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**TRANSFER AND COMMERCIALIZATION OF AGRICULTURAL
TECHNOLOGY: MICRO-ENTERPRISE DEVELOPMENT IN GHANA**

A CONSULTANT STUDY

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Dr. E.O. Asante
Agricultural Economist
Ghana Institute of Management
and Public Administration
Accra, Ghana

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Coordination Office / Bureau de Coordination
SAFGRAD
01 B.P. 1783, Ouagadougou 01 - Burkina Faso
Tél : 30-60-71/31-15-98
Fax : 31-15-86
Télex : 5381 BF

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LIST OF ABBREVIATIONS

ADB	AGRICULTURAL DEVELOPMENT BANK
ADRA	ADVENTIST DEVELOPMENT AND RELIEF AGENCY
AESD	AGRICULTURAL EXTENSION SERVICES DEPARTMENT
ARI	ANIMAL RESEARCH INSTITUTE
BOPP	BENSO OIL PALM PLANTATION LIMITED
COCOBOD	GHANA COCOA BOARD
CRI	CROPS RESEARCH INSITUTE
CRIG	COCOA RESEARCH INSTITUTE OF GHANA
CSIR	COUNCIL FOR SCIENTIC AND INDUSTRIAL RESEARCH
FAO	UNITED NATIONS FOOD AND AGRICULTURAL ORGANISATION
FRI	FOOD RESEARCH INSTITUTE
GLDB	GRAINS AND LEGUMES DEVELOPMENT BOARD
GOPDC	GHANA OIL PLAM DEVELOPMENT CORPORATION
GRATIS	GHANA REGIONAL APPROPRIATE TECH. TRANSFER SERVICES
IFAD	INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT
IRI	INDUSTRIAL RESEARCH INSTITUTE
ITTA	INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE
ITTU	INTERMEDIATE TECHNOLOGY TRANSFER UNIT
MOFA	MINISTRY OF FOOD AND AGRICULTURE
NBSSI	NATIONAL BOARD OF SMALL-SCALE INDUSTRIES
NGOS	NON GOVERNMENTAL ORGNAISATIONS
NRI	NATIONAL RESOURCES INSTITUTE OF THE UNITED KINGDOM
OPRI	OIL PALM RESEARCH INSTITUTE
PPRI	PLANT PROTECTION AND REGULATORY SERVICES
RELC	RESEARCH EXTENSION LINKAGE COMMITTEE
SARI	SAVANNAH RESEARCH INSTITUTE
SRI	SOILS RESERCH INSTITUTE
TOPP	TWIFO OIL PALM PLANTATION LIMITED
URS	UNIVERSITY OF GHANA RESEARCH STATION
USAID	UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
VORADEP	VOLTA REGIONAL AGRICULTURAL DEVELOPMENT PROGRAM
VSD	VETRINARY SERVICES DEPARTMENT
WIAD	WOMEN IN AGRICULTURAL DEVELOPMENT

1.0 INTRODUCTION

1.1. Background

Agricultural contribution to overall economic growth and poverty alleviation has been below expectation. Ghanaian agriculture is largely based on smallholder farms. Several factors contribute to the slow growth in agriculture. These factors include the following:

- Low technology
- Constraints to access to input and output markets.
- High post-harvest losses
- Absence of post-harvest processing of produce
- Unfavourable macro-economic environment (e.g., high interest rate policy and limited loanable funds to the agricultural sector).

Agricultural research in Ghana has led to the development of improved technology. Research has produced high yielding varieties of various crops and agronomic practices which if they have been adopted would have transformed the country's agriculture.

High storage losses have been often quoted even though storage technologies exist to ensure minimal losses. Technologies for agro-processing have also been developed. Some of these technologies have improved the productivity of traditional processes. Examples include the introduction of small oil-palm mills, sheabutter processing presses, small-scale rice mills and cassava flour mills.

The emphasis on technology for small to medium scale operations has a lot of promise for changing Ghanaian agriculture. Processing can help increase the demand for primary products that can in turn raise farm prices and serve as an incentive for increased production.

1.2. Objective of Assignment

The purpose of this assignment is to undertake a study on the identification of prospects for enhancing commercialization of agricultural technology through the development of micro enterprises. The study is expected to provide technical information and institutional framework and linkages essential for agro-enterprise development in Ghana.

1.3. Methodology

The information and data for analysis were obtained from questionnaires administered to stakeholders in technology transfer and commercialization. Additional information was also obtained from personal interviews with key stakeholders and material obtained from published and unpublished sources. The organizations surveyed include the following

Food Research Institute (FRI)

Crops Research Institute (CRI)

Cocoa Research Institute of Ghana (CRIG)

Savanna Agricultural Research Institute (SARI)

Animal Research Institute (ARI)

University of Ghana Research Station, Kade (URS)

Oil Palm Research Institute (OPRI), Kusi

Council for Scientific and Industrial Research (CSIR)

Soils Research Institute (SRI)

Agricultural Extension Services Department of MOFA

Women Agricultural Development of MOFA

Intermediate Technology Transfer Unit (ITTU)

TechnoServe

Adventist Development and Relief Agency (ADRA)

Ghana National Association of Farmers and Fishermen

Ghana Organic Agricultural Network

Selected farmers, owners and operators of micro enterprises were also interviewed. The micro enterprises covered input supply companies, agro-processing companies, marketing intermediaries and farm service companies.

1.4. **Scope of Work**

Main issues considered in the study are institutional aspects of technology transfer and commercialization and its impact on agro-enterprise development, technical and social economic barriers to efficient technology transfer and delivery to end users. A survey of small-scale enterprises also brought out users of innovations from the Research Institutes and the problems and constraints facing small-scale enterprise. A section of the study also identified key areas of micro-enterprise development and types of technology that have already been transferred and those ready to be transferred or commercialized. Another section considered the constraints faced by the providers of technology and mechanisms and/or institutions that can impede the transfer and commercialization of technology. The final section of the study is the summary and recommendations.

2.0. FINDINGS

2.1. Introduction

The analysis of findings presented in this section covers research institutes, which generate and transfer technology, non-governmental organizations, farmers, marketing intermediaries, processors and other service providers. Aspects of technology transfer covered include institutional set ups and linkages for technology transfer and commercialization. The process of technology transfer and areas of technology transfer and utilization are also analyzed and discussed.

Technical and socioeconomic constraints impacting on technology transfer and commercialization are identified. The requirements of farm-level micro-enterprises are also assessed.

2.2. Institutional Aspects of Technology Transfer and Commercialization

Areas covered under this section are institutional linkages, pathways of research results, institutional orientation, capacity and preparedness for transfer and commercialization of technology.

2.2.1. Institutional Linkages

Five Research institutes of the Council for Scientific and Industrial Research (CSIR) were surveyed. These are the CRI, SARI, OPRI and ARI. The Crop Research Institute (CRI) appears to have the best institutional linkage that facilitates the transfer of technology to the users. The Crop Research Institute works with intermediate organizations like the Grains and Legumes Development Board (GLDB), the Plant Protection and Regulatory Services (PPRS) of MOFA, the Crop Services Department and the Agricultural Extension Services Department of MOFA.

The research outputs on grains are released to the GLDB. The GLDB multiplies the foundation seeds and in turn releases the grower seed to the registered seed growers.

The registered seed growers sell seeds direct either to farmers or to seed distributors/wholesalers who in turn sell to the farmers. The PPRS monitors the performance of the registered seed growers to ensure that quality seeds are released to farmers.

The other research institutes namely ARI, SRI and FRI do not appear to have such strong institutional linkages as CRI. The Food Research Institute had collaborated with such organizations as the Department of Fisheries of MOFA and Women in Agricultural Development of MOFA.

The research results of CRI have made positive impact on Ghanaian Agriculture. A large number of farmers have adopted the technologies (improved seeds and agronomic practices) developed by CRI. This may be partly attributable to the strong institutional linkage existing between CRI and other collaborative institutions.

2.2.2. Pathways of Research Results

The research institutes have diverse ways of getting research results to users. Some of the institutes of CSIR, namely the Crop Research Institute, Savannah Agricultural Research Institute the Soil Research Institute, the Animal Research Institute, and Food Research Institute get their research results to users through the Research Extension Linkage Committees (RELCS). Subject matter specialists are exposed to or given training on the research results. The subject matter specialist passed on the knowledge acquired to the extension personnel who in turn pass on the innovations to the users. This mode of transferring research results to farmers appears to be limited to research findings that have applicability to production. The CRI and SARI in addition of normally transferring innovations to users through MOFA and GLDB, also carry out Field

Days and Training courses for users. On-farm trials are also carried out as a means of transferring results.

In the case of cocoa, the commodity systems approach is used to manage the industry. One body, the Ghana Cocoa Board (COCOBOD), manages the industry. The Cocobod is responsible for research, extension, quality control and marketing through subsidiaries, and divisions. In the case of internal purchasing of cocoa, Cocobod operates either through its own subsidiary or licensed buying companies.

The research results of the Cocoa Research Institute of Ghana are normally passed on through the Extension wing of the Cocoa Industry, the Cocoa Services Department. Regular meetings between extension and research personnel provide a good avenue for transferring research results to extension personnel. The extension staff through various means such as farmer durbars and field days passed on innovations and improved technology to farmers. The commodity systems approach used in the cocoa industry appears to provide a more effective means of transferring technology and innovations to farmers.

The research results of the Oil Palm Research Institute are passed on directly to farmers or through large-scale plantation owners who pass on the innovation to the out growers. The University Research Station at Kade has also been in the forefront of generating new technology. The station has produced plantain suckers and citrus seedlings (especially late valencia) for farmers in the area. The new citrus cultivar produced by the University Research Station has generated a major economic activity (citrus farming in the area). ADRA has in recent years contracted the University Research Station, Kade to produce thousands of citrus seedlings. The seedlings are supplied to farmers who have decided to go into citrus production.

The Food Research Institute does not have organized institutions through which research results are transferred to users. Users have direct access to the research results of the Food Research

Institute or researchers of the Institute have worked directly with users in technology transfer, e.g., the introduction of the Chorkor Smoker.

The results of the study point to the fact that innovations that have positive impact on crop production are more likely to be transferred through formal institutions to users than innovations related to marketing, processing and utilization. The Women in Agricultural Development Department of MOFA, it must be pointed out, in recent years have assisted women to utilize new knowledge in processing and utilization. The experiences of the RELC's, WIAD and some NGOs also confirm the importance of institutional linkages. A more formal way of getting research results (i.e. new technology developed by research institutions) to users would accelerate the transfer of new technology in an environment where there is a wide information gap between research and users (especially small scale operators who are in most cases not very well educated).

2.2.3. Institutional Orientation, Capacity and Preparedness for Transfer and Commercialization of Technology

Until recently, research institutions considered their mandate as carrying out research and the results to be used by others. The research findings have generally been published in scientific journals and or presented at professional conferences. Users in several instances get to know these innovations through these journals or attendance of these conferences. A researcher's career progression or promotion depended on the number of publications that appear in scientific journal. The application of the innovations and/or findings was not an issue.

The institutional orientation was not geared towards transferring innovations and/or improved technology to users. The mechanism for technology transfer, that is, through publications and or attendance of conferences was not effective for developing countries. For example, almost all farmers who should benefit from the innovations and improved technology do not have access to

these scientific journals or attend scientific conferences. The RELCS have been introduced to partly bridge the gap between the researchers and the farmers.

The new CSIR law mandates that 30% of the funding of the CSIR should come from the commercialization of its innovations or technology. To achieve the targets set under the commercialization policy, key research institutes were to appoint marketing managers. These officers were to spearhead the technology and commercialization effort. As at the time of the study, only the commercialization unit at the CSIR Secretariat has been set up. But even here the unit has not started any serious work. None of the key research institutes has as yet employed a marketing manager. The Industrial Research Institute is in the process of setting up a Business Development Unit. The orientation of researchers have traditionally been the development of new technology without much regard to its commercial viability or otherwise

Researchers of the CSIR institutes are mostly not commercially minded and may not put any premium on commercialization of their findings. One way of motivating the research personnel of the Research Institutes to be commercially minded would be to incorporate the rate or the extent of adoption of research results or innovations for commercial purposes as part of the criteria for promotion.

Commercialization and transfer of technology will be enhanced if the financial viability of the new technology can be demonstrated. The researchers may not have the capability of subjecting the research findings or new technology to financial and commercial viability. As a result the financial and/or commercial viability of new technology are not assessed before being recommended to users. The research institutes may have to look outside for this capacity. The research personnel working for the research institutes (especially the key research institutes identified by CSIR to be in the forefront of technology transfer and commercialization) may also be given training to help them determine the financial and or commercial viability of new technology. It is important that marketing managers who have the expertise in economic and financial analysis are appointed. In

marketing the findings, these officers would have more convincing basis to sell the innovations to prospective investors.

The criteria for funding research programs have also not been geared towards commercialization and may have to be modified to bring it in line with the new thinking. If researches carry out demand driven research it may be easier to market this type of research.

2.3. **Technology Transfer, Processing and Commercialization**

Technologies that have been transferred or ready to be transferred or commercialized were in the areas of;

- improved inputs
- agronomic practices
- animal husbandry practices
- storage and marketing
- processing
- utilization

Some of the research and technologies that have been transferred or ready to be transferred for some key institutions are presented below

2.3.1. **Animal Research Institute (ARI)**

The Animal Research Institute has over the years produced and transferred innovations in the area of animal husbandry to clients. These innovations and technologies include;

- The use of appropriate formulations of wheatbran for the preparation of animal feed
- A tsetse map of Ghana as a useful source of reference for cattle production planning

¹ The section below was mainly extracted from a publication published by the CSIR

- The development of AFBOSBEK breeds of chicken at Akropong Farms, partly with ARI Technology
- Pasture management for large-scale Farmers (Sale of highly nutritious and high-yielding pasture seeds).
- ARI-type wooden battery cages for the poultry industry.

Technologies Ready for Transfer

The ARI has also come out with new technologies that are ready to be transferred to users. These include the following;

- A variety of poultry housing structures.
- "Yeastlage" production and feed strategies
- Pasture seed production
- Pasture establishment/development
- Production of herbal preparations against helminthic worm infection in farm animals
- Crossbreeding for dual purpose cattle and their management
- Soybean milk replacement in calves
- Feed formulation using agro-industrial by products
- Grower-finisher and fattening operations in cattle production.

The ARI has more innovations yet to be transferred or commercialized.

Technical Services Offered

The Institute offers veterinary services and laboratory analyses to the public. It prepares and analyses feed and occasionally organizes practical training programmes for farmers. It offers general consultancy services.

Some User-agencies/Clients

Some of the user agencies and clients of ARI are,

- Poultry and Livestock Farmers.
- Agro-industrial companies such as Ghana Agro-Food Company and Cocoa Processing Company.
- Ministry of Food and Agriculture (through APD, VSD and DAES).

It must be noted that relatively large-scale farmers and corporate organizations utilize the technologies and innovations developed by the ARI. To what extent the GAFCO and Cocoa Processing Company use the services of ARI could not be determined.

Prospects

The research results and technologies that the ARI is ready to transfer or commercialized suggest that there is the potential for the institute to make a positive contribution toward animal production in the country. This will require a new system of making research findings available to users.

2.3.2 Crops Research Institute (CRI)

The CRI is one of the institutes of the CSIR whose research findings and technologies have been transferred to many users including small-scale farmers. The CRI has released to the farming community high-yielding, disease-resistant and pest-tolerant varieties of maize, cowpea and soybean, improved cultivars of roots and tubers and horticultural crops, improved new production technologies including farming systems, intercropping, rates of fertilizer application, etc. Innovations developed through research are transferred to farmers through on-farm trials supported with field trips and publication of farming guides and fact sheets.

Technologies Ready for Transfer

Minisett technique for rapid multiplication of yams, improved storage techniques at the farm level, cropping practices for various ecological zones, and others. Adventist Development and Relief

Agency has been assisting farmers in Brong Ahafo to multiply yam seeds using the miniset technique

Technical Services Offered

The Institute offers technical and advisory services in the following areas

Supply of improved and recommended planting materials such as breeder seeds of maize, cowpea, groundnut, soybean, kenaf, jute, millet, sorghum and rice, buddings and seedlings of mango, avocado and citrus.

- Cropping practices, particularly in the establishment of new farms/plantations.
- Management of diseases, insect pests and weeds of economic crops.
- Testing the potency and efficacy of agro-chemicals.
- Field application of agrochemicals including recommendations on suitable equipment for their application.
- Issuing of production guides and fact sheets on crops to farmers.

As stated earlier, CRI is one institute of the CSIR whose results have made positive impact on Ghana Agriculture. Thousands of farmers use seeds developed by the Institute. An industry may also develop around commercial local production.

Some User-Agencies/Clients

Ministry of Agriculture, Ghana Seed Company, Ejura Farms, VORADEP, Grains and Legumes Development Board, Agricultural Development Bank, International Institute of Tropical Agriculture, the Farming Community, FAO, rural banks and NGOs engaged in agricultural development.

Prospects

The technologies and innovations developed by the CRI have been accepted by several farmers. However, there is still room for more farmers to utilize the technologies and innovations development by the CRI. Farmers at times do not get the improved seeds to buy for planting partly because of inadequate production of grower seeds by the GLDB and seeds by the registered seed growers.

2.3.3. Food Research Institute (FRI)

The Food Research Institute has produced new processing technologies and innovations but stakeholders have not patronized the innovations. However, one major technology that was developed by the FRI and has been commercialized and heavily patronized is the **Improved Fish Smoking Equipment (Chorkor Smoker)**.

The FRI Chorkor Smoker is an improved fish-smoking equipment that has been adopted in many parts of Ghana and Africa. The Chorkor Smoker enables about ten trays of fish to be smoked at a time instead of one, making for fuel efficiency; significant improvement in the quality of smoked fish, reduction in smoking time and in labour force.

The Institute has also developed and transferred to industry a **Technology for refining and deodorizing vegetable oils**. The FRI's work on the refining and deodorization of coconut oil formed the basis of the development of a deodorizer plant for the vegetable oil industry in Ghana. This resulted in the production of high-grade oils such as the Makola and Goldnut cooking oils.

The FRI has developed several **Instant Foods**. The instant foods include fufu flour from plantain, cocoyam and yam, which it produces on a pilot scale for sale to general public. However, all these instant foods developed by the FRI have not as yet been commercialized. Some of the reasons of the low level of commercialization will be discussed later.

Other flours include: cowpea flour with recipe manual; composite flours; and dehydrated fermented maize meal (an intermediate maize product for preparing porridge, kenkey and banku).

Technology Ready for Transfer

These include the know-how for commercial production of: Fufu powder, fermented cassava meal; improved kokonte powder, groundnut paste; cowpea flour; FRI weaner; fermented maize meal; improved gari; and mushrooms.

The full utilization of new innovations and new technology may add value to the raw agricultural produce. Entrepreneurs also have opportunities to invest in technologies developed by FRI.

Technical Services Offered

The FRI performs technical services for users/clients. The main technical services offered are;

1. Analysis

Analyses of food samples and provision of quality control services to local food and pharmaceutical industries, private laboratories, food aid agencies, importers and exporters of food commodities, etc.

Evaluation of in-plant sanitation on request.

2. Product Quality Improvement

Assistance to local food industries to formulate and improve finished products such as marmalades, fruit juices, squashes and cordials, canned sardines and tuna, bakery products (including composite flours) and refined vegetable oil

3. Identification and Selection of Food Processing Equipment

Assistance to prospective food processors in the identification, selection and installation of appropriate equipment and machinery.

4. Training

The Institute provides technical training to Personnel from the food industry including quality control officers and production technicians for food processing establishments and extension officers. It also provides attachment training for students and graduates from the departments of biochemistry, agriculture, engineering, and food and nutrition from local universities.

5. Scientific and Technical Information

The institute disseminates scientific and technical information to industries, prospective entrepreneurs, students and the general public.

Some User-agencies/Clients

About 50 agencies and institutions in the public and private sectors are beneficiaries of the research and services of the FRI. They include: Cadbury (Ghana) Limited, Catholic Relief Services, the Cocoa Processing Companies at Takoradi and Tema, KIKU Company Limited, ELSA Foods, LUCAPA, Ghana National Procurement Agency (GNPA), Irani Brothers, Ghana Standards Board, Customs, Excise and Preventive Service (CEPS), UN Food and Agriculture Organizations, UNICEF, National Council for Women and Development, Lever Brothers (Ghana) Limited, Pee Cola Limited, World Bank Limited, World Food Programme, Greater Accra Cooperative Farmers Association, Mpohor Oil Company, Multi-Stores, Starwin Company Limited, Ministry of Food and Agriculture and local universities.

Prospects

The innovations and technologies developed by FRI have grossly been under utilized and commercialized. The effective utilization of FRI technologies and innovations will reduce post-harvest losses and also add value to farm produce. There are several processes and products that are waiting at FRI to be commercialized.

2.3.4 OIL PALM RESEARCH INSTITUTE (OPRI)

The OPRI has made a significant contribution to the production of oil palm in Ghana. The institute currently produces 1.22 million commercial seeds annually. The improved planting material transferred to farmers is capable of yielding between 3.75 and 4.2 tons of palm oil per hectare per year.

Technical Services Offered

The Institute provides the following services to farmers and a number of organizations:

- Provision of data to consultants for feasibility reports on oil palm projects.
- Testing and making of recommendations on the suitability of new herbicides, fungicides and pesticides arriving on the market.
- Surveys of insect damage on oil palm plantations to estimate the levels of insect pest populations for economic pest control.
- Visits to oil palm nurseries and plantations to advise on nursery management, phytosanitation, fertilizer use, field management and other agronomic practices to boost yield and income.
- Assistance to growers with plantations
- Provisions of training annually for farmers and, occasionally, for processors.
- Provision of data on profitability of oil palm cultivation and processing.
- Making available (relatively) disease-tolerant coconut planting materials.

Some User-agencies/Clients

Users-agencies and clients include Ghana Oil Palm Development Corporation (GOPDC), Twifo Oil Palm Plantation (TOPP), Benso Oil Palm Plantation (BOPP), Agricultural Development Bank (ADB), private farmers and out growers, Ministry of Food and Agriculture, Food and Agriculture Organization of UN, Governmental: Tanzania, Cuba and Zambia.

Prospects

The oil palm industry is expanding very fast in the oil palm growing areas. Thus, OPRI could increase its capacity to produce commercial planting materials.

2.3.5. SOIL RESEARCH INSTITUTE (SRI)

Fertilizer recommendations for various crops by SRI have benefited several farmers. Some large-scale farmers have also used soil analytical data, soil management practices, soil maps and soil conservation management practices developed by SRI.

Technical Services Offered

- Laboratory services: soil, plant, water, fertilizer analyses etc. for small-scale farmers and public and government organizations.
- Soil fertility evaluation surveys and determination of fertilizer rates for appropriate fertilizer recommendations.
- Provision of information on management methods for controlling farm erosion.
- Provision of general advisory and training services (laboratory training for university students as well as staff from other Institutes).

Some User-agencies/clients

Ejura Farms, Mankoadze Farms, Shai-Prampram Stock-rearing Project, UNILEVER, Ashanti Goldfields Company, SCOA, Midas Project (Atebubu), Kumawuman Industrial Farm Complex, Pioneer Tobacco Company, ACRES International, Ghana Oil Palm Development Corporation, Oil Palm Research Institute, Crops Research Institute, Environmental Protection Agency, Ministry of Food and Agriculture, Ministry of Finance and Economic Planning, Ministry of Environment, Science and Technology, Irrigation Development Authority, University of Ghana, University of

Cape Coast, University of Science and Technology, second cycle and tertiary institutions, FAO (Oncho-freed zone soil survey project), non-governmental organizations.

Prospects

The use of soil maps and soil analytical data if promoted on a large scale would increase the revenue base of the Soil Research Institute.

2.4. TECHNICAL AND SOCIOECONOMIC CONSTRAINTS FOR COMMERCIALISATION OF AGRICULTURAL TECHNOLOGIES

The use of technologies available to the farmer, the marketing intermediary and the processor depend on several factors. The constraints to technology transfer and commercialization are numerous. There are the technical and socioeconomic constraints.

2.4.1. Technical Constraints

Most of the stakeholders involved in technology transfer and commercialization face technical constraints. Researchers, farmers and marketing intermediaries and processors may face specific technical constraints.

Researchers: Researchers identified lack of adequate extension services compared to the number of farmers, farmers' level of education, availability of inputs including machinery and their prices as some of the technical constraints that inhibit movement and delivery of innovations to end users. With regard to improved inputs, it is not the researcher who has to make inputs available to the users but other intermediaries such as registered seed growers and distribution outlets. The quantity of improved seeds produced by the registered seed growers is not enough to service farmers who need the seeds. Similarly, researchers have observed at the FRI that customers or users would want the institute to supply them products that have been produced in small

quantities at laboratories. The Research Institutes are not geared to producing on commercial basis. They do not even have the facilities to produce on pilot basis.

Most of the research findings or new technologies have not been tried on pilot basis and as such the researchers may not be aware of operational bottlenecks. The research institutes may be assisted to acquire facilities that will enable them try some of the technology produced on pilot scale basis. The intermediate production stage will afford the researchers the opportunity to learn more about the probably operational problems go into commercial production. They will then be in a better position to advise entrepreneurs who want to adopt the technology for commercial purposes. The research institutes do not also have personnel with the requisite marketing skills to assist in the commercialization of their output.

Farmers: Some of the main technical constraints faced by farmers are unavailability of improved inputs, especially, seeds (maize, rice and cowpeas) and seedlings (citrus and oil palm), difficulty in obtaining extension assistance and lack of knowledge of innovations. The farmer/extension ratio of 2,100:1 implies that extension personnel may not reach quite a number of farmers.

The techniques available to most farmers may not be applicable to their particular circumstances and farming systems. Farmers who use fertility-enhancing technologies may have negative attitudes toward adoption of soil fertility enhancing methods in the future if they do not obtain yields expected from adoption of the new technology.

A household with limited labour force may find it difficult to adopt a technology that is labour intensive. Cotton farmers in northern Ghana complained some years ago about the ineffectiveness of urea. Urea has been successfully used in cotton production in Burkina Faso and Togo. The problem in Ghana tended out to be that the method of application of the urea was wrong. Thus

introduction of technology if not accompanied by the proper instructions on usage may be counter productive.

Recent experience with cashew has also brought to the fore the need to test new planting material in the local environment before its introduction to farmers. Several farmers have been disappointed with yields obtained from their cashew plantation. The cashew they planted were not tested locally and the yields which they have been made to believe would be obtained could not be achieved. Thus it is important that a new planting material not developed locally should be given to the appropriate research agency or organization to be tested and verified before it is introduced to farmers.

Processors: In the area of processing, the commonly stated technical problems facing owners of micro-enterprises include competition between traditionally processed products and products processed with improved technology at the artisanal level. A case in point is palm oil produced with traditional methods and palm oil produced from improved technology. The owners of the oil palm mills stated that consumers prefer the taste of oil palm produced traditionally to the oil produced with improved technology. Again palm oil obtained from technology introduced by the TechnoServe to oil palm cooperatives have not been acceptable to Unilever Limited, the largest single user of palm oil. If technology generation has been on demand driven concept, attempts might have been made to come out with a technology appropriate for the environment.

It is important that more work is done on acceptability of product and market access before a new processing technology is introduced to users. The establishment of research parks for some key research institutes, e.g. FRI and IRI, could assist in minimizing the effects of these constraints. Before a new processing technology is introduced to micro-enterprise processors, it

² The Director-General informed the writer that his organization intends to do something about this problem.

could be tried at the Research Park. Both the potential micro-enterprise owner(s) and the researchers can together assess the performance of the machinery and its products before micro-enterprise owners acquire the facility.

Another problem often mentioned by owners of micro-enterprises using improved technology is the low capacity utilization of their plants. This could be attributed to either the plant capacity being larger than the raw material available in the catchment area of the plant or it could be proliferation of the new processing technology in the area. There is evidence of proliferation of improved oil palm mills in the Amansie East area and cassava chips processing facilities in the Eastern region. Some processors may also lack technical skills to adopt new technology that may be too sophisticated.

2.4.2. Socioeconomic Factors

Two main principal economic constraints impacting on technology transfer and commercialization are profitability of the technology and the general economic environment.

Researchers: The research fraternity has indicated that its inability to try research findings on pilot basis, because of limited funds, to demonstrate the profitability of new technology to prospective entrepreneurs hinders the transfer and commercialization of the new technology. Acceptability of produce and products obtained from improved technology has been a major constraint to technology transfer and commercialization. Consumers have claimed that improved maize seeds and also maize cultivated with fertilizer when used to prepare local dishes do not have the same consistency and taste. Consumers also have complained about the use of broiler birds in preparing local dishes. These perceptions, limit the market for the produce or products obtained from the improved inputs and hence the slow rate of transferring these technologies and commercializing them. A demand driven research will produce the right type of technology that will be easier to transfer and commercialized. To minimize these problems, i.e. a product not

being acceptable by consumers or profitable, the CSIR may consider reorienting its research especially in the agricultural sector on commodity approach using a multi-disciplinary team. Members of the team may work on different aspects of the technology or innovation.

Farmers: Farmers interviewed ranked lack of funds as the number one reason for the non-adoption of new technology. Even when farmers have adopted technology, e.g. the use of fertilizer, the adoption rate in most cases is lower than the recommended level. This is may be mainly due to capital limitations.

The Government's macro-economic policies under the structural adjustment program have greatly increased the cost of agricultural inputs. The high cost of inputs (partly due to removal of subsidies and foreign exchange alignment) have also contributed in no small measure to farmers' inability to adopt new technology, especially, in an environment where credit to the farm sector has dropped significantly in the past few years. Most farmers do not have access to credit. Farmers who are supported by marketing companies (cotton and tobacco) or are part of an outgrower schemes do not face these problems.

The adoption of innovations by farmers is also affected by social and institutional factors such as property rights, land tenure arrangements, distribution of inputs and input output market linkages. Tenant farmers may not adopt soil fertility measures with long gestation period for fear of ejection from the land. Existing land tenure arrangements limit the farmers' ability to use land as collateral. Where adoption of new technology has increased production but there has not been a corresponding improvement in the marketing of such commodities, further adoption of technology has been curtailed. Promotion of nuclei farmers/outgrower schemes may be a solution to the perennial problem of high cost of inputs, unavailability of inputs, high farmer/extension ration, lack of credit and access to markets.

Input Dealers: Inadequate capital, lack of credit and marketing skills are the main constraints facing the input dealers. Most input dealers can purchase and store a small quantity of inputs e.g. fertilizers. The transaction costs for the input dealers may be quite high. They make several trips to purchase small quantity of inputs. They cannot take advantage of economies of scale.

Processors: High cost and unstable prices of raw materials that affect the profitability of processing enterprises are major problems faced by processors. As in the case of other stakeholders, the processors also lacked capital and credit and are thus not in a position to adopt new technology or acquire technology which could improve their efficiency. Most of the micro-processors are not aware of sources in the country where they can access capital facilities for acquisition of new technology. In addition to the high cost, processors may also not obtain desirable quantity of the produce to process. The processors are thus forced to operate below capacity that affects profitability.

2.5. MICRO-ENTERPRISE NEEDS AND DEVELOPMENT

Micro-enterprises were identified at the farm, processing and marketing and distribution levels.

Farm Level: At the farm level the major micro-enterprises identified were in the areas of seed production, oil palm and citrus seedlings' production. The seed growers specialized in the production of maize and cowpeas and to some extent rice. The seed growers have been limited in their operations by lack of funds and credit. As a result, the output from the registered seed growers is not enough to meet the demands of the market.

The producers of citrus seedlings produced a small proportion of the citrus seedlings required by farmers. The University of Ghana Research Station at Kade in Eastern Region is the main producer. There is the potential for private sector entrepreneurs to go into the production of both grain seeds and citrus seedlings.

Processing: Processing based on improved technology has been identified in oil palm and sheanut industries. TechnoServe has been the main promoter in the introduction of improved technology in the processing of palm oil. TechnoServe as of date has helped in the establishment of palm oil processing facilities in thirty-six locations in six regions. The regional distribution of the facilities is as follows:

Region	No. Of Oil Palm Processing Facilities	No. Of Gari Processing Facilities	No. Of Cassava Chips Enterprises
Eastern	1	1	
Central	7		
Volta	1		
Western	7		
Ashanti	9		1
Brong Ahafo	10	3	
TOTAL	36	4	1

TechnoServe has also helped in the establishment of gari processing facilities and cassava chips enterprises as indicated in the above table. The 31st December Movement has assisted women's groups to establish gari-processing facilities among other micro-enterprises. The Women in Agricultural Development (WIAD) of the Ministry of Food and Agriculture has also helped women's group in establishing gari processing facilities, palm oil extraction, sheabutter extraction, processing of weanimix and soya bean flour for infants and other soya bean products. A major problem facing these micro-enterprises has been lack of capital and credit to acquire raw materials

for processing and other inputs. The inability to link marketing to production and processing has at times created marketing problems for the output of the processing facilities.

Marketing and Distribution: The past years' policy, of MOFA, that is the State withdrawal from the procurement and distribution of agricultural inputs and outputs, has resulted in the creation of micro-enterprises in the area of marketing of inputs and outputs. There are several inputs' dealers servicing the farm sector. These input dealers sell improved seeds and seedlings, fertilizer, agro-chemicals and other farm equipment. The input dealers operate on a very limited scale because of lack of capital. The technical, marketing and management skills of these input dealers also limit their scale of operation. The input dealers would have to be given training in these areas so that they can improve on their operations in terms of quality of service and scale of operation.

TechnoServe and other institutions have assisted farmers and traders to improve on the marketing of maize and other agricultural commodities. The inventory credit scheme promoted by TechnoServe is one such activity that has helped the farmer to obtain increased revenue from the sale of his produce. The inventory credit scheme promoted by the Natural Resources Institute (NRI) of UK has helped some traders to more than triple the volume of maize that they handled. Limited successes have been achieved. These programmes would need to be expanded to improve the effectiveness and efficiency of the marketing of agricultural inputs and produce. An effective and efficient marketing system will lead to increase in revenue to farmers, distributors and processors and hence boost agricultural production. Farmers will have the ability to acquire improved technology if their revenues increased as a result of efficiency in the marketing system.

2.6. PROBLEMS, EXISTING POLICIES AND ENABLING ENVIRONMENT

The major problems facing small scale enterprises identified in the survey can be categorized under demand for inputs, raw materials and commodities; technical capacity; policy environment, constraints associated with production and distribution of some commodities.

2.6.1. Problems Associated with Raw Materials (or Inputs) and Marketing of Produce (and Products)

Farmers: The major problems with respect to inputs identified by the farmers interviewed are the high cost of inputs and the high cost of transporting the inputs to the farms. The high cost of inputs used by the farmers may be attributed to several factors including the near monopoly situation that exist in the procurement and supply of some inputs, e.g., fertilizer. The foreign currency alignments may partly contribute to the high cost of inputs, especially imported inputs, such as fertilizer and other agro-chemicals.

The wide seasonal variations of prices of agricultural commodities, which have been documented in several reports and studies, continue to be a bother to farmers. Farmers who are protected from the wide variation of prices of commodities are those who produce commodities that are tied to an organized marketing system, e.g., cotton, tobacco and cocoa. An inventory credit scheme, which allows traders to increase their volume of purchases at harvest time, may help reduce the wide seasonal variation. Increase in commodities processed may also achieve the same objective.

Marketing Intermediaries: Both input and produce marketing intermediaries complained of high cost of transporting inputs to the farming communities and also transporting produce from the farming communities. The marketing intermediaries (both input sellers and buyers of produce from farmers) consider inadequate capital and lack of credit as a major factor, which limit the

volume of business. They cannot therefore make profit based on volume of business or cannot achieve benefits from economies of scale. Most of the marketing intermediaries lack the managerial ability to operate effectively and efficiently.

Processors: The problems with respect to raw materials and marketing of products depend on the type of processing activity. However, almost all the processors interviewed consider the high cost of transporting raw materials to the processing sites as a big drain on their resources. The widely distributed small-scale holdings from which processors must obtain the raw materials increase the assembling cost.

Almost all the processors also complained of inadequacy of raw materials. In the case of 'gari' processors there is a high level of competition between consumers of the raw material (unprocessed cassava) and the semi-processed product (gari) and also chips. The owners of the micro-enterprises also lack capital to purchase large quantities of the raw materials during the period when the raw materials are in abundance also during the periods when raw materials are scarce and prices are high. During the time of raw material scarcity, processors find it difficult to compete with other buyers.

The problems of the owners of micro-enterprises with respect to adequacy of raw materials supplies suggest that very little investigation is carried out to ascertain the availability of raw materials for processing. Again, there may be too many processing facilities within the catchment area. There is ample evidence of the latter situation. There are micro-enterprises scattered throughout the country (TechnoServe oil mills and gari processing facilities) which operate far below capacity because of the high concentration of plants in a catchment area.

The processors interviewed did not have problems marketing their products, especially producers of intermediate goods (e.g., palm oil) which are sold to soap manufacturers. However, those who produce goods that are also produced under traditional conditions and purchased by the final

consumer may have problems marketing their products. Consumers may prefer the keeping and other characteristics of the products produced under traditional methods to those produced by owners of micro-enterprises using improved technology. Palm oil processors who utilized improved technology to produce palm oil for the consumer market have faced this problem.

A particular micro-enterprise establishment is not allowed to sell products to whoever wants but only to hospitals and institutions. This, the micro-processor believes prevent the processing facility's ability to take advantage of market conditions.

2.6.2 Technical Capacity

The Agricultural Extension Services Department of MOFA and some NGOs including TechnoServe and Global 2000 have given some farmers technical training to enable them appropriately use improved technologies. Some NGOs, especially, TechnoServe, have also assisted farmers to store and market produce under improved practices thereby giving the farmers better price for their produce. WIAD, other state organizations such as the ITTUs, the NBSSIs, some Research Institutes and NGOs have trained farmers and processors on improved methods of processing produce. WIAD has been in the forefront of assisting farmers and homemakers to learn of proper utilization of agricultural produce (for example, the preparation of soy products from soya beans).

Notwithstanding, the successes that have been achieved through the work of State Institutions and the NGOs, the stakeholders interviewed identify several technical problems that they face. The Extension Service, WIAD, the Research Institutes and some of the NGOs indicated that high illiteracy rates limit the farmers' ability to know and also use available technologies. The low levels of incomes of the farmers and their inability to access credit facilities do not allow them to effectively use technologies that have been developed by the Research Institutes.

The marketing intermediaries also lack in-depth knowledge of business skills for running or managing micro-enterprises. There is also the absence of the entrepreneurial culture. Some owners and operators of micro-enterprises do not have adequate technical skills to operate some of the equipment used in their enterprises.

2.6.3. Existing Policies

The policies of removal of the subsidy on agricultural input and the foreign exchange policy have all contributed to the high cost of inputs. The financial sector policies that gave the banks the freedom to channel funds to whatever sector they choose have resulted in the reduction of credit to the agricultural sector. The high interest rate policy has also made it difficult for operators in the agricultural sector to access credit. As a result, adoption of improved technology by stakeholders in the agricultural sector has been hampered by the lack of credit or funds needed to finance the adoption and use of improved technology.

The privatization of the procurement and distribution of agricultural inputs has had both positive and negative impacts. Fertilizer is more available on timely basis. However, where there were several selling points throughout the country, there are now areas with relatively high concentration of selling points while other areas do not have enough selling points.

On the other hand, the liberalized and structural adjustment policies have resulted in the increase of micro-enterprises in the country. There are now several registered seed growers and distributors of fertilizer and other agro-chemical dealers (these used to be the preserves of the Departments and parastatals under the Ministry of Food and Agriculture). Other micro-enterprise activities that have emerged include the use of improved technology for processing palm oil, gari, soya bean products etc. The activities of some NGOs and other agencies like WIAD, the ITTU and NBSSI have contributed a great deal in the transfer of technology in this respect.

These organizations have helped the owners of micro-enterprises and farmers to access and adopt improved technologies, acquire technical and business skills. Support to these organizations would be useful in increasing the number of micro-enterprises.

Improvements in the macro-economic environment, specifically measures to reduce the cost of credit and also measures to channel funds to the agricultural sector will be essential for the transfer and adoption of improved technology.

The research institutes that generate the improved technology are yet to fully develop the culture of facilitating the transfer and/or commercialization of research output. The research results, with exception of those from few institutions such as Crops Research Institute, invariably stay within the confines of the Institute. Mechanisms for transferring the results to enterprises, whether owners of micro-enterprises or small and medium scale enterprises, are virtually nonexistent. There are no commercial or marketing managers to promote the transfer and commercialization of relevant research results. These research institutes, as stated earlier, do not also have setups to try their inventions on pilot basis to determine the commercial viability of such innovations. Transfer and commercialization of research results will be enhanced if the technical and financial viability can be demonstrated to entrepreneurs.

2.7. ON-GOING MICRO-ENTERPRISES RELEVANT TO THE PROJECT AND LESSONS LEARNT

The study has revealed that there are existing micro-enterprises in the input supply sector, processing, warehousing and marketing of inputs, produce and products. Micro-enterprises have been established either on individual basis or around associations.

2.7.1. **Micro-Enterprises Formed Around Associations**

The micro-enterprises established around associations have been in the input supply, processing and warehousing. Some private voluntary organizations notably Sasakawa Global 2000, TechnoServe, ADRA and other church-related PVOs have developed expertise in transferring and promoting the use of improved technology through associations. The 31st December Women's Movement has also been instrumental in the organization of several micro-enterprises around associations.

Some state agencies, for example, the Ghana Export Promotion Council, the Extension Services Department and Women in Agricultural Development have also been effective working through associations in the transfer, adoption and use of technology.

The performances of the group-owned micro-enterprises have been varied. Both successes and failures have been recorded in input supply, processing and warehousing micro-enterprises. Example of successes in input supply and marketing the Fufuo Cooperative in Ashanti promoted by Sasakawa Global 2000, processing is the oil palm processing at Ntiananko in Ashanti promoted by TechnoServe, and in warehousing and marketing, the maize inventory credit schemes in Brong Ahafo Region promoted by TechnoServe. Several factors have influenced the success or otherwise of the group owned micro-enterprises. Among these are proper identification and appraisal of the enterprise, raw material base, technical and managerial skills, finance and cohesiveness of the group. However, the technical knowledge and managerial skills of the leadership of the group-owned enterprise appear to be the main determining factor on the success or otherwise of the enterprise.

The available evidence suggests that the potential to develop group-owned micro-enterprises exist in input supply, processing and warehousing sector.

2.7.2. Individually Owned Micro-enterprises

There have been successes in the development of individually owned micro-enterprises in the input supply, processing and marketing sectors.

Input Supply:

The private sector registered seed growers have taken over the functions of the Ghana Seed Company since the liquidation of the company. Most of the registered seed growers operate at the micro-enterprise level. Majority of these registered seed growers do not have their own cleaning, sorting and grading facilities. The supply of foundation seeds from the research institutes is not adequate. Other micro-enterprises may be encouraged and trained to produce foundation and grower seeds.

The Crops Research Institute has developed technologies for multiplying yam sets or seedlings and plantain suckers. Plantain and yam farmers in recent years have found it difficult to obtain adequate planting materials. Some Private Voluntary Organizations, notably, Sasakawa Global 2000, ADRA, and TechnoServe have been in the forefront of transferring improved inputs to farmers. ADRA helped in the production of yams for export through the introduction and promotion of the use of yam sets in the Brong Ahafo Region

The multiplication of plantain suckers and yam seedlings or sets, using the technology developed by the Research Institutes and extension services, could be developed as successful micro-enterprises.

There is proliferation of fertilizer dealers in areas such as the maize triangle (Techiman/Ejura/Kintampo), Kumasi and Tamale while other areas are poorly served. Thus, there is the opportunity to assist entrepreneurs to open up fertilizer and other inputs' dealerships in the poorly

served areas. Existing input dealers may be assisted by the project to access credit for expansion of their businesses.

Marketing:

The marketing of such inputs as fertilizer, Veterinary drugs and other agro-chemicals were mainly in the hands of state organizations or departments. However, since the early 1990s the Government of Ghana with its agencies has virtually withdrawn from the procurement and distributions of agro-chemicals. The private sector has taken over the procurement and distribution of fertilizer and to a large extent other agro-chemicals.

There are a couple of hundreds of fertilizer and other inputs' dealers. Results from other studies have shown that these dealers need to be trained in several areas including agribusiness and marketing management, retailer credit, fertilizer technology and recommendations and warehousing management (Asante et al, Gerner et al). A quick survey of the retailers confirmed that the input dealers need training in the areas specified. An NGO or a private organization may be hired to provide the requisite training to the input dealers to improve the efficiency of their business operating.

The marketing of food crops has been dominated by the private sector marketing intermediaries most of whom operate on a small-scale basis. Most of these traders, e.g. maize, cowpeas, groundnuts and yams etc., do not perform any storage function if even the commodities they handle are storable. They do not also perform grading, standardization and quality control functions. The output sellers, like their counterpart input dealers need training in such areas as business skills, credit, warehousing operations. It may be mentioned that TechnoServe has assisted farmers to improve on the marketing of their produce through an inventory credit scheme organized under sponsorship of Agricultural Development Bank. There was also another

inventory credit scheme for traders that was promoted by the Natural Resources Institute of the United Kingdom.

Other farmers and marketing intermediaries of other commodities may also be assisted to improve on their performance. Farmers and dealers in tomatoes may be assisted to know when to harvest the tomatoes to reduce post harvest losses and also how to package the produce for transportation to the consuming centers.

Processing:

One area that has seen proliferation of micro-enterprises is processing. There has been an increase in the use of improved technology in the processing of, especially, palm oil, sheabutter, soyabean products, gari and fish. These technologies have been promoted both by Private Voluntary Organizations (such as TechnoServe and 31st December Women's Movement) and the departments of government ministries (e.g. Extension Services and Women in Agriculture and the NBSSI and GRATIS). The proliferation of plantain chips in the streets of Accra and other such products give an indication of the increase in the micro-enterprises in the food processing area.

2.7.3. Lessons Learnt

The experiences observed in the study suggest that the transfer of technology and its adoption is enhanced, if in the case of agricultural produce, the Commodity Systems Approach is used. The success of cocoa, tobacco and cotton can be attributed to the fact that, research, production and marketing are all taken together. Producers have access to research findings and also do not have problems marketing their produce. Price variability is minimal and producers are assured of reasonable returns on their investment.

It also appears that with exception of CRI and SARI who through the RELCS get their results to farmers, the other research institutes do not have a formal system of transferring results to

stakeholders. It must be pointed out that technology transfer and adoption have been focused more on the production end than marketing, provision of services and processing.

2.8.0. **PARTNERSHIP OF POTENTIAL STAKEHOLDERS**

The study has revealed that there is a very great potential for the transfer, adoption of technology at the micro-enterprise level. However, the realization of this potential will depend on effective collaboration between stakeholders.

The potential stakeholders identified in the study are researchers or innovators or generators of improved technology and processors. Other stakeholders include personnel who can assess the technical and economic viability of such innovations under different socioeconomic and environmental conditions, promoters of use of technology and commercialization of improved technology, users of improved technology and financiers of the adoption, use and commercialization of improved technology.

2.8.1. **Researchers and Generators of Improved Technology**

The new direction of the Council for Scientific and Industrial Research is that research should be demand-driven. This direction is in line with the requirement that about 30% of the revenue of CSIR should be raised from the commercialization of technologies developed by the institutes. The potential to achieve this target could be very high if conscious effort would be made to bring the research findings to the knowledge of stakeholders.

It will be more persuading to stakeholders, users and financiers, if the research institutes can demonstrate the technical and financial viability of such innovations. This may be achieved if the research institutes have access to facilities to test on pilot scale basis the viability of new technologies that have been developed. Potential owners of micro and small-scale enterprises can

work with the researchers at the pilot facilities to learn at first hand the technical aspects of the innovations and their financial and commercial viability of these innovations

The research institutes as a matter of priority engage economists and other consultants who can assist in assessing the technical, financial and commercial viability of such innovations. The proposal to appoint marketing managers for the research institutes is in the right direction and should be implemented without delay. The market managers would help accelerate the commercialization of research results. They may also help researchers to work in areas that have high potential of commercial demand.

Researchers may be encouraged to go into commercial operations with technologies that they have developed. The transition from researcher to enterprise's owner should have to be worked out and modalities agreed upon by all parties. Conditions and modalities for the private sector accessing the technologies developed by the research institutes for profit should also be worked out. This arrangement may include incentive packages for the researchers who invented the technology. If patenting is not carried out at the research institutes it should be done immediately. As an incentive the researchers should share in any financial gains.

2.8.2. Users of Improved Technology

The transition from research or new technology to users must be managed carefully. A sure way to kill any enthusiasm for adopting new technology is nonperformance. It is important that new technology is tried and tested before it is released to potential users. It has come to the notice of the CSIR that some cashew variants that were "hurriedly" introduced have not matched up to expectation with respect to the expected yield by farmers. Again some products, e.g., palm oil and sheabutter produced by using improved technology were not acceptable to consumers.

Users of technology on hearing of the potential profitability of an improved technology had rush to adopt the technology with limited knowledge of the technology. The wrong application of the technology has caused such users, financial losses or less than the anticipated profit.

The marketing of produce or products from the use of improved technology as previously mentioned has been ignored in the past. Some users of improved technology have produced in abundance or produced a product whose quality does not meet the demands of the market. Prices, invariably have declined to the detriment of the users. Processors have also had problems with regularity of supply and/or adequacy of raw materials. Examples abound in the processing of palm fruits into palm oil, cassava into gari or starch, soyabean and cowpeas into weanimix in several locations. The under utilization of the capacity of the plants of these processors have affected their profitability. If a systems approach is introduced in the transfer of technology and coordinated some of the problems maintained above may be reduced or eliminated. Technology transfer and commercialization will be enhanced.

2.8.3. Promoters of Use of Technology

Different types of organizations promote the use of improved technology. The organizations promoting the transfer and use of improved technology range from government departments and private voluntary organizations. Foremost among the government agencies are the Agricultural Extension Services and Women in Agricultural Development of MOFA, the Ghana regional Appropriate Technology Information system (GRATIS) through its ITTU's and the NBSSI.

The most prominent Private Voluntary Organizations (PVOs) involved in Technology Transfer and commercialization are Adventist Development and Relief Agency (ADRA), TechnoServe, Sasakawa Global 2000, and 31st December Movements. In addition to the PVOs, Agricultural business firms have also been a major partner in technology transfer and commercialization.

These firms have either transfer technology to farmers through an outgrower scheme or through

provision of inputs, technical advice and marketing of produce. The operators of the outgrower schemes have their own nuclei farms. Examples of these firms can be found in the oil palm, rubber and pineapple industries. The firms supply improved inputs to the farmers and also help the farmers practice recommended agronomic practices. On the other hand the agribusiness firms who provide inputs, technical advice and purchase produce from farmers may not own nuclei farms. They also buy the output from their farmers at an agreed price. Corporate examples can be found in the oil palm sector, Twifo Oil Palm Plantation (TOPP), Benso Oil Palm Plantation (BOPP) and Ghana Oil Palm Development Company (GOPDC), and in tobacco and cotton sectors.

It may be mentioned that successes have been achieved in transferring technology in situations where the commodity systems approach is used. That is the input supply, technical advice on production and marketing of produce are all considered as one package. An example by an NGO is the introduction of yam setts and the production of yams for export. The rapid growth in the cashew industry can also be attributed to the commodity systems approach being used. ADRA and TechnoServe are the main promoters of the cashew industry.

2.8.4. Financiers

Financiers have played a major role in the adoption and use of improved technology. Most of the banks were very active in the financing of the agriculture especially before the era of structural adjustment in the financial sector when banks were required to extend 20% of loanable funds to the agricultural sector. In the past few years several banks have withdrawn from the agricultural sector especially in the area of crops' production, processing and marketing. About 80 percent of institutional credit to the agricultural sector is extended to the sector by the Agricultural Development Bank (ADB) which is one of the smaller banks. It came out of the study that users of improved technology are hampered in their operations by lack of funds.

Some successes that have been achieved in the adoption and use of improved technology for example in the oil palm, cotton and tobacco industries have been made possible because of availability of loanable funds or financing of the innovation by an agribusiness firm or private voluntary organizations. The TechnoServe program on oil palm processing and the programs such as input supply and inventory credit scheme were made possible because of the financial support provided by the Agricultural Development Bank. The ADRA, TechnoServe and Catholic Relief Service have also received financial assistance from USAID to support programs that come under food security. Micro enterprises that have received assistance from the Business Assistance Fund and NBBSSI have mostly been outside the agricultural sector. It is mainly through ADRA, TechnoServe and the IFAD-funded projects that micro enterprises in the agri business sector have received financial assistance. The IFAD-funded projects have been targeted to low income farmers and selected areas of the country. While the TechnoServe programme has been limited to processing and selected commodities.

To expand or increase micro-enterprises, in the agri business sector, provision should be made to provide financial assistance to potential micro-enterprises in the agricultural sector. The criteria for assistance should be based on viability.

A potential financial set-up that could assist in the establishment of micro-enterprises in rural Ghana is the rural banking system. A few rural banks are active in that direction. The Bank of Ghana and the European Union have provided assistance to qualified rural banks to support the establishment of micro-and small-scale enterprises in their catchment area. The funds given to the rural banks to fund micro-and-small scale enterprises have not in some cases been fully utilized for the purpose due to a number of reasons. These reasons include lack of qualified personnel in the area of assessing the feasibility of projects and marketing of the banks' products and services. Potential micro-enterprise owners in the catchment areas of the rural banks may not even be

aware that the banks have access to funds to support micro-and-small-scale enterprises. The potential for the rural banking system is yet to be fully tapped.

Availability of funds to stakeholders to support viable technologies will enhance the transfer, adoption and use of improved technologies for the promotion of micro-enterprises. Any project to increase technology transfer and commercialization should incorporate programs that will enhance the rural bank's capacity to support micro-enterprises.

3.0. SPECIFIC RECOMMENDATIONS OF VIABLE AREAS AND TECHNOLOGY OPTIONS FOR STARTING MICRO-ENTERPRISE DEVELOPMENT

The study has revealed that there are several areas that micro-enterprises can be promoted. Among the areas are production of planting materials distribution and sale of inputs, and processing.

3.1. Input Supply

It has been observed that some areas are not served by input dealers. The project can be of assistance in helping new entrepreneurs to go into the distribution and sale of agricultural inputs to farmers especially in areas where there are no sales outlets. The existing input dealers and prospective dealers should be given training in relevant areas.

3.2. Production of Seeds and Improved Seedlings

The productions of seed and seedlings are areas that need to be promoted. The current output of improved seeds, especially maize, is inadequate to meet the demand of maize farmers. A larger percentage of maize farmers throughout the country still use maize seed that they have stored from previous seasons. The project can assist the research institutions mainly the CRI and SARI and also the GLDB to expand the scale of activities so that Registered Seed Growers will obtain enough growers seed for production of improved seeds (maize, cowpeas, groundnuts and rice) for farmers.

The inadequacy of oil palm and citrus seedlings produced by the Oil Palm Research Institute, Kusi and the University Research station, Kade (both in the Eastern Region), respectively suggests that there is the potential for the development of micro-enterprises in these areas. The production of oil palm and citrus have caught on well with farmers in those areas and these have created a great demand for the seedlings of these plants. The University Research Station (URS) at Kade

could not meet an order from ADRA to produce citrus seedlings for farmers ADRA has been supporting to go into citrus production. The project will do well to encourage entrepreneurs to go into the production of such seedlings as cocoa, oil palm and citrus. It can do this by working in collaboration with the research institutes and the University Research Station (URS) at Kade to pass on the Technology to prospective entrepreneurs.

The drying and cleaning of maize in the major maize producing areas e.g. Techiman are mostly handled at the silos and warehousing sites operated by the Ghana Food Distribution Corporation (GFDC). This is one area which entrepreneurs may want to consider for investment. Already, one company, Letus Produce Company, has set up a grain cleaning and drying facility at Techiman.

3.3. Collateral Management

The two types of collateral management (via TechnoServe and the Natural Resources Institute of UK) should be evaluated and expand. The success of this scheme may reduce price variation, improve the marketing system and probably ensure stable supply of raw materials to processors.

3.4. Processing

A special program should be formulated to assist entrepreneurs to commercialize the many products that have been developed at the Food Research Institute.

4.0. SUMMARY AND RECOMMENDATIONS

4.1. Introduction

This study is concerned with technology transfer and commercialization. The main purpose of the proposed program for which the current study forms part is to enhance technology delivery and commercialization. The major issues addressed in the study are availability of improved technology and innovations, extent and use of technology, institutional aspects of technology transfer and commercialization and its impact on agro-enterprise development. Other issues considered are technical and socio-economic barriers to efficient technology transfer and commercialization and delivery to end users, micro-enterprise needs and development, partnership of potential stakeholders, on-going micro-enterprise relevant to the project and lessons learnt. The final section is specific recommendations of viable areas and technology options for starting micro-enterprise development.

The study was carried out in selected areas of Ghana. Some organizations notably research institutions were surveyed. Other stakeholders interviewed include farmers, extension personnel and owners of micro-enterprise. The micro-enterprises surveyed include input supply companies, agro-processing companies, storage companies, and other marketing intermediaries. Secondary material from research institutions and other sources were also used.

4.2. Summary of Finding

4.2.1. Institutional Aspects of Technology, Transfer and Commercialization

Some of the research institutions have elaborate system of getting their technology improvements and innovations transferred to users. In several instances, the users directly obtain the technology from the research institutions.

The Crop Research Institute (CRI) appears to have the best institutional linkage. The improved technology and innovations get to users through the Research Extension Linkage Committee (RELC). The CRI also works with intermediate organizations such as the Grains and Legumes Development Board (GLDB). The CRI appears to have transferred more improved technologies and innovations to users than any other institute of CSIR.

A large number of farmers (improved seeds) and fishermen (Chorkor Smoker) have availed themselves of the research output of CSIR. It may be concluded that linkages between research institutes and other collaborating organizations enhance technology transfer and commercialization. On farm trials, field days and training courses are other means through which research results get to the users.

The nuclei farm concept (e.g. in the oil palm industry) with outgrowers have also facilitated the transfer of technology to small-scale farmers. Where the industry is managed by one body as in the case of cocoa, where research, extension and marketing are all managed by the Ghana Cocoa Board the transfer of technology is enhanced

The FRI which has several research findings that can be commercialized but without elaborate institutional linkages as exists in the case of CRI and SARI has not been effective in getting its numerous research outputs transferred to users. The experiences of the RELCS, WIAD and some NGOs confirm the importance of institutional linkages. The study has also shown that technological improvements related to crop production (e.g. improved seeds and seedling, and fertilizer recommendations) are more likely to be transferred through formal institutions to users than innovations related to marketing, processing and utilizations.

4.2.2 Institutional Orientation, Capacity and Preparedness for Transfer and Commercialization of Technology

The research institutes orientation has not been geared towards transferring innovations and/or improved technology to users.

In most cases, the commercial viability of research findings or innovations have not been tested. The unavailability of facilities for the research output to be pilot-tested does not allow the researchers to identify operational problems, make the necessary modification and advise prospective users accordingly. Commercialization and transfer of technology will increase if the financial and commercial viability is known

Key research institutes, which were required to hire marketing managers to assist the organizations, transfer and commercialize the research findings.

4.2.3. Technology Transfer, Processing and Commercialization

Improved technologies and innovations which have been transferred or ready to be transferred by the selected research institutes and institutions include improved inputs, agronomic practices, animal husbandry practices, storage and marketing, processing utilization. The Crops Research Institute has been more successful in the transfer of technologies with respect to improved inputs.

A large proportion of farmers used improved maize and cowpeas seeds. There are now registered seed growers who produce seeds and sell either direct to farmers or to seed companies.

The research results of some Research Institutes of the CSIR, notably CRI, SARI, OPRI and to some extent FRI have made impact on the agricultural sector.

In addition to the research institutes of the CSIR, the research output of some of the research units in the universities have also been transferred to both small scale and large-scale farmers. Notable among these is the University Research Station at Kade that has been a leader in

providing farmers with improved citrus seedlings. The farmers in the area of the research station are making reasonable good income from their citrus farms.

4.2.4 Technical and Socio-economic Constraints for Commercialization of Agricultural Technologies

Several technical and socio-economic constraints have been identified as responsible for slowing down the transfer and the commercialization of improved technologies and innovations.

Some of the research institutions identified high farmer to extension officer ratio, farmers' level of education, inadequate supply of improved planting materials by registered seed growers and producers of other planting materials (e.g. plantain suckers, oil palm seedlings, yam sets etc.).

Absence of facilities at research institutes such as FRI to try the improved technology on pilot basis in order to identify operational bottlenecks and financial viability poses a major constraint to technology transfer and commercialization.

Farmers also identified unavailability of improved inputs (specifically planting materials), difficulty in obtaining extension assistance due to high farmers/extension officer ratio (2,100:1), technology not suitable to a farmer level of technical skills, managerial skills and socio-economic circumstances.

One major constraint facing owners of micro-enterprises in the processing sector is the preference of consumers to products processed by traditional means. For example consumers prefer palm oil produced by traditional methods. Even the leading user of palm oil (Lever Brothers Ghana Limited) does not like the quality of palm oil produced by groups using improved technology promoted by TechnoServe. The technology promoted should be demand driven so that micro-enterprise owners (processors) will not have problems marketing their products. It is necessary

that more work is done on acceptability of product and market access before a new processing technology is introduced to stakeholders.

4.2.5. Socio-economic Constraints

Initial acceptability of products from improved technological innovations and processes have always been a problem. Scientist may come out with a variety that may be high yielding but not profitable or acceptable on the market. A multi-disciplinary approach to research based on a commodity systems approach may help minimize these constraints.

Farmers interviewed ranked lack of funds or credit as the major constraint to adoption of technology. The lack of credit had been compounded by the fact that the government macro-economic policies under the structural adjustment program have significantly increased the cost of agricultural inputs. Existing land tenure arrangements in some cases affect the adoption of innovations and improved inputs. Lack of access to markets has also affected the farmers' ability to adopt improved technology.

4.2.6. Input Dealers

The main constraints identified by the input dealers are lack of capital, credit and marketing skills. Most of the dealers, as a result, can purchase and store small quantities of inputs at a time. They thereby have high transaction costs because of the frequent trips to purchase stocks.

4.2.7. Processors

High cost and unstable prices of raw materials, insufficient capital and credit are some of the constraints identified by the processors. Processors also consider inadequate raw materials which forces most of them to operate below capacity.

4.2.8. Micro-enterprises Needs and Development

Micro-enterprises were identified at the farm, processing and marketing and distribution levels. Improved seeds produced either by the private sector and or research institutes for sale to farmers are not adequate. There is the potential for private sector entrepreneurs to go into the production of grain seeds, citrus and oil palm . The weak link between marketing to production and processing has created problems for processing facilities.

The input dealers who sell improved seeds and seedlings, fertilizer, agro-chemicals and other farm equipment operate on a very limited scale because of lack of capital. In addition to the low level of technical, marketing and managerial skills of most of these input dealers operate at the rudimentary level. The input dealers will thus have to be given training in these areas so that they can improve on their operations in terms of quality of service and scale of operation.

Attempts have been made to improve the efficiency in the marketing of some commodities, especially maize through inventory credit schemes promoted by TechnoServe (for farmer groups) and marketing intermediaries by Natural Resource Institute (NRI) under the sponsorship of Department for International Development.

4.2.9. Problems, Existing Policies And Enabling Environment

The major problems facing small scale enterprises were categorized under demand for inputs, raw materials and commodities, technical capacity, policy environment, constraints associated with production and distribution of some commodities.

The farmers interviewed considered high cost of inputs, and wide variation of prices of agricultural commodities as major problems that they face. The high cost of such input as fertilizer is partly attributed to the near monopoly situation that exist in the fertilizer industry

The high cost of inputs that the farmers considered as a problem may partly be a reflection of the inadequate capital and lack of credit. An increase in processing of agricultural commodities may reduce the wide variation in prices.

The major problems complained of by the marketing intermediaries are high cost of transportation, inadequate capital and lack of credit which force the traders to operate on a small-scale basis. Majority of the marketing intermediaries lack managerial skills.

Processors

The processors interviewed attributed the high cost of transportation of raw materials to the processing facility partly to the assembling of raw material from widely scattered small-scale holdings. Almost all the processors complained of their inability to purchase acquired quantity of raw material with their inadequate capital during periods of raw material scarcity.

The concentration of many small-scale agro-processing enterprises in a catchment area may also account for the inadequacy of raw materials.

The facilitators of technology transfer, the Agricultural Extension Services Department, WIAD, the research institutes and some NGOs stated that high illiteracy among the farmers, their low incomes and lack of credit limit their ability to effectively use improved technologies.

Existing Policies

The financial sector reforms that removed sectoral allocation of loans and also freed interest rates have resulted in the reduction of credit to the agriculture sector.

The liberalized and structural adjustment policies have resulted in the establishment of micro-enterprises in input supply, marketing and processing. Some organizations both private sector and public, have facilitated the transfer of technology and creation of several micro-enterprises.

4.2.10. On-Going Micro-enterprises

The existing micro-enterprises are mainly engaged in production of seeds and other planting materials, processing of cassava, palm oil, sheabutter, and groundnut oil. Other areas are warehousing and marketing (of inputs, produce and products).

Micro-enterprises have been established either on individual basis or around groups or associations. The technical knowledge and managerial skills of the leadership of the group-owned enterprises are the main ingredients for success of the enterprises.

Successes have been achieved in the development of individually owned micro-enterprises in the input supply, production of seeds, and seedlings, processing, warehousing and marketing sectors. The private sector has taken over the procurement and distribution of inputs.

There are several micro-enterprises using improved technology to process agro-products especially palm oil, sheabutter, soyabean products, gari and fish among others. The technologies for processing these products have been promoted by both NGOs and state agencies such as WIAD, NBSSI and GRATTIS.

4.2.11. Partnership of Potential Stakeholders.

The potential stakeholders identified in the study are researchers or investors or generators of improved technology and processors. Other stakeholders include economists or other personnel who can assess the technical and economic viability of such innovations under different socio-economic and environmental conditions, promoters of use and commercialization of improved

technology, users of improved technology and financiers of the adoption, use and commercialization of improved technology. The collaboration between these stakeholders will promote the transfer, adoption and commercialization of technology at the micro-enterprise level.

4.3. Recommendations

The recommendations are based on the issues that have been analyzed and discussed in the paper with the object of promoting the transfer and commercialization of technology

4.3.1. Transfer of Technology to Farmers

The experiences of agricultural production in the country point to the fact that technology transfer is enhanced by the use of commodity systems approach. Cocoa, Cotton, tobacco and oil palm industries use more improved technology than in the production of other commodities.

The nuclei farm concept that is being proposed by Ministry of Food and Agriculture (MOFA) might be a better means of ensuring that technological improvement developed by the research institutes are transferred to farmers. The Research Extension Linkage Committee (RELC) which bridges the gap between research and extension should be strengthened so that they cover not only innovations for production but also processing and marketing.

4.3.2. Appointment of Commercial/Marketing Managers For Research Institutes

The research personnel of the research institutes are not commercially oriented. The need for key Research Institutes of the CSIR to appoint marketing managers to market and commercialize research findings have been agreed. Steps should be taken for such officers to be appointed soonest so that the drive towards commercialization can be achieved

4.3.3. Modification of Criteria for Promotion of Research Personnel

The current career progression is based on the number of scientific publications a researcher publishes. To give substance to the objective of commercialization, the criteria for promotion should incorporate the rate or extent of which research results or innovations are transferred to users or commercialized.

4.3.4. Capacity to Analyze Financial and Commercial Viability of Technological Innovations.

The research personnel should be given training to equip them to analyze the viability of technological innovations and research findings. The research Institute may, on the other hand, employ commercial and marketing managers who have the capacity to analyze commercial viability of research findings. Prospective investors will be more convinced if it can be demonstrated to them that the innovation is financially and commercially viable.

4.3.5. Establishment of Research Parks for Key Research Institutes

The establishment of research parks for key Research Institutes of CSIR or even the universities will afford the researcher and users of new technology the opportunity to assess the performance of new processing facilities and also assess the product suitability for the local Ghanaian market. The researchers will also observe operational bottlenecks at the research parks and would be in a better position to make necessary adjustment before the process is introduced for commercialization.

4.3.6. Multi-Disciplinary Approach to Research

The CSIR should consider a multi-disciplinary approach to research based on commodity basis. A system approach to research may minimize the problems associated with the introduction of new technology and products. The agronomist or scientist, the food scientist, the industrial engineer, the sociologist and the economist/marketing specialist should work together in order to reduce problem

of acceptability, commercial and financial viability and market access. It is believed that technology transfer and commercialization will increase if this approach is used.

4.3.7. Demand Driven Research

To ensure that micro-enterprise processors do not have problems marketing their products, technology being promoted for adoption should be demand driven. This also requires that research projects embarked on by researchers are also demand driven.

4.3.8. Promotion of Nuclei Farm/Outgrower Schemes

The high cost of inputs and lack of credit have contributed to farmers' inability to adopt new technology and innovations. Promotion of nuclei farm/outgrower schemes may be a solution to the nagging problem of high cost of inputs, unavailability of inputs, high farmer/extension ratio, lack of credit and access to market.

4.3.9. Assistance to Producers of Planting Materials

It has been established in the study that production of planting materials namely grain seeds, citrus seedlings and yam sets and others are not adequate to meet the needs of farmers. There is, therefore, the opportunity for the establishment of micro-enterprises in the production of planting materials.

The existing producers operate on a very small scale. These operators may need both technical and financial assistance to expand their scale of operations. New entrants may also be encouraged to establish micro-enterprises in these areas.

4.3.10. Financing of Marketing Intermediaries

The scale of operation of most marketing intermediaries (both input and output marketers) is quite small. Innovative financing such as arrangement of suppliers credit from distributors with bank guarantee may help the input dealers to expand their operation and hopefully achieve economies of

scale. The collateral management system promoted by TechnoServe and the Natural Research Institute (NRI) of UK for farmers and traders should be evaluated and promoted.

4.3.11. Training of Marketing Intermediaries

The operators of micro-enterprises especially, marketing intermediaries were found to lack some basic skills. A training program to upgrade the technical, marketing, accounting, warehousing and managerial skills is proposed.

4.3.12. Identification and Selection of Projects

A major problem facing most small-scale agro-processors is the low capacity utilization that affects profitability. Prospective small scale agro-processors should be assisted on proper identification and selection of projects to help avoid situations where facilities are sited in areas with inadequate raw materials base.

4.3.13. Support to NGOs and Other State Organizations

NGOs and some state organizations have been on the forefront of organizing groups to operate micro-enterprises. There some micro-enterprises that may beyond the reach of the average small-scale operator, e.g. oil mills, cleaning, drying and grading facilities for grains and warehousing. For such facilities group ownership may be the option to follow. For group owned facilities proper formation of groups and training given to the leadership will be essential. The NGOs and other state organizations may be assisted through the project to organize the groups and provide the necessary training to the leadership of the group.

4.3.14. Appointment of a National Coordinator

The promotion of technology transfer and commercialization would need to be well organized and coordinated. The recommendations made above, if they are to be implemented successfully, will require the appointment of a national coordinator. It is recommended that the office of the national

coordinator should be located at the head office of the Council for Scientific and Industrial Research.

The proposed qualifications and duties of the national coordinator is in Appendix I.

APPENDIX 1

NATIONAL COORDINATOR

Specific Duties

Plan, organize and control project operations.

Liaise with marketing/commercial managers of key research institutions in transferring technology to potential micro-enterprise operators.

Develop brochures on research findings that can be commercialized and distribute same to potential investors.

Work with NGOs, Ghana Export Promotion Council, Private Enterprise Foundation to promote commercialization and transfer of technology.

Develop and maintain a management system to track project progress and performance.

Will be responsible for the day to day running of secretariat of the Technology Transfer and Commercialization Coordinating Committee.

Qualifications

A minimum of a masters degree in Agricultural Economics, Business Administration, Marketing or any other relevant qualifications with at least 10 years experience in planning and implementation of programmes.

The candidate should preferably have knowledge in project planning and appraisal.

Must have good communication skills and ability to work with research institutions and private sector entrepreneurs.

Reporting Relationship

The National Coordinator will report to Technology Transfer and Commercialization Coordinating Committee (TTCCC) which will be located at the head office of the Council for Scientific and Industrial Research.