

MAFE Marketing & Enterprise Program (MEP)

Mid-Phase Report on Activities, Achievements and Prospects

*Strategic species, potential product and by-product uses and marketing,
raw materials procurement, process monitoring and adaptive research,
qualitative and quantitative analysis,
environmental impact and economic assessment*

November 2001

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Companion documents:

1. **MAFE Dossier on Mechanical Oil Extraction Systems
November 2001**
University of Malawi Bunda College of Agriculture (BCA)
Agricultural Engineering Department Reports:
 - Ø *Design Modifications to Sundhara Sayari Oil Expeller for Moringa Oleifera and other Agroforestry Tree Seeds*
 - Ø *Oil Extraction using Tinytech Expeller*
 - Ø *Optimization of Oil Extraction from Moringa Oleifera, Trichilia Emetica and Jatropha curcas using Ram and Spindle Presses***H.F. Mbeza, M. Chawala & K. Nyirenda**

2. **Malawi Bureau of Standards (MBS) Qualitative/Quantitative Assessment of Plant Oils (MAFE)
July 2001**
R.P. Banda et al

3. **University of Malawi
Chancellor College Chemistry Department (CCCD)
Qualitative and Quantitative Assessment of MAFE Plant Oils and By-products, and Recommendations
November 2001**
E.M.T. Henry, PhD et al

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CBNRM *community-based natural resources management*
NPP *natural plant product*
NR *natural resource based*

EXECUTIVE SUMMARY

Malawi Agroforestry Extension Project (MAFE) operates under a cooperative agreement between Government of Malawi, USAID and Washington State University.

MAFE Project launched a Marketing and Enterprise Program (MEP) in 2000. Objectives are to investigate, research, pilot, select and promote production and marketing of *natural resource-based* (NR) products, with the view to enhancing rural incomes and the adoption of *natural resources management* (NRM) practices.

MEP research and development and test marketing aim to provide the genesis of one or more *community-private sector partnerships* that sustainably exploit under-utilized agroforestry and wild plant species. *Early-maturing* species promoted for NRM purposes have been given priority in the screening process. They have been scrutinized against economic, social and environmental selection criteria devised by MAFE and its partners.

A cluster of seven *strategic species* has been selected. They all share potential as *sources of seed oils for various subsistence/food security and commercial applications* and, in some cases, offer interesting *by-products and/or plant extracts*. Most of the focus of effort is directed towards *Moringa oleifera*/ Moringa tree and *Jatropha curcas*/Jatropha, which are naturalized, fast-growing homestead/hedgerow species for which a rich bibliography has been traced. Both are under research and development at other focal points in Africa and show some success in commercialization; in West Africa Moringa is heavily promoted as a 'food security' vegetable crop.

Five other *indigenous oil-bearing species* are under investigation:
 Natal Mahogany (*Trichilia emetica*)

Manketti (*Schinziophyton rautanenii*)
 African Star-Chestnut (*Sterculia africana*)
 Marula (*Sclerocarya birrea*)
 Neem (*Azadirachta indica*)

A national and regional market survey is being mobilized by MAFE and is expected to reveal commercial opportunities for products from these and other plants. Coverage will include the leguminous under-sown fallow crop *Tephrosia vogelii*/Tephrosia, as well as a few species targeted by the USAID-supported continental 'project', Agribusiness in Sustainable Natural African Plant Products (A-SNAPP). The survey will include a focus on potential medicinal, pesticide and anti-feedant applications.

MAFE and its partners, notably University of Malawi and the Enterprise Development and Training Agency (EDETA), an NGO, have investigated manual and motorized seed oil extraction technologies and, out of necessity, have successfully improved their suitability for tree seeds. Motorized systems extract significantly more oil than manual systems; they involve technical complexity and significant capital outlays. Where seed supplies are not limiting, the *lifetime* capital cost of motorized extraction equipment/unit volume of oil produced is not a major determinant of profitability and is not materially different from the capital cost/unit volume in manual systems.

MAFE calculations indicate that in a free market, provided that seed transport is economic, owners of motorized oil extraction systems would probably be in a position to provide more *on-farm added value* from purchasing seeds than producers themselves can generate from manual systems. However, MAFE will not promote motorized extraction systems for tree seeds (it could for sunflower) until it is certain about the market potential of the 'products'.

Test batches of tree seed oils have been produced in partnership with a small-scale business, Khumbo Oil Refinery and the economics of the processes involved have been monitored, principally by EDETA.

Oil samples have been assayed and partly characterized by University of Malawi and Malawi Bureau of Standards (MBS). On their recommendations, detailed analysis and full product characterization is being commissioned abroad.

To enable edible tree oils to meet MBS Standards, current small-scale edible oil production systems need to be complemented by effective filtration and refining. The partners are finding means to address these problems.

Pending completion of the national and regional market survey, the partners are supporting a producers' association, BCM Associates, to scale up experimental production of Moringa oil. The association will explore its potential in the national market, determine the feasibility and logistics of seed procurement and, with partner support, find solutions to quality control problems. Although MAFE is underwriting certain elements, this program will not directly involve MAFE personnel; it is felt that MAFE's physical presence would disturb the normal processes of negotiation between buyers and sellers and possibly distort day-to-day management.

The partnerships developed over the last 12 months remain strong. The work is topical to the interests of the Southern Africa Natural Products Trade Association (SANProTA) - of which EDETA is a founding member - and of the DfID-assisted Southern Africa Marula Oil Producers' Network (SAMOPN).

For the period until the end of January 2002 all Project efforts are to be directed to :

full characterization of potential 'products' (by overseas laboratories); and
 generation of comprehensive national, regional and international market information for the respective products.

Once products have been fully characterized and market opportunities have been identified it will be important to establish that *seed acquisition costs* and *extraction efficiency* can assure commercial viability for each species. Provided that market research reveals potential for a strategic species, it should be subjected to an expanded product extraction and trial marketing program along the lines now applying for BCM Associates' work with Moringa.

Given the forecast timetable of market research, future extraction and trial marketing programs may not commence until February 2002 at the earliest. According to opportunities identified, this could catch the

harvests for three species before MAFE closes in July 2002 but would probably miss the window for one. The 2002 harvest seasons for two species will arise after MAFE's closure.

1 INTRODUCTION

This report covers work undertaken up to 30/09/01^[1]. Analysis of opportunities will be completed upon conclusion of on-going market investigations.

In October 2001 the draft document was circulated for peer review internally, among partner organizations and a small number of organizations engaged in similar work. In addition to guidance from Washington State University - International Programs, the following organizations provided helpful comments:

BTP
COMPASS
SADC-ICRAF
SHOGA
Pirimiti Limited

A separate report on the proceedings of a **Stakeholders' Mid-Phase Review** (25/07/01) is also available.

1.1 Malawi Agroforestry Extension Project (MAFE)

MAFE is a cooperative agreement between USAID and Washington State University (WSU) with the Ministry of Agriculture and Irrigation (MAI).

The **project purpose** is to *improve natural resource management with sustained improvements in smallholder farming by increasing the adoption of agroforestry*. MAFE's vision is for Malawi's people to use and manage their natural resources in ways that will improve their quality of life today and sustain improvements into the future.

The current **MAFE LandCare Phase** is broadening the nature of support services to better reflect the range of NRM technologies offered. The program maintains MAFE's basic management and programmatic structure with its affiliation under the Land Resources Conservation Department (LRCD) in the Ministry of Agriculture and Irrigation (MAI). It continues its core operational framework to aggressively maximize the adoption of proven NRM practices through MAFE's support services and partnerships with an added dimension on value-added benefits. Many NRM practices yield products that offer tremendous opportunities for domestic and export markets, particularly in the manufacture of environmentally friendly bio-chemicals, insecticides, medicines and cosmetics. The identification and development of market niches for these products will help transform the narrow base of Malawi's smallholder agriculture to a more vibrant, market economy that offers sustained productivity in harmony with the environment. The approach is consistent with the USAID's evolving development plans for Malawi's agricultural sector, which has a key focus on increasing smallholder productivity and incomes through improved crops and practices, and the development of new markets for high-value NRM products.

Materials and services will be provided on a semi-commercial basis through the new MAFE Resource Center (now located in LRCD premises) to meet real market demands and to build capacity for sustainability where partners and clients share costs for services received. Basic support will be offered to field partners and other implementers on a scaled down level as they become more self-sufficient. Support will include quality germplasm, extension and training materials on recommended practices, and technical advice and training on establishing and managing NRM practices. The nature of Resource Center support will include:

- Formal Partnerships based on a record of successful field-based programs. These include specific ADDs under the MAI, the Forestry Department, PROSCARP, VIFOR, and several NGOs, namely ELDP, CSC, CRS, WVI, OXFAM and CARE International.
- Informal Support to individuals, groups, communities, clubs, small NGOs and others that come to the project for information or support on NRM practices.
- Investigation of production and new market opportunities for NRM products that offer value-added benefits through research and linkages with the private sector.

1.2 Policy Environment

LRCD describes the Policy of Government of Malawi on agroforestry as follows:

- Establish long-term sustainable use of soil and related natural resources, with a focus (MAFE) on improving soil fertility;
- Expand agroforestry support generally, with assistance from NGO and donor communities;
- Establish a conducive investment climate to support investors in commercial production that has positive soil improvement/conservation benefits;
- Through the Planning Division of MAI, monitor prices and identify (seasonal) market windows inside *and outside* Malawi;
- Support production up to the level of foreseen market demand, and avert gluts;
- Resuscitate former institutional R & D in agroforestry-based products, specially from Moringa;
- Actively encourage agroforestry investment according to a farming system-compatible approach.

MAFE collaborates closely with the **Forestry Research Institute of Malawi** (FRIM) supporting two of the four FRIM core programs, i.e. **Trees on Farm** and **Seed and Tree Improvement**, and is a member of the **National Agroforestry Steering Committee**.

The following Strategies of the **National Forestry Programme 2001** (Priorities for Improving Forestry and Rural Livelihoods) are routinely pursued by MAFE although it is not directly associated with it:

- Support community-based forest management,
- Improve individual smallholder livelihoods, and
- Sharpen research and information systems.

MAFE operates under **USAID 2001 – 06 Natural Resources Management** Design Areas for Key Intermediate Result 1.3: Increased Local participation in NRM, i.e:

- Design Area 1: Improved CBNRM
- Design Area 2: Increased NRM-based Enterprise Development

The USAID-supported **Community Partnership for Sustainable Resource Management** (COMPASS) project is also active in these Design areas and is a potential facilitator of enterprises that may be supported by MAFE after the results of MEP R&D have been assessed.

1.3 Program Definition

1.3.1 Scope of Work, Personnel and Timetable

The MAFE Marketing and Enterprise Program (MEP) was launched in October 2000 upon recruitment of a Marketing and Enterprise Specialist. He collaborates closely with the Head of the MAFE Resource Center and with LRCD's National Coordinator. MAFE employees support specific activities of the MEP when their commitments permit.

The overall MEP Workplan^[2] for October 2000 to July 2002 was presented in the MAFE Annual Workplan 2000 – 2001 and is reproduced at Annex 1of this document.

Aims of the Program

The main aims are as follows:

Goal

Enhance rural livelihoods through production and marketing of natural resource based (NR) products^[3] from plants that contribute to the sustainable use and management of farm resources.

Purpose

Identify potential production and marketing opportunities of existing and new NR products for income generation (among farmers and others) and to enhance adoption of natural resources management (NRM) practices.

Principal Objectives

Investigate, research, pilot, select and promote the production and marketing of NR products having high commercial potential in Malawi.

MAFE research and development and the results of test marketing of products are expected to provide the genesis of one or more *community-private sector enterprise partnerships*^[4] that sustainably exploit selected under-utilized agroforestry and wild plant species.

It is expected that by July 2002 MAFE and its partners will be in a position to provide technical assistance to private interests that wish to apply developed technology at a pilot commercial level. Where sourcing of investment and working capital finance were a constraint, MAFE could consider facilitating discussions between the private interests and the funds provider/lender.

Favorable impact and sustainability assessment of pilot production would provide the foundation for systematic promotion by the Resource Center and MAFE partners of expanded planting and management of prescribed strategic species/cultivars.

The 2000 – 01 Annual Workplan stipulated primarily focusing on potential products from species currently promoted by MAFE. This criterion has dominated the initial process of product identification and selection.

1.4 Operating Methods and Budget

Formulation of the MEP anticipated that associated investigation, research and development would draw upon the specialist technical and other skills offered among MAFE partners and other organisations/institutions in Malawi. Such work would be organised through Collaboration Agreements. Most technical activities of the Program are now carried out in this manner. Typically these comprise contracts for surveys, analysis, research and/or design. Some of this work is being contracted with foreign laboratories.

MAFE's principle collaborator in all aspects of the MEP is the Enterprise Development and Training Agency (EDETA), a Malawian NGO. Trial production is carried out in partnership with small-scale producers. University of Malawi Colleges have major roles in chemical analysis, product characterization and engineering. Engineering research and design has involved extensive international discussion and on the practical level has been carried out in both Malawi and Tanzania. Details of the respective partnerships are described in Chapter 12.

Most of the remaining MAFE/USAID funds allocated to the MEP are planned to be applied as follows:

- detailed characterization of 'products',
- market investigations (including *regulatory environment*) and market probing with sample products,
- procurement of prototype processing equipment, and
- its trial and demonstration in various field settings within respective production areas.

2 INFORMATION CAPTURE

2.1 Sources of Information

MAFE has undertaken and is continuing a literature and internet search of products offering potential commercialization of agroforestry species included in the MAFE Extension Program. Very useful professional contacts have been made worldwide through subject searches and accessing institutional and commercial websites.

MAFE has also consulted over 50 organisations for advice and to identify areas of complementary interest in NR product development, as set out in the schedule of Correspondents.

A selected Bibliography is presented in this document.

2.2 Ethnobotanical Challenges

2.2.1 Challenges addressed

Products in international trade

Some NR products considered to have potential for production in Malawi are already made in other countries, have been fully analyzed and characterized, and are routinely traded. However, none of the foreseen equivalent 'products' from Malawi has been fully characterized for commercial introduction purposes.

Some local variation in NR product properties can be expected due to genetic and/or agro-ecological variance from other countries and/or differences in manufacturing processes. This immediately created problems for MAFE and its partners in defining the respective NR products that Malawi may have to offer. So, early in this Program, while the Project and its partners shared certain commercial hunches, they reached a consensus that the Project should commission local laboratories to determine the basic biochemical properties of products that could be offered *before* embarking on detailed market research.

Bio-prospecting for Novel 'Products'

Some potential NPPs identified by the Project and its partners as being of possible commercial potential are so novel that – although they may have very localized subsistence uses – they are not traded anywhere. They need to be carefully characterized and such work, unlike that on known products in international trade, amounts to *pure research*. Where applicable, "*bio-piracy*" *must be prevented*: the work must respect and *internalize* the (value of) respective "*intellectual property*" of the community(ies) that invented the use.

This work especially necessitates determination of the basic biochemical properties of the respective 'unknown' products that could be offered before carrying out *any* market investigations.

2.2.2 Immediate benefits

Hazardous materials

This approach has enabled MAFE Project to examine the safety of some of the substances it is dealing with and, in consultation with WSU, to determine the basis upon which further research and development, if any, on hazardous materials may be undertaken.

Scientific capacity

The work of local laboratories revealed the resources available for analytical services in Malawi and prompted preparations by the partners for further work to be undertaken in overseas laboratories. The absence of functional gas chromatography – mass spectrophotometer equipment (machines were out of order) frustrated efforts to identify components of the 'products' under review.

3 PRODUCT/STRATEGIC SPECIES SELECTION CRITERIA

Advice from the foregoing institutions, projects, the private sector and international sources enabled MAFE to begin screening their recommendations against various criteria. After examining ongoing research in NR product development by SADC-ICRAF, COMPASS and other organizations, MAFE took up the advice of University of Malawi and other partners to consider resuscitation of, and further develop former research on *oilseed tree species* meeting *provisional* product/species selection criteria^[5]. The provisional criteria included:

Potential for short-term development;
Abundance of raw material to allow immediate production trials and testing of product samples;
Probable suitability for small-scale production and marketing; and
Environmental impact benign or positive.

The seeds of the respective oilseed tree species have potential for production of oils for food, cosmetic and industrial purposes and offer interesting by-products, including products with water purification applications.

By July 2001 the criteria had been refined in consultation with WSUIP staff and A-SNAPP as follows:

All products should:

1. Have sizeable potential national and regional markets;
2. Be of interest to two or more regional countries, where cross-border trade will be analyzed, and possibly

(at a suitable scale of production^[4]) have international market potential;

3. Have significant local subsistence or commercial use (so they will still be of interest to producers if market conditions are temporarily poor);
4. Allow production and processing operations that are technically and economically feasible on a small or medium scale (i.e. determined as requiring capital investment of \$30,000 or less);
5. Be widely grown or abundant, at least locally, allowing rapid production response to market promotion *without depletion* of the species.

Special favor will be shown to plants that:

6. Offer benefits in addition to commercial development, such as food security, soil fertility or conservation, or wood supply.
7. Offer production and processing opportunities/synergies that have the potential to increase value added within existing farming systems.

Useful discussions have taken place between MAFE and COMPASS^[7] on product/species selection.

4 PRODUCTS/STRATEGIC SPECIES IDENTIFIED AND JUSTIFICATION

4.1 Moringa tree (*Moringa oleifera*) and Jatropha tree (*Jatropha curcas*)

By January 2001, the screening process had led to identification of two *early-maturing* agroforestry species with potential products for short-term research and development. Both species had been subject to previous product research in Malawi that had given promising results but research funding ran out in 1997. The Moringa Tree^[8] (*Moringa oleifera*) and Jatropha Tree^[9] (*Jatropha curcas*) thus became a focus of Program attention. Both had been promoted by MAFE and its partners for several years as part of the agroforestry extension package.

Moringa oil

Moringa had already been promoted in Malawi as a vegetable and oil crop for food security/vitamin nutrition purposes, notably by IEF for several years. IEF has embarked (2001) on a new COMPASS-assisted CBNRM program in the areas adjacent to Lengwe and Majete Wildlife Reserves involving, among other things, promotion of Moringa planting. IEF hopes to benefit from MAFE Project's results of research and product development. This attitude is shared by SADC-ICRAF.

SADC-ICRAF and GTZIFSP promote Moringa cultivation. This and the IEF work has been principally modeled on work elsewhere to exploit the nutritional/food security benefits of Moringa leaves, notably by Lowell Fuglie and partners in Senegal; Moringa flower buds are a popular savoury dish in India. In West Africa preparation of Moringa leaf powder food supplements from dense, plots of cash-cropped 'dwarf' trees is an expanding smallscale commercial enterprise^[10], notably in Niger. In Southern Ethiopia coffee lands (also Northern Kenya) *Moringa stenopetala*, an upland species^[11], is cultivated as a shade tree and dry-season vegetable crop that is used in the *daily* diet. It has relatively large, fleshy leaves that are ideal for this purpose.

In Southern India almost the entire focus of the *Moringa oleifera* industry is on *intensive horticultural enterprise* in which vegetable pods are marketed. Unlike many vegetables, they have several days' "shelf life". It is a lucrative business for which new cultivars such as *PKM1* and *PKM2* have been developed. These give exceptionally long pods, have a dwarf habit and require intensive cultivation methods. Replanting takes place every 4 years.

Malawi and Tanzania (to some extent Senegal) are considered to be the only countries in Africa engaged in systematic research and development on Moringa for oil commercialization. In the mid-1990s Chancellor College, FRIM and other research organizations demonstrated that Moringa yielded a seed oil (26% of whole seed content by weight^[12]) suitable for culinary use. Moringa had a remarkable 1800s history of commercial production in Jamaica, notably as a source of watchmakers 'Ben oil', before being superseded by Sperm Whale oil. Moringa oil has a very similar fatty acids profile to Macadamia nut oil^[13] and has been perceived as a potential, highly stable substitute for olive oil – which has a price *in bulk* of about

£1.80^[14]/kg (\$2.50-4.150/kg)

2.1.00 t/kg (2.00, 1.00/kg).

Moringa oil contains about 76% monounsaturated fatty acids of which nearly all is oleic; moreover *cold-pressed* Moringa oil is rich in natural antioxidants, notably the powerful anti-oxidant α -tocopherol.

Moringa water treatment

Adaptive research on Moringa was undertaken at Thyolo in the early 1990s by Blantyre Polytechnic, Southern Region Water Board and Leicester University with DfID support, based on technology developed in the Sudan by Jahn, SAA in the 1980s. This proved a cationic polyelectrolyte protein in Moringa powdered seed (& expressed seedcake) to

be an effective sediment flocculant^[15] (instead of alum) for drinking water preparation. The Thyolo work is understood to have been carried out with a crude mixture; further work was required at Leicester University to develop a proprietary pure flocculant extract from Moringa. Without isolation of the active principle, the Moringa powder would be too bulky to handle and (probably) cause contamination of water from microbial action on the sugars, celluloses and other proteins present in the seed.

In response to a 'Le Monde' French journal article on Moringa, in 1996 four Swiss venture capitalists established Optima in Tanzania as a Company to adapt and commercialize the above technology *developed in Malawi*. MAFE staff met Optima's Tanzania management in June 2001. Optima has established 62 hectares of its own Moringa plantations and, promising an attractive purchase price for seeds, is promoting major investment by outgrowers to develop 12,000 hectares of Moringa plantations for:

- oil production of up to 8,000 t/year (food, skincare and cosmetic applications) and
- commercial development of a proprietary cationic polyelectrolyte extract, "Phytofloc"^[16] for water treatment; also, subject to research
- commercial utilization of (protein-rich) detoxified filter cake.

The Optima Product Development Manager formerly worked in Malawi on behalf of Leicester University and Optima has linkages with faculty of the University. While much of the Optima development concerns intellectual property and is commercially sensitive, this industrial development needs to be tracked. MAFE has benefited from informal advice from the Product Development Manager, a Leicester University associate who formerly worked in Malawi, and Blantyre Polytechnic.

Following a hiatus of 4 years, in June 2001 CCCD convened a meeting of the Blantyre and Southern Region Water Boards, MAFE and the National Research Council of Malawi (NRCM) to initiate investigations into possible substitution of proprietary water treatment products (polyelectrolytes and alum) by Moringa extracts. These would follow up the earlier work of Blantyre Polytechnic. At the time of writing it is uncertain whether the Polytechnic will participate in this future work.

International Moringa products workshop

The MAFE Resource Center Coordinator, Dr Henry S.K. Phombeya and the Program Specialist will attend an international Moringa products workshop^[17] in Dar Es Salaam in November.

Jatropha uses

Jatropha is a poisonous plant that yields a non-edible oil (30% of whole seed content by weight^[18]). This makes an excellent smokeless lamp oil and has potential as an insecticide, for instance in the control of cotton bollworm; methanol extracts of Jatropha seed (which contains biodegradable toxins) are being tested in Germany for control of bilharzia-carrying water snails. Jatropha presscake contains curcin, a highly toxic protein similar to ricin in Castor. Jatropha oil can be used as an expensive^[19] diesel motor fuel, for which purpose it is at its most effective when transesterified. Binga Trees Project (BTP) reports Jatropha oil use by tanneries in Zimbabwe. It is also used extensively in West Africa, Zambia, Tanzania and Zimbabwe as a soapstock. MAFE will investigate the respective oil extraction and soap industries in Zambia and Zimbabwe to determine the scope for technology transfer to Malawi. A Jatropha variety of Mexican provenance is edible but no experience of this has been gained in Central Africa.

Habitat of Moringa and Jatropha

Conveniently, both species above grow fast and are normally planted around homesteads as a hedge/living screen; Jatropha is widely distributed, while Moringa is localised in the lowlands, notably Lower Shire Valley and the Lakeshore^[20]. Both meet Criteria Nos. 5 and 6. above, i.e. they are widely grown and offer benefits in addition to commercial development. Moringa can be grown from seed or propagated from truncheons. It

yields seeds within 1 - 2 years.

Taxonomy and agronomy

With regard to Moringa, Coote et al (1997) had recommended:

..... existing trials should investigate the potential for adoption and promotion of more productive and vigorous varieties. Should the *socio-economic value of continued work on Moringa oleifera be proven* there will be a need to develop a focused national breeding and improvement programme.

On the advice of the proprietors of KOR^[21], MAFE has approached the National Herbarium and FRIM^[22] with the view to commissioning an investigation to determine the different races of Moringa that have naturalized in Malawi. There are thought to be at least 3 races, each of which has distinct morphological and oil-bearing characteristics^[23]. Jatropha, and possibly other species, may receive similar investigation. This research theme is to be raised in the Triennial National Forestry Research Symposium in early December 2001.

Depending upon the results of oil extraction trials, MAFE may engage FRIM to assist investigation of, and possible field experiments on *household/hedgerow* (but not plantation) production costs, inputs and outputs for Moringa and Jatropha. Some useful Moringa *plantation* management guidelines have already been provided by Optima but MAFE has been unable to locate any information on long-term yield of Moringa under plantation conditions. Optima Company forecasts of yields from mature plantations therefore may need to be treated with some caution.

4.2 Other Oil-bearing Agroforestry Trees of Interest

Through advice from BTP and initiative of MAFE Field Technical Associates and with assistance from PROSCARP and LRCD, Natal Mahogany (*Trichilia emetica*) is being investigated for its seed^[24] oil properties and yield, and uses of aril paste^[25] and bark extracts. This tree is common in Karonga and already promoted by MAFE. Very little literature on this species exists yet the tree has numerous traditional food and medicinal uses and formerly sustained significant soap industries in Southern Tanzania and Mozambique (Williamson, J. 1975). Through informal assistance from the Centers for Diseases Control and Prevention (CDC), MAFE has acquired insight into confirmed pesticidal properties of this plant. The respective information is confidential.

Taking up the interest of the Southern Africa Natural Products Trade Association (SANProTA), Wildlife Society of Malawi, World Bank project for Community based NRM in Southern Malawi National Parks and Nyika-Vwaza Border Zone Project, investigation of the scope for manufacture and marketing of seed oils of Marula (*Sclerocarya birrea*) and Manketti (*Schinziophyton rautanenii*) has been initiated. Manketti is a target species of SANProTA. Marula is already receiving significant R & D attention from various organizations in four Southern African countries^[26] and MAFE plans to collaborate with them. African Star-Chestnut^[27], or Tick tree (*Sterculia africana*) and the naturalized species Neem (*Azadirachta indica*) may also be investigated. Excepting Neem which is a farm species, four of these species are found both in *natural forest* (including Forest Reserves and National Parks) and as *on-farm* trees. All the species under this section take longer to reach maturity than Moringa and Jatropha.

For the species under MAFE consideration, the proximity of the fatty acid composition (where available) of their oils to the composition of commercial vegetable oils are mapped in Table 1, along with relative fatty acids saturation. It is thought that some tree oils could possibly be marketed as substitutes for higher-priced oils, notably Sweet Almond and Jojoba, that are used as body/massage oils, cosmetic bases and carriers, in addition to finding food/edible oil uses.

Table 1: MAFE Study of Saturation of Fatty Acids in Tree Seed Oils

Seasonality

The seasonality of "seed drop" of the foregoing cluster of oil-bearing species has been considered. Although harvesting, sun-drying and storage of Neem and Natal Mahogany may be frustrated by rainfall and high humidity in their respective harvest seasons, the overall annual sequence of harvesting for the indicated species may, subject to feasibility assessment, provide opportunities for one or more commercial processors to specialize and orient their entire operations to tree seeds. Respective harvest seasons are:

processors to specialize and orient their entire operations to tree seeds. Respective harvest seasons are:

Moringa (<i>Moringa oleifera</i>)	Oct – Nov
Neem (<i>Azadirachta indica</i>)	Dec – Jan
Natal Mahogany (<i>Trichilia emetica</i>)	Jan – Mar
Manketti (<i>Schinziophyton rautanenii</i>)	Mar - Apr
Jatropha (<i>Jatropha curcas</i>)	Apr – Jun
Marula (<i>Sclerocarya birrea</i>)	Apr - Jul
African Star-Chestnut (<i>Sterculia africana</i>)	May – Sep

Synergy with other oilseeds

In some locations it may become attractive for businesses that crush conventional oilseeds, such as sunflower and/or groundnut, to integrate some tree seed oil production into their annual program, specially during the oilseeds “off-crop”, i.e. December – April.

4.3 Fish Bean (*Tephrosia vogelii*)

MAFE is committed to investigation of properties and potential uses of Fish Bean (*Tephrosia vogelii*). SHOGA has repeatedly expressed interest in promotion of this plant for both (organic management system) soil improvement and, possibly, NPP purposes.

Opportunities to investigate this species have been limited. CCCD *Tephrosia* specialists have been unable to find time to assist MAFE, however the Natural Products Research team led by Prof Berhanu M. Abegaz at the University of Botswana, with which WSU is associated, is undertaking leaf and seed analysis [\[28\]](#).

4.4 Related MAFE Core Species Considerations

Since Fish Bean, Moringa, Marula, Natal Mahogany and Neem are promoted in the MAFE 1995 *Agroforestry Field Manual*, they have been afforded special consideration in this Program; all decisions on selection of strategic species have been made jointly with LRCD.

Investigation of the commercial potential of other agroforestry species is being pursued as time permits.

5 DEVELOPMENT OF A MARKET DATABASE FOR TARGETED PRODUCTS

5.1 MAFE Strategy

MAFE’s approach to commercialization is holistic. Possibly a targeted species will become economically viable only when *several* of its uses/product applications are all fully exploited. Thus, although plant oils and their by-products are the current focus of MAFE research and development, it is intended that all potential subsistence and commercial products will be captured in market surveys for the targeted species.

MAFE accordingly plans to supplement the study of plant oils and by-products with inquiries into local usage and marketing of other products from the strategic species. These can range from food uses of plant materials to timber and firewood, also specialized uses such as traditional medicines and pesticides, where dosage rates need to be noted. Additionally, efforts will be made to value the environmental benefits (and costs, if any) of exploiting the species and their implications for NRM will be described.

Botanical pesticides and anti-feedants derived from Fish Bean, Neem and Jatropha are to receive special consideration.

Matrices of potential products of strategic species have been prepared by MAFE (Annex 2).

Market investigations will follow three principal thrusts:

- Assessment of Malawi’s comparative advantage (if any) to supply respective NPPs, including chemical isolates/fractions, that are already traded nationally, regionally and internationally;
- Determination of the opportunities for Malawi NPPs to replace and compete with other products in trade – by virtue of similarity of physico-chemical properties;

Reporting on the means of compliance with national regulatory/safety standards is the more promising

- Reporting on the means of compliance with national regulatory/safety standards in the more promising markets.

The nature of the marketing and distribution systems and market segmentation for identified products will be examined and, where possible, trends in supply and demand will be reported upon.

Price formation and the costs of production and processing will be studied and principal actors in trade will be interviewed. Institutions that are committed to supporting NPP development, including providers of finance, will be identified.

5.2 Some Commercial Benchmarks

Commercial Benchmarks: Industrial/mineral oils and cooking oils

For experimental control purposes, commercial oilseeds, i.e. groundnuts (+/- 44% oil content) and sunflower (+/- 40% oil content), have – when available - been included in MAFE trials. Their current bulk wholesale prices, delivered Blantyre are K40/kg (shelled) and K12/kg (whole seed) respectively.

Castor seed would have been included in the benchmarking exercise as its oil is popular with paint manufacturers but samples could not be obtained in time for trials. Its cultivation has declined markedly in recent years as a result of the withdrawal of Agricultural Development and Marketing Corporation (ADMARC) from this business.

The Lilongwe soya bean processing business, SEBA Foods (SEBA) was visited in September 2001. SEBA processes about 2,500 t of beans annually, supplied by a trader network. It manufactures various SEBA food products. Oil is produced as a by-product and probably amounts to up to 400 tonnes annually. Insoluble foots/fibrous matter is removed by filtration and settlement (6 vessels before filter; two after filter). The filtered oil is sold unrefined to other industries.

Industrial/Mineral Oils

International wholesale price benchmarks for crude oils taken for reference on July 5, 2001^[1] were:

	US\$/kg	K/kg (K80 = \$1)
Palm Oil	0.27	21.60
Soya Oil	0.35	28.00

After allowing for handling and transportation charges and taking advice from importers it was considered by MAFE that the landed (Blantyre) price of such crude oils for food and mineral/fuel/paint oil use should be taken as some K39/kg.

Cooking Oil

In July 2001, refined sunflower oil was being sold by Blantyre-based refineries ex-factory at retail prices (unpackaged) of some K80/litre (K89/kg) upwards; they were also selling the presscake by-product for animal feed (unmilled) at some K9/kg. Naming'omba Tea Estates Ltd produces about 20,000 litres of (by-product) macadamia nut oil annually. It sells to its employees and the general public at a price (excluding packaging and surtax) of K117/litre, and K149 including container; the same oil can be bought in Zomba at about K215/litre (retail, packed).

MAFE has taken K80/litre, as a benchmark price for considering the feasibility of marketing 'substitute' cooking oils derived from tree seeds.

We hope that in due course some tree oils will command far higher prices locally and internationally by lending themselves to specialized applications or as substitutes for costly oils such as olive oil. For example, Sweet Almond Oil B.P. (KTC brand) has been found in a Lilongwe supermarket priced at K695/500 ml (17.5 fl oz). It is used as body oil.

The price of Sunflower seed in Morogoro, Tanzania is (June 2001) TSh130/kg, equivalent (at K1=TSh 11.70) to some K11.10/kg, and the Tanzania unrefined sunflower oil price is TSh900/litre, i.e. K76.90/litre or about \$1/litre. These closely resemble prices in Malawi.

^[1]Financial Times 06/07/01

5.3 A-SNAPP linkage