Impact of Agricultural Research

Done in the Past Twenty Years for Selected Commodities in the Eastern and Southern Highlands Zones

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Food Security and Household Income for Smallholder Farmers
Applied Research with Emphasis on Women
(TARP II – SUA Project)

June 2002

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PREFACE

This report presents results on impact studies on research done in the past twenty years in the Eastern and Southern Highlands zones. The studies are part of the planned outputs under the Tanzania Agricultural Research Project Phase Two (TARP II) component on Food Security and Household Income for Small-holder Farmers in Tanzania: Applied Research with Emphasis on Women that is coordinated by Sokoine University of Agriculture (SUA) – TARPII-SUA.

TARP II is a national research project under the Ministry of Agriculture and Food Security (MAFS), Division of Research and Development (DRD) with support from various donors. The component on Food Security and Household Income for Small-holder Farmers in Tanzania is a collaborative effort between DRD of MAFS, the Agricultural University of Norway (NLH) and Sokoine University of Agriculture (SUA) with funding mainly from the Norwegian government through the Norwegian Agency for Development Cooperation (NORAD).

Among the outputs envisaged for TARPII-SUA is impact assessment of agricultural research in the Eastern and Southern Highlands zones with the following activities: (i) studying on-farm impact of research done in the past 20 years; (ii) using existing baseline data and conducting a study on use of farm technology; (iii) conducting an end-line study of impact of the current project; (iv) disseminating findings to the international research community; (v) disseminating findings to extension agents and farmers and (vi) communicating findings relevant for policy making to the Government of Tanzania and other stakeholders.

Apart from fulfilling the objective of the first activity under the output, i.e. the activity on impact assessment of past research, results of this study are expected to provide information that would be useful not only to the on-going research projects under TARP II - SUA in terms of providing useful feed back to researchers and project management but also to the research community at large. It is envisaged that the results will be useful in informing the research community within and outside the country, extension agents and project management staff, policy makers and other stakeholders with regard to many aspects such as in priority setting and implementation of research, in technology development and in technology transfer activities.

Impact assessment of research and development (R&D) activities is important I a number of ways. The essence of impact assessment of both past and on-going R&D is in mobilizing more resources for these activities, making efficient allocation of the limited resources available and in informing research on gaps and direction to be taken by future research. Quantifying the impacts achieved by past research will not only form basis for justifying the need for future funding of research against other competing funding needs, but will assist in identifying areas where future investment will have most impact, thus increasing the potential for research to

attract more funding and the chances for research contributing significantly towards poverty eradication, food security and environmental conservation.

The work presented in this document is a culmination of process that started with making an inventory of all research done in the past twenty years in the Eastern and Southern Highlands zones which produced "Reflection on Agricultural Research – Past Agricultural Research in the Eastern and Southern Highlands zones" (TARP II-SUA Project publication number TS 2-35). Among other things, information in the inventory provided the basis for selecting the research programmes for the impact assessment done by this study.

Although the coverage was limited to five impact studies on: Cassava research in the Eastern zone; Rice research in the Southern Highlands zone; Rice research in the Eastern zone; Pasture research in the Eastern and Southern Highlands zone; and Round potato research in the Southern Highlands zone, the findings obtained provide information that can be extrapolated to other similar crops and areas.

Prof. L. D. B. Kinabo
TARPII-SUA Project Coordinator

June 2002

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LIST OF ACRONYMS AND ABBREVIATIONS

ARI	Agricultural Research Institute
CAN	Calcium Ammonium Nitrate
DAP	Diamonium Phosphate
DRD	Department of Research and Development
DRT	Director of Research and Training
EAARSO	Government of German in East Africa
EEAAFRO	The East African Agricultural and Forestry Research Organisation
EZ	Eastern zone
FAO	UN Food and Agriculture Organisation
FARMESA	Farm Applied Research Methods for eastern and Southern Africa
FSRP	Farming Systems Research Programme
FYM	Farm Yard Manure
HPI	Heifer Project International
IAT	Impact Assessment Team
IDA	International Development Agency
IFAD	International Fund For Agricultural Development
IITA	International Institute
IRRI	International Rice Research Institute
JICA	Japanese International Cooperation Agency
KARI	Kenya Agricultural Research Institute
MAC	Ministry of Agriculture
MAFS	Ministry of Agriculture and food Security
NAELP	National Agricultural Extension and Livestoct Project
NARCO	National Agricultural Food Company
NARS	National Agricultural Research System
NCVS	Norwegian College Veterinary Science
NGO	Non Governmental Organisation
NLH	Agricultural University of Norway
NORAD	Norwegian Agency for Development
NPK	Nitrogen Phosphorous Potassium Fertilizer
NRI	Natural Research Institute
PIP	Potato Improvement Programme
PRA	Participatory Rural Appraisal
RIP	Rice Improvement Programme
SA	Sulphate of Ammonia
SACCAR	Southern African Centre for Cooperation in Agricultural and Natural Resources Research and Training
SARRNET	Southern African Root Crop Research Network
SH	Southern Highlands
SPAAR	Special Programme for African Agricultural Research
SRI	Sugar Cane Research Institute

SSDDP	Small Scale Dairy Development Programme
SUA	Sokoine University of Agriculture
TALIPO	Tanzania Livestock Research Organisation
TARO	Tanzania Agricultural Research Organisation
TARP II	Tanzania Agricultural Research Project Phase two
TDDP	Tanga Dairy Development Programme
TFNC	Tanzania Food and Nutrition Centre
TPRI	Tanzania Pesticides Research Institute
TSP	Triple Super Phosphate
UAC	Uyole Agricultural Centre
VEO	Village Extension Officer

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Dr. Msabaha (Uyole), Dr. Kanju (Ukiriguru), Mrs. Mtunda (Kibaha)-Cassava Research.

Dr. Mbapila (KATRIN), Mr. Musomba (KATRIN), Mr. Zakayo (Cholima) and Mr. Kisandu and Mr. Mwambene (Mbeya) -Rice research.

Mr. Mende (ARI Uyole), Ms Gondwe (ARI Uyole) and Mr. Mwambene (Mbeya)-Irish potato.

Mr. Kavana (LRC Tanga), and Dr. Mtengeti (SUA Morogoro) -Pasture and Fodder

Last but not least, we are grateful to all individuals who in one way or another made this task a success. Special thanks go to Mr. N. Madalla, Mr. O. Mtinda and Mr. L. Nyato for technical assistance in preparing this report.

SUMMARY OF FINDINGS

Introduction

- This report presents results on impact studies on research done in the past twenty years in the Eastern and Southern Highlands zone. The studies are part of the planned outputs under the Tanzania Agricultural Research Project Phase II (TARPII) component on Food Security and Household Income for Small-holder Farmers in Tanzania: Applied Research with Emphasis on Women that is coordinated by Sokoine University of Agriculture (SUA) – TARPII-SUA.
- The importance of impact assessment of research and development (R&D) activities is increasingly becoming apparent. The essence of impact assessment of both past and on-going R&D is in mobilizing more resources for these activities, in making efficient allocation of the limited resources available and in informing research on gaps and direction to be taken by future research.
- Work presented in this document is a culmination of a process that started with making an inventory of all research done in the past twenty years in the Eastern and Southern Highlands zone which produced the TARPII-SUA publication (No. TS 2-35) entitled: "Reflection on Agricultural Research – Past Agricultural Research in the Eastern and Southern Highlands zones". Among other things, information in the inventory provided the basis for selecting the research programmes for the impact assessment done by this study.
- Research programmes studied under the present work included: Cassava research in the Eastern zone; Rice research in the Southern Highlands zone; Rice research in the Eastern zone; Pasture research in the Eastern and Southern Highlands zone; and Round potato research in the Southern Highlands zone.
- Findings from this study compliment impact studies done for other commodities by other groups. Most significant among these is the study done by Anandaja yasekaram and others for the TARPII component under DRD in the Ministry of Agriculture and Food Security. Under that study, impact of R&D programmes done between 1900 and 2000 was assessed for root and tuber, agro-forestry, soil and water management (including tillage), dual purpose goats in Kondoa eroded areas, and for NCD disease control (using thermo-stable vaccines) in the Southern zone.
- Findings from each of the five impact studies done in this work are given in separate chapters and are summarized below under different sub-sections.

Impact of cassava research in the Eastern zone

- Cassava as a crop is changing its importance from being a famine reserve crop to being a commercial / cash crop.
- Important cassava producing areas in Tanzania include areas around lake Victoria, Tanganyika and Nyasa, along the Coastal strip of the Indian Ocean and along Ruvuma Valley.
- The study focused on cassava production in the Eastern zone that comprises Dar es salaam, Coast, Tanga and Morogoro region.

- In the surveyed villages, cassava was ranked as either the first or second food crop and was ranked as first up to third among cash crops.
- Cassava research started in Tanzania since 1920's at Amani Tanga and it went through various changes. Now cassava research is being undertaken in:
    - ARI Ukiriguru – In the Lake zone (Mwanza);
    - Naliendele – In Southern zone (Mtwara); and
    - SRI Kibaha – In the Eastern zone.
- There are no officially released varieties of cassava. Farmers are using their local varieties and some of the recommended improved varieties. There are six recommended varieties.
- The recommended varieties show to have yield increase over the farmer's varieties. As a consequence this yield increase has a potential of increasing farmers income.
- The tested processing technologies have the potential of improving the storage and marketability of processed cassava.
- The existing cassava varieties are also of importance to farmers since some of them have the characteristics preferred by farmers e.g. early maturity, good ground storability and good for marketing.
- There are spill over effects of farmers varieties through exchange of planting materials between villages.
- Most farmers (98%) have adopted row planting.
- Farmers are not using the low cost storage technologies for fresh cassava roots; This is because traditionally farmers do not store fresh tubers after harvesting. Conventionally cassava is harvested only when needed.
- In some of the areas visited, cassava diseases were ranked most important as they could cause losses of up to 87.5 percent.
- Cassava was observed to have economic impact to farmers. Cassava could be marketed both in fresh and dried form to earn income for the farmers. Income of cassava has improved the livelihood of some farmers in the study areas.
- The farm gate price of fresh cassava in the studied area did not have large variability. Dried cassava fetched in general, low price than fresh cassava; This is because of low quality of the dried cassava.
- Currently, non of the farmers in the surveyed villages in Bagamoyo and Rufiji district districts use the processing technology introduced. However, in Tanga district, a group of 12 urban women use the motorized cassava chipper and have been able to go commercial in the processing of cassava.
- Training done to farmers with regard to cassava included, training in: cassava production, management, processing and utilization and storage. Farmers in Tanga have not been trained. They mentioned their needs as including: improved varieties, training in management practices, and knowledge on the control of the cassava streak disease.
- Farmers in the surveyed areas were not using chemicals in their production process; and used environmentally friendly processing technologies. As such, the technologies in the study area have no negative impact to environment.

- The introduced processing technologies have reduced women workload and time spent in making flour compared to the local practice.
- There are still opportunities to improve cassava production because there is genetic diversity for more variety improvement; farmers have learned appropriate agronomic practices for cassava production.
- There are several constraints in cassava production such as: low yields, pest attack on stored cassava, disease attack, lack of knowledge of appropriate management practices and lack of clean planting material.

Impact of rice research in the Southern Highlands zone

- Major rice producing areas in the southern highlands zone (SHZ) of Tanzania are Usangu plains in Mbalali district; Kyela district, Msangano and Kamsamba in Mbozi district, Mbeya region, Pawaga in Iringa region; Kirando and Rukwa valley in Rukwa region and along lake Nyasa in Ruvuma region. In all these areas, rice is the main food crop.
- The mean estimated yield among small-holder farmers is one t/ha for rain fed lowland, .0.4 t/ha for upland rice and 3 t/ha for irrigated rice.
- Rice improvement programme (RIP) at Uyole Agriculture Centre (UAC) began in 1981/ 82 at Kikusya in Kyela district for upland rain fed rice and Uhambule in the Usangu plains lowland for rain fed rice.
- Collaborative work involving the exchange of materials and yield evaluation of germplasm from various parts of the world have been established with the International Rice Research Institute (IRRI), and the International Institute for Tropical Agriculture (IITA). Nationally, collaborative research had been between Ifakara, Dakawa, Katrin and SUA in Morogoro for the Eastern zone.
- In 1980, UAC established the rice improvement program (RIP) with the responsibility of developing rice improved technologies for smallholder farmers in the Southern Highlands zone. Technologies tested included seeds of the three improved varieties, seedbed preparation, optimum seed rate, time of planting, fertilizer types and application rates, methods of weed control and use of herbicides.
- Improved varieties tested were Afaa-Mwanza, Katrin and Salama. Other varieties were released without being tested in the farmer's field. Characteristics of these varieties are shown in the main report. These varieties have been exposed to farmers for the past sixteen years.
- Survey findings show only 3 farmers out of 57 farmers who participated in testing the improved varieties grow Afaa-Mwanza. None of the farmers grow Katrin or Salama' in Kyela disrict. The reasons for not adopting these varieties are their deficiencies in terms of palatability, marketability and cooking qualities that are mostly preferred by consumers.
- Of the management practices done, ploughing followed by two harrowing operations is practiced by all farmers in the area. This recommendation is not new to them, as it has been practiced even before the introduction of the new varieties.

- Planting time is between November and December. According to farmers, only a few (5%) farmers adhere to this recommendation, most of them (95%) plant between the ends of December to February.
- Most farmers (98%) are not following the recommended seed rate of 80kg-100kg per hectare, claiming that it results in a low plant population. Most of the farmers use 100 -120kg per hectare instead of the recommended rate.
- Basal application recommended rate for TSP and Urea is 20-30N and 20-40Pkg per ha. Only 25% of farmers use fertilizers mainly in the area with vertisol apart from adhering to this recommendation.
- Through experience, farmers have modified the recommended rate and currently they apply 15-20N kg per hector without mixing it with N fertilizer. The reason for reducing the rate is because of financial constraints. In areas with fluvisol, the soil is still fertile hence the use of fertilizer is minimal. Only 25% of the farmers apply top dressing as recommended.
- Most of the farmers interviewed practice hand weeding starting at 4-6 weeks after planting; the recommendation being similar to their traditional practice.
- No farmer is applying pre-emergency herbicides because the herbicides recommended are too costly. All farmers apply post emergence herbicide (Basagram or 2,4-D).
- Among the 17 varieties that existed in the survey area, there are only six varieties that farmers are still growing. 'Rangi mbili' and 'Zambia'.
- The yield advantage of the improved rice varieties tested on-farm was on average more than 2 t/ha compared to 0.5-1 t/ha of the local varieties. In Kyela Afaa Mwanza and Katrin increased yield by 37% when compared to Kilombero local variety i.e. 2700 to 3700 kg/ha
- **Economic impact**: If farmers had adopted the improved rice varieties viz. Afaa-Mwanza and Katrin, the increased rice yield of 1000-kg/ha (37%) over the local varieties, might also have made a positive contribution to farmers' income and household welfare.
- **Food security:** The popularly known miracle which was made by the improved varieties on food security in Asia during the Green revolution led researchers at Uyole to emphasize yield maximization when evaluating the new varieties regardless of other parameters especially culinary qualities and market value. The improved rice varieties have had no contribution on food security and poverty alleviation, because farmers have not adopted the new varieties in their farming systems.
- **Nutritional impact:** The women farmers who participated in on-farm trials for testing Afaa Mwanza continue growing the variety because they said that it was good for making flour mixture (maize + rice), for cooking "ugali". The culinary properties of Afaa Mwanza resembled those of "ugali" made from maize flour. According to the women farmers, Afaa Mwanza could be used as compliment for maize flour, often scarce in the rice farming systems.
- **Social impact- empowerment of farmers**: Past rice research has empowered farmers through participation in on-farm testing of varieties, fertilizers, herbicide, weed control and giving them a voice of their choice to accept or reject the technologies.

- **Genger concerns:** From the 57 farmers who participated in on-farm testing trials, 56 were men and one was a woman. The woman was the only one of the original farmers who is still growing Afaa Mwaza. In Kyela, mainly women do hand weeding of rice fields. The adoption of 2-4D herbicide to control weeds has reduced the workload of women labour.
- **Environmental impact:** There is no environmental destruction or pollution that is associated with agricultural expansion due to attractive new crops or varieties.
- **Capacity** building**:** During the period 1980-2002 one research officer attended a rice course at the International Rice Research Institute (IRRI) in Philippines. In 2000 one research staff was registered for PhD at SUA-Morogoro and another joined for Masters degree in 2001. Both in Kyela and Usangu the farmers participated in on-farm trials to test new varieties under recommended management.

Impact of rice research in the Eastern zone

- Rice is the third most important cereal crop in Tanzania coming after maize and sorghum. In terms of value, the crop ranks second, coming only after maize
- The history of rice production and research in Tanzania is very old, dating from the 8th century in connection with Arab traders who are believed to have brought to Tanzania the Asian rice (*Oryza sativa*) between the 8th and 10th centuries from India.
- Research work on the crop was initiated in 1935 at Ukiriguru. The work became more active in the early 1970s at Ilonga by improving the traditional cultivars through hybridisation, pureline selection and mutation breeding. In 1975 the rice research headquarters was moved from Ilonga to Katrin (Ifakara), where liaison and coordination of rice research work in and out of the institute was conducted.
- The major aim of rice research by then was to solve problems of rice growing for both small-scale farmers and large-scale state farms (NAFCO). The research covered rice grown under upland rain-fed, lowland rain-fed and lowland irrigated conditions.
- Since 1975, therefore Katrin has operated as the major institute dealing with rice research in the country. Currently, the centre is the headquarters for rice research for the Eastern Zone and for Tanzania as whole. Other research institutions dealing with rice research include Chollima Research Centre in Morogoro, Uyole Research Centre and Sokoine University of Agriculture in Morogoro.
- Apart from these institutions, rice research in Tanzania has benefited from the support and collaboration with many regional and international institutions as well as locally based government and non-government organizations. Important among these are IITA based in Nigeria and IRRI based in Philippines.
- Farmer PRA survey for study in the Eastern zone was carried out in six villages in Ifakara district consisting of Kisawasawa, Njagi, and Mang'ula A, Msolwa, Mchombe and Kidatu villages.
- Rice technologies that have been developed and transferred to farmers through research and extension in the surveyed areas are put under two categories consisting of rice varieties and rice crop management technologies.

- A number of traditional varieties including Faya of the Theresa, Afaa mwanza, Kihigo selection No. 1/159, 0/746, Kihogo selection No.7, 22 and 23, Gamti Tunduru Dunduli, Salama have been developed through pure-line selection, testing and evaluation at different locations in the country.
- Varieties which were brought in the country for testing as early as 1955 include Basmati Pishori, Kihogo Red, Ran Captain and Calyaman which were introduced in the country for testing before 1955.
- Rice varieties that have been introduced more recently include the IR series like IR5, IR8, IR20, IR22 which were introduced from IRRI Philippines in 1976.
- At the same time, there are a number of rice varieties that have been introduced as a result of hybridisation work. Hybridisation work in Tanzania was initiated in 1971; and was conducted through collaborative testing of introduced materials of some high yielding varieties.
- Varieties that have been released as a result of this work include Katrin, BG 400-1 and Salemwa. More recently, the hybridisation work has been able to develop several crosses between local cultivars and high yield potential cultivars from IRRI, IITA and other regions of the world.
- Varieties developed more than twenty years ago include: IR5, IR8, IR20, IR22, Katrin, BG 400-1 and Salemwa
- Varieties developed in the last twenty years include:IR8, IR54, IR579, Super India, Afaa Mwanza, Gamti Tunduru, Afaa Kilombero, Selemwa, Katrin, TXD85 and TXD88.
- Varieties that were mentioned by farmers as originating from research included: IR 54, TXD 85, TXD 88, TXD 220 and TXD 306 (SAROS 5); TXD220 and TXD 306 (SARO5) are not yet released however, farmers obtained them from farmers' trial sites.
- Varieties that were mentioned as being local varieties but which are in fact a product of research work include: Super India, Afaa Mwanza, Gamti Tunduru and Afaa Kilombero;
- Varieties which were not mentioned at all by farmers and which can therefore be regarded as being not adopted and extinct include: IR5, IR8, IR20, IR22, Katrin, BG 400-1 and Salemwa.
- Desirable rice characteristics which lead to farmer preference include: strong aroma, long grain size, translucent colour, high yielding, palatable, good milling quality, good cookability, early maturity, non–shattering characteristic and less susceptibility to bird attack. However it was observed that no single variety could possibly have all these quality.
- The challenge facing research is to combine the desirable market qualities and yield qualities in a variety in order to achieve highest adoption rates for the improved varieties.
- In terms of yield, improved varieties were found to out perform the local varieties by a significant margin. Yielding between 3.5 and 6.8 t/ha were mentioned for the improved varieties compared to between 3.0 and 4.0 t/ha for local varieties.
- Supa India is the only variety among the improved varieties that has been widely adopted (being grown by over 80% of farmers in the survey area) although

farmers regard it as a local variety. Considering its high yield potential and its high market demand, it can be concluded that it constitutes one of the areas where rice research has had the highest impact.

- Recently introduced varieties such as TXD 85 and 88 were also picking up speed in adoption and farmers mentioned lack of seeds as one of the factors limiting their wider use.
- Apart from the introduction of improved varieties, research impact on rice production has also come from the promotion of various rice management practices that have increased rice yields for both local and improved varieties.
- Rice production technologies introduced to farmers by the research station include: sowing, fertilizer application: weeding - use of herbicides, cultivation methods - use of bands and pest control.
- The use of improved production technologies versus local approaches for the Supa India variety under farmer conditions lead to the following yield increases:
    - Planting: Dibbling versus broadcasting: 36 % - dibbling is used by 1-2 % of the farmers in the survey area;
    - Planting: Row transplanting (improved) versus random transplanting (local): 35 % - row transplanting is used by 1 % of the farmers;
    - Weeding: Use of herbicides versus hand weeding (local): 58 % - herbicides are used by 5 % of the farmers;
    - Fertilizer use: Use of fertilizer versus no fertilizer: 15 % - use of fertilizer is used by 15 % of the farmers;
    - Cultivation: Use of bands versus flat cultivation (local): the use of bands has just been introduced; as such farmers were un-able to rate its effect on yield increase;
    - Pesticide application: use of pesticides versus non-use: 200 % - pesticides are used by 1 % of the farmers;
    - Planting time: Planting within the recommended period versus planting outside the recommended period: 234 % - 75 % of the farmers plant their rice within the recommended period.
- **Food security:** Although the increased rice yields from the introduced technologies were mentioned to have increased household food security, farmers mentioned a number of issues that needed to be addressed to ensure food security.
- According to farmers, husbands of some households take independent liberty to sell and misuse surplus of crop produced. Some farmers sell their entire crop at lower prices at peak harvesting time and later experienced food shortage.
- Interventions on improved storage method coupled with introduction of other income generating activities to meet petty cash demand at harvesting time were cited among solutions to this problem.
- **Economic impact:** Economic impacts of the rice research are attributed to the yield advantages of improved varieties of Supa India, TXD 85 and TXD 88 which have high market demand as has been elaborated before.
- **Environmental impact:** Contribution of the introduced technologies to environmental conservation can be seen in their effect on yield increase, which,

on its turn, decreases the need for farmers expanding their cultivation to marginal and environmentally fragile areas.

- **Socio impact:** Socio impact arising from rice research is attributed to two main factors. One is the empowerment, particularly for women farmers that has resulted from farmer groups established alongside with rice technology development work done in the area. The second is the empowerment for both men and women that have come as a result of increased income.
- **Capacity building:** The introduction of rice technologies went hand in hand with farmer training. Over the years, farmers have received training in several areas including seed production and farmer group organization.
- It can be concluded that rice research in the Eastern zone has had positive impact on the small-scale farmers as evidenced in the survey area. Despite these impacts however, there are research areas that still call for further research work.
- The search for better varieties must continue alongside the identification and promotion of better production technologies.
- Emerging problems which need to be addressed by research in the Eastern zone include the proliferation of noxious weeds and new pests.
- There is also the issue of developing varieties that will meet the increased quality demand of the liberalized rice market while ensuring higher farmer yields with affordable input requirements.

Impact of pasture research in the Eastern and Southern Highlands zone

- Pasture research in Tanzania started in 1930.
- Pasture research stations were established at Kongwa research centre, ARI Uyole, LRC Tanga and Sokoine University of Agriculture.
- The focus of research was on agronomic characteristics, nutritional qualities and ability of pasture species to improve soil fertility and control soil erosion.
- Several technologies were released which included management of natural pastures, fertilization of pastures, planting exotic pastures fodder conservation, pasture seed production and other related technologies.
- Record of pasture research provided in this report starts from 1973.
- There were very few farmers who adopted the technology of planting pasture grass – legumes; many farmers adopted the technology of multipurpose trees in contour. (The technology initially was introduced to 5 farmers).
- The technology of pasture seed production has not been successful as was expected. Only 20% of the initial seed producers continue to produce pasture seed today.
- The reason for failure of pasture seed production include: failure of the programme to purchase the seed produced by farmers, high production costs, particularly where plots needed to be fertilised, high cost of management, including weeding, and poor market of milk.
- There is moderate adoption of the technology of fertilizer / farm yard manure in the pasture plots. Only 26% of farmers are practicing the technology.

- Fodder preservation i.e. Silage making technology that was introduced in Southern Highlands zone was not adopted at all. This was because the approach that was used to introduce this technology was not sustainable and there was no follow up at the farm level.
- Hay making techniques introduced in SHZ have been taken up by farmers and farmers use both natural as well as improved pastures to make hay.
- The use of high plant density of *sorghum vulgar* has been reclaimed from the broad leaf *cassia rostriata* and *sida acuta.*
- By using improved pasture, milk yield has increased by about 49.6% which mean that farmers will increase their annual income by 50% through adoption of new technology.
- When the market for milk is good, farmers can afford to send their children to school as well as be able to afford to purchase farm equipment and other assets.
- Farmers acknowledged the importance of pasture technologies in sustaining milk production and provision of quality food to the family
- Environmental impact from the technologies introduced include, conservation of soil moisture using Guatamala cutting as mulch. In Uluguru Mountains, elephant grass, Guatamala and Setaria grasses are used to prevent soil erosion, and there are other environmental benefits of using pasture technologies.
- Framers have attended various types of training. The training attended includes: training in dairy management and pasture production. They have also participated in field visits and farmers exchange programmes. In Tanga region about 50% of dairy farmers including both men and women have attended various training courses on pasture production.
- A major constraint of dairy farmers in both SHZ and EZ is the low market prices for milk. This constraint jeopardizes the adoption of technologies related to dairy production.

Impact of potato research in the Eastern zone

- Potatoes *(solanum* tuberosum L) are the third most important starch food crop, after maize and rice in the southern highlands of Tanzania.
- Production of potatoes has been traditionally concentrated in the highlands areas of Iringa and Mbeya regions where the crop performs well.
- Biologically potatoes have considerable production potential because they are a short duration crop growing for 4-5 months in the field .
- Potatoes are the main source of income in the most area where no other cash crop is exists.
- Potato ranked second in the two surveyed villages in Njombe and second in the villages in Mbeya as a food crop and second and first in Njombe and Mbeya, as a source of income.
- About 90% of the potato crop in Tanzania is produced by smallholder farmers in the southern highlands zone where it is grown on rain fed land in two principal growing periods: One during the dry season crop at the end of rain season in May and June, and another during the rain season of December to April.

- The study on potato research was conducted in two districts Njombe and Mbeya in Southern highlands research zone. Three villages were selected, Usalule and Ihalula in Njombe district; and Kihondo village in Mbeya.
- Potato research in Tanzania started in the early 1950s with the evolution of introduced germplasm at Tengeru and Arusha. Several varieties were released for commercial production. However, reseach activities were terminated in 1967 after the centre was converted to be the headquarters for the East African community. Research work resumed in Mbeya Region in1974 / 75 after the establishment of Uyole Agriculture Centre (UAC).
- The potato improvement programme (PIP) in collaboration with other countries involved in the improvement of potatoes, concentrated on potato variety selection for adaptability, high yielding and disease resistance and development of agronomic recommendation packages.
- Through PIP, several improved varieties: - Baraka, Sasamua, CIP red and white Tana, Bulongwa and Subira have been developed.
- Improved agronomic practices, which include: spacing and plant density, seed rate and size, planting dates and fertilization ,plant protection:-weed control and pest/diseases control have also been developed through PIP and recommended for the various potato growing areas in the Southern Highlands zone.
- Since the inception of these technologies more effort has been given to promote on-farm research covering all major potato growing areas in the Southern Highlands zone.
- During the period 1975-1997 the research on roots and tuber programme has development and released six varieties of Irish or round potatoes.
- Out of the six varieties released, CIP variety (Kikondo) was 100% adapted in Njombe district because of good market qualities. Tana, Subira and Bulongwa were not grown because of poor market demand.
- In Mbeya district at Kikondo village improved variety grown by most farmers (80%) is K59a (26) named by farmers as Kagiri. Comparatively, the local variety ARKA was preferred by all farmers (100%).
- The farm level potato yield has increased from 1500kg to 72,000 kg/ha in Njombe district which is over and above tradition yield levels.
- Weed management, pest and diseases control were perceived to be the most important constraint in the production of potatoes.
- Application of inorganic fertilizer was practised by all potato growers. Nevertheless, the rates being applied were lower than the recommended levels largely due to lack of knowledge.
- Survey results for potato varieties in Njombe and Mbeya district show that farmers know a total of thirteen cultivars, three improved and ten local varieties in Njombe and five improved and 8 local varieties in Mbeya district.
- In Mbeya district at kikondo village, ARKA is grown by 100% of farmers and 80% in Kagiri,, and 15 % in Kikondo. At Kikondo Ndevile, Ndemwa farmers obtain ARKA seed from Arusha in 1971 and Yeremia Ndengwa farmers also obtain CAP seed (cream flush) from Njombe. Farmers also obtained improved potato varieties from Uyole Agriculture Centre.

- The most grown improved varieties in Njombe were CIP (100%) and Kala (25%). Farmers used to grow Baraka and Loti but because of low market demand and presence of a hole at the centre of the tube, they have stopped growing it. Farmers had no knowledge on Sasame, Bulongwa, Tana and Subira.
- The major reasons given by farmers for variety preference were good taste, high market demand, high yielding potato and early maturity.
- **Economic impact:** Farmers consider potatoes as a main source of cash income and sell the bulk of the potato that they harvested. The yield advantage of improved potato varieties over local varieties has made positive contribution to farmers income and household well-being in Njombe plateau and Mporoto highlands in Mbeya district.
- Yield has increased from the tradition level of 750 kg/acre to 14250 kg/acre depending on varieties grown. Kaala for instance is giving a maximum yield of 16000kg/acre while CIP is giving a maximum yield of 15000 kg/acre in farmers fields. Kajiri in Kikondo Mbeya district is giving a maximum yield of 14000 kg/acre while ARKA, the most marketable variety, is giving 10000 kg/acres.
- In Njombe plateau, household income has increased from 0 Tsh to 275000/= and 475000/= Tsh. In Mbeya district at Kikondo village in Mporoto highlands, household income has increased from 0 Tsh to 425000/=Tsh. Potato producers sell their potatoes to local traders at prices ranging between 5000-8500/= per bag of about 150 kg.
- **Food security**: Both the adaptors and non-adaptors indicated that potatoes were grown for food and sale. In Njombe, potato yields have increased from 5 bag to 90 bags. This has reduced poverty by more than 100%.
- In Kikondo in Mbeya district, potato yields have increased from 5 bags to 85 bags per acre and has reduced poverty by more than 100%.
- Farmers do not store potatoes in granary for food reserve; instead they sell a good amount of it and buy food that is easily storable such as maize.
- Potato seeds for planting next season are stored on raised rock or on floors in the sheds and huts. On the average, adaptors retain 6 bags and non-adaptors retain 4 bags of seed potatoes for planting in the next season.
- **Production impact**: Farmers recognize early planting as a key factor in production. The recommended time of planting in Usalule and Ihalula is November to December. This has been adopted by 20 percent of farmers.
- All surveyed farmers (100%) in Usalule and Ihalule planted potato in rows on prepared flat seedbeds at spacing of 60-75cm by 25-30cm
- All farmers, adaptors and non –adaptors controlled weeds in their potato fields. About 97% of the adaptors and 96% of the non-adopters.
- Aphids were considered by farmers to be the most important potato pest. Diseases of economical importance reported were potato blights and bacteria wilt.
- Farmers were able to control potato blight using fungicides but did not have a specific measure on bacteria wilt, apart from uprooting the diseased plant.
- Farmer's use of fungicide has been adopted by 100% of the farmers in Usalule and Ihalula in Njombe district.

- In Kikondo Mbeya district none of the farmers adopted the use of fungicides. The reason for not adopting is planting early enough to avoid diseases.
- The use of fertilizer is related to the importance of the crop. In Usalule and Ihalule there was 100% adoption in fertilizer use.
- **Environmental impact**: In Njombe plateau improved potato production has improved soil fertility through the incorporation of heavy plant biomass into the soil and the follow up crop rotation with maize.
- **Socio impact –** empowerment**:** The technology has empowered the adaptors through an increase purchasing power. Farmers indicated that they are now able to buy more fertilizer, are getting more education through seminars, workshops, extension and research contact and are able to pay tax that was difficult to pay before.
- **Gender concerns**: The potato crop is gender neutral in that both men and women grow and sell potatoes. Improved varieties have benefited equally the status of the whole families that grow the varieties .
- The improved varieties have also benefited long distance traders who are usually men selling potatoes in Dar es salaam, Arusha, Malawi and Zambia and in local road stands and resident town traders who are mostly women.
- **Capacity building**: During the period 1975 –1992 farmers received training in several areas. For example in 1987, 16 male farmers received a course on improved potato production and in 1984 in Njombe district, 15 male farmers were given various training on production techniques of different varieties through participation in establishing demonstration trials in their fields.
- Thirty farmers were trained on potato production techniques every year from 1980- 1990, giving a total of 300 farmers, 3-4 technician and 4 researches were trained in various disciplines at CIP Nairobi and Lima Peru between 1980 and 1990.
- Between one and two extension workers from each district in the Southern Highlands zone were trained at ARI Uyole each year from 1980 to 1990.
- In conclusion, research on potato in the Southern Highlands zone has had significant impact in the various areas mentioned in the previous discussion.

CHAPTER ONE

INTRODUCTION

1.1 Background

The importance of impact assessment of research and development (R&D) activities is increasingly becoming apparent and it derives from two major considerations. First, is the fact despite the considerably high past investment in R&D, poverty, malnutrition and environmental degradation have continued to persist in many areas. Second is the fact that available resources for R&D are continuously declining not only from the Tanzania government but from all funding sources which have previously funded R&D initiatives due to increased competition with other equally important concerns.

Within these concerns, the essence of impact assessment of both past and on-going R&D is in mobilizing more resources for these activities, making efficient allocation of the limited resources available and in informing research on gaps and direction to be taken by future research. Demonstrating and quantifying the impacts achieved by past research will not only form basis for justifying the need for future funding of research against other competing funding needs, but will assist in identifying areas where future investment will have most impact, thus increasing the potential for research to attract more funding and the chances for research contributing significantly towards poverty eradication, food security and environmental conservation.

This report presents results on impact studies on past research done in the past twenty years in the Eastern and Southern Highlands zone. The studies are part of the planned outputs under the Tanzania Agricultural Research Project Phase II (TARPII) component on Food Security and Household Income for Small-holder Farmers in Tanzania being coordinated by Sokoine University of Agriculture (SUA) – TARPII-SUA.

TARPII is a national research project under the Ministry of Agriculture and Food Security (MAFS) Division of Research and Development (DRD) with support from various donors. The component on Food Security and Household Income for Small-holder Farmers in Tanzania is a collaborative effort between DRD of MAFS, the Agricultural University of Norway (NLH) Sokoine University of Agriculture SUA with funding mainly from the Norwegian government through the Norwegian Agency for Development Cooperation (NORAD). The fact that this research component of TARPII is coordinated by SUA explains the coinage of the term TARPII-SUA for this research component.

The main objective of the studies was to assess farm level impact of past research on selected programmes. Apart from the aforesaid benefits, the study on impact of past research was envisaged to provide information that would have direct bearing on the on-going research projects under TARPII-SUA in terms of providing useful feed back to researchers and project management. It is also envisaged that the results of the

study will be useful in informing future management and the decision processes with regard to priority setting and implementation of research, technology development and technology transfer activities.

The work presented in this document is a culmination of process that started with making an inventory of all research done in the past twenty years in the Eastern and Southern Highlands zone. Information on past research was synthesized and produced into a publication by TAPII-SUA under a title called "Reflection on Agricultural Research – Past Agricultural Research in the Eastern and Southern Highlands zones (IAT/TARP II-SUA, 2002). Among other things, information in the inventory provided the basis for selecting the research programmes for the impact assessment in this study. Details of the process used in identifying the programmes for the impact study are presented in the methodology section.

Research programmes studied under the present work included: Cassava research in the Eastern zone; Rice research in the Southern Highlands zone; Rice research in the Eastern zone; Pasture research in the Eastern and Southern Highlands zone; and Round potato research in the Southern Highlands zone.

Findings from this study compliment impact studies done for other commodities by other groups. Most significant among these is the study done by Anandajayasekaram and others (DRD, 2001) for the TARPII component under DRD in the Ministry of Agriculture and Food Security. Under that study, impact of R&D programmes done between 1900 and 2000 was assessed for root and tuber, agro-forestry, soil and water management (including tillage), dual purpose goats in Kondoa eroded areas, and for NCD disease control (using thermo-stable vaccines) in the Southern zone. Although covering a shorter period than that covered under this study (i.e. ten years compared to twenty years under the present study), the study produced a worth of information and as such the commodities under that study were not included for this study. In addition to assessing impact on the commodities listed above, the DRD study presented an analysis of other impact assessment studies done in the country. To avoid duplication, this kind of analysis has not been done in the present study.

Findings from the five impact studies conducted under this study are presented in the following chapters, each covering one study. The chapters are presented in a comprehensive manner such that each one stands as an independent paper containing the discussion, conclusions, recommendations, references and the relevant annexes. A summary containing the major observations under each chapter is presented at the beginning of the document. By bringing together the findings from the different chapters, the summary therefore provides opportunity for obtaining an overview of the whole study.

1.2 Methodology

1.2.1 The study area

The study was conducted in the Southern Highlands and Eastern Research Zones. The selection is based on the fact that the two zones are the research target areas for TARPII- SUA research project.

1.2.2 Approach

1.2.2.1 Steps used in the study

Data collection for the study was done in two steps. Step one involved collection and compilations of an inventory of agricultural research done in the past 20 years in the Eastern and Southern Highlands zone – i.e. Production of inventory on past research. A number of documented were produced from the work at this level, the final one being the Synthesis report which was published by TARPII-SUA under the title "Reflection on agricultural research" ((IAT/TARP II-SUA, 2002). Among other things, information from the inventory was supplemented with information from other secondary sources and used in selecting the research programs for impact assessment under step two.

Activities under step two comprise of the conduction if the five impact studies culminating with the production of this report, i.e. the Impact study. The study approaches used under each step, i.e. for Production of the research inventory and for Impact assessment are elaborated below.

1.2.2.2 Production of inventory on past research

The research to produce the inventory of past research was conducted in three areas comprising of the Southern highlands zone, Eastern Zone and SUA. Information collected from these three areas was compiled into three reports, Kamasho and Mussei (2001), Nyaki, Mwinjaka, and Iranga (2001) and Nchimbi- Msola *et al*. (2002) for the Southern Highlands zone, Eastern Zone and SUA, respectively. This data was analysed and produced the Synthesis report mentioned earlier (IAT/TARP II-SUA, 2002).

The main objective of undertaking such an inventory was to get an overview of research activities conducted in the Southern Highlands and Eastern Zones during the past 20 years. The SUA research inventory by Nchimbi-Msolla *et al* (2002) provided a detailed account of research activities done by staff and students of SUA in the two zones. The commodities and research programmes as identified in the inventory include: crop, livestock and pasture, soil and water management, food processing and engineering, forestry, education and extension, cropping systems and social economic studies including marketing (IAT/TARP II-SUA, 2002).

1.2.2.3 Impact assessment of past research

Due to various reasons, including limitation of resources (time, funds, etc.) and the fact that some form of impact studies had already been done for some programmes, it was found inevitable to limit the coverage of the impact study under this study. A set criteria were therefore formulated to select a sample of the commodities / programmes (out of the large list contained in the inventory) for this study. Although relying heavily on information in the inventory, the criteria were made to be of general nature so as to use of other sources of information. Commodities / programmes to be selected were the ones that rated most highly under these criteria.

The criteria used included:

i. Whether the commodity / programme addressed food security and income generation;
ii. Extent and the scale of research done;
iii. Whether the commodity / programme was crop or livestock based;

iv. Whether impact assessment has been done in the past on the commodity / programme in question;
v. Whether the impact studies done (for commodities that have had impact assessment done) were at national level or at zonal or regional level;
vi. Whether the research done was commodity based or was a complement to other programmes.

Based on these criteria and the resources available four commodities were selected for the impact assessment. The commodities comprise of:

- Rice (Eastern and Southern Highlands);
- Cassava (Eastern Zone);
- Pasture (Eastern and Southern Highlands);
- Round potatoes (Southern Highlands);

Due to a number of factors, rice research in the two zones were treated separately both during the study and in presentation in this report. The differences are very apparent in the results from the two zones presented in this report.

1.2.3 Impact study approach

Due to limitation mainly of time, it was decided to conduct partial impact studies on the selected four commodities. A data collection scheme similar to that used by the DRD (2001) was used in collecting the data for the study. The scheme comprised of collecting both secondary and primary data from selected representative areas in the zones. Secondary data was collected from Agricultural Research Institutes, in the Eastern and Southern Highlands zones, Sokoine University of Agriculture, and District Agricultural Offices. Lead research scientists for the specific commodities were given forms to identify and document technologies generated by the respective programs in the past 20 years (see sample of form in Annex 1A).

Primary data was collected in sampled villages in respective zones. The selected villages were mainly those that were among the target villages under the researches at the time when the researches were in operation and those that fall within the major farming systems that produce the crop. Details on the selected villages are presented in the discussion under the respective research programmes in the report.
Participatory research methods were used to collect the necessary data. These included group interviews, key informant discussions, and various ranking methods. A checklist of questions was used to guide the interviews (see Annex 1B).

1.3 Overview of Past Research Impact Assessment

1.3.1 Agricultural Research in Tanzania

Agricultural (crops) research in Tanzania started in 1892 when the German colonial administration established the first agricultural institute at Amani in the Usambara Mountains. The main objective of agricultural research at the time was to support the development of plantation export crops (sisal, coffee, tobacco and groundnut) grown either by foreign companies or individual settler farmers (Liwenga 1988). Similar support was also given to cotton under smallholders. Livestock research started in early 1930s with the establishment of the first institute at Mpwapwa.

Since late 1980s, the promotion of food crops remains the main priority of agricultural research. However, together with this policy change over the years, there has been a

number of institutional changes involving the national agricultural research system. The first major change was implemented in the late 1970s and involved regrouping and bringing livestock and crop research centres both public and those managed by respective Marketing Boards or Authorities under the control of the Ministry of Agriculture. In 1980 yet another change was implemented when the Government streamlined its research system by creating parastatal bodies with specific research mandates. These were the Tanzania Agricultural Research Organisation (TARO), Tanzania Livestock Research Organisation (TALIRO) and Tanzania Pesticides Research Institute (TPRI) for crops, livestock and pesticide research respectively. Uyole Agricultural Centre that was already functional at the time had a mandate for both crops and livestock research.

In early 1990s the national agricultural research system was again reorganised. The change was a consequence of problems inherent in the previous institutional arrangement. These included the fragmentation of research, a large number (about 23) of unprioritised research programmes undertaken in about 17 research institutes and centres, and co-ordination of the research programs. Resources also had to be split thinly to cover the many programs carried in various centres (Department of Research and Training 1991). Under the new institutional set-up the DRD of the Ministry of Agriculture and Food Security (formerly Ministry of Agriculture and Co-operatives) is the lead institution of the National Agricultural Research System (NARS). It operates a network of institutions, centres and sub-stations for crop research, livestock research, farming systems research, and training and support services.

The other constituents of the NARS are the TPRI, Sokoine University of Agriculture (SUA) and the University of Dar-es-Salaam, and parastatal and private sector bodies for certain commodities such as tea, wattle, sugar, barley, and maize (Herz 1996).

For operational purposes, agricultural research under the NARS is organised into seven (7) agro-ecological zones and is managed under the DRT in the Ministry of Agriculture and Food Security. These are Eastern, Western, Northern, Central, Lake, Southern and Southern Highlands (Shao 1994). Under this system the SUA forms the eighth research zone. Each zone is mandated with certain priority research programs and maintains strong linkages to the extension system. Besides the zonal research organisation, research is also organised along commodity lines with each of the zonal centres in addition to its zonal mandate assigned the major responsibility for conducting and co-ordinating adaptive and applied research on specific commodities (Ravnborg 1996).

1.3.2 Research Impact Studies Done

As observed by Anandajayasekeram *et al* (2001), information on the impact of publicly funded agricultural research is increasingly needed for the mobilization and allocation of decreasing resources. In other words, the research community in Tanzania as elsewhere is faced with the challenge of showing that agricultural research works. Impact studies have therefore become the answer to this need as they show the effect of research in terms of adoption of technologies, increased yields, economic improvements from farm level to the national level, as well as environmental and socio-cultural gains from the research effort. However, while a number of adoption studies have been conducted over the years (Anandajayasekeram

et al 2001), only a limited number of impact studies have so far been done in the country (Table 1).

Table 1.1: Impact Assessment Studies Conducted in Tanzania

Title	Commodity/Research Programme	Author	Year of Publication
1. Assessing the effects of agricultural research expenditures on agricultural productivity in Tanzania	Maize, paddy, wheat, millet, cassava, Irish (round) potato, cooking banana, beans, pulses, cardamon, cashewnuts, sesame, sunflower, copra, castor beans, coconut, tomatoes, fruits, barley, other starches and other vegetables	Isinika	1995
2. Coconut impact assessment survey	Coconut	Ashimogo *et al.*	1996
3. Economic impact of maize research	Maize	Moshi *et al.*	1997
4. Impact assessment of selected research programmes	Bean, root and tuber, agroforestry, soil and water management including tillage, dual purpose goats and New Castle disease control	Anandajayasekeram *et al.*	2001

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1.5 Annexes

1.5.1 Annex 1A: Form 1A - Technology assessment

Technology Recommendation (Please specify)	Year of release/recommend of variety/ technology	Collaborators in developing technology	Technology Transfer				Other beneficiaries
			Targeted Location	Target Group	Coverage	Methods of Transfer	

- Location - targeted location
- Target group - small scale farmers, women, etc
- Coverage - localized, spread to other districts, spread to other regions
- Method - approach e.g. seminar, extension------, posters, field trials etc

1.5.2 Annex 1B: Form 1B - Benefits of technology

Technologies/ Recommendation (Identified in Form 1A)	Benefit at household level		Institutional benefit			
	Before yield	After yield	Farmers	Researchers	Extension	NGO staff

1.5.3 Annex 1C: Form 1C - Impact of technology

Technologies/ Recommendation (Identified in Form 1A)	Contribution of technology to						Others Specify
	Food Security	Poverty Alleviation	Nutritional Status	Environment	Empowerment of farmers	Gender Concerns	

1.5.4 Annex 1D – Guidelines for field discussion on specific technologies research, extension and farmer group

1. General information

- Types of crops / technology (Rank)
- Specific crop/ Technology Which variety(s) /technology in place
- Where did you get these varieties/ technology

2. Diagnosis and problem identification

- Target group specification / recommendation domain
- Problem definition: What was the problem being addressed?

3. Information on Farmer's Practice

- Data on Farm level Yield / Losses

E.g. Before using the variety /technology, what was the yield per acre during:

- Good season
- Bad season

Presently what is the yield per ha in

- Good season
- Bad season

4. Information on Recommended Technology

- Description of the recommendation
- When did you first cultivate/ grow this variety (year)
- On-farm data on the performance of the technology

5. Information on farmer training / capacity buildings activities

- Number of training conducted
- Number of participants by gender

6. Adoption of technology

- Number or percentage of farmers currently using the recommendation
- Farmers feed back on technology with regard to:
  - Reason for adoption / non adoption
  - Local modifications made if any
  - Farmers Impression about adoption
  - From contact group
  - From other farmers in the area

7. Farmer's assessment

Market of the new varieties/ technology

What are the constraints and potentials of the new varieties / technology

- Potentials
- Constraints

8. Contribution of Technology to;

a. Yield (use of surplus) / loss reduction
b. Income (use of increased income)
c. Food security
d. Poverty alleviation
e. Nutritional status (Adult-male and female and children)
f. Environment
g. Empowerment of farmers
h. Gender concern (roles)
i. Others (specify)

Checklist for Stockist

- Type of seeds sold
- Where did he/ she get them from
- Price/kg
- Where do customers come from
- Demand vs. Supply - for the different varieties
- Constraint & potentials in selling the variety

Market Visit

- Price development
- Varieties at the market
- Source of the variety

CHAPTER TWO

IMPACT OF CASSAVA RESEARCH IN THE EASTERN ZONE

2.1 Background

2.1.1 Importance of Cassava

Cassava (*Manihot esculenta cranz*), is a perennial woody shrub of the *Euphorbiacae* family. Cassava is largely cultivated for its roots. However, the leaves are also consumed as nutritious vegetable. The stems that are often used as planting materials; when dry are sometimes used as firewood.

The most important cassava producing areas in Tanzania include areas around Lakes Victoria, Tanganyika, and Nyasa; along the coastal strip of the Indian Ocean and along the Ruvuma valley (Msabaha and Rwenyagira, 1989). This study focuses on cassava production in the Eastern zone that comprise Dar es Salaam, Coast, Tanga and Morogoro regions.

The farming system in the study area is tree-based system. The main tree crops are cashew, coconut and fruits such as jack fruit and citrus. The dominant food crops are cassava, maize, sorghum and legume. Cassava and other food crops are normally intercropped with tree crops. Shifting cultivation is common. When tree crops are overgrown food crops yield is reduced significantly that force farmer to look for new land for food crops.

Table 3.1 shows the importance of cassava in the farming system. Cassava is used for both food and cash crop. Four out of five villages ranked cassava as the first main staple food crop and the one village ranked cassava second. It was also noted that cassava was ranked first as the main cash crop in three villages, that is Jaribu Mpakani, Kongo and Mapojoni and ranked second at Bungu. Farmers in Matimbwa village ranked it third (Table 3.1).

Generally, cassava was ranked high as a cash crop for its marketability.In areas where cassava is the main cash crop, the cultivated area under cassava is increased. At Jaribu Mpakani and Bungu for a example, a large of proportion of farmers cultivate more than 2 acres (Table 2.2). At least every household cultivates some cassava for cash and home consumption.

Table 2.1: Cassava Ranking as food and income source

Village	Staple food				Source of Cash Income				
	Cassava	Maize	Rice	Sorghum	Cashewnut	Coconut	Fruits	Cassava	Rice
Jaribu mpakani	1	2	3	-	2	4	3	1	
Bungu	1	2	4	3	1	4	3	2	
Kongo	1	3	2	-	3	4	-	1	2
Matimbwa	1	3	2	-	1	2	-	3	4
Mapojoni	2	1	3	-	-	2	3	1	-

Table 2.2: Estimated area under cassava in the study areas

Village	Estimated proportion of population		
	<1 Acre	1-2 Acre	>2 Acre
Bungu	30%	20%	70%
Jaribu Mpakani	-	-	100%
Kongo	-	100%	-
Matimbwa	80%	20%	-
Mapojoni	-	100%	-

2.1.2 Description of the study areas

The study was conducted in three Districts, Rufiji, Bagamoyo and Tanga. A sample of five major cassava-producing villages was selected for the group interviews. The villages included Bungu A and B, and Jaribu Mpakani in Rufiji district, Matimbwa and Kongo in Bagamoyo district and lastly Mapojoni in Tanga district.

Secondary data were collected from Agricultural Research Institute (ARI) Kibaha, Mikocheni, Chambezi, Sokoine University of Agriculture and Amani Research Center. Consultations were also made with lead cassava research scientist, of the Ministry of Agriculture and Food Security. The aim was to identify technologies so far generated by research.

2.1.3 History of cassava research in Tanzania

Cassava research started in Tanganyika (now Tanzania Mainland) in 1920s, at Amani (Tanga region) research institute that was established in 1902 by the government of German East Africa (EAARSA, 1929). Early research (1920s – 1930s) focused mainly on investigations on cassava virus diseases, mainly cassava mosaic and cassava brown streak diseases. In the late 1930s, breeding for cassava hybrids was initiated at Amani, and in 1938, 300 crosses of resistant cassava varieties were developed. In 1939 virus resistance trials started at the station. Thus the main focus of research in cassava was on pathology. In the 1940s breeding of cassava for disease resistance (mainly cassava mosaic disease and brown streak disease) continued. In the 1950s promising lines were multiplied, and 25 hybrid clones were selected and distributed throughout East Africa (Kenya, Uganda

Tanganyika and Zanzibar). In 1953, monitoring of small-scale trials continued by the then department of agriculture.

At the same time, the collection of varieties and hybrids were taken to Eldorate (Uganda) as intermediate quarantine against diseases. Between 1958 and 1960 promising clones were distributed to Serere Uganda, Muguga Kenya, and IITA in Nigeria. In 1960 the cassava breeding programme at Amani was stopped. Therefore the focus was put in collecting and maintaining germplasm of interest for coastal and hinterland. The East African Agricultural and Forestry Research Organization (EEAAFRO) under the East African Community then undertook agricultural research.

In 1971 cassava breeding work started at IITA, and cassava varieties highly resistant to mosaic virus were selected. These varieties in turn were supplied to EAAFRO (EAAFRO 1974). In the 1970s, research on cassava was conducted at Ukiriguru, Chambezi and Naliendele Agricultural Research Stations.

The main activity was multiplication of promising varieties. In 1978 these station were involved in collecting different cassava germplasm in the country. The regions involved included, Arusha, Kilimanjaro, Tanga, Dodoma, Tabora, Morogoro, Dodoma, Morogoro, Coast, Dar es Salaam, Iringa, Mbeya and Rukwa. It was intended to use these collections in breeding programme and Chambezi Research station, established a nursery bed for all cassava seeds/cuttings including those outside the country e.g. IITA.

The analysis of early cassava research in the Eastern zone shows that;

i. All research was conducted on-station
ii. Research activities were mainly focused on pathology, specifically on important virus diseases of cassava (cassava Mosaic and Cassava Brown Streak diseases)
iii. Cassava Breeding work focused on breeding for disease resistance.

Currently the main cassava research in Tanzania is undertaken at

i. ARI Ukiriguru – in Lake Zone (Mwanza)
ii. ARI Naliendele – in Southern Zone (Mtwara) and
iii. SRI Kibaha – in Eastern Zone (Coast)

In 1990 cassava research activities were shifted from Chambezi to SRI Kibaha. Kibaha was identified as a test site for varieties selected at ARI Ukiriguru, and as a Centre for maintaining cassava germplasm.

In 1994, cassava-breeding programme was initiated in collaboration with the Southern African Root Crop Research Network (SARRNET). A breeder from IITA was involved in the breeding work, which started with germplasm development. In 1998 the SARRNET Program 1st phase breeding programme was stopped. All the activities in these phases were done on-station. In 1998/99 the roots and tuber

programme did not have enough funding for research. In 2000/2001, the roots and tuber programme received funding from TARP II, IDA. With this funding the cassava on-farm testing of promising varieties was initiated. The trials have now been running for two seasons (2000/2001 and 2001/2002).

The focus of on-farm trials is on varieties:

i. Adaptability
ii. Yield potential
iii. Pest and disease resistance and
iv. Farmers acceptability in terms of taste, cooking quality and storage quality

2.2 Impact of developed technologies

Cassava breeding, agronomy and plant protection have been emphasized as the major research areas contributing to the high production yields of cassava in the eastern zone. To exploit the yield potential of cassava, research has been done to develop suitable improved varieties, agronomic practice and plant protection recommendation packages. Therefore, this part assesses the impact of cassava technologies in the eastern zone.

2.2.1 Economic impact

One of the objectives of this study was to determine economic returns of improved technologies such as varieties and improved management practices performance in terms of yield and marketing by farmers at the producer level

2.2.1.1 Varieties

In the study, farmers were able to identify improved and local or *farmers' varieties*. Farmers were also able to mention varieties that were no longer cultivated. Farmers' concept on improved varieties is based on varieties introduced by researchers in their locality with good attributes such as high yield, early maturity, marketability and resistance to pest and diseases. According to Nweke *et al., (1998*), the concept of improved varieties could mean breed varieties or selection from local cultivars with desirable attributes.

During the study, it was observed that currently all cultivated varieties are farmers' collection (Table 2.3 and Appendix 2.1). This is because none of the interviewed farmers could associate the cultivated varieties with research.

2.2.1.1.1 Cassava improved varieties

To date there has been no cassava varieties officially released by research. According to researchers involved with cassava research (Personal communication Dr. M. Msabaha and Mrs K. Mtunda), the main reason for non release of cassava varieties, is non – existence of a protocol for assessing and releasing root and tuber crops at TOSCA. However, there are recommended cassava varieties that were developed (through breeding or selection) by research. In 1999/2000 a protocol for sweet potatoes release was prepared. According to Anandajayasekeram *et al.*, (2001)

cassava varieties recommended in the Eastern zone include, Kibaha, Cheupe, and Vumbi ya Morogoro. Other varieties include TMS 83/01762 (6) ("Ukiriguru"), TMS 4 (2) 1425 ("Nigeria") Msitu Zanzibar and Aipin and Valenca in the Lake zone, Nachinyaya, Kigoma and Kibaha in the Southern zone.
Among these the recommended varieties, Kigoma was mentioned in 4 out of the 5 villages surveyed and Msitu Zanzibar was also mentioned in one village (Bungu). However, both varieties were identified as varieties that have disappeared because they were not preferred. Currently, four recommended varieties are tested on-farm in two sites in the eastern zone. These are:

i. Kibaha (NDL 90/034)
ii. Naliendele 90 (NDL 90/034)
iii. Kiroba (Farmers variety in Coast region)
iv. Ukiriguru UKG (93/041)

The two test sites are:

i. Kilosa 2 sites (Morogoro)
ii. Kibaha 2 site (Coast)

2.2.1.1.1.1 Economic impact of improved varieties (On-station trials)

During the survey it was noted that cassavas role in the system is changing from a famine reserve crop to a cash crop. This transformation is largely based on:

i. Continuous farmers with desirable characters
ii. Increasing demand for fresh cassava in urban market particularly Dar es salaam

The current research activities have the following economic impact potential

i. Increased Yield.

The research recommended varieties have indicated yield increases over the farmers varieties. Table 2.3 shows that yield of recommended cassava varieties

Table 2.3: Yield of recommended cassava varieties

Recommended variety	Yield Tons/ha	Remark
1. Kibaha (NDL 90/034)	12-16	Amani Hybrid
2. Kiroba	10-25	Farmers seed selection
3. Mumba (HBL 95/005)	10-20	Breeding line of SARRNET Program
4. UKG 93/041	10-20	Breeding line from ARI-Ukiriguru
5. Naliendele 90 (NDL 90/034)	?	Breeding line from ARI Naliendele
6. Vumbi la Morogoro	?	

Recommended varieties range from 10-25 tons per ha compared to 5-11.25 tons per ha of farmers varieties (Table 2.4)

ii. Increased Income

Cassava yield increases have potential for increasing farmers Income. This is because the quantity of cassava consumed at household level is relatively small compared to quantity produced. As indicated in Box 3.1 farmers can attain a net return of Tshs. 220,000 – 340,000 per ha from improved variety compared to 160,000 – 310,000 Tshs/ha from farmers variety by selling fresh cassava.

Box 2.1: Net Returns Improved and Farmers variety

I. Variety Kibaha NDL 90/034 (Improved)

1. Yield (Tons/ha) = 12-16

2. Price (Tshs/ton) = 40,000

3. Gross Returns i) 40,000 x 12 = 480,000 Tshs/Ton

ii) 40,000 x 16 = 640,000 Tshs/Ton

4. Variable Cost = Tshs 140,000 Tshs/ha

5. Net Revenue i) 360,000– 140,000 = 220,000

ii) 480,000 – 140,000 = 340,000

II. Variety Kiroba (farmers variety)

1. Yield (farmers practice) (Tons/ha) = 7.5 -11.25

2. Price (Tsh/ton) = 40,000

3. Gross Returns i) Tsh/Ton 40,000 x 7.5 tons = 30,000

ii) Tsh/Ton 40,000 x 11.25tons = 450,000

4.Variable cost = Tsh 140,000 Tshs/ha

5. Net Revenue i) 300,000– 140,000 = 160,000 Tsh/ha*

ii) 450,000 – 140,000 = 310,000 Tsh/ha

iii. Value added by processing cassava

The tested processing technologies, have the potential to improve the storage and marketability of processed cassava. As indicated in Box 2.9 by selling dried cassava chips or flour farmers can earn a net return of up to Tsh 57 per kg. This is because the quality of cassava flour is improved by tested technologies.

2.2.1.1.2 Impact of existing farmers' varieties

In the surveyed villages the following cassava varieties with different attributes in the study areas were common. These are Kiroba (Rufiji district), Mfaransa (Bagamoyo district) and Kitingisha ndevu (Tanga district).

Table 2.4: Attributes of currently cultivated farmers' varieties

District	Existing variety	Attributes	Yield	Maturity (months)
Rufiji	Kiroba	Sweet Marketable fresh	3 – 4.5 tons / acre	Early maturity 8 – 10 Can be eaten in 6 months
	Cosmas	Sweet Home consumption	-	Intermediate maturity 18-24 Can be eaten through out the year
	Kichooko	Bitter Home consumption, dry form, (Makopa – Ugali)	-	Ground storability up to 4 years Can be harvested after 1.5 years
Bagamoyo	Mfaransa	Sweet Market	2 – 3 tons/acre	Early maturity 8 – 12 Can be eaten throughout the year
	Kalolo	Bitter Consumed in dry form (Makopa– ugali)	4 – 4.5 tons/acre	Early maturity 6 to 7
	Agriculture	Sweet Late bulking Low yield	-	
Tanga	Kitingisha ndevu Erect Spreading	Sweet Market	2 – 3 tons/acre	8 –12 * Can be consumed in 6 months
	Mahiza	Sweet	-	8 –12
	Mzungu Agriculture	Sweet Sweet Disappearing	- -	8 – 12 18

*other varieties of cassava cannot be cooked during the dry season because of reduced starch content
** Up to 95% losses of cassava have been experienced due to rotting. Currently not cultivated, abandoned due to rotting. Spreading type of cassava is more affected by the disease.

Kiroba

This variety was found in Rufiji, Bagamoyo, and Kibaha. The main reasons for its wide distribution is its marketability as fresh cassava in Dar es Salaam markets (Tandika, Tandale, and Kariakoo).

Respondents noted that this variety started to be famous in 1990s replacing *Kitunguu/Kitumbua* variety at Jaribu Mpakani village. Currently all farmers (100%) cultivate this variety. Other attributes are shown in Table 3.4 and Appendix 3.1.

Mfaransa

This variety was common in Bagamoyo and Kibaha districts. It started to be grown in early 1990s. Farmers indicated that the variety was introduced from Kiwangwa village in the same Coast region. Like Kiroba, the main attribute that makes farmers

to prefer it, is the marketability in the Dar es Salaam. It is also cultivated by 100% of farmers in the surveyed village.

Kitingisha ndevu

This variety was found in Tanga District. Respondents noted that the variety started to be widely cultivated in the 1970s. This was the time when cassava started to be a cash crop (commercialisation). It was noted that cassava was traded even across the borders to Mombasa Kenya. Prior to this time cassava was grown in small quantities mainly for food.

Between 1980s and in the early 1990s , cassava was transformed from being a minor food or famine reserve crop to a major cash crop in the study villages with Tanga district being its main market.

However in 1997, cassava production in the villages declined due to (i) low prices resulting from increased cassava supply and (ii) severity of brown streak disease which caused the rotting of cassava roots (Box 2.2).

Box 2.2: Trends of cassava production at Mapojoni village

Farmers experienced up to 88% loss due to rotting. As a result for three years 1998/99 – 2000/2001 about 90% of farmers abandoned cassava production. During this time the price reached its lowest level of between Tshs 600 – 800 per Pishori (1 pishori = 100 kg).
In the season 2001/2002 farmers are making effort to revive cassava production once again after noting price increases.
Currently, the farm gate price is Tshs 3,000 – 3,500 while at the Tanga market is 5,000 – 6,000 Tsh per Pishori (100 kg). However, cassava yields have not reached the previously high level of up to 4 tons per acre. Currently farmers are realizing low yields of 0.5 – 0.8 tons per acre.
As a strategy against diseases and lower yield, farmers are now planting different varieties such as a (i) Kitingisha ndevu (short and erect) (ii) Mzungu and (iii) karatasi
selecting more carefully cassava planting materials.

2.2.1.1.3 Impact of other varieties

Together with sweet varieties at any one time farmers keep some bitter varieties. These varieties as identified during the study include, Kalolo, Kichooko, Lianga, and Msitu. The main reason for keeping these varieties are (i) food security, because of their long ground storability (ii) relative tolerance to brown streak (iii) resistance to vermin (wild pigs) attack.

Farmers therefore tend to plant at least a few of these bitter varieties in their fields, especially on the boarders. The varieties are usually processed by drying and form cassava flour. They are never eaten fresh. Farmers were able to mention cassava varieties that are no longer grown (Table 2.5) and the reasons why farmers no longer grow these varieties are shown in Box 2.3.

Table 2. 5: Cassava varieties abandoned by farmers

District	Local name	Remarks
Rufiji	1. Kibangili	
	2. Kigoma	Sweet
	3. Mwarabu	Sweet
	4. Mzungu	-
	5. Kishina rupia	-
	6. Mkange	sweet
	7. Usimpe Juma	bitter
	8. Mkukumkuku	-
	9. Kitumbua	-
	10. Bwna mref/kitunguu	
Bagamoyo	1. Bint Athmani	Bitter
	2. Kibangili	Sweet
	3. Kigoma	Sweet
	4. Dihanga	Bitter
	5. Swela	Bitter
	6. Jota	Biter
	7. Mzungu	Sweet
	8. Mbega	Sweet
	9. Sikio la Mgogo	Sweet
	10. Magimbi	Sweet
	11. Kambinjenge	Sweet
	12. Kikaniki (Moshi ya Jana)	Sweet
	13. Kajebo	Sweet
	14. Bora kupata]	Bitter
	15. Kibanga meno	Sweet
	16. Kiburuu	Sweet
Tanga	1. Kigoma	Sweet
	2. Mkunungu	-
	3. Kikaratasi	-

Box 2.3: Reasons for abandoning varieties

During the survey farmers noted that varieties "come and go". That is new varieties; with better attributes replace old ones. The main reasons for abandoning varieties according farmers include:

(i) Structure of Plant

Spreading varieties such as Lianga, were abandoned because the structure does not allow intercropping and makes weeding difficult.

(ii) Tolerance to pest and diseases

Cassava varieties which are highly susceptible to rotting are abandoned in favour of less susceptible ones. For example, in Bungu village Cosmas variety was abandoned because of rotting in 18 months.

(iii) Marketability

Varieties that are easily marketable replace not easily marketable varieties. For example Mfaransa replaced Agriculture in Bagamoyo, and Kiroba replace Kitumbua/Kitunguu in Rufiji District.

(iv) Taste

There is a tendency of sweet varieties to replace bitter varieties

(v) Time to maturity/bulking

Farmers prefer early maturing/bulking varieties. For example, Kiroba, Mfaransa and Tingisha ndevu are early maturing (6 – 12 months).

(vi) Yield and Dry matter content

High yielding varieties tend to replace relatively low yielding varieties. For example, although Kalolo is a bitter variety, farmers have maintained it mainly because of its high yields of up to 4.5 tons per acre.

(vii) Lack of individual farmers who keep and conserve varieties collect.

2.2.1.1.4 Spill over effects of farmers' variety

During interviews with farmers, it was learnt that there is spill over effect of farmers' varieties. Farmers' exchange seeds within and sometime between villages. The main source of seed material is neighbours. For example, in year 2001/2002, farmers at Jaribu Mpakani sold cassava-planting material (Kiroba variety) to farmers in Morogoro, Tanga and Rufiji. Cassava planting material is sold in bundles at a price of 500 Tshs. On average one bundle consists of 1000 sticks.

It was also observed that *farmers' varieties* are found across the districts. However, it was very difficult for farmers to identify an institution that introduced a particular variety in the village. In most cases farmers were able to indicate by name who brought a variety in the village. It was very interesting to note that *Kiroba* variety was found in Rufiji, Bagamoyo, and Kibaha while *Mfaransa* was identified in Bagamoyo and Kibaha districts. Farmers indicated that the variety was introduced from Kiwangwa village in the same Coast region. The *Agriculture* cassava variety was found in Rufiji, Bagamoyo and Tanga but is disappearing. In Tanga, it was noted that cassava was traded across the borders to Mombasa Kenya. This indicated some spill over effects across the borders.

2.2.1.2 The Impact of cassava management practices

2.2.1.2.1 Planting

Cassava is planted on ridges or on a flat field. The recommended spacing is 1 meter by 1 meter (TARP II SUA, 2001/02). Three weeding and application of Farmyard manure are also recommended.

The showed that farmers were practicing traditional production practices, spacing, and varieties. In Jaribu Mpakani farmers observed a planting spacing of 1 x 1m which they learned from Village Extension Officer in 1977/78. Weeding is done 4 times per year. About 85% of farmers plant cassava during the short rainy season (*Vuli*) – November, while the remaining 15% plant in June. The main harvesting season is July/August. Ninety eight percent of farmers practice row planting. Farmers noted an increase in yield by planting in rows. In all yield increased by 350% (Table 2.6).

Table 2.6: Cassava yield for row and random and planting

Planting	% of farmers practising	Yield Bags	Tons/acre	% increase (mean)
Random	2	3 – 4	0.9 – 1.2	-
Row	98	10 – 15	3 – 4.5	350

1 Bag = 300Kgs.

Cassava is mostly intercropped with other crops. Major intercropping patterns include:

i. Cassava + cowpeas
ii. Cassava + maize
iii. Cassava + pigeon peas
iv. Cassava, maize, cowpeas
v. Cassava + tree crops (cashew nut, mangoes and coconut)

It was noted that when intercropping with other crops, the between rows spacing is more than 1 meter. Spacing of up to 1.5 m x 1.5 m was observed. Farmers maximised productivity per unit area through intercropping.

2.2.1.2.2 Harvesting

Cassava harvesting is done from 6 – 48 months, from the date of planting depending on variety.

Time to maturity can be broadly categorized into 3:

(i) Early maturing 6 – 12 months
(ii) Intermediate maturity 13 – 18 months
(iii) Late maturity >18 months.

The experience of farmers is summarised on Box 2.4. At 6 months the early maturing (early bulking) varieties, can be harvested for home consumption but not for marketing. Respondents noted that the optimum harvesting time is 8 months and beyond 12 months, cassava cannot be easily marketed, because of

(i) large tuber/root size

(ii) rotting
(iii) reduced starch content

Box 2.4: Harvesting of cassava

According to the interviewed farmers large tubers/roots sizes are not preferred by the traders/consumers, the harvesting and packing for transportation becomes difficult.
Rotting is a major problem because when harvesting is delayed beyond one year especially for sweet varieties. The main cause of rotting is disease attack (cassava brown streak and cassava root rot).

Late harvesting causes reduced starch content. However this attribute differ depending on a variety and time of harvesting. For some varieties (e.g. Cosmas and Mfaransa), they don't loose the starch throughout the growing season.

2.2.1.2.3 The Impact of cassava utilisation and storage

In the study area cassava is used as fresh cassava or dry cassava (makopa). Fresh cassava is boiled, or cooked as 'Futari'. Box 2.5 shows the cassava utilisation and storage according to interviewed farmers.

Box 2.5: Utilisation and storage of cassava

Dried cassava is usually pounded into flour that is used to make a stiff porridge (ugali). In the study villages, farmers identified 3 ways of drying cassava as follows,

1. Drying with fermentation, where by fresh cassava is slightly dried, then covered with grass for few days, until fungus grow, then dried again
2. Drying directly in the sun.
3. Soaking and drying.

The most common practice in the area is drying with fermentation. The quality of "ugali" of flour processed locally is low, and produced black stiff porridge. Farmers noted that there are 2 major ways of storing cassava
1. In ground storage, whereby cassava is left in the field and is harvested piece meal. This is where farmers prefer varieties with long ground storability

2. Stored as dry cassava. However, due to problems of pest attack, only small quantities are stored for very short periods of time up to 2 months.

2.2.1.2.4 Impact of other technologies tested on-farm

During the survey it was noted that there are other cassava technologies tested on-farm. These technologies include:

- Low cost storage techniques for fresh cassava roots
- Cassava processing machines
- Cassava chipper and

- Cassava grater (manual and motorized)

Farmers interviewed in Rufiji district indicated that, the low cost storage technologies was introduced by the Tanzania food and Nutrition Centre TFNC in collaboration with Natural Resource Institute (UK) (Box 2.6)

Box 2.6: Low Cost Fresh Cassava Storage Technology introduced by TFNC/NRI.

The Tanzania Food and Nutrition Centre in collaboration with NRI introduced a simple low cost fresh cassava storage technology between 1997 and 2000. The technology involved:

(i) Careful harvesting (uprooting) of cassava without damaging the roots
(ii) Soaking of fresh cassava roots in water for about 1 minute
(iii) Packing the soaked cassava roots in plastic bags, and tied at the top with a rope.
(iv) Covering the bags with grass and sparkling with water to keep the cassava fresh

In this way it is argued that fresh cassava can keep for up to 7 days without rotting.

NB: Farmers have not adopted the method because traders don't buy stored cassava and farmers prefer harvesting cassava only when needed for immediate consumption.

The technology had the potential to increase shelf life of fresh cassava from 1 – 2 days to 7 – 10 days (Anandajeyasekaram et al. 2001, Mashamba 1997), increase farmers income by 5% to 10% (Mashamba 1997). However the survey results show that none of the farmers are currently using the technology. The main reason for not using the technology is that households do not store cassava for food, they prefer in ground storage. The fact that there is always some cassava in the fields and therefore in house storage is not found necessary. For the same reason farmers indicated that they do not need to store for the market either. Traders prefer fresh cassava rather than stored cassava.

For this reason, the potential benefits of the technology have not been realised mainly because the technology did not address the felt need of the beneficiaries. Interviewed farmers indicated that their main problem is storage of dry cassava. Currently, dried cassava cannot be stored beyond 2 months. Interviewed farmers and especially women indicated their willingness to adopt the technology if given some soft loan to acquire the machines for processing.

2.2.1.2.5 Impact of pests and disease in cassava production

Cassava brown streak is common in all study areas. However, interviewed farmers indicated the severity of the disease vary from one variety to another. In Tanga, the impact of the disease is very obvious. It has caused a loss of up to 87.5 percent from normal yield of 4 tons/acre. Other pests and diseases affecting cassava are as in Box 2.7.

Box 2.7: Pests and Diseases

According to the description of interviewed farmers in Rufiji, Bagamoyo and Tanga, the main diseases affecting cassava include:
**Cassava mosaic*
**Cassava brown streak*
**Cassava soft rot*

The main pests and wild animals include
**Cassava mealy bug*
**Pigs*
**Monkeys*

2.2.1.2.6 Impact of cassava marketing

Cassava is marketed both as fresh and dried cassava (Makopa). The main market for fresh cassava is in Dar es Salaam. Farmers identified best attributes of cassava for the market (Box 2.8). Cassava has obvious economic impact on farmers at household level. Income of cassava has improved the livelihood of farmers in the study areas. Interviewed farmers noted that good houses thatched by iron sheets, bicycles as well as food security in the study areas was due to income from cassava. The improved life standard due to cassava was more prominent at Jaribu Mpakani village in Rufiji district. Farmers income at Mapojoni was significantly affected by the rotting of cassava that was due to cassava brown streak. It was found that their income was reduced from 3500 to 600 Tshs per bag of 100 kgs.

Box 2.8: Attributes of cassava for the market

Farmers identified the best attributes for cassava produced for the market. These attributes depend on the traders and consumer tastes and preferences. These attributes include:

1. Traders point of view

>Medium size roots/tubers are preferred for easy transportation. Large size tubers tend to break more easily while transporting, and occupy large space in tracks (more volume)

***large size tubers requires more effort (energy) in harvesting.*

***Farmers therefore prefer that cassava which is harvested at optimum maturity time, to avoid large size roots/tuber.*

>Moderate stem size that allows easy harvesting[1]

>Sweet varieties because cassava is consumed fresh.

2. Farmers point of view

High yields

Early maturity

Resistance to pests and disease

Marketability

3. Consumers point of view

***Cookability (less time, soft)*

***Taste – sweet varieties*

***High starch content*

***Skin colour (attractive) sometimes traders peel the outer brown skin to attract customers.*

[1] Harvesting cassava for marketing is a responsibility of traders and not farmers.

2.2.1.2.6.1 Impact of Fresh cassava in marketing

The main markets for cassava produced in Rufiji and Bagamoyo are: Tandika, Tandale, and Kariakoo markets in Dar es Salaam whereas the market for cassava produced in Tanga is mainly in the Tanga Municipality. During the survey it was noted that there was no large variability in farm gate price in studied villages (Table 2.7).

Table 2.7: Fresh Cassava Farm Gate Prices in Selected Villages

District	Village	Unit quantity		Price per bag*
		Local unit	Kgs**	
Rufiji	Jaribu Mpakani	Kiroba (Rumbesa)	300 – 350	4,500 – 7,000
	Bungu	Kiroba	300 – 350	2,000 – 3,000
Bagamoyo	Matimbwa	Kiroba Rumbesa	90 – 100 kg	2,000 – 3,500
	Kongo	Kiroba	90 – 100 kg	3,000 – 3500
Tanga	Mapojoni	Pishori	90 – 100	2,500 – 3,500

* During Ramadhani (when moslem fast) cassava fetch a higher price

** Based on farmers estimates

In addition to wholesale marketing, cassava is also traded locally at village markets. The main unit of measure is a bundle of cassava (Fungu). A bundle of fresh cassava consist of about 5 – 10 cassava roots. Measurement taken at Bungu village showed that on average a bundle weighs about 4.5- 5 kgs, and is sold at a price of 100 Tshs. Although no detailed analysis was done on cassava marketing it was noted during the study that few cassava traders tend to monopolise cassava trade such that only few traders can enter into cassava marketing. For example, in Mapojoni village (Tanga) there were only 2 cassava traders buying cassava at village level. These traders have links with retailers at the Tanga market. Farmers noted that this was a disadvantage to them because it tends to lower cassava price.

2.2.1.2.6.2 Impact of dried cassava in marketing

The major market for dried cassava from Rufiji district are mainly Ikwiriri, Kilwa and Tanga. The main varieties used are bitter varieties. The price of dry cassava is shown in Table 2.8.

Table 2.8: Market price of dry cassava

Unit quantity	Kg	Price Tshs	Average Unit price Tsh/Kg
Kiroba (Rumbesa –bag)	100 – 150	2,000 – 3,000	13 – 30
Fungu (Bundle)	1.75	100	57

The comparison between the price of fresh and dry cassava shows that fresh cassava fetches a higher price than dry cassava at wholesale price (Table 2.9).

Table 2.9: Comparison of fresh and dry cassava price

Fresh cassava		**Equivalent amount of dry cassava**	**Price Tshs**	
Quantity	Average price	Quantity 30% of fresh by weight	Wholesale	Retail
300 kg	5,000	90 kg	1,170-2,700	5,130

*Based on data collected at Bungu village

At retail price of about 57 Tshs/kg, dry cassava fetch a slightly higher price than fresh cassava when costs of processing and drying are not taken into consideration. The main reason as noted by respondents for low price of dry cassava is its low quality. This is a result of poor technology used in processing cassava. Improved processing can attract cassava in the now emerging urban market in Dar es Salaam super Markets, food processors, and restaurants.

2.2.1.2.7 Impact of cassava processing and utilisation

Cassava processing machines were introduced in selected villages, through SARRNET activities. Farmers in two villages in Rufiji district indicted having attended a demonstration on the use of cassava processing machines in 2001. Up to the time of interview none of the surveyed villages in Bagamoyo and Rufiji districts used the technology. The main reasons for not using the technology are:

i. Farmers have not yet met the conditions to be included in the programme for receiving the machine from SARRNET. That is formation of women groups that have a cassava farm.
ii. Farmers expect father training on the use of the machines.

Farmers were impressed by the demonstration and they indicated that they see the potential benefits for using the technology. They identified the following potential benefits

i) Improved quality of dried cassava, and consequently cassava flour
ii) Easiness in drying chipped cassava
iii) Reduced women's drudgery in processing cassava.

However, In Tanga district a group of 12 urban women, with the use of a motorized cassava chipper, have been able to go into commercial processing of cassava. They are using the motorized cassava chippers to chip and then dry cassava. They sell the dried cassava to some food processors in Dar es Salaam. Three of the group members attended training on cassava processing at ARI Kibaha in 2001/2002. The machine was provided by SARRNET. The analysis of the returns from the processing of cassava using the data from the group is presented on Box 3.9.

Box 2.9: DEMROS - Cassava Commercialization; Case of DEMROS Women Group in Tanga Municipality

A. The Group:
The group is made up of 12 women, most of whom had lost their job after the Regional Trading Company was dissolved. Three of the members attended training of cassava processing at SARI Kibaha.
B. Cassava processing:
They prefer to process cassava that is about 12 months maturity. Beyond which time cassava will be fibrous, less starch and therefore produce poor (light) flour.
C. Variable cost of processing cassava
i) 1 Bag of fresh cassava = 90kg
ii) Price of buying 90 kg bag of fresh cassava = Tsh. 3,000 – 3,200
iii) Cost of peeling 1 bag of fresh cassava – Tshs 400
iv) Price of fuel for processing about 550 Tshs per litre
1 litre of fuel can grate about 1 ton of fresh cassava
cost of grating one 90 kg bag of fresh cassava = Tshs. 49.50
v) Total cost of processing 90 kg of cassava
= 3,000 + 400 + 49.50 = 3449.50 or
= 3,500 + 400 + 49.50 = 3949.50
D. Gross Revenue from processed cassava = Tshs. 200 x
Processing 90 kg of cassava produce on average 22 kg of chips or 20 kg of flour
Price of 1Kg of cassava flour or chips =Tsh 200
Gross Revenue from selling
Flour :Tsh 200/kg x 20kg = Tsh. 4,000
Chips: Tsh. 200/kg x 22kg = Tsh. 4,400
Net Revenue from sale of processed cassava
i) Scenario 1 prices of fresh cassava Tshs. 3,000 per 90-kg bag.
Flour: Tshs 4,000 – Tsh. 3449.50 = Tshs. 550.50
Chips: Tshs 4,400 – Tsh. 3,449.50 = Tsh 950.5
ii) Scenario 2 price of fresh cassava Tshs. 3,500 per 90 kg fresh cassava
Flour: Tshs. 4,000 – Tsh 3,949.50 = Tshs. 50.50
Chips: Tsh. 4,400 – Tshs. 3,949.50 Tsh. 450.50

A simple gross margin analysis (Box 2.9) show that high Net Revenue can be obtained by selling cassava chips. A gross margin of up to Tshs 950.50 can be realized from processing a 90 kg bag of fresh cassava (about 27 – 32% revenue above the price of fresh cassava).

Currently, under the TARP II –SUA (2001/2002) project researchers are investigating on the possibility of commercialising cassava through sensitisation and training of

i. Cassava farmers to process cassava using cassava graters/chippers and drying to form cassava chips
ii. Livestock feed processors to formulate cassava based livestock feeds
iii. Cassava traders to buy dry cassava chips from farmers
iv. Livestock keepers to feed their livestock on cassava based feed.

In accordance with Nweke *et al* (2002) hypothesis, the outcome of this project will be a breakthrough in transforming cassava crop from a famine reserve crop to livestock feed and industrial raw material.

2.2.1.2.8 Intermediate Impact -Capacity Building

The aspect of training is very important in the process of empowering farmers. SARRNET, ARI-Kibaha, Village extension officers and TFNC in collaboration with NRI conducted the training programs in the study areas (Table 2.10). There is one booklet on cassava storage provided to farmers by TFNC/NRI and a cassava leaflet produced by TARPII -SUA. It was noted that not much has been done with respect to training of farmers or Extension officers at village level. Some of the interviewed extension officers mentioned that they have not received any type of training in cassava production since they left college.

The recent training on cassava processing to farmers was on processing and utilisation. The training was conducted by SARRNET and Kibaha ARI. These training were conducted recently (2000).

In the 90's, farmers in Rufiji and Bagamoyo were trained on cassava production management such as spacing and storage of cassava (TFNC and NRI). Interviewed farmers in Tanga (Mapojoni) said that were not trained on cassava management. Farmers in this village are looking for improved varieties and better management practices to control cassava streak disease that has affected their household income. Therefore training is of crucial importance to bring awareness to them (Box 2.10).

Box 2.10: Farmers impression on need for training on cassava management practices, processing and utilisation

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Farmers at Kongo village in Bagamoyo district noted that Cassava is planted in any how without recommendation. With this planting one can expect poor yield.

Some of the farmers recommend to plant short cassava cuttings, others long cuttings. Thus without training farmers will not know the recomended practices.

In all study villages farmers showed great interest with new technologies in processing and utilisation.

Table 2.10: Capacity Building

District/Village	Type of Training	When	No. of farmers		Source	Remarks
Rufiji Jaribu Mpakani	1.Cassava processing	2001/2002	M 8	F 12	SARRNET	Promised machine
	2.Cassava storage technique	1998/1999	5	5	TFNC/NRI	1.One booklet 2.Methodology is not used
	3. Row planting (1X1m)	1977/1978	Not known	Not known	VEO (Village Extension Officer)	Used by 98% of farmers
	4.Trained on mealy bug control	1986	-	-	VEO	Release of wasps
Bungu	1.Cassava processing	2001/2002	10	10	SARRNET	Promised machine
	2.Cassava storage technique	1998/1999	5	5	TFNC/NRI	1.One booklet 2.Methodology is not used
	3.Row planting (1X1m)	1977/1978	Not known	Not known	VEO (Village Extension	Methodology used by 75%
	4.Trained on mealy bug control	1986			VEO	5 farmers -release of wasps
Matimbwa	1.Storage of cassava planting material	1996	-	-	-VEO -District Official	-District campaign due to shortage of planting material
	2.Trained on mealy bug control	1990				-Release of wasps to control mealy bug
Tanga/ Women group (DEMROS)	1.Cassava processing	2001/2002	-	2	SARRNET Kibaha ARI	>This group has 1machine given free of charge >Group is very active consist of 12 members

2.2.2 Environmental Impact

During the survey it was observed that farmers are not using any chemicals to control pests or diseases. In the case of cassava streak disease farmers in Mapojoni village are selecting disease free planting materials. In the case of cassava mealy bug, the release of parasitoid wasp A. lopezi by the National Biological Control project between 1989 and 1993 in some cassava producing areas in the Coast region has reduced the damage from a score of 4 to 2. Farmers mentioned that the damage of cassava meal bug is more severe during the dry period compared to the rainy season. These control measures do not involve the use of chemical and therefore are environmentally friendly. Cassava processing technologies are also found to be environmental friendly.

Currently, the observed technologies in the study areas have no negative impact on the environment.

2.2.3 Social Cultural Impact

It was clear that farmers within and across the villages accepted some of the farmers' varieties. Thus some of these varieties still exist. For example, cassava varieties such as *Kiroba, Mfaransa*, *Kitingisha ndevu* have been accepted by farmers because of their attributes. These attributes include cookability, marketability, and high yield and pest and disease resistance. Varieties with these attributes have high potential of being adopted by end users.

In the past cassava was grown as a food crop but currently, it is accepted as a cash crop because it has contributed to improve their household income and food security. For example, Jaribu Mpakani and Bungu villages have good assets such as good houses, radio and bicycles.

Cassava processing technologies seems to be accepted by the community members. It is in these lines that farmers at Bungu and Jaribu Mpakani have requested processing machines on loan basis. Women's group in Tanga, mentioned that the cassava flour produced through this process is preferred because it is white in colour and the chips dry very fast at least in 3 hours if there is enough sunlight. Thus it reduces the women workload and time spent on getting flour through local methods.

2.3 Opportunities and constraints

2.3.1 Diversity

The large collection of cassava types and the diversity of characteristics are important assets for cassava improvement. Farmers have continuously selected preferred varieties and have established criteria for selecting best varieties (Table 3.4). Cassava breeders in their breeding process can use such criteria. With improved production and processing technologies farmers can increase cassava production. Marketing opportunities exist in livestock feed industry and food industry especially for the urban population.

The main researchable constraints are to

i. Increase cassava yield

ii. Control pest and disease attack on the crop
iii. Introduce a wide range of cassava processing technologies
iv. Analyse alternative ways for cassava utilization.

2.3.2 Agronomic practices

Farmers through experience and occasionally extension advice have learned appropriate agronomic practices for cassava production. Important practices identified during the study include:

i. Row planting
ii. Seed selection
iii. Planting spacing

Farmers noted that with row planting spacing of 1m x 1m, and proper seed selection. Yield is increased by as much as 350%.

2.3.3 Farmers constraints

During the study farmers were asked to identify major constraints to cassava production. They identified the following major constraints (Table 2.11).

Table 2.11: Major constraints in cassava production

District	Village	Major constraints
Rufiji	Jaribu Mpakani	Cassava yields are low. They need higher yielding varieties Pest attack on stored dried cassava. Need technologies to store dry cassava for more than 2 months. Poor quality and inefficient method of processing cassava into flour. Need improved technologies for processing cassava.
	Bungu	Poor quality and inefficient method of processing cassava Vermin attack especially wild pigs and monkeys. Need equipment e.g. nets to hunt the animals. Inefficient and weak cassava market. They need research on cassava marketing. Low capital to increase cassava production. Need credit to increase cassava production. Poor cassava processing technologies. Need improved technologies to process cassava.
Bagamoyo	Matimbwa	Lack of knowledge on recommended cassava management practices (time of planting, spacing, weeding, pests and disease management). Need training on management practices. Lack of knowledge on selection of planting materials. Need training of how to select disease free planting material Inadequate extension services especially on cassava crop. Need village level extension officer. Lack of improved cassava planting material They need improve, high yielding disease resistant varieties Inadequate farm equipment e.g. tractors for cultivation.
	Kongo	Vermin attack on cassava fields Cassava market and price Knowledge for recommended cassava management practices (selection of planting material, spacing, and preparation of planting material. Inadequate utilization and processing technologies Inadequate extension services especially on cassava crop. Need village extension officer
Tanga	Mapojoni	Cassava market and price. Few traders create monopoly affecting prices Lack of disease resistant cassava planting materials Lack of knowledge on cassava management practices (spacing, weeding etc) Need training on selection of disease free cassava planting materials and management practices Need a diverse set of improved cassava planting materials resistant to common cassava diseases.

2.4 Comparative advantage of Cassava compared to rice production in the study areas

The existence of cassava production and processing technologies is an important opportunity for commercialisation of cassava. According to interview farmers the cost of cassava production is relatively low if compared with other annual crops such as maize, rice and sorghum. Table 2.12 shows the comparison of rice and cassava production. This table provides a simple analysis to compare the cost of producing 1 acre of rice and 1 acre of cassava. The net revenue from cassava is about Tshs 64,000 per acre compared to rice Tshs. 48,000 per acre, and the risk of loosing a crop due to bad weather is high for rice.

Table 2.12: Returns from rice and cassava production

Variable costs	**Rice**	**Cassava**
1. Land preparation		
Plowing	15,000	16,000
Harrowing	15,000	-
2. Planting	12,000	20,000
3. Weeding 1	14,000	10,000
4. Weeding 2	14,000	10000
5. Structure for scaring birds	6,000	-
6. Bird scaring/vermin	40,000	-
7. Harvesting	16,000	0*[1]
8. Transport	20,000	0*[1]
Total	152,000	56,000
Revenue of rice [2]		
1 acre x 20 bags/acre x shs 10,000/bag	200,000	
Net Revenue at shs. 10,000/bag	48,000	
Revenue of Cassava[2]		
1 acre x 30 bags/acre x shs. 4,000	120,000	
Net Revenue at sh. 4000 per bag	64,000	

1. The cost of harvesting and transporting cassava is incurred by the traders
2. Farmers attach a high risk of loosing rice crop from bad weather (low rains) than on losing cassava crop

2.1 Conclusion and Recommendations

2.1.1 Conclusion

In the early years (1920s – 1970s), most cassava research was conducted on-station with the main focus on control of major cassava diseases (cassava mosaic, cassava brown streak) and pests (cassava mealy bug). During this time cassava was basically considered as a famine reserve crop.

During the past 20 years, some on-farm testing of promising varieties has been done in the Lake Zone, Southern zone and eastern zone. However, in the Eastern Zone major activities on on-farm testing started in the 2000/2001 season. During the study no direct impact of on-farm testing was found, as farmers could not identify cassava varieties from research. When asked on cassava varieties that farmers got from

research. Farmers in Jaribu Mpakani (Rufiji) answered “Researchers come here to collect seeds not to bring seed”.

There are 2 major factors that make it difficult to make a direct assessment of impact of on-farm research on cassava

1 Early cassava varieties from research were assigned and identified by numbers. Whereas farmers identify cassava varieties by names, particularly names of people or places where particular seed originated. Therefore, unless a detailed technical characterization of the varieties is done, it is not possible to directly link between farmers’ and research developed varieties.
2 Related to this, there has been no officially released cassava variety. Thus, it is difficult for research to link any existing varieties with varieties from research. This is mainly because of non-existence of seed-release protocol for root and tuber crops. It was not until the year 2000 when a protocol for sweet potatoes was produced.

The introduction of cassava processing technologies that started in the 1990s, shows some promising results for having a significant impact. Farmers are looking forward to processing cassava and selling to urban markets and feed/food processing industries

2.1.2 Recommendations

The observed trend in cassava as a crop is that, it is changing from a famine reserve crop to a commercial/cash crop. Research should therefore also focus research programmes that will encourage this positive trend. Recommended areas for future research and development include:

i. Marketing of both fresh and dry cassava in terms of potential markets, prices, supply and demand for cassava
ii. Technical and economic analysis of cassava processing technologies (such as cassava graters, chippers, driers and milling machines)
iii. To produce high yielding, disease resistant varieties that meets both the market and household demand.
iv. Design appropriate agronomic/management practices for different farming systems such as tree crop-based systems and for cassava sole cropping systems.
v. Initiate demonstration plots at village level and training programs for both farmers and extension officers on cassava management, processing and utilisation.
vi. Chemical analyses of bitter cassava varieties for their cyanogenic glucosides content. To be able to give recommendations for their use in human food and animal feed. This is because these varieties end to be relatively more high yielding, and disease and pest/vermin resistant.

2.5 References

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2.6 Appendices

2.6.1 Appendix 1A: Form 1a - Technology assessment

Technology Recommendation (Please specify)	Attributes	Years of Release /recommended Of variety/ technology	Collaborators In developing technology	Technology Transfer				Beneficiaries outside the project area (spill over effect)
				Targeted Location	Target Group	Coverage	Methods of Transfer	
Kibaha	Planting Nov- Dec	1980's	R/T - Other zone	Coastal humid	Small scale	Localized	Onfarm trials	
Kiroba	Planting Nov- Dec	1998	R/T SARRNET	Coastal humid	Small scale	Localized	Onfarm trials	
UKG 93/041	Planting Nov- Dec	1995/96	R/T SARRNET	Coastal humid	Small scale	Localized	Onfarm trials	
NDL 90/034	Planting Nov- Dec	1991/92	R/T SARRNET	Coastal humid	Small scale	Localized	Onfarm trials	
HBL 95/005	Planting Nov- Dec	1996/97	R/T SARRNET	Semi Arid	Small scale	Localized	Onfarm trials	
MUMBA	Planting Nov- Dec	1995/96	R/T SARRNET	Semi Arid	Small scale	Localized	Onfarm trials	
Improved Cassava processing	High Quality	1996/97	SARRNET 11TA	wide	Small scale	Spread to Other regions	Demonstration	

Location- targeted location
Target group- small scale farmers, women, etc
Coverage- localized, spread to other districts, spread to other regions
Method- approach e.g. seminar, extension…….., posters, field trials etc.

2.1.3 Appendix 1b: Form 1B - Benefits of technology

Technologies/ Recommendation (Identified in Form 1 A)	Special delivery Attributes of the Technology Consumer acceptance	Benefit at household level			Institutional benefit			
		Before Yield	**After Yield**	**Other Benefits**	**Farmers**	**Researchers**	**Extension**	**NGO staff**
Kibaha NDL 90/034	-High dry matter -Cookability is good in about 10 months	2.0-4.0 t/ha	12- 16 t/ha	High dry Matter	Leaflet on Cassava production	Researchers Trained on crop management		
Kiroba	-Early bulking -High yield - consumer acceptable	2.0-4.0 t/ha	10-25 t/ha		Leaflet on Cassava production	Researchers Trained on crop management		
HBL 95/005 Mumba	- leaf retention -high dry matter - Consumer acceptance - Extra ability to tolerate drought	2.0 4.0 t/ha	10-20 t/ha		Leaflet on Cassava production	Researchers Trained on crop management	Extension Staff trained on crop management practices in Dodoma	NGO staff trained on crop management practices in Dodoma
UKG 93/041	-High dry matter -High yield -Many roots per plants -Disease and Pest tolerant	2.0 4.0 t/ha	10-20 t/ha		Leaflet on Cassava production	Researchers Trained on crop management		
Improved processing	-High quality flour -Odourless -With no sand	Flour with Sand, Fibres And odour		Industrial use -Biscuits Starch confectory	Leaflets 1 on Processing	Researchers trained on processing and utilization technologies	Trained on processing	Trained on processing in Dodoma

2.6.2 Appendix 1C: Form 1C - Impact of technology

Technologies/ Recommendation (Identified in Form 1A)	Contribution of technology to						Others (specify)
	Food security	**Poverty alleviation**	**Nutritional status**	**Environment**	**Empowerment of farmers**	**Gender Concerns**	
Cassava- Kibaha - Kiroba - UKG93/041 - NDL90/034 - Mumba - HBL95/005	Drought tolerant Hence increased Food availability	Surplus crop sold for cash	Cassava leaves, has 20-25% protein good for health	Cassava controls erosion	Farmers groups Involved in cassava	Cassava originally was woman crop	Women concentrate on food security
Improved Cassava processing	Wider consumption by new population segment	- Cash income from flour chips sales	Completely Removal of HCN compound		Farmer groups involved in pilot sites	-Woman groups involved in pilot sites -Increased income distribution	

CHAPTER THREE

IMPACT OF RICE RESEARCH IN THE SOUTHERN HIGHLANDS

3.1 Background

3.1.1 Rice-farming system in the southern highlands of Tanzania

Major rice producing areas in the southern highlands (SH) of Tanzania are Usangu plains in Mbalali district; Kyela district, Msangano and Kamsamba in Mbozi district, Mbeya region, Pawaga in Iringa region; Kirando and Rukwa valley in Rukwa region and along lake Nyasa in Ruvuma region. In these areas rice is the main food crop. Other the crops grown by farmers in Kyela and Usangu are presented in Table 3.1. Both upland and lowland rice farming is practiced. Lowland rice can be divided into rain fed with shallow flooding using traditional irrigation schemes where flooding is controlled using constructed canals.

Mainly commercial farms (Mbarali, Kapunga and Madibira) owned by the National Agricultural Food Company (NAFCO) in the Usangu plains grows irrigated lowland rice, whereas rain fed shallow flooded rice is grown by smallholder farmers. The mean estimated yield among small-holder farmers is one ton per hectare for rain fed lowland, .0.4t/ha for upland rice and 3t/ha for irrigated rice (Mghogho, 1992). A number of factors limit the yield produced by small scale farmers, for instance the use of unimproved local varieties weed problem soil fertility problem, poor management of water, low plant population and untimely planting.

3.1.2 History of rice research in Tanzania

Rice improvement programme (RIP) at Uyole Agriculture Center (UAC) began in 1981/82 at Kikusya in Kyela district for upland rain fed rice and Uhambule in the Usangu plains lowland rain fed rice. Collaborative work involving the exchange of materials and yield evaluation of germplasm from various parts of the world have been established with the International Rice Research Institute (IRRI), and the International Institute for Tropical Agriculture (IITA). Nationally, collaborative research had been between Ifakara, Dakawa, Katrin and SUA Morogoro in the eastern zone. The objective of these collaborations was to identify superior genotypes exhibiting high yield potential to answer rice production problems specific to the southern highlands.

Table 3.1: Main food and cash crops grown in Kyela and Usangu rice farming system.

District	Crops	
	Food crops	**Cash crops**
Kyela	Rice, banana, maize, oil palm, beans, sweet potatoes, groundnuts, oranges, mangoes, bambaranuts.	Cocoa, rice, oilpalm, cashewnuts, fruits (eg oranges, mangoes, etc.)
Mbarali-Usangu plain/Chomoto village	Rice, maize, bean, onions, groundnuts, cassava, banana, tomatoes, sweetpotatoes, simsim, soghum, pigeonpeas, cocoyams, bambaranuts, greengram.	Rice, groundnut, onions

Rice breeding had made possible the screening of several improved high yielding varieties, which were proposed for release as commercial varieties. Table 3.2 summarizes the technologies released including agronomical package for adoption by smallholders. RIP and farming systems research programme (FSRP) conducted on-farm research trials to disseminate the recommended technologies.

3.1.3 Description of study area

The impact study was conducted in May 2002 in Kyela district and Usangu plains, Mbarali district, Mbeya region. The team in collaboration with extension staff in the respective districts and villages conducted the study using the participatory rural appraisal (PRA) approach.

In Kyela district, a purposive sampling technique was used to select farmers for interviews. Selection was based on farmers who have participated in carrying out the on – farm trials during the period 1986 – 1994 when the improved rice varieties were being demonstrated in the district. More than ten farmers were asked to attend the PRA discussion organized to take place at Kyela district Agricultural Development office.

In the Usangu plain, Chamoto village was selected for the interviews as representative for the area. 20 farmers including men and women participated in the discussion.
A prepared checklist was used to guide the interview during primary data collection. Also special prepared forms to be filled by the programme leader was used to collect secondary information on the technologies developed and released.

3.2 Technologies developed

3.2.1 Kyela District

In 1980 the UAC established the rice improvement program (RIP) with the responsibility of developing rice improved technologies for smallholder farmers in the SH zone. On-station research was started at Kikusya-Kyela district for rice breeding and agronomical experiments both for national and international programmes. Nationally coordinated research activities have been conducted under the National Rice Trial series, from which most of the current commercial rice varieties have been released. Additional research on agronomic practices for rice production, such as time

of planting, weed control and fertilizer response have been carried out in collaboration with the soil science programme at UAC.

In 1986 the Faming System Research Program (FSRP) initiated on farm trials in Kyela district to encourage farmers to adopt the improved rice technologies. Technologies tested included seeds of the three improved varieties, seedbed preparation, optimum seed rate, time of planting, fertilizer types and application rates, methods of weed control and use of herbicides (Table 3.2). The trials lasted for six years and covered 48 villages, which is 60% of all villages in Kyela district.

Table 3:2: Rice Technologies for Adoption by Smallholder Farmers in Southern Highlands

Innovation	**Technology Package**
Improved varieties: Anticipated mean yield of 2000kg/ha	Afaa-Mwanza , Katrin, Selemwa, Salama, Kihogo sel.7, Kihogo -red Morogoro, ITA 172, ITA 283, Dakawa 83 and Subarimati.
Land preparation	One ploughing and two harrowing
Time of planting Kyela Usangu	 November - December December- January
Seed rate	80 - 100 Kg/ha
Fertilize application Basal Top dressing	 20-30N + 20 - 40 P Kg/ha 20 - 30 N Kg/ha
Weed control: Hand weeding 1st Hand weeding 2nd **Herbicide:** Pre- emergence broadleaf and grasses Past emergence broadleaf and sedges Post- emergence broadleaf	 4 - 6 weeks from planting At booting stage Ronstar 25 EC Basagram Propanol 2, 4D

3.2.1.1 Varieties tested

Improved varieties tested were Afaa-Mwanza, Katrin and Salama. Other varieties were released without being tested in the farmer's field. Characteristics of these varieties are shown in Table 3.3. The varieties have been exposed to farmers for the past sixteen years.

According to the survey findings (Table 3.3), only 3 farmers out of 57 farmers who participated in testing the improved varieties grow Afaa-Mwanza. None of the farmers grow Katrin or Salama' in Kyela disrict. The reasons for not adopting these varieties are their deficiencies in terms of palatability, marketability and cooking qualities which are mostly preferred by consumers.

3.2.1.2 Management practices

Land Preparation
Ploughing followed by two harrowing is practiced by all farmers in the area (Table 3.2). This recommendation is not new to them, as it has been practiced even before the introduction of the new varieties.

Planting time
Planting time is between Nove mber and December. According to farmers, only a few (5%) farmers adhere to this recommendation, most of them (95%) plant between the ends of December to February. This is because planting depends on the onset of rains and planting between December and Febr uary ensure good seed germination (Table 3.2).

Amount of seed per hectare (Seed rate)
Most farmers (98%) are not following the recommended seed rate of 80kg- 100kg per hector, because they have observed that, that seed rate gives low plant population. Most of the farmers use 100 -120kg per hectare instead of the recommended rate because they have observed that it gives higher yield.

Fertilizer use
Basal application recommended rate for TSP and Urea is 20-30N and 20-40Pkg per ha. Only 25% of farmers use fertilizers mainly in the area with vertisol. However, through experience, farmers have modified the recommended rate and currently they apply 15-20N kg per hector without mixing it with N fertilizer. The reason for reducing the rate is because of the financial constraints. In areas with fluvisol, the soil is still fertile hence the use of fertilizer is minimal. Only 25% of the farmers apply top dressing as recommended.

Table 3.3: Adoption of Technologies in Kyela District

Technology	When Introduced	Source	Attributes	Percent of farmers using technology	Remarks by farmers and traders
Improved Varieties Afaa Mwanza	1986	Uyole	- High yielding -Good plant height (120cm)	5 (3farmers out of 57)	-Not palatable -Not marketable -Poor cooking quality
Katrin	1986	Uyole	-High yielding	0	-Short stature (80cm -Not palatable -Poor cooking quality
Salama	1986	Uyole	- Early maturity -Upland rice - Good plant height (115cm)	0	-Low yield -Rotoon after 1st maturity
Selemwa Kihogo sel. 7 Kihogo red ITA 172 ITA 283	1990	Uyole	Anticipated average yield More than 2000kg/ha		Farmers were not aware of the varieties because they were not involved during trials
Management practices Land ploughing and two harrowing	1986	Uyole		100	
Planting time: November- December	1986	Uyole	To avoid floods in the most lowland areas	5	Follow recommended planting time
Modified planting time: Planting end of December - February	Traditional practice	Farmer	Increase yield	95	Planting depend on the onset of rains for easy harrowing

Table 3.3: Adoption of technologies in Kyela District (contd.)

Technology	When Introduced	Source	Attributes	Percent of farmers using technology	Remarks by farmers and traders
Seed rate: 30 - 40 kg/acre	1986	Uyole	Increase yield	2	Gives very low plant population
Modified technology: 40 - 60 kg/acre	Traditional practice	Farmer	Increase yield	98	Gives optimum plant population
Fertilizer use: Basal:TSP +Urea 20- 30 N + 20- 40 Pkg/ha	1986	Uyole	Increase yield	25	In areas with vertisols application rate has been reduced from 20 P Kg/ha to 15 P kg/ha and there is no mixing with N fertilizers
Top dressing: 20 - 30 N Kg/ha				25	-Have modified the rate because of financial constraints. In fluxions areas fertilizer is not used because soils are fertile
Weeding Hand weeding: to start 4 -6 weeks after planting	1986	Uyole	Increase yield	100	Farmers know if they do not do weeding early, they will loose yield
Weeding at booting stage	1986	Uyole	Increase yield	0	No weeding at this stage to cut down costs and the second weeding does not significantly increase yield
Use of Herbicide: Pre emergence- use Ronstar 25EC	1986	Uyole			Ronstar is easily available but cost is very high
Post-emergence use Basgram or 2, 4D	1986	Uyole		100	2,4D and Basagram are available and cost is affordable

3.2.1.3 Weeding

a) Hand weeding

Most of the farmers interviewed practice hand weeding starting at 4-6 weeks after planting, the recommendation being similar to their traditional practice. The recommendation of weeding at booting stage is not practical to all farmers. Farmers indicated that weeding at that stage add cost and also if weeding was done well at the first weeding there was no significant increase in weeds at booting stage.

b) Use of herbicides

No farmer is applying pre-emergency herbicides because the herbicides recommended are too costly. All farmers apply post emergence herbicide (Basagram or 2,4-D), this is because these herbicides are available in the district shops, they are less costly and they know the method of application and their effectiveness in controlling weeds.

3.2.2 Usangu

Rice Improvement Program at UAC carried out its activities also in Usangu plains which are in Mbarali district. From 1985-1990. National rice variety trial were evaluated at Uhembule station in Usangu plains.

3.2.2.1 Varieties

Improved varieties, which were tested on farm in Kyela, were also targeted for Usangu plains farmers, but the on farm trials were not conducted on farmer's fields in Usangu plains. The farmers in Usangu plain used several other varieties from different sources.

Table 3.4 shows the varieties that are known by the farmers from different sources, time they were introduced; yield potential, important attributes of the variety and the percentage of farmers who are using those varieties. Among the 17 varieties that existed in that area, there are only six varieties that farmers are still growing. 'Rangi mbili' is the variety that is grown by the majority of farmers (80-90%) in that area. This variety was introduced from Mlimba /Kilombero in Morogoro. 'Zambia' is another variety which is grown by 10-20% of the farmers in the area. Other four varieties are grown by small number of farmers. Rice varieties, Zambia and Mwendambio have been introduced to the area recently and some of the farmers are not aware of the varieties or they just hesitate to use the new varieties. Variety Maria (Mwasungo) has been recently (1998) introduced to Usangu plains from Kyela and according to farmers no one is growing it, may be because of the some reasons explained previously.

3.2.2.2 Management practices

Management practices followed by the Usangu plains farmers are as shown in the Table 3.4. The farmers are growing the varieties following their own traditions with regard to activities such as land preparation, seed nursery preparation, planting time seed rate and weed control. The farmers in this area do not apply fertilizer and do not use herbicides.

Table 3:4: Existing rice varieties in Usangu plains

Variety/Technology	When introduced	Source	Attributes	Percentage of farmers using technology	Remarks
Varieties Rangi mbili(India)	1990s	Mlimba/Kilombero	-Marketable -High yield -Palatable	80-90	
Zambia	1998/99	Kyela	-Marketable -High yield -Palatable	10 -20	Recently introduced (new)
Kilombero	1971	Kilombero	-Marketable -Palatable	10	An old variety
Mwendambio	1995	Mbarali rice farm	-Early maturity -Palatable	5	Recently introduced (new)
Mahia	1986	Mwanza(Sukuma)	-High yield -Have spicklets traders cannot compress in the bags	5	
Kisaki	1975	Kisaki-Morogoro	-High yield -Have spicklets traders cannot compress in the bags	3	
IR varieties	1988	FAO Irrigation schemes	-High yield	0	
Kibibi	1988	FAO Irrigation schemes	-High yield	0	
Katrin	1988	FAO Irrigation schemes	-High yield	0	

Table 3.4: Existing rice varieties in Usangu plains (contd.)

Variety/Technology	When introduced	Source	Attributes	Percentage of farmers using technology	Remarks
Kihogo	1961	Kilombero	-Medium yield	0	
Kula na bwana	1972	Mlimba/Kilombero	-Low yield -Palatable	0	
Pijo	1964	Mwanza	-Not palatable	0	
Maria(Mwisungo)	1998	Kyela	-Medium yield	0	
Subarimati	1975	Mbarali rice farm	-Medium yield	0	
Faya	1961	Kilombero	-Medium yield	0	
Sosomela	1961	Kilombero	-Low yield	0	
Mwangulu	1996	Kyela	-Low yield	0	Upland rice
Land preparation: October-November	Traditional practice	Farmers	Early planting	100	Farmers' practice
Seed nursery preparation: November-December	Traditional practice	Farmers	Early transplanting	100	But depends on the onset of rains
Planting time: January- March	Traditional practice	Farmers	Gives good crop yield	100	
Seed rate: 40Kg/acre	Traditional practice	Farmers	Gives good plant population	100	
Fertilizers					Not used because soils are fertile

3.3 Impact of developed technologies

Rice breeding, agronomy and plant protection have been emphasized as the major research areas contributing to the high production yields of rice in the southern highlands zone. To exploit the yield potential of rice, research has been done to develop suitable improved varieties, agronomic practice and plant protection recommendation packages. Therefore, the following section assesses the impact of rice technologies in the southern highlands zone.

3.3.1 Economic impact

The objectives of this study among other things was to determine economic returns of improved technologies such as varieties and improved management practices performance in terms of yield and marketing by farmers at the producer level

3.3.1.1 Field improvement

The yield advantage of the improved rice varieties tested on-farm was on average more than 2t/ha compared to 0.5-1t/ha of the local varieties. The use of the improved varieties would have significantly improved rice yield of smallholder farmers in the targeted areas. In Kyela Afaa Mwanza and Katrin increased yield by 37% when compared to Kilombero local variety i.e. 2700 to 3700kg/ha (Mussei *et al*, 2001). However, Afaa Mwanza and Katrin have not been adopted by the majority of farmers (62%) who participated in conducting the trials on farm. It is only 3 farmers who are still growing the variety of Afaa Mwanza. The reason why other farmers have rejected the improved rice varieties are presented in Table 2.4. The study conducted by Mussei *et al.*, 2001, revealed that the major constraints of some of the varieties as perceived by farmers were their lack of preferred qualities, such as aroma, palatability, milling quality, cookability, easy threshing and marketability. The same study also identified that farmers and traders had preference for culinary qualities, market value, milling and grain qualities.

3.3.1.2 Improved income

If farmers had adopted the improved rice varieties viz. Afaa- Mwanza and Katrin, the increased rice yield of 1000-Kg/ha (37%) over the local varieties, might also have made a positive contribution to farmers' income and household wellfare. In May 2002 when the impact assessments PRA were conducted, 1 Kg of paddy (unmilled) was sold at 90 - 100 Tsh. At this price household income would have increased to 90,000 - 100,000 Tshs per ha.

3.3.2 Food security and poverty alleviation

The popularly known miracle which was made by the improved varieties on food security in Asia during the Green revolution led researchers at Uyole to emphasize yield maximization when evaluating the new varieties regardless of other parameters especially culinary qualities and market value. The improved rice varieties have had no contribution on food security and poverty alleviation, because farmers have not adopted the new varieties in their farming systems.

3.3.3 Nutritional Impact

The women farmers who participated in on-farm trials for testing Afaa Mwanza continue growing the variety because they said that it was good for making flour mixture (maize + rice), for cooking "ugali". The culinary properties of Afaa Mwanza resembled those of "ugali" made from maize flour. According to the women farmers, Afaa Mwanza could be used as compliment for maize flour, often scarce in the rice farming systems.

3.3.4 Social Impact

3.3.4.1 Empowerment of Farmers

Past rice research has empowered farmers through participation in on-farm testing of varieties, fertilizers, herbicide weed control and giving them a voice of their choice to accept or reject the technologies.

3.3.4.2 Gender concerns

From the 57 farmers who participated in on-farm testing trials, 56 were men and 1 was a woman. The woman was the only one of the original farmers who is still growing Afaa Mwaza. In Kyela, mainly women do hand weeding of rice fields. The adoption of 2, 4D herbicide to control weeds has reduced the workload of women labour.

3.3.5 Environmental Impact

There is no environmental destruction or pollution which is normally associated with agricultural expansion due to attractive new crop/variety.

3.3.6 Capacity Building

During the period 1980-2002 one research officer attended rice course at the International Rice Research Institute (IRRI) in Philippines. In 2000 one research staff was registered for PhD at SUA-Morogoro and another joined for masters degree in 2001.

Both in Kyela and Usangu the farmers participated in on farm trial to test new varieties under recommended management (Tables 3.5 and 3.6). From these on- farm trials, the farmer's indicated that they leaned how to use fertilizers, the importance of weeding and the problems of the new varieties.

Table 3.5: Capacity building for rice farmers in Kyela district

Type of Training	When conducted	No. of farmers		By whom	Remarks
On-farm trials to demonstrate the recommended rice technologies	1986-1994	**M**	**F**	Uyole Agriculture Centre	More on farm research of palatable varieties is needed. -Have taste panels for the farmers to taste new varieties
		64	1		

Table 3.6: Capacity building for rice farmers in Usangu district

Type of Training	When conducted	No. of farmers		By whom	Remarks
On-farm trials to demonstrate improved varieties, fertilizers, herbicide use and row planting.	1998	**M**	**F**	FAO	There was no collaboration with research institutes e.g. Uyole therefore the exact number of farmers trained is not known
		Farmers in the schemes Number not known	Farmers in the schemes Number not known		

3.4 Reference

1. Mussei, N and Mbogolo (2001). Adoption constraints of improved rice varieties in Kyela District, Southern Highlands, Tanzania

2. Mghogho, R.M (1992). A Review of rice production in the Southern Highlands of Tanzania from 1960s to 1990s. In Akpere, J.A, et al (Eds).
3. Proceedings of an International Conference in Agricultural Research, Training and Technology Transfer in the Southern Highlands of Tanzania: Past achievements and Future prospects, held at Mbeya 5 - 9 October, 1992.

CHAPTER FOUR

IMPACT OF RICE RESEARCH IN THE EASTERN ZONE

4.1 Background

Rice is the third most important cereal crop in Tanzania coming after maize and sorghum. In terms of value, the crop ranks second, coming only after maize. Figures from 1979 estimated the area under rice production at 295,600 ha (Monyo, 1979). At that time, the average yield of the crop was also very low, estimated at only 1.5 tons per hectare. However, since that time, the area under production has increased and averaged yields have also increased as shown under this study.

Worldwide, rice is the world's most important food crop. It is the principal food of more than half of the world's population. It is a major source of protein and calories in both Africa and Latin America. Rice is a strategic component of food security and crucial element in the staple food economies of several African countries. Demand for rice in the sub-Saharan Africa is becoming more acute as a result of a general dietary shift from conventional foods brought about by urbanization. These trends are true in Tanzania, where the local demand for rice has drastically increased along with increased urbanization (Ching'ong'a, 1985)

4.2 Importance of rice

Results from the survey, rice was ranked first both as a food crop and a cash crop except in except in Kidatu village where rice ranked second both for the food and cash crop. In this particular village, maize ranked highest for the food crops and sugarcane for the cash crops (see Table 4.1).
Sugar cane ranked highest in this village because of the existence of the two major sugar factories in Tanzania - Kilombero and Kidatu sugar factories in the area. The factories have introduced a highly profitable 'sugarcane out-grower' programme in which they encourage small-scale farmers in the vicinity of the factories to grow sugarcane and sell it to the factories. Overall, rice was found to be of highest importance in the survey area.

Table 4.1: Farmer ranking of rice as a food and cash crop

Crop	Farmer Ranking of the Crops as Food and as Cash Crops by Village											
	Kisawasawa		Njagi		Msolwa		Mang'ula		Mchombe		Kidatu	
	F*	C*	F	C	F	C	F	C	F	C	F	C
Rice	1	1	1	1	1	1	1	1	1	1	2	2
Maize	2	2	2	2	2	2	2	2	2	2	1	3
Cassava	3	3	4	4	3	4	3	3	3	4	3	4
Banana	4	4	3	3	4	6	4	4	4	3	4	9
Coconut	5	5	10	12	7	9	9	5		9	9	6
S/potatoes	6	6	5	5	5	5	5	6	5	6	5	8
Pigeonpeas							6	9		5		
G/nuts			8	6	9	10	7	8	8	8		
Vegetables			6	10	6	7	8	7	6	7	7	5
Sugar cane					10	3			9	10	10	1
Palm									10			
Yams					8						6	10
Fruits			7	11							8	7
Cocoa			12	9								
Simsim												
Sunflower												

* C represents the rank given to the crop as a food crop

** F represents the rank given to the crop as a cash crop

4.3 Description of the study areas

As mentioned in Chapter 1 and 2, impact assessment of rice research under smallholder farming in the Eastern zone was conducted in the Kilombero basin. In accordance to the survey approach used, information on the introduced technologies came from two main sources. The first source represented the opinion of the research side and the second one represented the opinion of the target beneficiaries including farmers and traders. For the Eastern zone, the research side was represented by information collected from Katrin Research Centre. This information is summarized in under Table – in Annex --. Information from the target group came mainly from Farmer PRA survey and was supplemented by information collected from traders and rice millers at Ifakara town.

Farmer PRA survey was carried out in six villages in Ifakara district consisting of Kisawasawa, Njagi, and Mang'ula A, Msolwa, Mchombe and Kidatu villages.

4.4 History of rice research in Tanzania

The history of rice production and research in Tanzania is very old, dating from the 8th century in connection with Arab traders who are believed to have brought to Tanzania the Asian rice (*Oryza sativa*) between the 8th and 10th centuries from India. Research work on the crop was initiated in 1935 at Ukiriguru. The work became more active in the early 1970s at Ilonga by improving the traditional cultivars through hybridisation, pureline selection and mutation breeding. In 1975 the rice research headquarters was moved from Ilonga to Katrin (Ifakara), where liason and

coordination of rice research work in and out of the institute was conducted. The major aim of rice research by then was to solve problems of rice growing for both small-scale farmers and the large-scale state farms (NAFCO). The research covered rice grown under upland rain-fed, lowland rain-fed and lowland irrigated conditions.

Since 1975, therefore Katrin has operated as the major institute dealing with rice research in the country. Currently, the centre is the headquarters for rice research for the Eastern Zone and for Tanzania as whole. Other research institutions dealing with rice research include Chollima Research Centre in Morogoro, Uyole Research Centre and Sokoine University of Agriculture situated in Morogoro. Of these Chollima Research Centre has the highest concentration of rice research coming only next to Katrin. The centre was established in 1983 and has since become the main sister Institute to Katrin in rice research. Other agricultural research centres through out the country such as Tumbi in Tabora and Ukiriguru in Mwanza have been used invariably as trial sites for the rice research.

Apart from these institutions, rice research in Tanzania has benefited from the support and collaboration with many regional and international institutions as well as locally based government and non-government organizations. Important among these are IITA based in Nigeria and IRRI based in Philippines.

4.4.1 Research focus

Results of this study show that the there has been a shift in the main focus of the research since the 1970s. Changes have occurred in two main areas, one being the change from serving large state farms and small holder farmers to the currently system of solving problems of small scale farmers and medium scale farmers. The other change, has been the movement from the researches from concentrating on on–station work to include on- farm research work as well as involving farmers in problem identification and in seed production as is noted the areas covered during the survey of this study.

4.5 Developed Technologies

Rice technologies that have been developed and transferred to farmers through research and extension in the surveyed areas are put under two categories consisting of rice varieties and rice crop management technologies. Rice varieties taken to farmers have been those developed through pure-line selection, testing and evaluation; direct introductions from other countries and those developed through hybridisation work.

4.5.1 Rice varieties taken to farmers

A number of traditional varieties including Faya of the Theresa, Afaa mwanza, Kihigo selection No. 1/159, 0/746, Kihogo selection No.7, 22 and 23, Gamti Tunduru Dunduli, Salama have been developed through pure-line selection, testing and evaluation at different locations in the country.

Varieties which were brought in the country for testing as early as 1955 include Basmati Pishori, Kihogo Red, Ran Captain and Calyaman which were introduced in

the country for testing before 1955. Rice varieties that have been introduced more recently include the IR series like IR5, IR8, IR20, IR22 which were introduced from IRRI Philippines in 1976.

At the same time, there are a number of rice varieties that have been introduced as a result of hybridisation work. Hybridisation work in Tanzania was initiated in 1971 and through collaborative testing of introduced materials of some high yielding varieties. Varieties that have been released as a result of this work include Katrin, BG 400-1 and Salemwa. More recently, the hybridisation work has been able to develop several crosses between local cultivars and high yield potential cultivars from IRRI, IITA and other regions of the world.

Information collected by this study from Katrin Research Centre on rice varieties developed in the last twenty years is shown on Table --- in Annex – includes IR8, IR54, IR579, Super India, Afaa Mwanza, Gamti Tunduru, Afaa Kilombero, Selemwa, Katrin, TXD85 and TXD88.

4.5.2 Farmer perception of the introduced rice technologies

4.5.2.1 Rice varieties introduced

Results from the farmer PRA survey indicated the following varieties as having been obtained from research: TXD 85, TXD 88, TXD 220 and TXD 306 (SARO 5). These are fewer than those mentioned by the research station which include IR8, IR54, IR579, Super India, Afaa Mwanza, Gamti Tunduru, Afaa Kilombero, Selemwa and Katrin varieties over and above those listed by farmers and traders.

From these results, the list of varieties given by the research station as having been introduced to farmers as a result of research work is longer than that cited by farmers. Varieties that were released from the station long ago were among those which farmers cited as being local varieties.

One of the reasons for farmers not being able to know the true origin of some the varieties could be the long time lapse between that has occurred between the time when the varieties were released (in the 1970s and 1980s) and the time of the interview which has caused farmers to forget the source of the varieties.

The other reason could be the fact that at the time when these varieties were released some varieties were mainly focussed to large scale farms as has earlier been mentioned. As a result of this, farmers obtained the varieties from the farms as a spillover of the research such as IR8.

These observations are supported by the fact that most varieties which farmers have directly been able to associate with research work are those that have been introduced in the recent times and ones which farmers have invariably been involved in their development – through involvement in on farm demonstrations, on-farm trials on farmer plots or in farmer seed production research programs.

Another reason for the omission of some of the station released varieties from the list of varieties mentioned by farmers could be the lack of adoption of the respective

varieties due to lack of qualities desirable to farmers. Varieties adopted by farmers from the research station are those that bear some desirable qualities, mainly being yield potential combined with acceptable quality (palatability, milling quality and appearance) and marketability. Both farmers and traders mentioned marketability as the main factor for the popularity and the adoption of some rice varieties as shown on Table 4.2 below. Box 4.1 gives a summary of the farmer perception of the varieties released from the research stations.

Box 4.1 Summary of Farmer perception on introduced rice varieties

Varieties released from rice research work include:

Varieties developed more than twenty years ago: IR5, IR8, IR20, IR22, Katrin, BG 400-1 and Salemwa

Varieties developed in the last twenty years:IR8, IR54, IR579, Super India, Afaa Mwanza, Gamti Tunduru, Afaa Kilombero, Selemwa, Katrin, TXD85 and TXD88.

From the Farmer PRA studies:

Varieties that were mentioned by farmers as originating from research included: IR 54, TXD 85, TXD 88, TXD 220 and TXD 306 (SAROS 5); TXD220 and TXD 306 (SARO5) are not yet released however, farmers obtained them from farmers' trial site.

Varieties that were mentioned as being local varieties but which are in fact a product of research work include: Super India, Afaa Mwanza, Gamti Tunduru and Afaa Kilombero;

Varieties which were not mentioned at all by farmers and which can therefore be regarded as being not adopted and extinct include: IR5, IR8, IR20, IR22, Katrin, BG 400-1 and Salemwa.

Table 4.2: List of rice varieties grown by farmers and their attributes

Variety	Yield (t/ha) Bad Year	GoodYear	Attributes	% Farmers Adopting
1. TXD 88	-	5.4 (5)*	High tillering, high yielding	4
2. TXD 85	-	6.4 (5)	High tillering	4
3. TXD 220	-	6.0 (1)	Early maturing	$\leq$ 1
4. TXD 306	-	4.0 (1)	Aromatic, high yielding	$\leq$ 1
5. IR 54	-	6.8 (2)	High yielding, palatable	
1. Zambia	0.8 – 1.0	3.6 (20	-	
2. Super India	0.4 – 0.6	3.4 (6)	Aromatic	90
3. Jambo Twende	0.4 – 0.6	3.0 (3)	Non-aromatic, Cracks when dry	
4. Kaling'anaula	0.8 – 1.0	4.0 (5)	Delicious	
5. Kula na Bwana	0.4 – 0.6	2.8 (5)	Aromatic	
6. Sina Bibi	0.4 – 0.6	3.2 (1)	Early maturing	
7. Lingalang'ala	0.2 – 0.4	1.8 (1)	Early maturing, good for brewing	
8. Dunduli	0.8 – 1.0	4.4 (4)	Early maturing Used for brewing	
9. Usiniguse	0.4 – 0.6	1.8 (5)	Aromatic but Shatters very much	
10. Chikweta	0.6 – 0.8	2.4 (1)	Aromatic	
11. Mchuzi Kuku	0.4 – 0.6	2.4 (1)	Aromatic, has good yellow colour	
12. Karatasi	0.4 – 0.6	2.4 (1)	White appealing colour, not seen by birds	
13. Afaa Mwanza	0.8 – 1.0	3.4 (2)	High yielding, bold seeds, highly marketable, Poor palatability	$\leq$ 1
14. Faya Nambari	0.8	3.2 (1)	Glumed, not attractive to birds	
15. Faya Rangi	0.4 – 0.6	3.2 (2)	Aromatic, yellow colour, good looking	
16. Afaa	1.2	3.8 (6)		
17. Rangi	1.0	2.6 (5)	Yellow colour, late maturity, and Aromatic	
18. Rangi Mbili	1.2	3.2 (5)	More tillers, Do not crack and Aromatic.	
18. Kihogo	1.6	3.8 (2)	Palatable, high yielding.	
19. Rufiji	1.4	3.0 (3)		
20. Songea	3.0	4.0 (1)	Black colour, Not eaten by birds.	
21. Mwarabu	1.6	3.6 (2)	White seed coat, Not seen by birds.	
22. Nambande	0.4	4.0 (1)		
23. Karafuu	1.0	3.8 (1)	Difficult de-husking, No bird problem.	
24. Kaniki	0.4	2.0 (1)	Black in colour, late maturity.	
25. Msonga	0.4	2.0 (1)	Early maturity, low yield.	
26. Meli	1.4	3.2 (1)		
27. Sigara	2.4	3.6 (1)	Black colour, Disliked by birds.	
28. Super India	2.0	5.0 (1)	Palatable, good milling quality	
29. Hodi hodi	2.0	5.2 (1)	Late maturity, high cracks when dry	
30. Kisaki	0.8	3.6 (1)	Palatable, high yielding.	
31. Chikweta	0.6	2.4 (1)	Good for a snack Pepeta (Flakes?).	

* Number in bracket refers to number of villages citing the variety out of the six surveyed villages

Rice variety characteristics

Desirable rice characteristics which lead to farmer preference include: strong aroma, long grain size, translucent colour, high yielding, palatable, good milling quality, good cookability, early maturity, non–shattering characteristic and less susceptible to bird attack. However, it is not possible to have all these qualities within a single variety. This is true from the scientific point of view whereby strong aroma in rice is negatively correlated to yield potential and early maturing varieties are of low yield potential. This fact is clearly demonstrated by the findings from the farmer survey presented on Table 4.1 below. Farmers characterise rice varieties into five groups based on attributes (Box 4.2).

Box 4.2: Rice attributes mentioned by farmers

Group1: *Aromatic, early maturing and poor yielding (1.8 – 2.0 t/ha) – examples are Usiniguse, Msonga and Sina Bibi,. With these qualities, the varieties are grown in small quantity in near homestead farms to get an early crop to cope with household food shortage before harvest season. In addition to the mentioned qualities, Usiniguse and Msonga varieties have another undesirable quality of shattering in the field just after maturing which further reduces their appeal to farmers.*

Group 2: *Early maturing and relatively high yielding (1.8 – 4.4 t/ha) but un-palatable. Examples include Dunduli and Lingalang'ala. These are grown in low quantities and are mainly used for brewing purposes.*

Group 3: *Highly aromatic, palatable, good milling quality, good grain colour and shape but low yielding (1.4 – 3.0 t/ha). These include: Kula na Bwana, Mchuzi kuku, Karatasi and Faya rangi. These are grown by the majority of the households in small quantities mainly for home consumption although the varieties command high market demand.*

Group 4: *Moderately high yielding varieties (3.5 – 4 t/ha), aromatic, having good palatability, good milling quality and good grain shape and colour. The combination of good grain quality and yield makes these to be mostly preferred among the local varieties. They have high market demand and because of their relatively high yield they give high income to the farmers in comparison with other local varieties. Varieties in this group include: Supa India, Kaling'anaula, Afaa Mwanza and Faya Rangi. Some of the varieties under this group have heavy grains (e.g. Supa India). Another observation about the varieties under this group is the fact that it includes varieties which were reported to have been released by the research station but which farmers claim to be local varieties. These include Supa India and Afaa Mwanza.*

Group 5: *Improved varieties from the research station with high yield (5.4– 6.8 t/ha under farmer conditions). The varieties have good palatability and good milling qualities. Other qualities under this group are mixed. For example, where most varieties in the group are not aromatic, TXD 306 is semi-aromatic. Similarly, TXD 88 has a white belly that makes it have a less market appeal during peak harvest periods, but quite palatable.*

In view of the above analysis, the level of adoption of the released varieties has been highly influenced by the competing qualities between those held by the medium

yielding local varieties with high market demand and the moderate market quality appeal of the improved varieties but which yield very high. For this reason, farmers have adopted a strategy of cultivating both the local varieties under group four to compete during peak harvest period and the improved varieties that have high demand during the non-harvest period where demand for rice (any rice) is high. The challenge facing research is to combine the desirable market qualities and yield qualities in a variety in order to achieve highest adoption rates for the improved varieties.

4.5.2.2 Performance of improved rice varieties

From the data shown on Table 4.2 and from the analysis presented above, it is evident that the improved varieties are out performing the local varieties by a significant margin. Improved varieties under group 4 and 5 in the above categorization yield between 3.5 and 4 t/ha for group 4 and between 5.4 and 6.8 for group 5. These yield levels are significantly higher when compared to those obtained from the local varieties under group 1, 2 and 3.
Local varieties with the exception of those under group 2 yield between 1.4 to 3.0 t/ha. Varieties under group 2 have quite high yields of up to 44 t/ha. Despite this high yield performance however, the varieties under this group bear a number of un-acceptable qualities that negate the yield benefit leading to their low preference by farmers.

Supa India is the only variety among the improved varieties that has been widely adopted (being grown by over 80% of farmers in the survey area) although farmers regard it as a local variety. Considering its high yield potential and its high market demand, it can be concluded that it constitutes one of the areas where rice research has had the highest impact.

Recently introduced varieties such as TXD 85 and 88 were also picking up speed in adoption and farmers mentioned lack of seeds as one of the factors limiting their wider use.

4.5.3 Rice production technologies

Apart from the introduction of improved varieties, research impact on rice production has also come from the promotion of various rice management practices that have increased rice yields for both local and improved varieties. Rice production technologies introduced to farmers by the research station in collaboration with extension and other organizations fall in the following areas:

I. Sowing – Sowing methods: dibbling (in rows) and transplanting (in rows); Recommendations on sowing dates; and Spacing;
II. Fertilizer application: Types of fertilizer and application rates;
III. Weeding: Use of herbides – Types and application rates;
IV. Cultivation methods: Use of bands (and use of no bands – flat cultivation); and
V. Pest control: Pesticide types and application rates.

Farmers cited pest control and use of bands under technologies introduced to by research. Since these two technologies are not included on the list of technologies which the rice research station developed and transferred to farmers (Table 4A.1 on

Annex 4A), it is most likely that these technologies reached the farmers through other research programs such as NAELP and NGOs working in the area.

Production technologies that have been introduced in the study area through research are shown on table 3.3 together with their effect on rice yield. The yield figures quoted on the table are based on yield levels on farmer conditions for the Supa India local variety. Supa India variety was chosen for this analysis since it is grown by almost all farmers - over 80 % of the farmers in the survey area.

Farmers mentioned that similar increases in yield are obtained with the other local varieties when the technologies are used. The use of these technologies is part of the recommendation packages for improved varieties. When applied in accordance to recommendation, rice yields for the improved varieties are even higher than those cited for Supa India.

The response in yield increase for the improved varieties under these management technologies is even higher than Supa India variety as cited in the Table 4.3.

Information on yield increase resulting from the use of improved production technologies against yields achieved using the "local" practice and the number of farmers using the improved methods is summarized in Box 2. Gauged on yield effects, technologies (and technology recommendations) with highest yield increase in descending order include: planting within the recommended period, use of pesticides (for years with heavy pest attack), use of herbicides for weed control and use of improved planting methods (Dibbling or row transplanting). Use of fertilizer was rated to have the least effect, contributing only 15 % yield increase. This could be attributed to the high soil fertility still existing in most of the surveyed areas. The same could be the reason for the low difference between dibbling and row transplanting.

Box 4.3: Comparative effects of improved production technologies on yield for Supa India variety

The use of improved production technologies versus local approaches for the Supa India variety under farmer conditions lead to the following yield increases:
Planting: Dibbling versus broadcasting: 36 % - dibbling is used by 1-2 % of the farmers in the survey area;
Planting: Row transplanting (improved) versus random transplanting (local): 35 % - row transplanting is used by 1 % of the farmers;
Weeding: Use of herbicides versus hand weeding (local): 58 % - herbicides are used by 5 % of the farmers;
Fertilizer use: Use of fertilizer versus no fertilizer: 15 % - use of fertilizer is used by 15 % of the farmers;
Cultivation: Use of bands versus flat cultivation (local): the use of bands has just been introduced; as such farmers were un-able to rate its effect on yield increase;
Pesticide application: use of pesticides versus non-use: 200 % - pesticides are used by 1 % of the farmers;
Planting time: Planting within the recommended period versus planting outside the recommended period: 234 % - 75 % of the farmers plant their rice within the recommended period.

Table 4.3: Impact of introduced technologies (averages among surveyed villages)

Technology	Source	Yield (t /ha)		% Increase of Yield	% Farmers Adopting
		Before	After*		
1. Planting					
Broadcasting	Local	2.8 (6)**			
Dibbling	Research		3.8 (4)	36	1 - 2
Local transplanting	Local	3.4 (6)			
Improved transplanting (rows)	Research		4.6 (5)	35	1
2. Weeding Hand weeding	Local	2.4 (6)			
Herbicides	Research		3.8 (6)	58	5
3. Fertilizer application					
Without fertilizer	Local	2.8 (6)			
With fertilizer	Research		4.8 (6)	71	15
4. Cultivation					
Flat cultivation	Local	1.8 (1)			
Bands (majuruba)	Research		4.4 (2)	144	-
5. Pesticides application Without pesticides	Local	1.6 (2)			
With pesticides	Research		4.8 (3)	200	1
6. Planting time					
Outside recommended time	-	1.2 (5)			
Within recommended time 30 Dec – Feb 15	Research		4.0 (5)	234	75

* Yield comparison made with reference to India local variety;
** Numbers in brackets refer to the number of villages used to obtain the average value among the six surveyed villages

4.6 Impact of research

From the foregoing discussion, impact areas resulting from the research interventions on rice can be summarised to comprise of production impact, food security, economic impact, environmental impact, social impact and capacity building.

Apart from the impact that is directly related to yield increases resulting from the use of improved varieties and the use of better management practices, the evidence of impact occurrence from the introduced technologies was corroborated by results from questions that were posed to the farmers during the PRA interviews. The questions required them to give their opinion on a number of issues that are related to the impact areas mentioned above. The result of that exercise is given on Table 4.4 below.

4.6.1 Production impact

Rice production in the area has increased progressively over the years due to increases in yield per unit area as a result of the use of improved varieties and better management practices.

Given other factors remaining the same, increases in rice production would lead to impacts in other areas including food security, economic impacts and environmental impacts as elaborated below.

4.6.1.1 Food security

In the survey area, rice is grown first as a food crop and second as a cash crop. From this point of view, surplus in rice yield resulting from the use of high yielding varieties and yield enhancing production management practices introduced by research can be seen to have positive impact on household food security. This observation is supported by the farmer response on the food security item on Table 3.4. However, farmers, mostly the women participants in the PRA discussions, pointed out a few things which require intervention in order to ensure that the surplus production leads to household food security. Important among these was the fact that there were still a few among the husbands who took independent liberty to sell and misuse the surplus crop produced without consulting their wives. More education on home management from social security workers was pointed out to be one of the solution to this problem.

The other was the problem of farmers being induced to sell their entire crop at low prices during the peak harvest time only to experience food shortage at near harvest time in the following year. Interventions on improved storage methods coupled with introduction of other income generating activities to meet petty cash demand at harvest time were cited to be among the solutions to this problem.

Box 4.4: Food security

According to farmers, husbands of some households take independent liberty to sell and miuse surplus of crop produced. Some farmers sell all their crop at lower prices at peak harvesting time and later experienced food shortage. Interventions on improved storage method couped with introduction of other income generating activities to meet petty cash demand at harvesting time was cited among solutions to this problem.

4.7 Economic Impact

Economic impacts of the rice research are attributed to the yield advantages of improved varieties of Supa India, TXD 85 and TXD 88 which have high market demand as has been elaborated before.

At the same time, the adoption of improved rice production practices has increased yield levels of local varieties that have even higher market demand but performed very poorly under local practices. Overall, rice research has increased farmer income. Apart from farmers themselves making this note, the evidence of high income among the farmers in the survey area was evident from the many newly built improved houses build with burnt brick with corrugated iron roofs. In Ifakara town, the number of tractors that could be seen in the area is above what can be seen in many areas of Tanzania. Farmers affording to use tractors either by owning them or hiring them is an indicator of existence of a crop with high return.

4.8 Environmental impact

Contribution of the introduced technologies to environmental conservation can be seen in their effect on yield increase, which, on its turn, decreases the need for farmers expanding their cultivation to marginal and environmentally fragile areas. For this reason, it can be said that the introduced technologies have had positive impact on the

environment. This conclusion is corroborated with the farmer response on Table 4.4 below.

4.9 Socio impact

Socio impact arising from rice research is attributed to two main factors. One is the empowerment, particularly for women farmers that has resulted from farmer groups established alongside with rice technology development work done in the area. Some of the groups were established in the 1980 in connection with NAEP project activities. Most recently, groups have been established for seed production under the ASPS programme.

The second is the empowerment for both men and women that have come as a result of increased income. It was mentioned during the farmer interviews that increased women income from their sideline farms – under their groups or on their private farms have reduced dependence on their husbands for petty cash expenditures. The effect of this was indicated to have had positive effect on the husbands who could now plan to invest their income in durable assets such as improved houses.

4.9.1 Capacity building

The introduction of rice technologies went hand in hand with farmer training as shown on Table 3.5. Over the years, farmers have received training in several areas. Areas covered under the training have been on general rice production conducted through demonstration farms, training on seed production and promotion of farmer group organization.

It is envisaged that these training efforts contributed to higher rates of adoption of the rice technologies developed by the research stations.

4.10 Conclusion

It can be concluded that rice research in the Eastern zone has had positive impact on the small-scale farmers as evidenced in the survey area. Despite these impacts however, the areas the research areas investigated still call for further research work. The search for better varieties must continue alongside the identification and promotion of better production technologies.

Apart from continuing to address old production problems, new problems are continuing to arise including the proliferation of noxious weeds and new pests.

There is also the issue of developing varieties that will meet the increased quality demand of the liberalized rice market while ensuring higher farmer yields with affordable input requirements.

Other problems requiring research intervention are indicated on Table 3.6 below. These include pest infestation, declining soil fertility, lack of farm machinery, weeds, lack of markets for rice, crop diseases and shortage of labour. The problems are listed starting with the highly ranked problems. The first two problems represent an emerging situation as the problem of pest infestation and low fertility were mentioned

not to have been a problem in the past. These, together with the issues mentioned earlier pose new challenges for research.

Table 4.4: Contribution of technologies to village and farmer welfare

No	Improved aspect	Nature of contribution under surveyed villages						
		Kisawasawa	**Njagi**	**Mangula A**	**Msolwa A**	**Mchombe**	**Kidatu**	**Overall comments**
1	Yield	Positive	Positive	Positive	Positive	Positive	Negative	Positive
2	Income	Positive	Positive	Positive	Positive	Positive	Negative	Positive
3	Food security	Positive	Neutral	Positive	Positive	Positive	Negative	Positive
4	Poverty alleviation	Positive	Neutral	Positive	Positive	Positive	Negative	Positive
5	Malnutrition	Negative	Negative	Negative	Negative	Negative	Positive	Negative
6	Environmental conservation	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
7	Decision making Voice	Positive	Positive	Positive	Positive	Neutral	Positive	Positive
8	Division of labour/responsibility	Neutral	Neutral	Positive	Positive	Positive	Positive	Positive
9	Others							
	High inputs costs	Positive	Positive		Negative			Positive
	More Education be given							

Table 4.5: Capacity building

DISTRICT / Village	Type of Training / Knowledge media	When Conducted	No Farmers Involved		By Whom
			Male	Female	
Kisawasawa	Farmers' group training	1996	9	67	Extension
	Leaflets	1996	21	4	Extension
	Farmer excursion to KTC Moshi	-	1	0	FAO
	Farmers' day	Every year	2	4	Extension
Njagi	Farmers' group training	1996	12	2	Extension
	Field visits	2001	3	1	Research
	Farm field days	2000	50	40	Extension
	Training on seed production	2000	2	-	Extension
Mang'ula	Extension field visits	1994	2160	2160	Extension
	Demonstration farms	1994	15	45	NAELP / Extension
	Farmers' group training	1994 - 96	15	36	KTC Moshi / Extension
Msolwa	Farmers' group training	1993 - 01	5	161	Extension
	Training at Msolwa village agricultural training centre	1985	65	65	Centre is currently close
	Demonstration farms	1993	168	168	NAELP / Extension
	Training on Seed production	1993 - 97	1050	1200	Extension
Mchombe	Farmers' day	2000 - 01	35	25	Extension
	Field visits by extension staff	2000	50	40	Extension
	Leaflets (two types)	2000	3	5	Extension
	Training at KTC Moshi	1998	-	-	KTC / Extension
Kidatu	Training of Farmers' groups	2001 - 02	13	42	ASPS
	Field visits	2002	3	8	Extension
	Leaflets	1992	-	-	Extension / Research
	Training at Msolwa village agricultural training centre	1988	24	12	Msolwa agricultural Training centre

Table 4.6: Production problems cited by farmers

Problem	Rank by Village						Overall Rank	Research interventions / comments
	Kisawasawa	Njagi	Mang'ula A	Msolwa	Mchombe	Kidatu		
1. Lack of improved seeds	2	1	7	4	1	5	1	Under ongoing research programme
2. Pest problems	7	2	1	3		7	2	Under ongoing research programme
3.Decline of soil fertility	4		5		5	4	3	Use of fertilizer
4. Weeds	3	3	6		4	6	4	Use of herbicides
5.Lack of farm machinery	1		4	1	3	2	5	No intervention
6. Lack of markets			3	2			6	No intervention
7. Lack of irrigation water		4	8		7		7	No intervention
8. Crop diseases	5		2		6		8	No intervention
9. Lack of labour						8	9	No intervention
10. Land scarcity						3	10	Remedial measures are under process
11. Lack of capital						1	11	No intervention
12. Weather	6						12	No intervention

4.11 References

1 Ching'ang'a, H.M (1984) Rice in Tanzania. Proceedings of International Rice Workshop at Lusaka, Zambia, April 9-19, 1984. IRRI 1985. Los Bonos, Laguna Philipines. ISBN 971-104-148-0.

2 IRRI Rice Almanac, International Rice Research Institute, P.o.Box 937, Manila, Philipines. ISBN 971-22-0042-6

3 Mgonja, A.P and Mgonja M.A. Rice Research and Production in Tanzania. International Rice testing Program for Africa Workshop, Arusha, Tanzania.

4.12 Annexes

4.12.1 Annex 4A: Information on rice developed rice technologies collected from Katrin Research Station

Table 4A 1: Developed technology from Katrin research station

Technology recommendation	Attributes	Year of release /recommendation	Collaborating institutions	Technology transfer				Beneficiaries
				Target location	Target group	Coverage	Method of transfer	
Rice varieties: IR8	100 % higher yield than local variety Supa/lodging tolerant/photo period Insensitive N-ferti;lizers responsive	Early 1970s	IRRI,IITA,NAFCO farms	Irrigated, 500-1500masl Not suitable along the coastal areas	Small, medium and large scale farmers	Mbarali, Ruvu, Dakawa, Lowere Moshi	Experimentation in NAFCO farms (Ruvu, Dakawa, Mbarali)	
IR 54	75% higher yield than local variety Supa/Lodging tolerant/Photoperiod-insensitive N fertilizer responsive	Mid 1970s	IRRI,IITA NAFCO farms, KADP	Iriggated, 500-1500m asl Not suitable along the coastal area	Small, medium & large scale farmers	Mbarali Ruvu, Dakawa, Lower Moshi, Kilombero, Mombo, Ndungu, Uhambule	Experiments in NAFCO farms (Ruvu,Dakawa, Mbarali)	Small scale farmers in lower Moshi, Kilombero

Table 4 A1: Developed technology from Katrin research station (contd.)

Technology recommendation	**Attributes**	**Year of release /recommendation**	**Collaborating institutions**	**Technology transfer**				**Beneficiaries**
				Target location	Target group	Coverage	Method of transfer	
IR 579	50% higher yield than local variety Supa/ Lodging tolerant/Photoperiod insensitive, N fertilizer responsive	Mid 1970s	IRR,IITA,NAFCO farms	Irrigated 500-1500m asl. Not suitable along the coatal areas	Small, medium & large scale farmers	Mbarali, Ruvu, Dakawa,Lower moshi	Experimentation in NAFCO farms	
Technology recommendation	Attributes	Year of realease/recommendation	Collaborating institutions	Technology transfer				Beneficiaries
Supa/Supa India/Kilombero	Aromatic	Early 1970s	Farmers, Extension	Irrigated/Rainfed lowlands 0-1500 m a.s.l	Small scale & medium scale farmers	Mbarali,Ruvu, Dakawa,Lower Moshi, Kilombero, Mombo, Ndungu,Kitere	Field trials/farrmers firld visit in Mwanza, Kilombero, NAFCO, Dakawa	Small scale farmers in Kyela, Usangu plains
Afaa Mwanza 1/159	25% higher yield than local variety Supa	1978	Farmers, extension	Rain fed lowland 0-1500 m a.s.l	Small scale farmers	Ukiluguru, Mombo, Ndungu, Kitere	Field trials, Farmers field visits, Mwabagole-Mwanza	Small scale farmers in lower Mwanza, Kilombero
Gamti Tunduru	Drought tolerant Early maturing	early 1970s	farmers & eatension	Iupland 900-2000m asl	Small scale farmers	Kilombero	Field trials, Farmers field visits in Ulanga, Matombo	Small scale farmers in Mtwara

Table 4A 1: Developed technology from Katrin research station (contd.)

Technology recommendation	Attributes	Year of release /recommendation	Collaborating institutions	Technology transfer				Beneficiaries
				Target location	Target group	Coverage	Method of transfer	
Afaa-Kilombero	Blast tolerant	1978	Farmers & extension	Rainfed lowland 0-1500 m a.s.l	Small scale farmers	Kilombero	Field trials/farmers field visits	
Selemwa	50% higher yield than local variety Supa/Intermediate stature/Lodging tolerant	1983	Farmers& Extension	Irrigated/Rainfed lowland 0-1500 m a.s.l Small medium & large scale farmers	Small scale & medium scale farmers	Mbarali,Ruvu, Dakawa,Lower Moshi, Kilombero, Mombo, Ndungu,Kitere	Field trials/farrmers firld visit in Kilosa and Morogoro	Small scale farmers in Tabora
Katrin (IET 2397)	50% higher yield than loacl avriety Supa/Photo period insensitive/ Semi dwarf/Non shartering	1983	IRRI,IITA, Farmers, Extension	Irrigated/Rainfed lowlands 0-1500 m a.s.l	Small scale & medium scale farmers	Mbarali,Ruvu, Dakawa, Kilombero, Kitere	Field trials/farrmers firld visit in Ifakara and Kilosa	Small scale farmers in Tabora and Zanzibar
TXD 85	60% higher yield than local variety Supa/ lodging tolerant/Photoperiod insenstive	2001	Farmers, extension	Irigated rainfed lowlands	Small scale , medium and large scale farmers	Mbarali,Ruvu,Daklawa, Lower Moshi, Kilombero,Mombo,Ndungu,Kitere	Field trials, Farmers field visits/ On farm trial at Mkindo, Mngeta, Malinyi, Bahi	Small scale farmers, Kilombero
TXT 88	50% higher yield than local variety Supa/ Lodging tolerant/ Photoperiod insensitive.	2001	Farmers & eatension	Irrigated lrainfed lowalands 0-1500m a.s.l	Small, medium and large scale farmers	Mbarali, Ruvu, Dakawa, Lower Moshi., Kilombero, Mombo, Ndungu, Kitere	Field trials, Farmers field visits	
	Blast tolerant	1978	Farmers & extension	Rainfed lowland 0-1500 m a.s.l	Small scale farmerss	Kilombero	Field trials/farmers field visits	

4.12.2 Annex 4B: Information collected from the survey villages

Table 4B 1: Food Crops

No	Crop	Ranking of crops grown under surveyed villages					
		Kisawasawa	**Njaji**	**Msolwa A**	**Mang'ula**	**Mchombe**	**Kidatu**
1.	Paddy	1	1	1	1	1	2
2.	Maize	2	2	2	2	2	1
3.	Cassava	3	4	3	3	3	3
4.	Bananas	4	3	4	4	4	4
5.	Coconuts	5	10	7	9		9
6.	Sweet potato	6	5	5	5	5	5
7.	Pigeon peas				6		
8.	Ground nuts		8	9	7	8	
9.	Vegetables		6	6	8	6	7
10.	Sugarcane			10		9	10
11.	Palm					10	
12.	Yams			8			6
13.	Fruits		7				8
14.	Cocoa		12				
15.	Simsim		9				
16.	Sunflower		13				

Table 4B 2: Cash crops

No	Crop	Ranking of crops grown under surveyed villages					
		Kisawasawa	**Njagi**	**Msolwa A**	**Mang'ula**	**Mchombe**	**Kidatu**
1.	Paddy	1	1	1	1	1	2
2	Maize	2	2	2	2	2	3
3	Cassava	4	4	4	3	4	4
4	Bananas	5	3	6	4	3	9
5	Coconut	3	12	9	5	9	6
6	Sweet potato	6	5	5	6	6	8
7	Pigeon peas				9		
8	Ground nuts		6	10	8	5	
9	Vegetables		10	7	7	8	5
10	Sugar can			3		7	1
11	Palm oil					10	
12	Yams						10
13	Fruits		11	8			7
14	Cocoa		9				
15	Simsim		7				
16	Sunflower		13				

Table 4B 3: Existing Varieties – Kisawasawa village – Ifakara district

Variety	When Introduced	Source	Yield (t/ha)	
			Bad Year	Good Year
1. Super India	1965	Local	2 - 5	4.0
2. Kisegese	1980	Local - Mwanza	2 - 5	4.0
3. Rangi	-	Local	2 - 5	4.0
4. TXD 88	1996	Research	10 -15	6.0 – 8.0
5. TXD 85	2000	Research	10 - 15	6.0 – 8.0
6. Kaling'anaula	-	Local	2 - 5	4.0
7. Tule na Bwana	-	Local	2 -5	4.0
8. Afaa Mwanza	-	Local	5 - 10	4.0
9. Usiniguse	-	Local - Kilombero	1 - 2	2.0
10. Kaniki	-	Local - Kilombero	1 - 2	2.0
11. Rangi Mbili – Mweupe	-	Local - Kilombero	5 - 10	4.0
12. Rangi Mbili Mwekundu	-	Local - Kilombero	5 - 10	4.0
13. Msonga	-	Local – Iringa	1 - 2	2.0
14. Kihogo	-	Local - Kilombero	5 - 10	4.0
15. Dunduli	-	Local	25	5.0
16. Jambo Twende	-	Local - Mrimba	2 - 5	4.0
17. Nambande	-	Local - Mrimba	2 - 5	4.0
18. Karafuu	-	Local - Kilombero	2 - 5	4.0
19. IR54	1998	Research	-	6.4

Table 4B 4: Existing Varieties – Njagi village – Ifakara district

Variety	When Introduced	Source	Yield (t/ha)		Attributes
			Bad Year	Good Year	
1. Super India	-	Local	1.6 – 2.4	3.6	
2. TXD 88	2000	Research	3.0	4.0	
3. Tule na Bwana	-	Local - Kilombero	1.4	3.2	
4. Afaa Mwanza	-	Local - Ulanga	1.6 – 2.4	3.4	Broad grain, delicious
5. Usiniguse	-	Local - Ulanga	2.0 – 3.0	3.2 – 3.6	Short duration, shatters
6. Dunduli	-	Local - Kilombero	3.2	4.0	Not very palatable, Yields high in bad year
7. Jambo Twende	-	Local - Kilombero	0.8 – 1.4	2.8	-
8. Meli	-	Local - Kilombero	3.2	-	Short duration, shatters
9. Rangi - Njano	-	Local – Kilombero	-	2.8	
10. TXD 306	-	Research	3.2	4.0	
11. Zambia	1999	Local - Mbarali	3.6	4.0	Slender grain, delicious
12. Rangi Mbili	-	Local - Kilombero	1.6 – 2.4	3.6	

Table 4B 5: Existing Varieties – Mang'ula village - Ifakara district

Variety	When Introduced	Source	Yield (t/ha)		Attributes
			Bad Year	Good Year	
1. India	1960s	Local - Kilombero	0.2 – 1.2	4.0	
2. Kikangaka	-	Local - Kilombero	0.4 – 1.2	3.6 – 5.0	Heavy grain
3. Super India	1998	Research	2.0	5.0	
4. Afaa Mwanza	-	Local - Mwanza	1.2	3.2 – 3.6	Heavy grain
5. Kaling'anaula	-	Local - Kilombero	0.4 – 1.4	5.0	Heavy grain
6. Rangi Mbili	-	Local - Kilombero	0.4 – 1.2	3.0	-
7. Rangi	-	Local - Kilombero	0.4 – 1.2	3.0	-
8. Usiniguse	-	Local - Kilombero	0.2 – 0.6	1.6	-
9. Hodihodi	-	Local - Kilombero	2.0	5.2	-
10. Kula na Bwana	-	Local - Kilombero	0.2 – 0.6	1.6	
11. Mwarabu	-	Local - Kilombero	0.4 – 1.2	4.0	
12. Unguja	-	Local - Pemba	0.4 – 1.2	4.0	
13. Kisaki	-	Local - Kisaki	0.4 – 1.2	3.6	
14. TXD 88	1994	Research	2.0 – 4.0	6.0 – 7.0	
15. TXD 85	1998	Research	5.0 – 5.6	7.2	
16. TXD 220	1999	Research	3.0	6.0	
17. IR 54	1998	Research	-	7.2	

Table 4B 6: Existing Varieties – Msolwa village – Ifakara district

Variety	When Introduced	Source	Yield (t/ha)	
			Bad Year	Good Year
1. Super India	-	Local	1.2 – 1.6	3.6
2. Afaa Mwanza	-	Local	-	-
3. TXD 88	1998	Research	3.0	6.0
4. TXD 85	1999	Local	4.0 – 5.0	7.0
5. Rangi Mbili	-	Local – Kilombero	1.6 –2.0	2.0 – 3.0
6. Rangi	-	Local – Kilombero	1.6 – 2.0	2.0 – 3.0
7. Usiniguse	-	Local – Kilombero	2.0	1.2
8. Mwanza	1980	Mwanza	2.0 – 15	4.0
9. Sigara	-	Local – Kilombero	2.4	3.6
10. Kisegese	-	Local – Mahenge	3.0	4.0
11. Songea	1980	Local – Songea	3.0	4.0
12. Unguja	-	Local – Unguja	1.6 – 2.0	3.6
13. Kula na Bwana	1980	Local – Songea	3.0	4.0
14. Rufiji	-	Local – Rufiji	1.6–2.0	3.0
15. Kalimanaula	1998	Local - Kilombero	2.0 –2.4	4.0

Table 4B 7: Existing Varieties – Mchombe village – Ifakara district

Variety	When Introduced	Source	Yield (t/ha)		Attributes
			Bad Year	Good Year	
1. Kisegese	1994	Local – Kisegese	0.6 – 1.0	3.0	-
2. Rangi Mbili	1992	-	0.6– 1.0	3.2	Aromatic
3. Zambia	1992	Local – Mbeya	0.8 – 1.0	3.4	-
4. Super India	-	-	0.4 – 0.6	2.4	Aromatic
5. Jambo Twende	1950	Local – Iringa	0.4 – 0.6	2.0	Non-aromatic, Cracks when dry
6. Kaling'anaula	-	Local – Ulanga	0.8 – 1.0	3.4	Delicious
7. Kula na Bwana	-	Local – Mchombe	0.4 – 0.6	2.4	Aromatic
8. Sina Bibi	-	Local – Mchombe	0.4 – 0.6	3.2	Early maturing
9. Lingalang'ala	-	Local – Mchombe	0.2 – 0.4	1.8	Early maturing, good for brewing
10. Dunduli	-	Local – Mchombe	0.8 – 1.0	2.6	Early maturing Used for brewing
11. Usiniguse	-	Local – Mchombe	0.4 – 0.6	2.4	Aromatic but Shatters very much
12. Chikweta	-	Local – Mchombe	0.6 – 0.8	2.4	Aromatic
13. Mchuzi Kuku	-	-	0.4 – 0.6	2.4	Aromatic, has good yellow colour
14. Karatasi	2000	-	0.4 – 0.6	2.4	White appealing colour, not seen by birds
15. Afaa Mwanza	1994	Local – Mwanza	0.8 – 1.0	3.4	High yielding, bold seeds
16. Faya Nambari	-	Local – Mchombe	0.8	3.2	Glumed, not attractive to birds
17. Faya Rangi	-	-	0.4 – 0.6	3.2	Aromatic
18. TXD 88	1998	Research	-	3.2	High tillering, high yielding
19.TXD 85	1998	Research	-	3.4	High tillering
20. TXD 220	1998	Research	-	3.0	Early maturing

Table 4B 8: Existing Varieties – Kidatu village – Ifakara district

Variety	When Introduced	Source	Yield (t/ha)	
			Bad Year	Good Year
1. TXD 88	1998	Research	0.8	4.0
2. TXD 85	2001	Research	-	-
3. Super India	-	Local - Kidatu	0.4 – 1.0	3.0
4. Kaling'anaula	1999	Local - Ifakara	0.8	4.0
5. Afaa	-	Local - Kidatu	0.8	4.0
6. Rangi	-	Local – Kidatu	0.4 – 0.6	1.0
7. Rangi Mbili	-	Local - Kidatu	1.0	3.0
8. Mwanza	-	Local – Mwanza	1.0	3.0
9. Dunduli	-	Local – Kidatu	2.4	4.4
10. Kihogo	1958	Local – Kidatu	2.0	3.6
11. Rufiji	-	Local – Rufiji	1.0	3.0
12. Songea	-	Local – Songea	-	-
13.Kula na Bwana	-	Local – Kidatu	0.8	1.6
14. Usiniguse	1999	Local - Kidatu	0.4	1.2

Table 4B 9: Existing Technologies – Kisawasawa village – Ifakara district

Technology	When Introduced	Source	Yield (t/ha)		% Increase of Yield
			Before	After*	
1. Planting					
Broadcasting	Local	Local	2.0	-	80
Dibbling	1978 - 96	Research		4.0	
Local transplanting	Local	Local	2.0		
Improved transplanting (rows)	1978 - 96	Research		4.0	80
2. Weeding					
Hand weeding	Local	Local	1.4	-	
Herbicides	1983 - 96	Research		4.0	85
3. Fertilizer application					
Without fertilizer	Local	Local	2.4	-	
With fertilizer	-	Research		4.0	67
4. Cultivation					
Flat cultivation	Local	Local			
Bands (majuruba)	1990 - 94	Research			
5. Pesticides application					
Without pesticides	Local	Local			
With pesticides	-	Research			
6. Planting time					
Outside recommended time	-	-	1.0		
Within recommended time 30 Dec – Feb 15	1994 - 96	Research		4.0	300

* Yield comparison made with reference to "India" local variety

Table 4B 10: Existing Technologies – Njagi village – Ifakara district

Technology	When Introduced	Source	Yield (t/ha)		% Increase of Yield
			Before	After*	
1. Planting					
Broadcasting	Local	Local	2.4		
Dibbling	1978 - 96	Research		-	
Local transplanting	Local	Local	3.6		
Improved transplanting (rows)	1978 - 96	Research		3.6	0
2. Weeding					
Hand weeding	Local	Local	1.6		
Herbicides	1983 - 96	Research		3.6	125
3. Fertilizer application					
Without fertilizer	Local	Local	4.0		
With fertilizer	-	Research		6.0	50
4. Cultivation					
Flat cultivation	Local	Local	-		
Bands (majuruba)	1990 - 94	Research		3.6	-
5. Pesticides application					
Without pesticides	Local	Local	-		
With pesticides	-	Research		3.6	-
6. Planting time					
Outside recommended time	-	-	2.4		
Within recommended time 30 Dec – Feb 15	1994 - 96	Research		3.6	50

* Yield comparison made with reference to "India" local variety

Table 4B 11: Existing Technologies – Mang'ula village – Ifakara district

Technology	When Introduced	Source	Yield (t/ha)		% Increase of Yield
			Before	After*	
1. Planting					
Broadcasting	Local	Local	2.0		
Dibbling	1978 - 96	Research		4.0	100
Local transplanting	Local	Local	4.0		
Improved transplanting (rows)	1978 - 96	Research		5.2	30
2. Weeding					
Hand weeding	Local	Local	3.4		
Herbicides	1983 - 96	Research		4.0	17
3. Fertilizer application					
Without fertilizer	Local	Local	1.6		
With fertilizer	-	Research		5.0	212
4. Cultivation					
Flat cultivation	Local	Local	1.8		
Bands (majuruba)	1990 - 94	Research		5.0	178
5. Pesticides application					
Without pesticides	Local	Local	1.0		
With pesticides	-	Research		5.0	400
6. Planting time					
Outside recommended time	-	-	0.8		
Within recommended time 30 Dec – Feb 15	1994 - 96	Research		5.0	500

* Yield comparison made with reference to "India" local variety

Table 4B 12: Existing Technologies – Msolwa village – Ifakara district

Technology	When Introduced	Source	Yield (t/ha)		% Increase of Yield
			Before	After*	
1. Planting					
Broadcasting	Local	Local	4.0		
Dibbling	1978 - 96	Research		5.0	25
Local transplanting	Local	Local	4.0		
Improved transplanting (rows)	1978 - 96	Research		5.6	40
2. Weeding					
Hand weeding Herbicides	Local 1983 - 96	Local Research	2.0	 4.0	 100
3. Fertilizer application					
Without fertilizer	Local	Local	2.4		
With fertilizer	-	Research		5.6	134
4. Cultivation					
Flat cultivation	Local	Local	-	-	
Bands (majuruba)	1990 - 94	Research	-	-	
5. Pesticides application					
Without pesticides	Local	Local	2.0		
With pesticides	-	Research		5.6	180
6. Planting time					
Outside recommended time	-	-	-	-	
Within recommended time 30 Dec – Feb 15	-	Research	-	-	

* Yield comparison made with reference to “India” local variety

Table 4B 13: Existing Technologies – Mchombe village – Ifakara district

Technology	When Introduced	Source	Yield (t/ha)		% Increase of Yield
			Before	After*	
1. Planting					
Broadcasting	Local	Local	3.0		
Dibbling	1978 - 96	Research		4.0	34
Local transplanting	Local	Local	3.0		
Improved transplanting (rows)	1978 - 96	Research		5.0	67
2. Weeding					
Hand weeding	Local	Local	3.4		
Herbicides	1983 - 96	Research		4.0	18
3. Fertilizer application					
Without fertilizer	Local	Local	3.0		
With fertilizer	-	Research		4.0	34
4. Cultivation					
Flat cultivation	Local	Local	-	-	
Bands (majuruba)	1990 - 94	Research	-	-	
5. Pesticides application					
Without pesticides	Local	Local	-	-	
With pesticides	-	Research	-	-	
6. Planting time					
Outside recommended time	-	-	1.0		
Within recommended time 30 Dec – Feb 15	-	Research		3.0	200

* Yield comparison made with reference to "India" local variety

Table 4B 14: Existing Technologies – Kidatu village – Ifakara district

Technology	When Introduced	Source	Yield (t/ha)		% Increase of Yield
			Before	After*	
1. Planting					
Broadcasting	Local	Local	3.0		
Dibbling	1978 - 96	Research			
Local transplanting	Local	Local	4.0		
Improved transplanting (rows)	1978 - 96	Research		-	
2. Weeding					
Hand weeding	Local	Local	2.4		
Herbicides	1983 - 96	Research		3.6	50
3. Fertilizer application					
Without fertilizer	Local	Local	3.0		
With fertilizer	-	Research		4.0	34
4. Cultivation					
Flat cultivation	Local	Local			
Bands (majuruba)	1990 - 94	Research	-	-	
5. Pesticides application					
Without pesticides	Local	Local			
With pesticides	-	Research	-	-	
6. Planting time					
Outside recommended time	-	-	1.0		
Within recommended time 30 Dec – Feb 15	-	Research		4.0	300

* Yield comparison made with reference to "India" local variety

4.12.3 Annex 4C: Form 1A - Technology assessment by the programme leader(s)

Technology recommendation	Attributes	Year of realease/recommendation	Collaborating institutions	Technology transfer				Beneficiaries
				Target location	Target group	Coverage	Method of transfer	
Rice varieties: IR8	100 % higher yield than local variety Supa/lodging tolerant/photo period Insensitive N-ferti;lizers responsive	Early 1970s	IRRI,IITA,NAFCO farms	Irrigated, 500-1500masl Not suitable along the coastal areas	Small, medium and large scale farmers	Mbarali, Ruvu, Dakawa, Lowere Moshi	Experimentation in NAFCO farms (Ruvu, Dakawa, Mbarali)	
IR 54	75% higher yield than local variety Supa/Lodging tolerant/Photoperiod-insensitive N fertilizer responsive	Mid 1970s	IRRI,IITA NAFCO farms, KADP	Irrigated, 500-1500m asl Not suitable along the coastal area	Small, medium & large scale farmers	Mbarali Ruvu, Dakawa, Lower Moshi, Kilombero, Mombo, Ndungu, Uhambule	Experiments in NAFCO farms (Ruvu,Dakawa,Mbarali)	Small scale farmers in lower Moshi, Kilombero
IR 579	50% higher yield than local variety Supa/ Lodging tolerant/Photoperiod insensitive, N fertilizer responsive	Mid 1970s	IRR, IITA, NAFCO farms	Irrigated 500-1500m asl. Not suitable along the coastal areas	Small, medium & large scale farmers	Mbarali, Ruvu, Dakawa,Lower moshi	Experimentation in NAFCO farms	

Annex 4C: Form 1A - Technology assessment by the programme leader(s) (contd.)

Technology recommendation	Attributes	Year of realease/recommendation	Collaborating institutions	Technology transfer				Beneficiaries
				Target location	Target group	Coverage	Method of transfer	
Supa/Supa India/Kilombero	Aromatic	Early 1970s	Farmers, Extension	Irrigated/Rainfed lowlands 0-1500 m a.s.l	Small scale & medium scale farmers	Mbarali,Ruvu, Dakawa,Lower Moshi, Kilombero, Mombo, Ndungu,Kitere	Field trials/farrmers firld visit in Mwanza, Kilombero, NAFCO, Dakawa	Small scale farmers in Kyela, Usangu plains
Afaa Mwanza 1/159	25% higher yield than local variety Supa	1978	Farmers, extension	Rain fed lowland 0-1500 m a.s.l	Small scale farmers	Ukiluguru, Mombo, Ndungu, Kitere	Field trials, Farmers field visits, Mwabagole-Mwanza	Small scale farmers in lower Mwanza, Kilombero
Gamti Tunduru	Drought tolerant Early maturing	early 1970s	farmers & eatension	Iupland 900-2000m asl	Small scale farmers	Kilombero	Field trials, Farmers field visits in Ulanga, Matombo	Small scale farmers in Mtwara
Afaa- Kilombero	Blast tolerant	1978	Farmers & extension	Rainfed lowland 0-1500 m a.s.l	Small scale farmers	Kilombero	Field trials/farmers field visits	
Selemwa	50% higher yield than local variety Supa/Intermediate stature/Lodging tolerant	1983	Farmers& Extension	Irrigated/Rainfed lowland 0-1500 m a.s.l Small medium & large scale farmers	Small scale & medium scale farmers	Mbarali,Ruvu, Dakawa,Lower Moshi, Kilombero, Mombo, Ndungu,Kitere	Field trials/farrmers firld visit in Kilosa and Morogoro	Small scale farmers in Tabora

Annex 4C: Form 1A - Technology assessment by the programme leader(s) (contd.)

Technology recommendation	Attributes	Year of realease/recommendation	Collaborating institutions	Technology transfer				Beneficiaries
				Target location	Target group	Coverage	Method of transfer	
Katrin (IET 2397)	50% higher yield than loacl avriety Supa/Photo period insensitive/ Semi dwarf/Non shartering	1983	IRRI,IITA, Farmers, Extension	Irrigated/Rainfed lowlands 0-1500 m a.s.l	Small scale & medium scale farmers	Mbarali,Ruvu, Dakawa, Kilombero, Kitere	Field trials/farrmers firld visit in Ifakara and Kilosa	Small scale farmers in Tabora and Zanzibar
TXD 85	60% higher yield than local variety Supa/ lodging tolerant/Photoperiod insenstive	2001	Farmers, extension	Irigated rainfed lowlands	Small scale , medium and large scale farmers	Mbarali,Ruvu,Dakawa, Lower Moshi, Kilombero,Mombo ,Ndungu,Kitere	Field trials, Farmers field visits/ On farm trial at Mkindo, Mngeta, Malinyi, Bahi	Small scale farmers, Kilombero
TXT 88	50% higher yield than local variety Supa/ Lodging tolerant/ Photoperiod insensitive.	2001	Farmers & eatension	Irrigated lrainfed lowalands 0-1500m a.s.l	Small, medium and large scale farmers	Mbarali, Ruvu, Dakawa, Lower Moshi., Kilombero, Mombo, Ndungu, Kitere	Field trials, Farmers field visits	
	Blast tolerant	1978	Farmers & extension	Rainfed lowland 0-1500 m a.s.l	Small scale farmers	Kilombero	Field trials/farmers field visits	

Annex 4C: Form 1A - Technology assessment by the programme leader(s) (contd.)

Technology recommendation	Attributes	Year of realease/recommendation	Collaborating institutions	Technology transfer				Beneficiaries
				Target location	Target group	Coverage	Method of transfer	
Sowing Dates: Dec. to Mid Feb. for Kilombero valley	Drought avoidance	1985	Farmers, Extension	Irrigated/rainfed lowland	Small, medium and large scale farmers	Kilombero, Kilosa	Field trials in Kilombero and Kilosa	
Spacing: **Intermediate statured**: Direct seeding; 20 cm x 20 cm Transplanting: 15 cm x 15 cm direct seeding *Tall variety*: 20cm x 20 cm transplating. 20cm x 20cm direct seeding	Yield increased by 20-100% because recommended plant population achieved	1985	Farmers, Extension	Irrigated/Raifed lowland/Upland	Small, medium and large scale farmers	Kilombero, Kilosa, Dakawa	Field trials in Kilombero	Small scale farmers in Mwanza, Shinyanga and Mbeya
Fertilizer rates for Kilombero and Kilosa: ***Tall traditional varieties***: 60 kg N/ha ***Intermediate statured*** varieties 80kg N/ha	Yield increased by 50% in traditional tall varieties and by greater than 100% in intermediate statured varieties	1985	Framers, Extension	Irrigated/Rained lowland	Small, medium and large scale farmers	Kilombero, Kilosa, Dakawa	Field trials at Katrin Ifakara and Ilonga Kilosa	All rice growing areas in Eastern zone
Herbicides: 2-4D 1.5-2 l/ha. Propanil (Stam F34) 10 l/ha or Comvination of 2-4D at 1.5 l/ha + Propanil at 7 l/ha	Control of broad leaved weeds	1985	Farmers & extension	Irrigated/ Rainfed lowland	Small scale, medium and large scale farmers	NAFCO farms, Mbarali, Ruvu, Dakawa, Kapunga	Field trials at KATRIN, Dakawa	Small scale farmers in Kyela, Usangu plains, Bagamoya

4.12.4 Annex 4D: Form 1B - Benefits of Technology

Technology/recommendation (identified in form 1A),	Special attributes of technology	Benefits at household level			Institutional benefit			
		Before Yield	After Yield	Other benefits	Farmers	Researcher	Extension	NGO staff
Rice varieties: IR 8,	100% higher yield than Supa /lodging tolerant/photo period intensive N-fertilizer responsive	1-1.5 t/ha of local Supa variety	8 t/ha		Increased food security /increased income	3 field officers trained in rice production at IITA in 1987	6 field groups (one from Kilosa) attended field days at KATRIN between 1987 and 2000	
IR 54	75% higher yield than Sup a/lodging tolerant/photo period insensitive N-fertilizer responsive	1-1.5 t/ha	7 t/ha		Increased security /increased income	1 field officer trained in Egypt in 1987	3 farmers field visits in 2001 (one each in the Bahi, Irindi and Mgeta	One NGO field visit at Katrin in 2001
IR 579	50% higher yield than local Supa/lodging tolerant/photo period insensitive N-fetrilizer responsive	1-1.5 t/ha	6 t/ha		Increased food security /increased income	1 research officer and 1 field officer attended a SUA /IRRI organized at SUA between 1980 and 1990		
Supa/Supa India/kilombero	Aromatic	1.5 t/ha	4 t/ha		Increased food security /increased income	6 research officers trained at IRRI (3 in rice production and 3 on integrated pest management between 1987 and 2002		

Annex 4D: Form 1B - Benefits of Technology (contd.)

Technology/recommendation (identified in form 1A),	Special attributes of technology	Benefits at household level			Institutional benefit			
		Before Yield	After Yield	Other benefits	Farmers	Researcher	Extension	NGO staff
Afaa Mwanza 1/159	25% higher yield than local Supa	1-1.5 t/ha	5 t/ha		Incerased food security /increased income	2 researchers trained at IRRI (Ph.D) between 1990 and 1995		
Gamti Tunduru	Drought tolerant/early maturity	1-1.5 t/ha	2.5 t/ha		Increased food security/increased income			
Afaa Kilombero		1 - 1.5 t/ha	3 t/ha		Increased food security/increased income			
Selemwa	50% higher yield than local Supa /inetrmidiate stature/lodging tolerant	1 - 1.5 t/ha	6 t/ha		Increased food security/increased income			
Katrin (IET 2397)	50% higher yield than local Supa	1 - 1.5 t/ha	6 t/ha		Increased food security/increased income			
TXD 85	60% higher yield than local Supa	1 - 1.5 t/ha	6.5 t/ha		Increased food security/increased income			
TXD 88	50% higher yield than local Supa		6 t/ha		Increased food security/increased income			
Sowing dates: Dec. to mid February for Kilombero valley	Drought escape	0.5 t/ha	4 t/ha		Increased food security/increased income			

Annex 4D: Form 1B - Benefits of Technology (contd.)

Technology/recommendation (identified in form 1A),	Special attributes of technology	Benefits at household level			Institutional benefit			
		Before Yield	After Yield	Other benefits	Farmers	Researcher	Extension	NGO staff
Spacing: Intermediate statured: Direct seedidng ; 20cm X 20cm. Transplanting. 15cm X 15cm direct seeding. Tall varieties: 20cm X 20cm transplanting, 20cm X 20cm direct seeding	Recommended plant population acheived	0.5 t/ha	4 t/ha		Increased food security/increased income			
Fertilizer rates for Kilombero and Kilosa: Tall traditonal varieties: 60kg N/ha. Intermediate stutured varieties: 80 kg N/ha	yield increased by 50% in traditional tall varieties and by > 100% in intermediate statured varieties	0.5 t/ha	4 t/ha		Increased food security/increased income			
Herbicides: 2 - 4D 1.5 - 2 l/ha Propanil (stam F34) 10 l/ha or Combination of 2-4D at 1.5 l/ha + Propanil at 7 l/ha	Timely and faster weed control	0.5 t/ha	4 t/ha	Extra mandays to attend to other activities acquired	Drudgery in weed control reduced			

4.12.5 Annex 4E: Form 1 C - Impact of technology

Technologies /Recommendation (identified in form 1A)	Contribution of technology to					
	Food security	**Poverty alleviation**	**Nutritional status**	**Environment**	**Empowerment of farmers**	**Gender concerns**
Rice varieties: IR 8,	Household food production increased hence improved household food security	Surplus sold to generate extra income			6 on farm seed production farms established (4 in Kilombero and 2 in Ulanga) between 2000 and 2001 increasing quality of seed available to farmers	Extra income for domestic expenses available
IR 54	-do-	-do-				
IR 579	-do-	-do-				
Supa /Supa India/ Kilombero	-do-	-do-				
Affa Mwanza1/159	-do-	-do-				
Gamti Tunduru	-do-	-do-				
Afaa Kilombero	-do-	-do-				
Selemwa	-do-	-do-				
Katrin (IET 2397)	-do-	-do-				
TXD 85	-do-	-do-				
TXD 88	-do-	-do-				
Sowing dates: Dec, to mid February for Kilombero Valley						
Spacing: Intermediate stutured: Direct seeding ;20cm X 20cm, Transplanting. 15cm X 15cm direct seeding. Tall varieties: 20cm X 20cm transplanting. 20m X 20cm direct seeding						
Fertilizer rates for Kilombero and Kilosa: Tall traditional varieties: 60kg N/ha, Intermediate statured varieties: 80 kg N/ha				Soil fertility improved		

CHAPTER FIVE

IMPACT OF PASTURE RESEARCH IN THE EASTERN ZONE AND SOUTHERN HIGHLANDS ZONE

5.1 Research Background

Pasture research in Tanzania started way back in the 1930s and a number of pasture research stations were established before and after independence eg. Kongwa pasture research center, ARI-Uyole, LRC Tanga and of late Sokoine University of agriculture. Following an inventory of past research in the Eastern and Southern highland zones, it was evident that in the Eastern zone and Southern highland zones studies on pasture were largely based on natural pasture, grasses and legumes, fodder and multipurpose trees. Most research programs were conducted on-station and lasted between 2 and 3 years. The focus of the research was concentrated on agronomic characteristics, nutritional qualities and ability of the pasture species to improve soil fertility and control soil erosion.

In the Eastern and Southern highland zones, a great need for pasture research was attributed to the introduction of small-scale dairy development programs such as the Small Scale Dairy Development Program (SSDDP) in Southern highlands in 1978 and the Tanga Dairy Development Program (TDDP), in Tanga region in 1985. The SSDDP was later renamed Southern Highland Dairy Development Programme (SHDDP) under the support of the Swedish Government. Other projects include Heifer Project International (HPI), where individuals or groups were provided with in calf heifers on loan basis.

The objective of these programs was to improve the income and nutritional status of the poor communities by using dairy animals. Crossbred heifers were given to a few pilot farmers after being trained and fulfilling some of the conditions including improved pasture establishment. In a mixed farming system such as the Southern highlands and some areas of the eastern zone such as Amani in Tanga region feeding resources inevitably become inadequate to support the high genetic potential of the improved breeds of dairy animals to maintain their productivity. As a result research focus has been directed towards development of feed resource base including pasture husbandry packages to improve feed availability as well as quality.

5.2 Technologies released and their current status

Pasture technologies released in the Southern and Eastern zones are summarized in Table 5.1 and 5.2. Overall, based on the information collected, the technologies developed in the two zones and the impact of the technologies can be considered to be more or less the same.

5.2.1 Pasture establishment

A number of pasture species were introduced and recommended in the Southern highland. These include natural grass (with fertilization), Rhodes grass, *Nandi setaria*,

Desmodium, Napier grass, Giant setaria and Guatemala grass. On station testing have shown that all these varieties performed well under conditions of Southern highlands. They can also be easily propagated and have longer reproductive cycle. Napier grass *(Pennisetum purpureum*) grown in contour bands to minimize soil erosion was introduced by ARI - Uyole in 1994 in collaboration with programs such as IFAD, FARMESA and extension personnel. Initially, only a few villages were involved. However, due to easiness of propagation the technology has spread widely. So far for example, about 90% of dairy farmers in Rungwe have adopted the technologies. Moreover, due to poor market for milk and high cost of mineral fertilizers some of the pasture plots have been neglected or diversified to what is perceived to be more productive uses. The cost of improved pasture seeds has also been prohibitive for some farmers to afford. In Galijembe village (Mbeya rural) a kilogram of pasture seed cost 3000 Tsh. For this reasons many farmers have resorted to natural pasture and crop residue both being abundant in some areas.

In the Eastern zone, Napier grass was recommended by dairy development projects such as TDPP as a pre-requisite practice for fodder supply for zero grazing systems. In support of the dairy industry development, researchers collected and evaluated 27 Napier cultivars and ecotypes. Ten cultivars were found suitable and released in the Eastern zone sometimes in 1993 (TA 107, TA124, TA 120, TA102, TA 110,TA101, TA106, TA112, TA113, and TA128). Napier grass has been shown to establish best on deep soils of moderate to fairly heavy texture. It tolerates short droughts, but does not withstand water-logging conditions. The biomass production is very high reaching up to 17 tons of dry matter when fertilized with large quantity of farmyard manure (5 tons/ha or more).

The other widely recommended fodder for high altitude areas within Eastern zone was found to be Guatemala grass, which was released in 1983 for Muheza (Amani area) and Lushoto districts. This grass is also widely cultivated in Morogoro region. Guatemala grows better on rich soils and tolerates acidity. It is more persistent than Napier grass and can be mixed with leguminous grass eg. *Desmodium.*

Box 5.1: Farmers perception on the introduced grasses

In Amani district over 75 % of the dairy farmers have adopted and sustained the introduced pasture technologies. Alternative sources of fodder are very limited this area. Guatemala grass was ranked number one in comparison with food crops grown in Amani. Milk production from such areas are the highest due to high consumption of Guatemala and high level of management livestock.

Less than 50% of farmers in Muheza, Tanga and Southern highland zone have failed to sustain the technologies due to availability of alternative but lower quality native grasses which also leads to lower milk production The management of animals is also relatively poor compared to that of Amani livestock keepers

Napier technology is in dilemma of being abandoned because farmers particularly in Muheza, and Tanga and most areas in Southern highland feel that dairy business is no longer very profitable The management of livestock in these areas is also very poor due to high dependence on casual labor resulting in very low milk yields).

Around the Uluguru Mountains history shows that the Luguru, had no culture of keeping Ruminant (Cattle or Sheep/Goats). In late 1980's dairy goats were introduced to the area through a NORAD supported Project. Since the area is under intensive vegetable cultivation farmers were encouraged to establish fodder banks along the contours especially multipurpose trees. In the early 1990's research was initiated to

address the issue of feed availability as well as issues pertaining to soil erosion. Two grasses (Elephant grass and Setaria) were recommended and planted along the contour bands following demonstrations that were conducted in the area. About 67% of the farmers including non-dairy goat farmers are currently using the technology and the trend is on the increase. This technology has spread as far as Mbinga District in the Southern highlands through the support of JICA.

Table 5.1: Technology assessment (pastures and forages) in the southern highlands

Technology recommendation	Attributes	Year of recommendation	Collaborators	Technology Transfer				Beneficiaries outside the project area
				Targeted location	Targeted group	Coverage	Methods of transfer	
Natural pastures Fertilization and cutting management	Increased yield and forage quality	1973	Extension Farmers	All the southern Highlands	Large and small-scale farmers	At farm level around Mbeya only	Publications leaflets, Seminars	
Planted pastures Rhodes grass, Nandi Setaria (Dec - Feb)	High yielding, longer growing season, Ease seed availability	1975	Extension, Farmers	Southern Highlands except Kitulo plateau	Small and large scale farms	Southern highlands 4 regions	Seminars Field trials, bull centres	
Fertilizer application to planted pastures	High yields High nutritive value Longer growing season	1978	Extension, Farmers	Southern Highlands	Small and large scale farmers	Mbeya & Iringa regions	Field trials leaflets Seminars	
Planting pasture legume mixtures. Rhodes/Desmodium Setaria/Desmodium	Higher yields Cost reduction High nutritive value	1978	Extension, Farmers	Southern Highlands Except Kitulo	Small and large scale farmers	Mbeya & Iringa regions	Field trials leaflets Seminars, Substations	
Fodder Conservation Hay	Sustained feed availability	1978	Extension, Farmers	Southern Highlands	Small and large scale farmers	Mbeya & Iringa regions	Field trials leaflets Seminars	

Table 5.1: Technology assessment (pastures and forages) in the southern highlands (contd.)

Technology recommendation	Attributes	Year of recommendation	Collaborators	Technology Transfer				Beneficiaries outside the project area
Fodder crops planting Napier, Guatemala Giant Setaria Multipurpose trees Calliandra, L. diversifolia	High yield and land unavailability, green feed during the dry season High protein supplies green feed in dry season.	1980 1994	Extension, SHDDP (NGO) IFAD Farmers IFAD/SHDDP Extension, Farmers	Southern Highlands Mbeya rural	Small-scale farmers Small scale farmers	Mbeya Iringa & Rukwa regions Mbeya & Mbozi Districts	Field trials Leaflets Seminars Extension Manuals Bull centres	About 90% of dairy farmers in Rungwe are now using Napier
Use of crop residues maize stover, Bean stalks	Increased feed base	1990	Extension, Farmers, SHDDP	All the Southern Highlands	Small-scale farmers	Mbeya and Mbozi districts	Seminars, leaflets	
Pasture seed production package at farm and small-scale level Rhodes grass	Assurance of seed availability within community.	1990	SHDDP Farmers	Mufindi, Makete & Mbozi districts Sao – Hill, LMU	Small Scale farmers	SAO HILL – LMU Ukwama (Makete) Mtwago (Mufindi) Isangu Igamba) [Mbozi]	Seminars, leaflets Field trials	Seeds readily available even to coastal regions.
Planting of Napier and multipurpose trees on Alleys or contours	Soil erosion control soil fertility improvement Dry season feed availability, high feed value in dry season	1994	IFAD Extension Farmers FARMESA	Mbeya rural (Iyawaya Isangati).	Small scale farmers including women (Farmer groups)	Iyawaya, Isangati Rukwa (in 5 villages)	Field trials, leaflets, Seminars	

Table 5.2: Technology assessment (pastures and forages) in the eastern zone.

No.	Technology recommendation	Attributes	Year of recommendation	Collaborators	Technology Transfer			
					Targeted location	Targeted group	Coverage	Methods of transfer
1	Elephant grass "Morogoro variety Clone 4"	Drought resistant	1997	Researches initiatives	Sub-humid and humid areas	Small holder dairy farmers	Around SUA and Mbinga District	Personal contact, publications, conferences, farmer to farmer contacts
2	Use of high plant density of *Sorghum vulgare* as pre-planting wed control in pasture seedbed	Suppress broad-leaf weeds	1996	SUA, Magadu dairy farm and Farm Department	Sub-humid and humid areas	Small and large scale farmers	So far only at SUA	-
3	Use of fodder grasses(Elephant, Guatemala and Setaria to stabilize the bench terraces	Reduce soil errosion	1990-2000	NORAD,JICA	Hilly and sub-humid to humid areas	Small holder farmers	Mgeta along the Uluguru mountains, Mbinga District	Researcher-farmer contact
4	Introduction of Napier grass	Fast growth, drought tolerant, recommended for cut and carry	-	TDDP	Muheza,Tanga and Amani	Small holder farmers	Muheza,Tanga and Amani	Training, farmer exchange, brochure
5	Introduction of Guatemala grass	Tolerate acidity, high yield, good fodder for highland areas	-	TDDP	Muheza,Tanga and Amani	Small holder farmers	Muheza,Tanga and Amani	Training, farmer exchange, brochure

5.2.2 Pasture grass-legumes mixture

This technology was introduced in the Southern highland zone between 1978 and 1994. The grass/legume species recommended by SSDDP were Rhodes grass/Desmodium and Setaria/Desmodium mixture. On-station studies demonstrated that the grass legume mixture to result into a higher biomass yield with improved nutritive value. Both small-scale and large-scale farmers were initially targeted. Despite the high potential, of the mixture very few farmers have adopted the technology. The main reason being lack of market for fresh milk, land availability, labour and high husbandry requirements of grass legume mixture.

5.2.3 Multipurpose trees in contour

The species commonly found to do well in the Southern highland includes *Calliandra* and *L. diversifolia*. These species provide green feed through out the year and in addition the help in conserving soils. The technology was introduced way back in 1994 through IFAD/SSDDP collaborating with ARI-Uyole, extension personnel and farmers. According to the statistics obtained there were only 5 farmers in the six villages visited initially but, as of 2002 the number has increased to 44 representing a 780 % increase.

5.2.4 Pasture seed production

In an effort to cope with the anticipated high demand for improved forage, ARI-Uyole and SSDDP contracted some farmers to produce pasture seeds. This was done with an agreement that the program (SSDDP) would purchase the seeds and re-sale it to other farmers at a subsidized price. Initially the idea was well received but currently the general trend is on the decline. For example in Isangu village 5 farmers were recruited, but as of 2002 only 2 have remained. In Zelezela the technology failed completely to take off, while in Igamba village only 20 % of the initial seed producers continue to produce pasture seed seeds today.

Box 4.2 Reason attributed the decline in pasture seed production.

i)	***Failure of the program to purchase the farmers seeds***
ii)	***High production cost particularly where the plots need to be fertilized***
iii)	***High cost of management involved including weeding.***
iv)	***Poor market of milk***

5.2.5 Use of fertilizer/Farm yard manure in pasture plots

Dairy farmers were motivated to use commercial fertilizers or farm yard manure to improve productivity of the natural or planted pastures. Demonstrations were conducted, during training and of the six villages visited in the Southern highlands only 11 out of 43 farmers who initially used farm yard manure in pasture plots continued to do so, this represents a drop of (74 %) in 7 years. Moreover, some farmers experienced problems with farmyard manure due to problems associated with transportation due to the bulkiness nature of FYM. Despite this transportation problem a good number of farmers interviewed (over 80 %) are actually applying FYM in their pasture fields. In Tanga region it has been demonstrated that use of NPK fertilizer resulted into a substantial increase in biomass production (Table 5.3).

However, farmers in Muheza and Tanga district, feel that the dairy business is no longer paying to apply such fertilizers. One farmer reported to have sold 10 dairy animals out of 13 and diverted to pig production. At the time of the study no dairy farmer used commercial fertilizer, due to the high costs involved.

Table 5.3: On-farm performance of the recommended technologies.

Location	Forage species	Fresh Forage yield (kg/ha)	Estimated dry matter yield (kg/ha)
Amani	Guatemala	6600	1650
Muheza	Napier	4875	1462
Tanga	Napier	7050	2115

5.2.6 Fodder Preservation

Silage making technology was introduced as a pilot trial in some villages of Southern highland zone in Mbeya rural district by the district extension service. However, it failed to gain popularity (zero adoption). The main reason being attributed to the way the technology was introduced. The approach was not sustainable and no follow-up was made nor cost-benefit analysis done at farm level.

Hay making techniques on the other hand, were introduced between 1988 and 1995 in 4 of the 6 villages visited in the SHZ in particular, Mbozi district. Farmers used both the natural as well as the planted improved pasture. Of late hay made from natural pasture is a common practice. These practices are not common in Tanga region Table 5.4 shows the adoption rate of this technology.

Table 5. 4: On- farm adoption of fodder conservation (Hay)

Village	Percentage increase in year 2002
Isangu	113
Zelezeta	95
Ihanda	35
Igamba	50

The main feature from the adoption data is that the technology has been well received Farmers consider the technology to be relatively cheap, as they don't have to incur extra cost in growing the fodder. The natural forages are also abundant in the communal land though of less superior quality nutritionally and less sustainable. The same factor was considered as the major reason for the abandonment of most Napier grass plots in Muheza and Tanga districts soon after repaying the loans for the in calf heifers.

Associated with fodder preservation is the increased use of crop residues as farmers grow crops such as maize, beans, groundnuts, sweet potato etc. In all villages visited especially in the southern highland zone, use of crop residue as livestock feed is steadily increasing. largely due to easy availability, easy to store, including cheap storage structures. Farmers are also aware that natural grass alone is not adequate during the dry season, hence crop residue could sustain the animals during this period.

5.2.7 Elephant grass "Morogoro variety Clone 4"

The grass is a local variety and has been tested on station at Sokoine University. It has been found to be drought tolerant and produces substantial levels of biomass under moderate management. In 1997 the variety was released to a few farmers and surrounding institutions especially Sokoine University. However, its performance under farmer managed condition has not been evaluated.

5.2.8 Use of high plant density of *Sorghum vulgare* as a pre-planting weed control in pasture seedbed.

At the Sokoine University of Agriculture (SUA) farm weed infestation is a serious problem. Over the years the SUA farm has been infested with the broad-leaved weed, *Cassia rostriata* and *Sida acuta*. Attempt to remove the weed by conventional means eg. cutting, digging and burning the residue has had little success due to long dormancy of the seeds and the weeds being very prolificacy. Researches at SUA tested the use of high density of *Sorghum vulgare* as a pre-planting weed control strategy. The strategy was successful and the technology was released in 1997. By year 2002 about 20 ha has been reclaimed from the broad leaf *Cassia rostriata* and *Sida acuta* and more land is being reclaimed. The sorghum harvested is used as fodder or ensiled. The impact of this strategy is provision of more grazing land where other suitable grass species eg. Rhodes grass has been planted.

5.3 Research impact

The benefits of the released pasture research technologies in terms of economic, social, environmental as well as with regard to capacity buildings are summarized in Table 5.5 and 5.6 for the Southern highlands and Eastern Zones respectively.

5.3.1 Economic impact

Unlike farmers of involved in the production of other crops, farmers who establish pasture plots do not have the habit of determining forage yield quantitatively. The farmers normally observe the feeding value of forage in terms of milk yield and body condition of their animals. Data presented in this report indicate farmers acknowledge the potential of the introduced pasture technologies as compared to using natural pasture alone without fertilization. Table 5.5 for example demonstrates the contrast in milk yield between cows fed with natural pasture and those fed with improved pasture during the wet and dry conditions in the Southern highlands and Eastern zone.

The result shows that by using improved pasture, milk yield can be increased by about 49.6%. Translated in terms of the whole lactation period (305 days), it means that the farmer will almost increase his annual income by 50% through adoption of the new technology.

Box 4.3: Other economic benefits arising from sale of pasture and crop residue.

In Amani and Muheza the price of one bundle of forage weighing between 35 –50 kg is sold at 200-300 Tsh. Guatemala is also abundant especially during and post rain period. When sold in-situ at Amani a row of harvest (100 m) cost about 5,000 Tsh .

In the southern highland crop residue sale between 100 –200 Tsh per bag of beans straw.

At Sokoine University Elephant grass "Clone 4" has been shown to yield about 5 – 10 tons of DM per ha in the dry season when compared to the unimproved varieties.

Use of sorghum as pre-planting weed control have reclaimed about 20ha of grazing land in a span of 6 years.

Table 5.5: Average milk (lt/cow/day) with and without using improved pastures during the wet and dry seasons in the Southern highland zone

District	Village/District	Season	Natural pasture (lts)	Improve d pasture (lts)	Percentage increase
Mbeya Rural	Galijembe	Wet	12	14	16
		Dry	10	12	22
	Iyawaya	Wet	11	13	18
		Dry	9	11	22
Mbozi	Isangu	Wet	12	15	25
		Dry	8	10	25
	Zelezeta	Wet	5	8	60
		Dry	4	6	55
	Ihanda	Wet	8	12	50
		Dry	5	8	60
	Igamba	Wet	4	10	150
		Dry	4	6	50
Tanga	Amani	Wet	12	20.4	70
		Dry	<10	15	50
	Muheza	Wet	6.8	12.2	79
		Dry	-	-	
	Tanga	Wet	8.8	13.5	53
		Dry	5	7	40
Mean					**49.6**

5.3.2 Social cultural impact

The socio cultural impact of pasture technologies in the project area could not be readily quantified. However, farmers reported that when the market for milk was good they could afford to send their children to school (40% of the respondent) as well as afford to purchase medicines and a few assets. The nutrition status of the family also improved through drinking of milk and the practice has been sustained through various campaigns.

The study showed that farmers acknowledged the importance of pasture technologies to in sustaining milk production. and in turn provision of quality food to the family. Milk consumption at household ranged from 1.5 to 2 liters per day

5.3.3 Environmental Impact

Regarding the impact of pasture establishment and its associated management practices farmers in Amani Tanga reported to use the excessive Guatemala cutting as mulch to conserve soil moisture. Other benefits included prevention of soil erosion eg. In Uluguru mountains where the number of bench terraces planted with Elephant grass, Guatemala and Setaria grasses has been observed to be increased. Napier grass is used to stabilize contours in the Southern Highlands eg in Iyawaya village. Labour demand to repair the terraces has been reduced and in Mbinga after one year of the technology the soil filling the contour ditch has been reduced by 50% on the average.

In the Southern highland, farmers have resorted to using crop residues due to high cost of producing cultivated pasture. The negative impact of this practice on the environment is continued nutrient mining as manures are not returned to the fields located away from the homestead. However, farmers acknowledge that grass alone is not enough during the dry season and using crop residue is taken as a coping strategy.

5.3.4 Capacity building

Farmers have attended various types of training in aspects of dairy management and pasture production etc. (Fig 5.1)

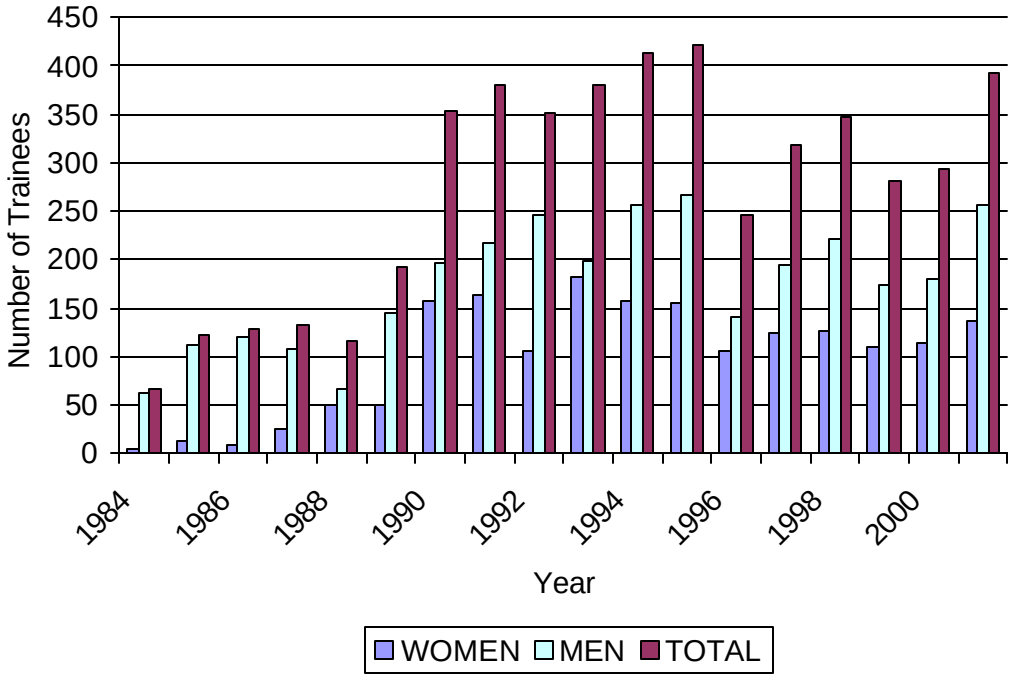

Figure 5.1: Number of Trainees for Basic Farmers Courses at LITI Buhuri Since 1984 - 200

In addition to training, field visits and farmers exchange have been done at different times by the projects in collaboration with the extension officers. The fact that farmers

groups are still in existence it shows that the program had a long positive impact on this aspect (Table 5.6).

Table 5.6: Farmers groups in the six village surveyed in the Southern Highlands

Village	Name of the group	Year of starting	Initial member (Number)	Current status (Number)
Iyawaya	Ushirikiano	1983	5	26
	Mtandao	1983	3	30
Galijembe	Uwagaha	1984	6	8
	EDF	1997	6	3
	Tumaini	2001	6	18
	Non member	-	6	12
Isangu	-	-	-	27
	Non members	-	-	22
Zelezela	-	-	-	28
Ihanda	-	-	-	27
Igamba	-	-	-	20

Based on the information collected it was evident that in Tanga region about 50% of dairy farmers including both men and women have attended various training courses on pasture production, particularly at Buhuri Livestock Training Center (Kavana, 2002). Some have also attended various seminars meetings and workshops elsewhere related to pasture production and management. Other benefits include participation of extension officers and farm managers in testing the packages. Some of the farmers themselves were also found to be professionally trained in dairy husbandry which includes various aspects of pasture management.

5.4 Conclusion

Pasture technologies has had a significant positive impact to the target communities, and farmers acknowledge the economic, social and environmental benefits associated with the technologies. However, over the years farmers faced a number of constraints.including low market prices for their milk. This problem has been experienced in most areas of the Southern highlands as well as the Eastern zones jeopardizing the technologies related to dairy production. As a result farmers have increasingly resorted to using hay from natural pasture and crop residue. Some farmers have reduced the number of dairy animals as a coping strategy or abandoned dairying altogether. Using fertilizer in pasture plots is considered as a costly practice and has been abandoned by virtually all farmers Fertility improvement in pasture fields is mainly confined to application of farmyard manure.

Table 5.7: Benefits of technology

Recommendations identified in Table 4.1	Benefit at Household level			Benefit (Institutional)		
	Before yield	After yield	Other benefits	Farmers	Researchers/Extension	NGO Staff
Natural pastures: Fertilization and cutting management	2.5t/ha without fertilizers	9 tonsDM/ha after applications of 160 kgN/ha & cutting 4 times/season	Increased feed base and high quality 3% to 11% CP	Increased awareness of natural pasture sales along roads.		
Planted pastures Rhodes grass Nandi Setaria	2.5t/ha on natural pasture	3.8 t/ha on Rhodes alone 4.0 t/ha on Setaria alone	High quality materials	Yield increase of both pasture and milk	No. of materials Leaflet 1 Handbook reports 1 Extension guide 1 Most extension workers in Mbeya and Iringa trained.	
Fertilizer application (Split - apply) Rhodes grass Nandi Setaria	3.8 t/ha 4.0 t/ha	8 t/ha with 150 kgN 7.8t/hawith 150kgN/ha/	High quality Longer season of growth	Not sustained due to cost	(As above)	
Pasture/legtume mixtures: Rhodes/Desmodium	3.8 t/ha on pure Rhodes	6.7 t/ha for the mixture	High yield, High quality	Highly preferred especially in Mbozi, Ludewa, Mufindi & Mbeya	(As above)	
Fodder conservation as hay and *in situ*	N/A	Dry season feed available	Increased feed base	Widely now practiced in Mbeya, Mbozi, Rungwe & Mufindi	(As above)	

Table 5.7: Benefits of technology (contd.)

Recommendations identified in Table 4.1	Benefit at Household level			Benefit (Institutional)		
	Before yield	After yield	Other benefits	Farmers	Researchers/Extension	NGO Staff
Planting fodder crops: Napier, Napier + 160 kgN Napier + Desmodium	2.5t/ha without N on national pastures 5t/ha 5t/ha	5.t/ha on Napier 11.5 t/ha 10.0 t/ha	Increased feed base. New materials of Napier now available	Widely adopted in Mbozi, Rungwe, Rukwa, Mufindi	Most extension officers trained	
Guatemala (Rungwe, Njombe tea growing areas) Giant Setaria Rungwe, Rukwa (Mlanda) Multipurpose trees. Calliadra, Leunaena diversifolia	2.5tDM/ha for natural pastures 2.5tDM/ha per natural pastures	4T/hafor Guatemala 4 tons DM/ha for Setaria	Slightly highest quality fodder High quality fodder Easily conserved *in situ*	Increased yield of pasture hence milk production	1 Extension manual produced 1 leaflet produced	Experience high on use of Multipurpose trees
Use of crop residues Maize stovers bean stalks	7 tons/ha 1 ton/ha	14 tons/ha 3.4 tons/ha	Increased dry season feed base	Increased number of farmers using crop residues	1 seminar proceedings produced/About 15 Extension officers trained on use of Crop residues	More knowledge on use of crop residues
Pasture Seed production package at farm and small-scale level	1.5 tons of seed from Uyole and Langwira	Up to 4 tons of seed available in 1999	Ease farmer exchange of seeds in vicinity	12 farmers trained in Mbozi district	Extension materials 1 Field note produced by researchers	Increased seed production technology.
Napier and multipurpose trees in alleys or contours	1.5L milk/day / cow 2.5tDM/ha on natural pastures	8Lmilk/day / cow 12t DM/ha on Napier & MPTS	Reduced soil erosion contour stabilization by Napier		1 leaflet produced by both Researches and Extension	

Table 5.8: Benefits of the technology (pastures and forages) in the eastern zone.

Technology recommendation	**Benefits at farm level (compared to farmers' practice)**	**Number of farmers trained/adopted the technology**
Elephant grass "Morogoro variety Clone 4"	Increased yield of gree forage from 5 t DM/ha to 10 t DM/ha in the dry season compared to unimproved variety	Few farmers around Morogoro and about 7 in Mbinga
Use of high plant density of *Sorghum vulgare* as pre-planting wed control in pasture seedbed	Only at SUA farms. About 20 ha has been reclaimed from broad leaf weeds, esp. *Cassia rostriata* and *Sida acuta*	About 67 % of the farmers in Mgeta are applying the technology
Use of fodder grasses(Elephant, Guatemala and Setaria to stabilize the bench terraces	After one year the soil filling the contour ditch has been reduced by about 50%	So far 7 farmers in Mbinga have adopted the technology
Introduction of Napier grass	Increased biomass yield to 5000 kg per ha	
Introduction of Guatemala grass	In Amani the biomass yield per ha was 6600 kg Adopted as a basal diet	

Table 5.9: Impact of technology

Technologies Recommendations	Contribution of Technology to						Others (Specify)
	Food Security	**Poverty Alleviation**	**Nutritional Status**	**Environment**	**Empowerment of farmers**	**Genders Concerns**	
Natural pastures Fertilization and cutting management		Extra income by sale of natural pasture in Mbeya region	Nutritional status of households improved due to balanced diet	Soil nutrient status enhanced	Grass sales at farmers own natural pasture forested areas (Mporoto)		
Planted pastures Rhodes grass Nandi Setaria	Milk yield increased hence improved household food security	Income increase due to increased milk yield and sales	Nutritional status of households improved due to balanced diet	Soil structure & erosion control improved			
Fertilizer application Rhodes grass Nandi Setaria	Food Security		- do -	Soil nutrient status enhanced			
Pasture grass/legume mixtures. Rhodes/Desmodium mixtures	- do -	- do -	- do -	- do – Soil physical properties improved			
Fodder conservation as hay and *in situ*		Hay sales increase farmers income	- do -				

Table 5.9: Impact of technology (contd.)

Technologies Recommendations	Contribution of Technology to						Others (Specify)
	Food Security	Poverty Alleviation	Nutritional Status	Environment	Empowerment of farmers	Genders Concerns	
Planting of Fodder crops. Napier + Fertilizer and mixtures Multipurpose trees Calliandra L. diversifolia L. pallida	- do -			Enhanced soil nutrient status	DFG established in most districts		
Pasture seed production package at farm and farmer level.	Increase in seed production	Farmers income increased by extra seed sales			FG established in Mbozi, Rungwe, Rukwa and Mbeya rural		
Napier and multipurpose trees in alleys and on contours	Increase in food production to alleys or between contours		- do -	Soil erosion reduced. Soil productivity improved	Farmer sites were used where they managed the contours, DFG formed Iyawaya, Rukwa	Few women farmers involved at Iyawaya, Isangati and Rukwa	

Table 5.9: Impact of technology (contd.)

Technologies Recommendations	Contribution of Technology to						Others (Specify)
	Food Security	Poverty Alleviation	Nutritional Status	Environment	Empowerment of farmers	Genders Concerns	
Use of crop residues. Maize stovers Bean Stalks	Increased feed base in dry season	Extra revenue for sale of bean stalks.	- do -	- Burning of crop residues minimized. - Residue removals reduce nutrient cycling.	Individual farmers' plots now used for crop residue collection.		
Elephant grass "Morogoro variety Clone 4"	-	-	-	- Increase land stability against erosion	Farmers field used to multiply the forage		
Use of high plant density of *Sorghum vulgare* as pre-planting wed control in pasture seedbed	-	-	-	- Reduce pasture and land deterioration	SUA farm manager participated in testing the technology		
Use of fodder grasses(Elephant, Guatemala and Setaria to stabilize the bench terraces	Vegetables and other crop production improved, improve in milk production from dairy goats	Increased house hold income through sale of crops and, milk and goats	-	- Reduced erosion and improved discharge of the streams due to increased rain filtration	Farmers field used to test technology		

Table 5.9: Impact of technology (contd.)

Technologies Recommendations	Contribution of Technology to						Others (Specify)
	Food Security	Poverty Alleviation	Nutritional Status	Environment	Empowerment of farmers	Genders Concerns	
Introduction of Napier and Guatemala	Able to sustain high milk yield	Income from milk increased	Milk consumption increased from 0 to 1.5 l – 2l per day	- Forage production compel to use manure - Surplus Guatemala used as mulch	Female farmers showed confidence	Majority showed no gender discrimination	

CHAPTER SIX

IMPACT OF POTATO RESEARCH IN THE SOUTHERN HIGHLAND ZONE

6.1 Background

6.1.1 Importance of potatoes

Potatoes *(solanum tuberosum* L) are the third most important starch food crop, after maize and rice in the southern highlands of Tanzania (Mayona and Mwambene 1993). Little information is available on origin of potato in Tanzania. According to oral tradition; potatoes were probably brought to the southern highlands by European missionaries in the 19th century. Accoding to Mussei *et al* (1999), production of potatoes has been traditionally concentrated in the highlands areas of Iringa and Mbeya regions were the crop performs well. Biologically potatoes have considerable production potential because they are a short duration crop growing for 4-5 months in the field .Potatoes are the main source of income in most area where no other cash crop is grown. Potato ranked second in the two villages in Njombe and second in the villages in Mbeya as a food crop (Table 6.1). They also ranked second and first in Njombe and Mbeya, as a source of income.

Table 6.1: Main crops grown in rank order using pairwise ranking

Njombe District		**Mbeya District**
Ihaulula Village	Usalule Village	Kikondo Village
Maize	Maize	Maize
Potatoes	Potatoes	Pyrethrum
Wheat Beans	Wheat Beans	Cabbage Round potatoes
Peas (garden peas)	Peas (garden peas)	
Pyrethrum	Pyrethrum	
Cabbage	Cabbage	
Living stone potatoes	Living stone potatoes	
Fruits	Fruits	

According to Mayona (1991), 90% of the potato crop in Tanzania is produced by smallholder farmers in the southern highlands and is grown on rain fed land in two principal growing periods. One is in the dry season at the end of the rainy season in May and June, and the other is in the rainy season between December and April.

Potato production in Tanzania has increased from 109,917tons in1965/67 to well over 300,000tons in 1988/89 (Mayona and Mwambene 1993). About 90% of the country's total potato crop in 1988/89 was produced in the southern highlands. The increased production is attributed mainly to an expansion in areas under cultivation and the use of improved technologies such as varieties, agronomic practices and plant protection.

6.2 Description of the study area

The study was conducted in three districts: two districts Njombe -Usalule and Ihalula and one district in Mbeya - Kihondo village (Table 6.2).

Table 6.2: Villages involved in the study and respondents

District	Village	Number of respondents	
		Male	Female
Njombe	Usalule	13	14
	Ihalula	28	10
Mbeya	Kihondo	13	3

6.3 History of round potato research in Tanzania

Potato research in Tanzania started in the early 1950s with the evolution of introduced germplasm at Tengeru and Arusha. Several varie ties were released for commercial production. However, research activities were terminated in 1967 after the centre was converted to be the headquarters for the East African community. Research work resumed in Mbeya region in1974/75 after the establishment of Uyole Agriculture Centre (UAC).

The potato improvement programme (PIP) in collaboration with other countries involved in research on potato improvement, concentrated on variety selection for adaptability, high yielding and disease resistance, and on development of agronomic recommendation packages. The work produced several improved varieties:-Baraka, Sasamua, CIP Red and White ,Tana, Bulongwa and Subira. Agronomic practices developed included recommendations on: plant spacing and density, seed rate and seed size, planting dates and fertilization, plant protection: -weed control and pest/diseases control.

Since the inception of these technologies, more effort has been given to promote on-farm research covering all major potato growing areas in the southern highlands. Literature on potato research is concentrated on potato production (Uyole Annual Report 1974/75-1992/93) while there is much less literature on potato technology adoption.

Research activities in breeding and agronomy, including some aspects of plant protection have concentrated on selection for adaptability, high yielding, disease resistant varieties and the development of agronomic practices for potato production in the various agro ecological zones where potato is grown. (Table 6.3).

Table 6.3: Developed technologies

District /Village	Technology	When introduced	Source	Yield		Attributes			% of farmers using technology	Remarks
				Before	After	1	2	3		
NJOMBE USALULE & IHALULE	Varieties	1986 - 1995	IGERI	5bgs	30-100bgs	Higher yield	Marketable	More shelf life	100%	
	Time of planting	1986 - 1995	IGERI	5bgs	30 - 100bgs	More yield	Less disease		20%	
	Spacing & plant density	1986 - 1995	IGERI	5bgs	30 - 100bgs	Higher yield	Easy to weed	Better plant growth	100%	
	Seed rate & size	1986 - 1995	IGERI	5bgs	30 - 100bgs	Plant population	Better use of the land		100%	
	Fertilizers	1986 - 1995	IGERI	5bgs	30 - 100bgs	Higher yield	Better plant growth		100%	
MBEYA KIKONDO	Varieties	1970 - 1995	UYOLE	5bgs	30 -120bgs	Higher yield	High income	More market	10 - 100%	
	Time of planting Seed	1970 - 1995	UYOLE	5bgs	30 -120bgs	Avoid disease			100%	
	Seed rate	1970 - 1995	UYOLE	5bgs	30 -120bgs	Increase yield	Good germination		100%	
	Seed treatments	1970 - 1995	UYOLE	5bgs	30 -120bgs	Increase yield	Good germination		100%	

During the period 1975-1997, roots and tuber research has released six varieties of potato. Out of the six varieties released, CIP variety (Kikondo) was adopted by 100% of the farmers in Njombe district due to its good market qualities. Tana, Subira and Bulongwa were not grown because of poor market demand.

In Kikondo village (Mbeya), K59a (26) variety which is named by farmers as Kagiri, is the most widely grown variety among the improved varieties being grown by 80% of the farmers. On the other hand however, the local variety ARKA is the most preferred variety being grown by 100% of the farmers.

Farm level potato yield has increased from 1500 kg to 72,000 kg/ha in Njombe. This figure is well above the yields that are obtained under local practice.

Weeds, pests and diseases were mentioned to be the important constraints for potato production. All farmers, adopters and non-adopters were weeding their fields twice and using Ridomil to control the blight disease. All potato growers practised application of inorganic fertilizer. Nevertheless the applied rates were lower than the recommended levels largely due to lack of knowledge.

6.4 Impact of developed technologies

Potato breeding, agronomy and plant protection are the areas that have received most emphasize in the southern highlands. These researches have had varied impacts as elaborated below.

6.4.1 Economic Impact

6.4.1.1 Varieties

The choice of the variety to grow is determined by its seed availability, high yield, and good market and food security. Survey results for potato varieties in Njombe and Mbeya district show that farmers knew a total of thirteen cultivars (Table 6.4 and 6.5), three improved and ten local varieties in Njombe and five improved and 8 local in Mbeya district. In Mbeya district at kikondo village, ARKA is grown by 100% of the farmers and 80% of the farmers in Kagiri, 15% of the farmers in Kikondo.

Table 6.4: Round potatoes in Kikondo in Mbeya district

Type of varieties	Source	Current variety	% of household growing	When introduced
1. Arka	Arusha 1971 (Ndavile Ndemwa)	Arka	100%	1971
2. Kagiri/59	Kilimo Uyole (1984/85	Kagiri	80%	1984/85
3. CAP (Cream flesh)	Njombe (1995 Yeremia)	CAP	10%	1995
4. Kikondo	Sokoni D'Salaam 1988/89 Kikondo)	Kikondo	15-20%	1988/89
5. Ndelenga	Asili			

Table 6.5: Round potatoes in Kikondo in Mbeya district (contd.)

Type of varieties	Source	Current variety	% of household growing	When introduced
6. Malawi	Malawi			
7. Loti	Asilia/Ukinga (Local)			
8. Baraka	Kilimo Uyole 1984/85			
9. Suzana	Local			
10. Sasamula	Kilimo Uyole 1984/85			
11. Bongoloti	(Asilia) Local			
12. Benati	Ukinga			
13. Kenya Ushirika				

Table 6.6: Round potatoes Ihalula and Usalule in Njombe district

Varieties	Source	Current variety	% of household growing	When introduced
CIP	Igeri	CIP	100%	1986
Arka	Igeri	Arka	<50%	1995
Kala	Igeri	Kala	<25%	1986
Maloti	Ukinga			
Baraka	Igeri			
Salukanga	Native			
Vumilia Samkenge	Igeri Native			
Kenya	Native			
Pruta	Igeri			
Buti	Ukinga			
Samfindi	(Usalimini)			
Filiji	(Usalimini)			

The most grown improved varieties in Njombe were CIP (100%) and Kala (25%). Farmers used to grow Baraka and Loti but because of low market demand and presence of a hole at the centre of the tuber, they have stopped growing it. Farmers had no knowledge on Sasame, Bulongwa, Tana and Subira. The preferred varieties by farmers are summarised in Table 6.4 and 6.5.

The major reasons given by farmers for variety preference were good taste, high market demand, high yielding and early maturity. In Njombe district, farmers relied on on-farm trials and on Igeri substation (substion of Uyole Agricultural Research Institute) as the main source of new varieties.

6.4.1.2 Increased income

Farmers considered potatoes as a main source of cash income and sold the bulk of the crop produced. The yield advantage of improved potato variety over local varieties has made positive contribution to farmers' income and household well being in Njombe plateau and Mporoto highlands in Mbeya district. Table 5.6 shows the yield potential as speculated by the research. Yield has increased from tradition 750 kg/acre to 14250 kg/acre depending on the varieties grown (Table). Kaala for instances is giving a maximum yield of 16000 kg/acre while CIP is giving a maximum yield of

15000 kg/acre in farmers field. Kajiri in Kikondo Mbeya district is giving a maximum yield of approximately 14000 kg/acre while arka the most marketable 10000 kg/acres.

Table 6.7: Attributes of improved varieties

Variety	Yield potential (Ton/ha)	Tuber shape	Tuber colour	Late blight resistance	Maturity period (days)
Baraka	15-30	Round elliptical	Red/brown	Moderate	105-160
Sasamua	15-30	Oblong	White	Moderate	90-120
CIP red	20-40	Round elliptical	Red/brown	Moderate	105-160
CIP white	15-30	Oval round	White cream	Low	90-120
Tana	15-25	Long oblong	White	Moderate	105-165
Subira	15-30	Round	White	Moderate	75-104
Bulongwa	15-30	Long oblong	White	Moderate	100-150

In Njombe plateau, household income has increased from 0 Tsh to 275000/= and 475000/= Tsh. In Mbeya district at Kikondo village in Mporoto highlands, household income has increased from 0 Tsh to 425000/=Tsh. Potato producers sold their potatoes to local traders at prices ranging between 5000-8500/= per bag of about 150kg.

6.4.1.3 Improved food security and poverty alleviation

Both the adaptors and non-adaptors indicated that potatoes were grown for food and sale. At Njombe, potato yield has increased from 5 bag to 90 bags/acre, this reduced poverty by more than 100% while at Kikondo in Mbeya district potato yield has increased from 5 bags to 85bags per acre and has reduce poverty by more than 100%. Farmers did not store potatoes in granary for food reserve; instead they sell a good amount of it and buy food that can be stored over a long period such as maize. Potato seeds for planting next season are stored on raised rock or on floor in the shed and huts. On average, adaptors retain about six bags for seed whereas non-adaptors retain about 4 bags of seed for planting in following season.

Table 6.8: Varieties performance in farmers field

No.	Variety	Year started growing	Yield on-farm current/present (bags/acre)
1	Arka	1970	40-70
2	CIP	1986	70-100
3	Kala	1986	70-110
4	Kagiri/59	1984/85	90
5	CAP (cream flush)	1995	1000
6	Kikondo	1988/89	85

Key: 1 bag of potatoes = 150kg, 1 hectare = 2.25 of a land

6.4.1.4 Impact of improved management practices

6.4.1.4.1 Land preparation and planting time

Farmers recognize early planting as a key factor in improving yield. The recommended time of planting in Usalule and Ihalula is November to December. This has been adopted by 20 % of farmers. The non-adopters (80%) plant in August to October because of (i) pre germination in the soil (ii) easy planting in the dry season and (iii) to avoid high temperature (Table6.8).

Table 6: 9 Adoption of technology in Usalule and Ihalula - Njombe district

Technology	Adoption	Reason for Adoption	Modification of Technology	Reasons for non/partial adoption
Varieties CIP	100%	Higher yielding Good market Food Security	-	-
Arka	<50%	Higher yielding Food security	-	Less acceptable in market
Kala	<25%	Higher yielding Food security	-	Limited market
Time of Planting November - December	20%	Stegade planting to avoid loss	Planting in August to October	Pre-germination Easy planting in dry season To avoid high temperature
Spacing and plant density 60 - 75 cm by 25 - 30 cm	100%	Better plant growth and yield	-	-

Table 6.8: Adoption of technology in Usalule and Ihalula - Njombe district (contd.)

Seed rate and size Small tubers - 60 g (4-5 bags) Medium size 60 - 120 g (8-10 bags) Large size >120 g (9-10)	100%	Plant populations per acre. Better land use	-	-
Seed treatments Sprouting seeds before planting	0%	None	Sprouting in the soils	No yield difference No cost for labour
Fertilizers	100%	Increase soil nutrients Increase yield	-	-
Seed treatments Sprouting seeds before planting	100%	Control blight	-	-

In Kikondo, Mbeya district recommended planting time is September to October. This has been adopted by 100%. The reason for high adoption is to avoid diseases during the growing periods (Table 6.9).

Table 6. 10: Adoption of technology in Usalule and Ihalula - Njombe district

Technology	**Adoption**	**Reason for Adoption**	**Modification of Technology**	**Reasons for non/partial adoption**
Varieties Arka Kagiri/59 CAP Kagiri	 100% 80% 10% 15-20%	 Higher yielding Higher income Market		 Recently introduced Recently introduced
Time of Planting September - October	100%	Avoid diseases	-	-
Spacing and plant density 45 - 60 x 30 cm used 60 - 70 x 30 cm recommended Seed rate and size Small 4-5 bags (6) Medium 8-10 bags (8) Large 9-10 (10) Figures in brackets indicate recommended rate	 0% 100%	Better plant growth and yield Increase yield and good germination	- -	No demonstration on this technology -
Seed treatments Sprouting of seeds before planting	100%	Increase yield and good germination		
Fertilizers 80 - 140 kg Urea + 60 kg TSI/Acre	0%	None	2 + 1 CAN or 3 - 4 DAP bags	No knowledge on use of fertilizer sent
Use of Fungicides	0%	None	None	Planting early to avoid diseases

The main sources of information on potatoes planting time were from farmer to farmer and from extension workers. Some of the adopters got their information from Igeri substation and from Uyole.

6.4.1.4.2 Planting method, seed rate and cropping pattern

All surveyed farmers (100%) in Usalule and Ihalule planted potato in rows on prepared flat seedbeds at spacing of 60-75cm by 25-30cm (Table 6.8). The reason for adopting the system was easy weeding and easy fertilizer application. In addition, they get better plant growth and higher yields per acre through this practice.

In Kikondo Mbeya district (Table 6.9), the recommended spacing of 60-70 x 30cm was not adopted. Farmers used 45-60 x 30 cm because of lck of knowledge (no demonstration had been done) on the recommended spacing. The recommended seed rate and size in bags per acre are given in Table 6.8 and 6.9. Farmers have adopted the technology by 100% and current plant density in their respective fields is 53,000-55,555 plant population per acre. The price of potato seed of all the size range 8000 to 1000/= per bag.

6.4.1.4.3 Management of weeds

All farmers, adaptors and non –adaptors controlled weeds in their potato fields. About 97% of the adaptors and 96% of the non-adopters controlled weeds twice to three times, while the rest weeded their fields once. The common method used in weeding is the hand hoe and some hand pulling. None of the surveyed farmers used herbicides to control weeds. The reason given for not using herbicides was lack of information on how to use the m. The most notorious weeds mentioned by both adaptors and non adaptors included: *Cynodon dactylon* (kidilu), *Galinisoga parviflora* (Wondering Jew), *Commelina bengalensis* and *Cyperus spp.*

The time frequency of weeding was mentioned to be dependent on the time of planting and weed infestation. Early planted potato crop with high weed intensity necessitated several weeding to produce a weed-free field. The first weeding was done between one and half week and one month after emergence. The second weeding was done at hilling stage, two to three weeks after first weeding.

6.4.1.4.4 Pest and disease control

Aphids were considered by farmers to be the most important pest under potato. Diseases of economical importance reported were potato blights and bacteria wilt. Farmers were able to control potato blight using fungicides but did not have a specific measure on bacteria wilt apart from uprooting the diseased plant. The use of fungicide has been adopted by 100% of farmers in Usalule and Ihalula in Njombe district (Table 6.8). In Kikondo - Mbeya district, non of the farmers (0%) were using fungicides (Table 6.9). The reason for not adopting was the fact that they planted their fields early enough to avoid the diseases.

Pesticides and fungicides are readily available in agricultural chemical shops in Njombe and Uyole Mbeya town. Information flow through farmer to farmer exchange has facilitated wide use of fungicides in the control of potato blights. Also the

extension service was another source of information. Other important sources of information mentioned were research, NGOs and research extension leaflets.

6.4.1.4.5 Use of fertilizers and Soil fertility

Farmer in Njombe district (Table 6.8) use different types of strategies to restore declining soil fertility. Strategies used included application of organic and inorganic fertilizers, crop rotation and fallowing .The use of fertilizer is related to the importance of the crop. In Usalule and Ihalule, there was100% adoption in fertilizer use. In Kikondo, farmers used fertilizer at a lower rate than recommended because they rated their land as being fertile. The common inorganic fertilizer used were Diamonium phosphate (DAP), Calcium Ammonium Nitrate (CAN), Triple super Phosphate (TSP), Urea and Sulphate of Ammonia (SA). In potato production, especially in Njombe district (Table 6.8), farmers preferred basal fertilizer application rather than top dressing.

6.4.2 Environmental Impact

In Njombe plateau, improved potato production has improved soil fertility from the incorporation of heavy plant biomass into the soil and the follow-up practice of crop rotation with maize. Early weeding followed by the practice of lifting-up the soil to form ridges in the field greatly control soil erosion. However in Mbeya Mporoto highlands, expansion of potato production due to high market demand has caused great loss of natural vegetation. Due to land scarcity, the practice of fallowing is not done. At the same time, crop rotation is not practised because there is no other crop of comparable advantage. This has increased the potential for occurrence of soil erosion in the area.

6.4.3 Social-cultural impact

6.4.3.1 Empowerment of farmers

The introduced technologies have empowered the adaptors through the increased purchasing power obtained. Farmers indicated that they are now able to buy more fertilizer; obtain better education through seminars, workshops, extension and research contact; and are able to pay tax which was difficult to pay before. Also, transport is now easily available because the roads have been opened up and there is periodical maintenance to allow lorries go to the villages to carry bags of potato.

As a result of the research interventions and increased economic activity, social interactions of customs and norms have increased. These and other matters have brought about social changes in society. This has been the case in all the villages surveyed and especially in Kikondo where most houses have been improved with iron sheet roofing.

6.4.3.2 Gender concerns

Potato production is gender neutral in that both men and women grow and sell the crop. Improved varieties have benefited equally the status of the whole families that grow the varieties .The improved varieties have also benefited long distance traders

who are usually men selling potatoes in Dar es salaam, Arusha, Malawi and Zambia and local road stand and town traders who are mostly women.

6.4.3.3 Capacity building (famers training)

During the period 1975 –1992 farmers received training in several areas. For example in the 1987 period in Njombe district, 16 male farmers received a course on improved potato production and in 1984 in Njombe district, 15 male farmer received or were given training on different aspects of potato varieties production through conducting demonstration trials in their respectively fields (Table 6.10)

The potato project leader - Dr. Gondwe (Personal Communications, 2002) reported that 30 farmers were trained on potato production techniques every year from 1980-1990. This gives a total of 300 farmers being trained through this way. Along with these were 3-4 technicians and 4 researches being trained in various disciplines at CIP Nairobi and Lima Peru between 1980 and 1990.

At the same time, there were one to two extension workers from each district in the southern highland being trained at ARI Uyole each year from 1980 to 1990.

In conclusion therefore, it can be observed that potato research in the Southern Highlands zone has had significant impact in the various areas mentioned in the previous discussion. There is also a lot to be learnt from the research experiences cited by farmers which future research will need to take into consideration before bringing any new interventions in the area.

Table 6.11: Capacity building

District /Village	Type of training ON FARM	When conducted	No: of farmers		By whom	Remarks
			M	F		
NJOMBE USALULE /IHALULE	Course on improved potatoes production	1987	16		Mr. Macha & Jacobson	Include more women Use of fertilizers should be included
	Potatoes varieties Trials/demonstration	1984	15		Mr. Macha	Need more training on use of fertilizers and chemicals
MBEYA KIKONDO	-	-	-	-	-	Need course on use of fertilizers Look for alternative crop

6.5 Appendices

6.5.1 Cash crops

	Njombe District	Mbeya District

Type of food crop (Rank)	**Njombe District**		**Mbeya District**
PYRETHRUM	**Village 1**	**Village 2**	**Village 3**
MAIZE	**USALULE**	**IHALULE**	**KIKONDO**
POTATO	2	2	1
WHEAT	3	3	
BEANS	4	4	
PEAS	5	5	
CABBAGE	7	7	
LIVINGSTON	8	8	
FRUITS	9	9	

6.5.2 Existing varieties: potatoes

District /Village	Varieties	When introduced	Source	Yield		Attributes	% Of farmers using technology	Remarks
				Bad year	Good year			
NJOMBE USALULE/IHAULE	CIP	1986	IGERI	70 bgs/acre	100bgs/acre	Higher yielding Good market Food security	 100%	
	ARKA	1995	IGERI	40 bgs/acre	60bgs/acre	Higher yielding Food security	 < 50%	Less acceptable in market due to short shelf life
	KALA	1986	IGERI	70 bgs/acre	110bgs/acre	Higher yielding Food security	< 25%	Limited market
MBEYA DISTRICT KIKONDO	ARKA	1971	ARUSHA		70bgs	Higher yielding	100%	
	KAGIRI	1984/85	UYOLE		90bgs	Good foe chips Higher income Larger tubers	80%	
	CAP	1995	NJOMBE		100 - 120 bgs/acre	Marketable	10%	Cream flesh
	KIKONDO	1988/89	D'SALAAM		85bgs/acre	Higher income	15 - 20%	Yellow flesh

6.5.3 Production problems (rank)

Problem	Njombe District		Mbeya District		
	Village 1 USALULE	**Village 2 IHALULE**	**Village 3 KIKONDO**	**Position**	**Solution**
Low yield	5	5	3	7	Management Practices
Disease susceptible	2	2	2	1	Use resistance varieties and use of chemicals
Varieties	4	4	4	4	Introduction of varieties
Poor husbandry practices	3	3	1	3	Education to farmers
Soil fertility decline	6	6	5	5	Education, seminars and workshops
Unstable prices	1	1	6	2	Look for more markets Maintain roads
Poor husbandry	5	5	7	6	Management practices
Unavailability of improved seed stock	8	8	8	8	Introduction on how to produce seeds

6.5.4 Contribution of technologies to:

Item	Njombe District		Mbeya District
	Village 1 **Usalule**	**Village 2** **Ihalule**	**Village 3** **Kikondo**
Yield	Increase 55 - 95bags	Increase 55 - 95bags	Increase to 85bags/acre
Income	Increase 275,000 - 475,000	Increase 275,000 - 475,000	Increased from 50,000 - 400,000
Food security	Increase from 5bags to 90bags/acre	Increased from 5bags to 90bags/acre	Increase from 5bags to 85bags /acre
Poverty Alleviation	Reduced poverty by more than 100%	Reduced poverty by more than 100%	Reduced poverty by more than 50 - 100%
Malnutrition	Decreased by 50%	Decreased by 50%	Decreased by 50%
Environmental	Improve soil fertility control erosion	Improve soil fertility control erosion	Reduced vegetation No crop rotation Erosion possible
Empowerment of farmers	Building houses Pay tax School fees Purchasing power	Building Pay tax School fees Purchasing power	Increase purchasing power of : 1. Fertilizers 2. Education 3. Pay tax 4. Social charges 5. Modern house
Gender concern	CIP gender perspective Crop gender control Crop benefit	CIP gender perspective Crop gender control	More trades on woman especially The petty business trades Improve the status of the whole family

6.6 Reference

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