMENT

Tanzania relies heavily on farm-saved seed, since 94.2% of the farming community plant their own seed. Treated seed inputs are supplied by the Tanzania Seed Company (Tanseed)which is based in Arusha. 5000 to 6000 tonnes of treated maize seed is produced per annum using Gustafson treaters; the country requires 90 - 100,000 tonnes per annum. There are four Gustafson slurry treaters at the Arusha treatment plant each of which produce around 8 tonnes per hour of treated seed. Chemicals applied (Farnasan D on maize; vitavax on wheat and sorghum) are imported directly from Europe. Pesticide approval comes through the Tanzania Pesticide Research Institute (TPRI). also based in Arusha. Analysis of Chemical loading on seeds could be undertaken at the TPRI or at the University; however, quality is checked by sight as in all other countries visited.

Apart from maize, Tanseed also produce beans (500 tonnes), wheat (5-600 tonnes), Sorghum (4-500 tonnes), rice (not treated, 200 tonnes), sunflower and millets. They do not treat soyabean, green grams or cowpeas, although some is cleaned. Farmers rely totally on saved seed for groundnuts and pigeon peas. Maize is supplied in 25,10,5 and 2kg packs, beans are supplied in 90kg sacks, then sold from the sack in the distributors shop in the required amounts. All bags carry warnings in English and Swahili about the chemicals used in .

Maize seed comes in both hybrid (60%) and composite (40%) varieties. Hybrids are purchased by high altitude farmers who have reliable climate and then, only by those who have access to the necessary inputs. Anybody who can get to the distributors has access to the seed, but it is mainly commercial farmers who benefit. Wheat is bought by commercial farmers. Maize seed is distributed via 5 distribution offices: 2 in the south, 1 central and 2 in the north. Tanseed sells maize seed to cooperative unions (at 74 shillings/kg) or private stockists (at 72 shillings/kg) and it is sold to the farmer at 80-82 shillings/kg. The farmers cooperative unions pay more since they pay on credit, and Tanseed invariably ends up chasing the money.

Certification is undertaken by the Tanzanian Official Seed certification Agency (TOSCA). Germination is checked before treatment, then, after treatment it is retested. Some samples have failed the second test but this is due to poor storage in damp/humid conditions; no seed has failed the test due to overdressing or phytotoxicity. Testing is undertaken at the National Seed Testing Laboratory in Morogoro and any seed lot which does

not meet the minimum germination requirement of 85% is destroyed.

Waste seed is burned under supervision of the Ministry of Agriculture, any residue is buried with waste powder and slurry on a special site at the treatment plant in Arusha. Seed treatment also occurs at foundation seed level. Powders are applied using hand-powered drums, slurries are applied using Gustafson treaters. Gustafson, whose treaters are utilised by all major seed suppliers in the countries visited, are used because they produce a good finished product, but more importantly, they have good back-up facilities.

Tanseed realise that they cannot reach the majority of seed requirements in the near future, and farmers are advised through the extension service to retain composite varieties for replanting. The farmers are instructed how to select the best seeds from their harvested crop. Tanseed would be willing to help in the production and testing of a mobile seed treater to enable small scale farmers to benefit from the technology. They have facilities for field trials and demonstration plots in the farming areas and could interact with field days, machinery demonstrations, lectures and staff training. The FAO currently runs equipment training courses in which the Tanseed staff participate. The company's engineers could also participate in machine design.

Any agricultural machinery needs the Ministry of Agriculture's go ahead before it can be manufactured. Discussions with the mechanisation department of the ministry were met with enthusiasm on the project proposal for a mobile seed treater, although they also want seed cleaning and grading to be part of the package.

There is a definite need in Tanzania for seed treatment technology to meet the small scale farmer; however, the small scale farmer may see the problem differently. Many are more interested in applying pesticides to visible pests i.e. using spraying techniques. There will be great need for trials and demonstrations backed up with good extension work.

There used to be a good seed industry in Tanzania until 1981, when the American support was withdrawn resulting in a rapid decline within the industry. The FAO is attempting to rehabilitate the production of seed. Under the control of Mr Felix Mathenge, the objectives of the project are to revitalise the seed farms by the importation of spare parts for existing equipment, the purchase of new machinery, and installation of complete seed processing systems. With the installation of new centres for processing and storing, it is hoped to improve seed quality control. Even though the project is underway, it is not expected to supply more than 20% of seed requirements by the year 2000. It may be possible to collaborate with the FAO project as seed treatment is an intergral part of seed production.

AGRICULTURAL RESEARCH

Agricultural research is conducted mainly by the Ministry of Agriculture and the Universities. At the various agricultural research stations throughout the country in most agroecological zones, pertinent research related to food and export crop production and protection are being conducted. So also is the Agricultural Department of the University i.e. Sokoine University of Agriculture at Morogoro where appropriate technology packages are taken to end users through extension.

A project on beans includes pests of the crop amongst others. The Botany and Zoology Department of the University of Dar-es-Salam also undertake some agriculturally related projects including breeding for high yields and resistance to pests.

Other projects being conducted include an FAO project on the Development of National Seed Production in all food crops; Master Plan for Plant Protection Service in Tanzania; and the large grain borer projects. In addition there is also in Arusha the project on the biological control of cassava mealybug.

PERSONNEL

Some qualified personnel exist in most of the institutions mentioned. At the University of Dar-es-Salam there is a plant pathologist working on bean rusts and 2 entomologists, one of which is agricultural, working on armyworm. At the Sokoine University of Agriculture there are both pathologists and entomologists as there are in the various Agricultural Research Centres throughout the country.

ENGINEERING DESIGN INSTITUTES

INSTITUTE OF PRODUCTION INNOVATION (IPI)
P.O.BOX 35075
D.E.S.

The IPI was established originally to be a link between the Faculty of Engineering at the University of Dar-es-Salam and industry. The IPI is now a separate entity which still undertakes its original objective, and also produces agricultural machinery prototypes for sale.

They specialise in village level projects, recent undertakings have included crystalline brown sugar production,ethanol columns, oil nut crackers, maize mills (using 3 1/2h.p. motors) and dehullers. The only previous seed dressing experience is with crop dusters which were developed in conjunction with Rural Investment Overseas(RIO).

Current manpower includes 11 engineers (MSc) although 5 are out on PhD's, 50 workshop staff (some trained in Germany) and 20 administrative staff. R & D facilities are limited although workshop facilities are excellent,and the Institute is keen to be included in any fabrication work to be undertaken. They already collaborate with many organisations such as FAO, Ministries of Energy and Minerals, GTZ (the IPI is GTZ funded) and Unicef, as well as with the University faculties and local industry.

The IPI can usually obtain raw materials, it is purchase which is difficult due to the lack of local financing. Imports are priced at current world prices, and local incomes cannot compete with world market prices. A tonne of steel can cost between 150,000 and 195,000 depending on section.

The problem with many Tanzanian institutes and bodies is that wages are controlled by the Standing Committee on Parastatal Organisations(SCOPO). Wages are low so morale suffers and performance deteriorates. Many parastatal organisations suffer from manpower shortages, because of this expatriates are often brought in at considerably greater expense.

Further development of the prototype would be no problem to the IPI, problems would be incurred in field trials due to transport difficulties and logistical support. They are keen to participate in the project as it will enable further training of their staff whilst helping small scale farmers to increase productivity.

CENTRE FOR AGRICULTURAL MECHANISATION AND
RURAL TECHNOLOGY
P.O.BOX 764
ARUSHA
TANZANIA

Camertec produce agricultural implements (ox-drawn), test imported agricultural equipment, and develop appropriate technology. There are 137 permanent staff in five main departments, three of whom are involved in areas of interest to the project.

The Technology Development Directorate has two departments; the agricultural mechanisation department which is currently working on a number of projects including an ox-drawn muck spreader, a sugar cane crusher, air tight containers for storage purposes and tool frame development, and the rural technology department which is involved in investigations into biogas and water supplies, solar energy, low cost housing, cook stores and windmills.

The Directorate of Testing and Production undertake evaluations on agricultural implements from simple machetes to tractors. Current investigations include the testing and evaluation of grinding mills, knapsack sprayers, ox-drawn cultivation equip-

ment, and a number of tractors which require clearance before importation can be considered. Any machinery designed as part of the seed treatment technology project will have to be evaluated before production can be sanctioned in Tanzania.

The Directorate of Extension and Training,as its name suggests, is the centre for extension worker training. As well as undertaking extension work, surveys and giving technical advice, the department also carries out training programmes within and outside the institute. They also have a documentation centre which contains a library and files on CAMERTEC activities.

Time did not allow a personal visit to CAMERTEC, however, discussions in Dar-es-Salam led to Mr Josef Wirth and Mr Erwin Protzen being named as possible collaborators within CAMERTEC for this project. The CAMERTEC engineers like to develop new machinery from scratch; they are not so keen on redeveloping old ideas. Staffing is good but the salary, SCOPO controlled, tends to limit performance; bonus wages for workers would lead to more efficient and economic performance.

5.5 KENYA

Agriculture is the mainstay of Kenya's economy. This sector is dominated by small scale farmers who make up 90% of the agricultural population and large scale ones who contribute the remainder.

The major crops of Kenya include maize, wheat, sorghum, millet, sugarcane, coffee, tea, sisal, cotton, rice and pyrethrum, peas, beans, potatoes, groundnuts and sunflower. Some of the common pests and diseases are shown in Table 7.

TABLE 7 - Some common pests and diseases of major crops

Crop	Pests/ Diseases	Control
Maize (Zea mays)	Stalk borer (Busseola fusca)	Cultural practice Endosulphan or Diazinon
	Armyworm (Spodoptera exempta)	Endosulphan or Malathion
	Aphid (Rhopalosiphum maidis)	Dimethoate, Diazinon, formothion or fenitrothion
	Weevil (Sitophilus zeamis)	Malathion or Pirimiphos-methyl Dusts or Methyl bromide fumigation
	Red flower beetles (Tribolium castaneum)	
Wheat (Triticum spp.)	Wheat aphid Schizaphis graminum	Malathion, diazinon, dimethate, or formothion.
	Shiny Cereal Weevil Nematocerusspp.	Endosulphan or fenitrothion
	Barley fly Hylemya arambourgi	Dress seeds with aldrin or dieldrin
	Brown leaf rust Puccinia recondita	Resistant varieties
	Yellow rust Puccinia striformis	

	Glume blotch Leptosphaeria	Rotation Dress seedlings Burn stubble
	Leaf blotch pyrenophora	Rotation and seed seed dressing
	Take all Ophiopulus graminis	Rotation Firm seedbed
	Stem rust Puccinia graminis	Resistant varieties
Soya Beans (Glycine max)	American bollworm (Heliothis armigtera)	Fenvalerate, Permethrin, Cypermethrin Quinalfos, or Methidathion
	Bean fly Ophiomyia phaseoli	Seed dress with aldrin, chorfeninphos or dieldrin
	Bacterial blight Psuedomones glycinea	Use clean seed rotation
	Rusts (Pucinia purpurea)	Rotation Resistance varieties
	Downy mildew (Sclerospora sorghi)	Rotation Destroy residues
Sorghum (Sorghum vulgare)	Shootfly (Atherigona soccata)	Plant early Triclorphon Fenitrithion or Fenthion
	Pink stalk borer (Sesamia calamistis) Spotted stalk borer (Chilo partellus)	Cultural practices and Endosulphan or Diazinon
	American Bullworm (Heliothis armigera)	Fenvalerate, Permethrin,Cyper- methrin, Quinalfos or Methidathion
	Armyworm (Spodoptera exempta)	Endosulphan or Malathion
	Smuts	Seed dressing used

	Covered smut (Sphacelotheca sorghi)	routinely
	Head smut (Sphacelotheca reiliana)	Seed Dressing Rogueing, Rotation
Beans (Phaseolus Vulgaris	Beanfly (Melanagrimyza phaseoli)	Dress seeds with aldrin or dieldrin
	Bean aphid (Aphis fabae)	Dimethoate,Formothion or Diazinon
	American Bullworm (Heliothis armigera)	Fenvalerate, Permethrin, Cypermethrin,Dichlores or Trichlorphori
	Anthracnose (Colletotricham lindemuthianum)	Seed dress with captan Clean seeds, cultural practice.
	Ashy Steam Blight or charcoal rot	Use healthy seeds or dress with Thiram
	Angular leaf spot (Isariopsis griseola)	As for Anthracnose
	Fusarium Root Rot (Fusarium solani)	Seed dress with thiram. Crop rotation
	Sclerotinia sp.	Seed dress with Zineb Maneb or Mancozeb. Crop rotation and use of healthy seeds.
Groundnuts	Groundnut blight (Sclerotum rolfsii)	Early weeding
	Leaf spot (Cercospora personata)	Early planting and seed dressing. Crop rotation.

KENYAN AGRO-ALLIED INDUSTRY

Like Zimbabwe, Kenya has a highly developed manufacturing and foundry industry. Numerous companies will fabricate designs from drawings and there seems to be a reasonable supply of material. There are eight mini steel plants in Kenya, seven of which are in or around Nairobi, so sections and bars are produced locally.

The manufacture of agricultural equipment is advanced, but large scale farmers benefit more than the small scale even though small holder production accounts for the bulk of agricultural commodity output. An appropriate and cost effective mechanisation system is being promoted to bring versatile motorised hand tractors and animal draught tools to the rural communities.

Companies identified with good engineering capabilities include H. Young Engineering, Manet Engineering Works, United Filters and Engineers Ltd (fabricators from drawings), Sehmi Engineering Works (precision engineers), and Venus Industries Ltd. (producers of hand powered maize mill).

Fertilizer is imported in quantities which vary from year to year between 100,000 and 250,000 tonnes. No local manufacture occurs although the government is examining the feasibility of local production. The recent initiation of the distribution of small packets of fertilizer has been extended to ensure access to the small farmer who may not require, or be able to afford larger packs.

There is no local production of pesticides, again, supply is reliant on importation. The only plan for the production of pesticides is the P.T.A. undertaking to carry out a pre-feasibility study for a copper-oxychloride plant for the eastern part of the subregion (serving Kenya, Ethiopia and Uganda).

SEED TREATMENT

Seed treatment in Kenya is mainly undertaken by the Kenya Seed Company (KSC), a parastatal organisation which has three main treating centres. Certified agricultural seeds including maize are treated at Kitale , cereals (mainly wheat and barley) are treated at Nakuru and beans (including some vegetables and flowers) are treated in Nairobi.

The machinery, principally Gustafson is used to apply slurries to a variety of crops; maize, wheat, barley, sorghum and beans. Some large scale commercial farmers also treat their own seed, using drum mixers for powder applications and Murphy "Mist-O-Matic" treaters for liquids. Other methods such as shaking seed and powder applications together in a bag or mixing seed and chemical by shovel are also utilised on farm.

The treatment machinery utilised for bean seed production was

viewed at Horti-Seed in the Nairobi Industrial Estate. For mass production, cleaned/graded seed is treated in a Gustafson S 100 SS film coater using slurries mixed in Gustafson PM50 premix tank.

The machine uses a stiff brush auger for transport and mixing of the beans, this being less aggressive on the seed coat than wire loop augers used in similar machinery for cereal seed production. For small batches of bean varieties, the seed is heaped on to a plastic sheet, powder formulation is mixed with water in a bucket to form a slurry and then it is poured on to the heap. The slurry and beans are mixed by hand before being manually packaged in paper bags (approximately 2kg per packet). The process of mixing is undertaken by workers wearing plastic hand gloves as their only form of protection.

Seed quality comes under the National Seed Quality Control Services (NSQCS) based in Lanet. The NSQCS works in close conjunction with the KSC, undertaking field inspections, quality assessment etc. The main seed producers are positioned around the seed treatment centres. This enables transport from farm to KSC to be minimal and ensuring efficient manpower utilisation for NSQCS field workers. The seed producing farms are either large private farms (70%) or para-statal farms (30%), the size of the farm being large due to the need for isolation between crops.

If a crop is rejected for seed purposes, then it is sold to the Grain Board like a normal commodity. If accepted for seed, harvest is undertaken at physical maturity and artificial drying is necessary to reduce moisture content. The NSQCS checks treated seed for purity (99% purity is minimum requirement) and germination before it is released for sale. Seed kept in store prior to distribution is tested for germination every 3 months. If germination decreases the seed lot is destroyed by burning.

The government is actively encouraging farmers to buy treated certified seed by subsidising seed sales. Current cost of seed maize is 125 K shillings/10kg, this approximates to US$1.20 per 2kg pack, the smallest unit sold. The price is consistent throughout the country. Seed is distributed by rail through the Kenyan Grain Growers Cooperative Union (KGGCU) who has sixty branches covering all the arable areas to ensure farmers have access to seeds before the on-set of the rains. The KGGCU sells seeds to other stockists as well as directly to farmers.

The KSC works in close conjunction with the in-field agricultural extension workers. The extension worker is the link between the seed company and the farmer, advising on varietal choice, planting strategy, input timing etc. As such, many farmers rely on the extension service for information. The success of the service depends on the workers ability to keep up with modern methods as well as being able to move efficiently between farming communities to disseminate the information required.

Annual seed sales fluctuate between crops depending on the previ-

ous seasons yields. In a good year, farmers tend to keep seed back for the following season. This makes seed requirement predictions difficult and often lead to export of carry-over stock.

Hybrid maize is purchased every season (one or two seasons per year depending on agro-climate) by 90% of farmers. Medium to high altitude farms have a choice of 8 hybrid maize varieties, there is only one hybrid which is suitable for farmers in the dry areas and coastal region. The KSC produces 2 open-pollinated varieties for the arid region farmer, the usual practice is to buy new seed stock every 2-3 seasons. Due to increased demand for food supplies arid regions are being brought into production and, as such, there is an increased effort into the research for production of short-maturing varieties which can survive the unpredictability of the rains. Farmers buy treated seeds because they are aware that the cost of associated inputs is outweighed by the advantages of increased yields.

In terms of seed treatment, wheat is a target crop for many commercial farmers. In any one year, 50% of the farmers' wheat crop is farm-saved seed, 50% purchased from KSC. Wheat is expensive, so many farmers utilise on-farm seed treatment using, as previously mentioned, drum mixers or Murphy "Mist-O-matic" equipment. A further device under evaluation, the ICI P500 manually operated seed treater, has been used in trials with wheat producers in Kenya. A separate report on this machine appears after this section.

Other treated seeds produced by KSC include hybrid white sunflower seed which is grown for oil-extraction and to supply the European bird-seed market. The crop is not used in Kenya, it is purely for export. Sorghum, both brown and white varieties are produced in quantities to fulfil local demand and supply export markets. Being open-pollinated, the sorghum is purchased by farmers every few years. Pasture seed is also produced by KSC, although this is not treated. Seed is purchased for ley production every 4-5 years.

Although bean seed is sold (treated) by KSC, many farmers rely on farm-saved due to costs. The company treats in excess of 1000 tonnes of bean seed per annum and either carries surplus to the next season, or exports it.

Seeds routinely kept back by the farmer include groundnuts, cowpeas, pigeon peas and grams, as there are no viable alternatives. Dressing of such seeds would be extremely difficult due to the unavailability of seed treatments outside the KSC. Treatment of seeds, apart from that by KSC, is only undertaken by commercial farmers using sizable amounts on wheat or by firms specialising in small quantities such as vegetable seeds.

On the whole, good quality treated seed is available to the vast majority of farmers in Kenya. The supply system is enabling distribution to remote villages, and the major seed supplier

(KSC) is meeting the market for seed in maize, sunflower, wheat, sorghum and pasture.

TWIGA CHEMICAL INDUSTRIES LTD.
P.O.BOX 30172
NAIROBI

Twiga Chemical Industries Ltd., which is owned by ICI and local shareholders, has recently undertaken trials using a manually powered powder applicating seed treater. The P500, as the machine is known, is the first type of "rotostat" seed dresser designed primarily for developing countries. Using the proven Milik mixing principle, the machine has been used in a number of locations in Kenya's wheat growing areas to apply powder treatments to farm-saved wheat seed.

Using a three-man team, throughput of up to 2 tonnes per hour are achievable. Chemical application is precise: 10kg of seed are placed in the treating chamber, and the quantity of chemical required is placed on top i.e. 30g of fernasan D for instance. The machine is pedalled forwards for 10-15 seconds, then stopped and pedalled backwards to discharge the treated seed.

The pedalling action spins a rotor in the base of the treating chamber or stator. Seed moves centrifugally to the outside of the rotor, rises up the stator wall where it is slowed, and returns to the rotor surface. A helically rotating "donut" of seed is formed in which each seed rubs against the rotor and stator and against neighbouring seeds which are being continuously replaced. In this way, powder applications are rubbed from seed to seed forming a homogeneous chemical coat on the individual grains of the seed mass.

Kenya was chosen for the trials because of the availability of suitable personnel, not because it was seen as a target market, although a number of farmers wanted to buy the machine specifically for treating their wheat seed. The only problem with the machine, apart from being priced above the small scale means, was the weight. Although small enough to be mobile, the machine had to be moved around in a pick-up, again meaning it would be of limited use to smallholder communities. Further developments have led to a lighter, more mobile unit being produced, although at around £1,000, the price still remains high. The new machine can apply liquids as well as powders.

Unfortunately, the trials did not include the treatment of seeds most likely to be grown by small scale farmers. It would be necessary to undertake evaluation on application adherence and individual seed loading for various chemical formulations applied to the small scale farmer crops. It may be possible to collaborate these trials in the U.K. with the machines designers at ICI who have all the equipment necessary for such tests.

It was feared that dust may be a problem with the P500 since

there is no liquid application to "damp down" dust production; however, in practice, dust remained minimal due to the chemical quantity applied being exact to the mass of seed being treated thus most chemical adhered to the seed. The hazard was negligible when compared to that of powder applications in cement mixer drums. Even so, full safety gear was issued to the machine operators.

Whilst under trial, interest was expressed in the P500 from Rwanda, specifically for treatment of beans which are intercropped with bananas. Rwanda has a poorly developed seed treatment industry and could benefit from such technology.

It is recommended that the possibility of collaboration between the project and ICI is investigated fully since both parties have the same objective; that is bringing seed treatment to the peasant farmer.

PLANT PROTECTION IN KENYA

As in the other countries discussed, crops in Kenya are also affected by a number of important pests and diseases of economic importance.

In Kenya, the Governmental Kenya Agricultural Research Institute is charged with the responsibility for Agricultural Research in the country. It also liaises with other institutions both within and out of Kenya such as the National Council for Science and Technology and the ICIPE. KARI has various research centres in different agroecological zones throughout the country. Its priority research programmes include research on the major crops such as maize, root and tuber crops, wheat, sorghum etc, seed quality, entomology and pesticides, plant pathology and weed science amongst others. In addition it provides advisory services in the area of plant protection, pesticides, agrochemicals etc. Farmers benefit from these services geared towards alleviating pest and disease problems.

All plant protection methods are used from use of resistant varieties, cultural practices to biological control and plant quarantine legislation.

Pesticides are available from various chemical companies and stores. With reference to seed dressing, the Kenya Seed Company which is responsible for producing all certified seeds in the country treats maize seeds with Lindane and Thiram or captan and Gamma HCH. Other treatments include Baytan (universal) from Bayer i.e. powder or liquid formulations or vitavax (Uniroyal). Beans are treated with Mutano (thiram). Powdered treatments have been used for wheat and barley. Fernasan D (lindane/Thiram) another seed dresser in 30 g packets was sold to the tune of 5 tonnes in 1989 (equivalent 17 tonnes of maize). This chemical or mutano is being used by the Kenya Seed Company for treating beans

(Phaseolus). Gustafson or hand mixing using gloves or drums are utilised. Sorghum and millet are also treated on request. They are used locally or exported. Another seed dresser, Vincit (liquid and powder) for the control of soil and seedborne diseases in barley and wheat will soon be approved for use in 1990. However, at present both commercial farmers of wheat and barley dress their seeds using drums. There is however, still a market for insecticide seed treatments even though there exist a debate as to their usefulness. The Gamma HCH on the other hand is considered dangerous for use by small farmers. Furadan is thus being investigated by a chemical company and Rwanda has recently inquired about supply of Fernasan D.

Most vegetables are imported into Kenya without treatment since this may decrease their viability. However, there are laws governing this importation stating which seeds must be treated. Onions are however treated routinely. In the case of wheat and sorghum, since some farmers keep their own seeds (composites and local varieties) they are either not treated at all or self treated using traditional methods. Wheat and barley do suffer from damping off, take all and barley fly. It is claimed that small scale farmers can actually double their output by the use of pesticides.

MANPOWER

Human resources at KARI totalled 4,300, of which 600 are Research Scientists in various specialities. At the ICIPE over 200 Scientists are employed in various aspects of research relating to Insect Science.

The University of Nairobi, Faculty of Agriculture at Kabate, can boast of six plant pathologists and one entomologist, while the Zoology Department at Chiromo, six entomologists and the Botany Department two Plant Pathologists/Mycologists. Kenyatta University College has 1 entomologist.

AGRICULTURAL RESEARCH

Agricultural research in Kenya is largely under the Kenya Agricultural Research Institute (KARI). Its several research centres conduct various aspects of plant protection research from breeding for resistance to biological control of important pests and diseases. To strengthen the national capacity in carrying out the planned programmes of research effectively, KARI has established important linkages with the institutions under the Consultative Groups of International Agricultural Research Centres (CGIARs). KARI also collaborates with ICIPE and ICRAF, various foundations (coffee and tea) and even the private sector, on specific areas.

Research and Development activities on seed dressing have been conducted at KARI (NAL) and at the NSQCS. Any new chemicals must meet the requirements of the pesticides board before they are made available for sale.

The ICIPE in Nairobi and its field station in Mbita Point, undertakes on-farm research, studies and demonstrations. The main research activity is centred around the crop pest research programme aimed primarily at developing an environmentally safe and economically feasible integrated pest management system for the resource-poor small-scale farmers in developing tropical countries. It is hoped that adoption of such pest management strategies will reduce food losses caused by various insect pests and thus increase food production. At ICIPE also, the Chemistry and Biochemistry Research Unit is interested in developing new models for anti-insect activities and to explore the possibility of exploiting plant spp. by developing simple processing methods suitable for cottage-type or small-scale industries.

Other plant protection and related research are conducted by the Faculty of Agriculture at Kabate, Nairobi. For example, research activities include diseases of grain legumes and horticultural crops; control of Fusarium oxysorum on beans (Phaseolus) using organic matter (manure); breeding for resistance in legumes; fungicides of coffee; resistance mechanisms of insects to benomyl; and resistance mechanisms in sunflower; storage entomology including studies on beetles; a Commonwealth Science Council's Project on the effect of mixed cropping on diseases, pests and weeds (maize/cowpea, maize/bean intercropping). Other projects include use of tissue culture to eliminate citrus greening and the cassava mosiac virus, and a Danish sponsored project on Seed Technology. At Kenyatta University College, Zoology Department, a project on control of beanfly of Phaseolus including seed dressing was initiated, while at the Zoology Department, University of Nairobi, Chiromo, entomologists are interested in agriculture pests of economic importance. At the Botany Department, Plant Patholcgists/Mycologists are also involved in fungal pathogens of crop plants.

AGRICULTURAL ENGINEERING INSTITUTIONS

The agricultural engineering department of the University of Nairobi has direct experience of seed dressing technology. Of the five PhD's in the agricultural processing and structures department, three are in seed processing. They would be willing to participate in such a project as they have the knowledge and experience in both areas related to the project, i.e. seed treatment and equipment for rural development.

The Head of Department undertook his PhD in conjunction with Germaines of Norfolk, U.K., to design and produce a fluidised bed "pelletiser" for the production of pelleted sugar-beet seeds to enable precision drilling of the crop.

The department has limited workshop facilities but can collaborate with local industry for components that cannot be produced on campus. There are adequate design facilities and further staff training would not be necessary.

Current work includes the analysis of artificial drying techniques and their affects on seed vigour due to mechanical and thermal cracking. Other projects include soil and water conservation, animal draught and storage of non-perishables.

The department collaborates with industry and research bodies as well as internal cooperation between university faculties. Both KARI and the Kenya Seed Company work with the department. The agricultural engineering section of KARI is, as yet, non-existent. It is envisaged that an Institute of Agricultural Engineering will be established within 2-3 years; building work is under way at the National Research Centre in Muguaga to house the section.

6. CONCLUSIONS AND RECOMMENDATIONS

Plant diseases and pests, including seed and soil borne ones cause significant yield losses of important crops in the PTA subregion.

Seed treatment is being carried out on an ad hoc basis in most countries in the subregion. For example in Tanzania, Malawi, Zambia and Kenya, farmers depend almost exclusively on one centralised seed company for their supply of treated seeds. Zimbabwe on the other hand has a fairly decentralised maize seed treatment in which members of the seed coop (usually large scale farmers) produce, clean, grade and treat specified quantities of seeds on-farm, while other crops remain centralised and hence treated by the seed coop. In addition to these, there are smaller seed companies handling and treating some other seeds apart from maize on a more or less irregular basis.

In some cases the small scale farmers have to travel long distances to purchase treated and certified seeds, on other occasions, some treat their own saved seeds using archaic, inefficient and inappropriate methods such as drums, shovels, bags and hand mixing using gloves. These methods including the cement mixers are environmentally unsafe to the machine operators and seed handlers. In addition, the loading of the pesticides on the seeds is usually not homogeneous, a factor of extreme importance in any efficient seed treatment.

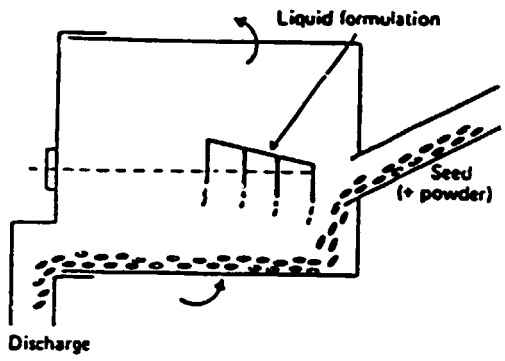
The applicators used by the seed companies are mainly imported Gustafson treaters. Large scale farmers use cement mixers and drums. Generally scientific data is lacking on the effectiveness of the treaters and even the associated pesticides used for treatment in the PTA subregion.

Usually, the physical properties, especially the shape, surface area, nature of the seed (whether smooth, hairy, wrinkled or hard) often determine the type of seed dressing methods to be used. The machinery used could therefore be sophisticated or simple, multiple or single application depending on the characteristics of the seeds. The basic process flow of a one step-multistep application are shown in Fig 1.

Seed characteristics of crops grown by the small scale farmer are important in terms of seed treatment due to the variation in degrees of adhesion between different formulations on various seed types. Adhesion of pesticides to a surface is a complicated process brought about by many factors, from molecular forces to physical trapping of small particles.

Formulations must adhere to seeds and be distributed uniformly among them, characteristics of the seeds, especially shape and surface texture, are important components of the seed treatment process in terms of mixing, chemical distribution and chemical retention.

FIG 1. PRINCIPLE OF DRUM MIXING TREATER



PRINCIPLE OF HORIZONTAL AUGER MIXING AS USED IN STATIC GUSTAFSON MACHINERY ALREADY PRESENT IN MANY P.T.A. COUNTIRES.

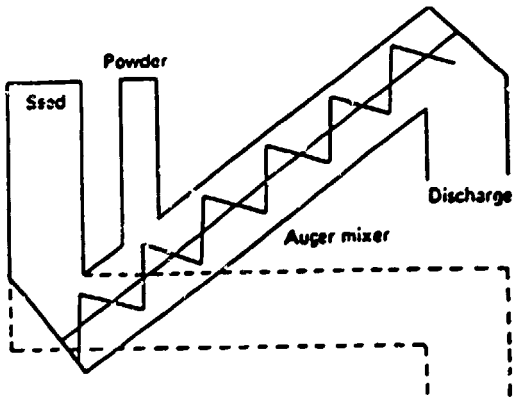
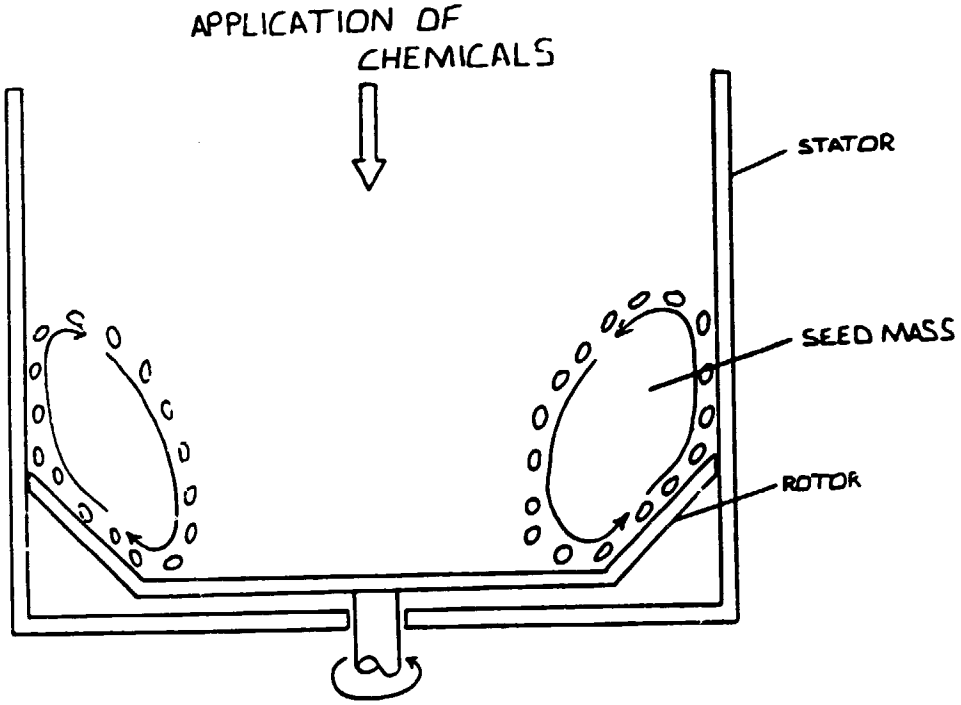


DIAGRAM TO SHOW "MILIK" MIXING PRINCIPLE



Zea mays (Maize) which is the main crop in the countries visited has a hard, flat, discoid seed which, it was noted, picks up slurry treatments especially on the pedicel at the base of the seed. Most farm saved seed is flint type, which contains less soft starch than hybrid (dent) varieties and has a more rounded kernel.

Arachis hypogaea (Groundnuts) vary in shape from almost spherical to roughly cylindrical, and have a rough texture. Powder treatments adher well, however, hand sowing or subsequent handling could easily dislodge powder applications. The use of an adhesive agent would be recommended.

Phaseolus spp. (Beans) have a smooth testa which will not pick up powders well unless the formulation consists of very small particles (this forms a dust hazard) and adequate mixing is undertaken to give an increased area of surface contact between the seed and the powder.

Soyabeans are ovoid, nearly spherical, and up to 12mm long. Mixing the seed should present no problems, however, chemical pick-up may be limited with powder applications.

After treatment, the seeds will be carried to stores, carried to the field and then sown by hand. If the chemicals are not adhering well, much of the treatment will be lost prior to the sowing of the seed leading to inadequate protection. It will be necessary to evaluate various formulation and adhesive agents with each crop to ensure an adequate coverage and chemical retention are achieved.

The estimated percentage of treated maize seeds produced in the various countries is shown in Table 2. Also, the percentage of agricultural output by small and large scale farmers is given in Table 3.

It is clear that the percentage of farmers in receipt of treated seeds varies from one country to the other. In Zimbabwe for example, more than 80% of the farmers utilise treated maize seeds while in Kenya 90%; in Zambia, 60-70%; in Malawi, 10%; and in Tanzania, about 14%.

The percentage of farmers receiving or utilising treated seeds of the other crops apart from wheat in Zambia and Zimbabwe is far less than that of maize. Table 4 shows the certified seeds used as a percentage of the total seeds planted for each crop in selected PTA countries.

TABLE 2 Estimated Percentage of Treated Maize Seeds Produced in Selected PTA Countries

Country	% Treated Maize Seeds
Kenya	90
Malawi	10
Tanzania	14
Zambia	70
Zimbabwe	83

TABLE 3 Agricultural Output by Small and Large Scale Farmers

Country	Small Scale Farmers	Large Scale Farmers
Kenya	Small scale (90%)	Large scale (10%)
Malawi	Smallholder agri-culture (85%)	Estate agriculture (3/4 total output)
Tanzania	Small scale(83%)	Large scale (17%)
Zambia	Small scale(80%) 22,000 medium scale farmers and large numbers of small scale traditional farmers producing 60% of maize and 45% of other produce.	Large scale (20%) Commercial farmers (800) produce 40% maize and 55% other produce
Zimbabwe	Small scale African commercial farmers (8500) using 1.5 million ha, and small holder family farms in communal areas (850-950,000) using 16 million ha.	Large scale Commer-farmers (4500 farms) using 1.5 million ha.

TABLE 4 - Certified Seeds* as a Percentage of Total Seeds Planted for each crop in selected PTA countries**

Country	Maize	Wheat	Sorghum	Rice
Kenya	90	50	-	-
Malawi	10	19	5	12
Tanzania	14	15	9	1
Zambia	70	97	0	0
Zimbabwe	83	97	25	0

- data not available, however Kenya does meet its requirements for treated sorghum seeds and exports surpluses.

* For both maize and wheat all certified seeds are treated.

** Countries like Rwanda and Burundi will have low percentage of treated seeds.

Indications are that there is a large proportion of the different crop material sown that would benefit from seed treatment. The majority of staple and non-staple seed inputs are still farm saved in countries such as Malawi, Tanzania and Rwanda. Other countries rely on farm saved seed for non-staple products. The potential for mobile seed treatment technology is immense relative to percentage of harvested crop resown in these countries per annum. This gap could thus be filled by producing a mobile seed dressing applicator that can satisfy the needs of the large numbers of small scale farmers, who produce the bulk of the agricultural commodities in the various countries, but utilise untreated seeds.

Large scale farmers keen to reduce input costs will also be interested is dressing their previous seasons crop for seed. Other interested parties would include seed companies wishing to dress small quantities of seed which do not warrant the use of the large static machinery, possible use for dressing of low volume high value seeds (vegetable seeds) on a commercial basis, dressing of seed from store when a shortfall in seed is experienced, and for utilisation by farmers contracted to supply seed companies with treated seeds.

The scope for Malawian involvement is increased due to the excellent service undertaken by the in-field ADD extension workers. The ADDs act as a bridge between the farmers and technical service researchers. They also advise and train farming communities and conduct adaptive research. As such, the ADD and similar establishments in other PTA countries are ideally placed to disseminate the technology.

Given the difficulties of transport and communication in rural societies, it is recommended that seed treatment plant should be developed which could serve different parts of the country and which would offer on-the-spot treatment of seeds to be used by the farmers probably through farmer groups or cooperatives. Individual farmers and seed companies can also utilise the technology. This however, means that a prototype mobile seed treatment applicator would have to be developed and tested in selected PTA countries. Mobile seed treatment applicators have in the past been developed and used in the UK and Australia. The technical knowledge used for the development of seed applicators could therefore be adapted using a modern technology to develop appropriate mobile seed dressing applicators for use in Africa. In designing the applicators provision should be made for safe disposal of any waste generated in the seed dressing process and for easy maintenance and repairs in addition to availability of appropriate power source and safety for the operators.

Although some amount of crop pest programme is carried out in the sub-region, notably that at the various Ministry of Agriculture Research Stations, the Universities and the ICIPE in Kenya, very little engineering design for agricultural machinery and implements has been done in the sub-region to date.

The Ministry of Agriculture of most countries in the sub-region contain agricultural research station(s) undertaking inter alia, crop pests research in their plant protection division and agricultural engineering research and development. In general, the major crops of the sub-region are investigated by these research stations which include the Mount Makalu Research Station in Lusaka, the Department of Research and Specialist Service in Harare, the Chitedze Agricultural Research Station in Lilongwe and the Kenya Agricultural Research Institute in Nairobi. At Lilongwe actual research on seed dressing of groundnuts have been conducted.

Likewise, the Agriculture and Science Faculties of most of the universities undertake some amount of plant protection research on pests and diseases of important crop plants in the subregion, while the Agricultural Engineering departments undertake limited design and fabrication. These institutions include the Universities of Zambia, Zimbabwe, Malawi, Tanzania and Kenya; the Sokoine University (Tanzania) and the Kenyatta University (Kenya).

The ICIPE, located in Kenya, undertakes on-farm research studies and demonstrations. The main research activity is centred around the crop pest research programme aimed primarily at developing an environmentally safe and economically feasible integrated pest management system for the resource-poor small scale farmers in developing tropical countries.

It is hoped that adoption of such pest management strategies will reduce food losses caused by various insect pests and thus increase food production. The actual components of pest management being developed at the ICIPE belong to four main categories:

(1) Manipulating cultural practices, including (a) intercropping host-nonhost or inter-varietal crop combinations to reduce pest attack, (b) adjusting planting time in relation to pest attack, (3) using natural enemies (parasitoids, predators, pathogens) of the pests to control the pests biologically; and (4) manipulating pest behaviour for indirect pest control.

Also at the ICIPE, the Chemistry and Biochemistry Research Unit is interested in the development of new models for anti-insect activities and to explore the possibility of exploiting the plants by developing simple processing methods suitable for cottage-type or small-scale industries. Thus this unit could also participate in future research projects into new formulations, and alternate pesticides from plants such as the Neem, Tephrosia spp. and Schinus spp. which are already being used in traditional agriculture in various countries.

Suggested tests that could be conducted

Several experiments could be conducted to assess the efficiency of seed dressing including the following:

* Experiments with powder, liquid or slurry; powder plus adhesive, using different pesticide rates (fungicides, insecticides or mixtures of both).

* Assessment of loading (ug pesticide/g seed) and distribution (ug pesticide/seed), using a fluorescent tracer dye or simple extraction and quantification.

* Effects of humidity (dry days vs. wet days).

* Assessment of pesticide retention on to seeds.

* Effect on pesticide on seed germinability.

* Phytotoxicity of pesticides.

* Standard field trial experiments: Replicated trials using statistically appropriate methodologies such as randomised blocks of plots for assessment of level and severity of disease, insect damage, seedling emergence and crop yield.

SPECIFIC RECOMMENDATIONS

1. Two or three PTA countries e.g. Malawi, Tanzania and Zambia should undertake the project to research and design a mobile seed treater for use in the PTA subregion. At least one country should be in the South, one in the East. This will enable testing to be undertaken in a wide variety of agroecological zones. The chosen countries need not have been included in this report, e.g. Rwanda.

2. A company or institution in a developed country which has experience in seed treatment technology should be sub-contracted to participate in the project. Engineers from selected PTA institutions should participate and obtain training in seed treatment technology.

3. The training of technical staff in various aspects of seed treatment technology should be undertaken in conjunction with a developed country. People to be trained in the sectors relevant to their own field should include a biologist, an engineer, and a chemical formulator from each participating country. Training could involve collaboration with universities, research stations, chemical companies etc and areas to be covered would include operation, maintenance, field trials and safety aspects.

4. A regional coordinator should be appointed to the project

5. The fabrication of the prototype should be undertaken in the PTA countries using locally available materials wherever possible.

6. Testing and evaluation of the prototype should be undertaken by local scientists, engineers and extension workers in the PTA country concerned. By the use of field trials and demonstration plots, technology will be introduced to rural areas whilst machine performance is assessed. It is recommended that personnel at local research stations and universities identified in this report be utilised in field trial analysis.

7. Collaboration between PTA countries (TCDC) and between institutes should be actively pursued.

8. Further research should be undertaken into new formulations, new pesticides, natural products; the performance of various chemical applications in terms of adherence and effectiveness; and on safety aspects of pesticides.

9 Treated seeds should be packaged in such a way as to prevent misuse or accidental consumption. Seeds must be labelled in local languages explaining clearly the dangers of chemical abuse, how to use the seed correctly, and remedial action to be taken in the event of contamination. Extension workers should be employed to disseminate knowledge of treated seeds, and to educate the small scale farming communities into the correct utilisation of

the commodity.

10. The design should be a model for similar mobile machinery for application of chemicals to grain prior to storage. The possibility of incorporating cleaning and grading equipment into the treater should be investigated.

11. The possibility of governments or foreign aid agencies subsidising the prototype should be investigated.

12. A report containing descriptive accounts of the R & D process, the techno-economic analysis and data from field trials conducted in selected PTA countries should be produced.

13. Logistics of operation should be investigated in terms of machine use: cooperatives, farmer groups, private ownership, etc.

14. Other target beneficiaries for the utilisation of the machine such as seed companies, commercial farmers, research institutes etc. should be explored.

7. SELECTED BIBLIOGRAPHY

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2. Commercial Crop Production Recommendations, Department of Agriculture, Zambia (1987).

3. Kenya Agriculture Research Insitute (KARI) Handbook (1989)

4. Jeffs, K.A. (1986) Seed Treatment, British Crop Protection Council Publication, U.K.

5. National Development Plans of Zambia, Zimbabwe, Malawi, Tanzania and Kenya.

6. UNDP/FAO (1984) Action Programme for Improved Plant Protection in Malawi - Report of Survey on Plant Protection.

7. Wellring, A.H.A. (1984) Seed Production Handbook of Zambia Department of Agriculture, Lusaka, Zambia.

8. ANNEXES

8.1 LIST OF PERSONNEL INTERVIEWED

Zambia

1. Mr Mwencha
   Director of Industry
   PTA Secretariat

2. Mr Semiti
   Director of Agriculture
   PTA Secretariat

3. Mr M. Soko
   Deputy Director of Planning
   Ministry of Agriculture
   Lusaka

4. Mrs Thole
   Production Manager
   Zamseed Company Ltd
   Lusaka

5. Mr Bo Hermansson
   Processing & Storage Manager
   Zamseed Co. Ltd.
   Lusaka

6. Dr S. Kanyanga
   Head, Mech. Eng.
   University of Zambia

7. Dr N.G. Musanda
   Head, Dept. Agric. Eng.
   University of Zambia

8. Dr N. Kwendakwema
   Dept. Agric. Eng.
   University of Zambia

9. Dr Mwenbe
   Head, Dept. of Crop Sciences
   Faculty of Agriculture
   University of Zambia

10. Mr Samson Banda
    NCSR
    Lusaka

11. Mr Kashweka
    Engineer, Storage Dept.
    Ministry of Agric.
    Mt. Makulu

12. Mr Sindazi
    Chief Agric. Engineer
    Ministry of Agric.
    Lusaka

13. Mr Chalabesa
    Entomology Dept
    Ministry of Agriculture
    Mt. Makulu

14. Mr J.M. Moonga
    Head, Seed Control &
    Certification Insitute
    Ministry of Agriculture
    Mt. Makulu

15. Mr C.K.M. Kaposhi
    NCSR
    Mt. Makulu

16. Mr Joseph L. Nyangu
    Marketing Officer
    Zamseed Co. Ltd
    Lusaka

17. Mr Kazaluka H.K. Goma
    Sales Engineer
    Northland Agricutural Ltd
    Ndola

18. Mr Tapacha
    Spares Manager
    Rover Zambia
    Lusaka

ZIMBABWE

1. Mrs Kono
Ministry of Industry
Harare

2. Dr S. Wringwiri
Ministry of Industry
Harare

3. Mr Nkomangi
Ministry of Industry
Harare

4. Dr D.L. Cole
Crop Science Department
Faculty of Agriculture
University of Zimbabwe

5. Dr D. Giga
Crop Sceince Department
Faculty of Agriculture
University of Zimbabwe

6. Dr M. Simon
Mech. Engineering Dept.
University of Zimbabwe

7. Mr J Ascough
Development Technology Centre
University of Zimbabwe

8. Mr T. Rukuni
Development Tech. Centre
University of Zimbabwe

9. Mr S. Tembo
Dept. Agricultural Engineering
University of Zimbabwe

10. Mr Chiuswa
Dept. Agricultural Eng.
University of Zimbabwe

11. Mrs E. Konjeku
Zoology Department
University of Zimbabwe

12. Dr(Mrs) F. Nychawa
Botany Department
University of Zimbabwe

13. Ms Audrey Mutambara
Zoology Department
University of Zimbabwe

14. Mr Pete de Villiers
Production Manager
Seed Coop, Harare

15. Mr Jimmy Young
Production Manger(crop seeds)
Seed Coop, Harare

16. Mr A. Derek Cailey
Research Manager
Grain Marketing Board
Harare

17. Dr Mlambo
Head, Plant Protection
Dept. of Research & Specialist
Service (DRSS)
Ministry of Agric, Harare

18. Dr C.L. Keswani
Technical Adviser
Dept. of Research &
Specialist Service(DRSS)
Min. of Agric, Harare

19. Mr C.R. McCulloch
FAO Representative
Harare

20. Mr D. McConaghy
Zimbabwe Fertiliser Co.
Harare

21. Mrs Munyaradzi
Seed Services
DRSS, Harare

22. Mr Ndola
National Farmers Ass.
Harare

23. Mr B. Mukwende
National Farmers Ass.
Harare

24. Mrs V. Marimbe
National Farmers Ass.
Harare

25. Mr K. Elliott
Institute of Agricultural
Engineers
Ministry of Agric, Harare

26. Mr Ian Norman
Certseed Zimbabwe(PVT)
Ltd., Export Co. for
Seed Coop, Harare

27. Mr J.J. Bungu
Executive Manager
Technical Services
Zimbabwe Iron & Steel Co. Ltd
Redcliff, Zimbabwe

MALAWI

1. Dr J. Chigaru
Ministry of Trade & Industry
Lilongwe

2. Mr P.P. Rivah
Ministry of Trade & Ind.
Lilongwe

3. Mr L. Bwea &
Mr G.M. Limwada
National Research Council
Lilongwe

4. Ms Maria Paris
FAO
Programme Officer
Lilongwe

5. Dr D. Mthindi
Senior Deputy Secretary
for Planning
Ministry of Agric.
Lilongwe

6. Mr Huva
Senior Economist
Planning Department
Ministry of Agric.
Lilongwe

7. Dr G.Y. Mkamanga
Chief Agric. Research Officer
Ministry of Agric
Lilongwe

8. Mr Signan Chiranbo
Ag. Deputy Programme
Manager, Kasoogo ADD
Lilongwe

9. Mr Barry King
Agrimal(Malawi) Ltd
Blantyre

10. Mr S. Durante
Brown & Clapperton Ltd
Blantyre

11. Mr D.A. Nkosi
General Manager
Shell Chemicals Ltd
Blantyre

12. Mr R.K. Chawinga
Sales Manager
Shell Ltd.
Blantyre

13. Mr P.N.H. Zulu
Seed Technologist
Chitedze Agricultural
Research Station
Lilongwe

14. Mr k.F. Kapila
Crop Storage Unit
Chitedze Agricultural
Research Station
Lilongwe

15. Mr Charles Kisyombi
Senior Plant Pathologist
Chitedze Agric. Res. Station
Lilongwe

16. Mr W.F. Kumwenda
Farm Machinery
Chitedze Ag.Res.Station
Lilongwe

17. Mr S. Givera
School of Agricultural Eng.
Bunda College of Agric.
Lilongwe

18. Dr O.G. Simango
School of Agric. Eng.
Bunda College of Agric
Lilongwe

19. Mr E.J.R. Hazelden
Director
National Seed Company of
Malawi, Lilongwe

20. Mr J. Graves
UNDP Programme Officer
Lilongwe

TANZANIA

1. Mr E.G. Moyo
Extension Department
Ministry of Agriculture
Dar-es-Salaam

2. Programme Officers
FAO
Dar-es-Salaam

3. Mr F. Mathenge
FAO Project Officer
Development of National
Seed Production
Dar-es-Salaam

4. Mrs F.F. Katagira
Agriculture Officer
Plant Protection
Ministry of Agriculture
Dar-es-Salaam

5. Dr Musa Hassan
Mechanisation
Ministry of Agriculture
Dar-es-Salaam

6. Prof. M.T.Mnbaga
Botany Department
University of
Dar-es-Salaam

7. Prof. F.K. Kasule
Zoology Department
University of Dar-es-Salaam

8. Mrs S. Masawe
Seed Multiplication Unit
Ministry of Agriculture
Dar-es-Salaam

9. Mrs S. Mlay
Seed Multiplication Unit
Ministry of Agriculture
Dar-es-Salaam

10. Mr S. Kanga
Director
Tanseed, Arusha

11. Mr Jan R. Jasper
Inst. of Production Innovation
(IPI), Dar-es-Salaam

12. Mr W.M.N. Mrema
Hoechst Tanzania Ltd
Dar-es-Salaam

13. Mr Magari
Statistician
Ministry of Agric.
Dar-es-Salaam

14. Mr Limu
Agricultural Economist
Ministry of Agric.
Dar-es-Salaam

KENYA

1. Mr Oduigi
Ministry of Planning
Nairobi

2. Mr Ongongo
Ministry of Industry
Nairobi

3. Ms S. Alambo
Ministry of Industry
Nairobi

4. Dr J.D. Wachira
KARI
Nairobi

5. Mrs M.N. Wabule
KARI
Nairobi

6. Dr N.C. Otieno
Botany Department
University of Nairobi

7. Mr G.N. Kibata
Plant Protection
National Agriculture Lab.
Nairobi

8. Mr M.R. Brown
Twiga Chemical Industries
Ltd., Nairobi

9. Mr R. Muriuki
Kenya Seed Company
Nairobi

10. Mr Gadhua
Hortiseeds
Nairobi

11. Deputy Director
ICIPE
Nairobi

12. Prof. A. Hasanali
ICIPE
Nairobi

13. Dr W. Lwande
ICIPE
Nairobi

14. Dr W. Otieno
ICIPE
Nairobi

15. Prof. Mukunya
Faculty of Agriculture
University of Nairobi
Kabete

16. Dr D.K.A. Some
Agric. Eng. Dept.
Univ. of Nairobi
Kabete

17. Mr B. Vadera
Booth Manufacturing Africa Ltd.
Nairobi

/

KENYA

1. Kenya Seed Company
   Head Office
   P.O.Box 553
   Kitale

2. East African Seed Company
   Nairobi

3. H. Young Engineering
   P.O.Box 30118
   Funzi Road
   NBI

4. Manet Engineering Works
   P.O.Box 18186
   NBI

5. Mr M.H. Bharadia
   United Filters and Engineers Ltd.
   P.O.Box 18092
   NBI

6. Sehmi Engineering Works
   P.O.Box 42944
   Kombo Munyin Road
   Pumwani
   NBI

7. Venus Industries Ltd
   P.O.Box 78124
   NBI

8. Mr Peter Kabudia
   Production Manager
   Hortiseed
   Nanyuki Road, Industrial Area
   NBI

ZAMBIA

1. Dr Zulu
   Biology Dept.
   University of Zambia
   Lusaka

2. Prof. Kapoona
   Biology Dept.
   University of Zambia
   Lusaka

3. Dr Dedaat
   Crop Science Dept.
   University of Zambia
   Lusaka

ZIMBABWE

1. Lane Engineers(PVT) Ltd
   Harare

2. G. North & Sons (PVT) Ltd
   Harare

3. NEI Cochrane Engineers
   Harare

4. Tinto Industries Ltd
   Worthington

MALAWI

1. Malawi Iron & Steel Corporation Ltd (MISCOR)
   Blantyre

2. Mr Kosta
   Engineering Foundry
   Blantyre

TANZANIA

1. Small Industry Development
   Corp (SIDO)

8.3 CURRENT PRICES

PRICES OF INPUTS AND FINISHED AGRICULTURAL PRODUCTS

MALAWI:	Bicycle:	M.K. 300.00
	Chain:	" 10.50
	Pedals:	" 12.00
	Cotter pin:	" 0.60
	Crank:	" 4.30
	Sprocket:	" 12.50
Animal drawn:	Plough:	" 106.67
	Ridger:	" 143.00
	Cultivator:	" 128.00
	Groundnut lifter:	" 172.00
	Pump sprayer:	" 210.00(3.5litre)
Safety equipments:	Gloves:	" 17.50
	Masks:	" 12.50
	Goggles:	" 2.50
Steels:	Sheet:	" 3000.00/tonne
	plate (12mm):	" 2000.00/tonne
TANZANIA:	Steel sheet:	5000 sh/m
	Steel plate (12mm):	195000 sh/tonne
	Ox cart:	7500/=
	Axle and wheels:	2900/=
	Pneumatic wheel rims:	850/=
	Pillar block bearing:	4000/=
KENYA:	Square steel hollow section per 6m length:	
	40mm x 40mm x 2mm thick:	Kshs 260.70
	60 x 60 x 4	:Kshs 767.25
	Rectangular hollow section per 6m length.	
	40mm x 20mm x 2mm thick	Kshs 192.30
	60mm x 40mm x 2mm "	Kshs 328.30
	60mm x 40mm x 3mm "	Kshs 483.35
	Sheets: 8ft x 4ft x 1mm	Kshs 435.30
	Plate : 8ft x 4ft x 6mm	Kshs 2280.70