AGRICULTURAL TECHNOLOGY ECONOMIC VIABILITY AND POVERTY ALLEVIATION IN TANZANIA

by

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Abbreviations

ADT	Animal Draught-power Technology
CARMATEC	Center for Agricultural Mechanization Technology
DRD	Department of Research Development
HYV	High Yielding Variety
MAC	Ministry of Agriculture and Co-operatives
NARIs	National Agricultural research Institutes
NARS	National Agricultural research System
NBRP	National Bean Research Programme
NMRP	National Maize Research Programme
SUA	Sokoine University of Agriculture
UAC	Uyole Agricultural Center
URT	United Republic of Tanzania

1. INTRODUCTION

All indicators suggest that agriculture in Tanzania is, thirty seven years after independence, still underdeveloped. Available information confirms that use of modern agricultural technology is not a common practice. According to the 1994/95 National Sample Census of Agriculture out of every ten holders, only three use improved seeds; four use farm yard manure; two use chemical fertilizers (and this is mainly in seven out of the total twenty regions); three use pesticides, insecticides, or herbicides; six receive advice from extension agents. The common farm implement owned by all holders is the hand hoe. Out of ten holders, eight own an axe, eight big knife matchet, seven a motar, five a grinding stone, and one owned a plough. Out of a thousand holders, four own harrows, one a tractor, five get agricultural credit, and irrigation is carried out only by three holders mainly in only three regions (URT, MAC: 1996)

Agricultural production in the country is dominated by smallholders who produce about 75 percent of total population. About 3.9 million households in the rural community are engaged in small scale agriculture (World Bank 1994). More than 60 percent of the rural populations live in absolute poverty. Land and labour productivity in agriculture are well below what they could be. Average yields in kilograms per hectare of crops (1994/95) are very low: maize 1630, paddy 1580, wheat 1382, sorghum 1216, and 625 beans (URT; MAC 1998). Increasing the productivity of land already under cultivation and increased use of labour saving technologies are necessary components of efforts to alleviate poverty in developing countries including Tanzania where agriculture is a lead sector.

An assumption is often made that there are adequate profitable technologies on the shelf in Tanzania which farmers can use to increase productivity, and incomes and hence reduce the level of poverty. But because of the way in which agricultural research has been organized for decades, we know that economic assessment of these technologies has not been sufficiently integrated with the process of agricultural technology development. Most technologies have been released based on attributes like high yield, early maturity and taste rather than on being based on economic benefit.

Economic viability of technologies has in reality not been a concern of agricultural researchers, but it remains a very important attribute that a farmer

continuously assesses in deciding whether or not to use a particular technology. It is also the case that some of the technologies are not clearly defined, i.e. what is the technology being addressed and what are its unique characteristics and contribution to the total output? How does profitably combine with other technologies?

The problem this study looks into is the issue of low adoption of agricultural technology. Many of the problems with adoption seem to be outside their domain of the National Agricultural Research Institutes (NARIs). The extension systems have not worked to expectation of beneficiaries, inputs were not available or were too costly, farmers lacked information or had a set point of satisfaction and would not make an effort to produce more. It appears that researchers are not aware of the economic return to be derived from shifting from an existing variety to a new one they were developing. The economic benefit of agricultural technologies is one factor that influences adoption of the technologies developed. In numerous occasions, the adoption of these technologies may have been difficult, either because the technologies proposed, were not sufficiently adapted or because they presented economic risks, contradicted local culture, or were constrained by inadequate accompanying economic policies.

Studies on the economic viability of recommended agricultural technologies are meant to provide some insights into the extent to which the recommended technologies are profitable. More specifically this study attempts to answer the following questions: what are the recommended agricultural technologies in Tanzania? Are the recommended technologies profitable? If yes, at what level, and to what extent in relation to other competing enterprises at the farm household setting? If they are not profitable, what are the implications for policies related to agricultural research agenda for the programme leaders within NARIs, for research administrators within NARIs and to the Ministry of Agriculture and Co-operatives? If the technology is profitable and yet adoption is low, what are the policy areas that may be hindering the process of adoption and what should be done to mitigate them?

This study is important because agricultural technology, its development, transfer and adoption are fundamental in increasing productivity, rural incomes, growth and subsequently in contributing to poverty reduction. This is particularly important in semi-subsistence agriculture which is typical of the countries of eastern and central Africa. The aim is to develop, promote and support market oriented,

demand driven research. NARIs should be helped to focus their research programmes on those issues where improved technologies create measurable economic impact at the farm level. The objective should be to promote economic growth by developing, introducing and disseminating agricultural technologies which both create markets and respond to future economic opportunities for new technologies as well as maintaining the long term sustainability of the natural resource base. Findings from this study will develop better understanding by the Tanzania policy makers and donors about how to make reform programs more effective in fostering broad-based development. The study is supposed to contribute to the debate on revolutionizing agricultural research in the Tanzania to better respond to the really challenges of poverty alleviation. It is envisaged that the findings will be applicable to all levels of policy making starting at the commodity programme to the ministerial level.

The main hypothesis being tested in the study is "Agricultural technology adoption and use by farmers will be improved by more explicit attention to the underlying market factors that (both input and output) determine economic viability and by greater consideration of the technology transfer systems".

The methods applied in undertaking this study include: analytical review of literature leading to a general overview of agricultural technology development, dissemination and adoption and its likely impact on the farm and household level; interviews to research administrators, research scientists, planning and policy units; researcher working closely with and received valuable inputs from experts (breeders, entomologists, plant protection experts, etc) in research institutes (SUA and Selian) and at the Ministry of Agriculture and Cooperatives (for the list of names see Appendix); and inputs from a mid-term review that took place in April 1999 in Enttebe.

Four agricultural technologies: i.e. improved maize variety, improved bean varieties, Animal Draught Technology (ADT) and dairy farming were selected. The next section reviews the institutional aspects of research and development in the country, followed by section three where a detailed economic analysis of the selected technologies is made. Section four relates the economics of the technologies presented in the previous section with poverty alleviation. It is an attempt to investigate the extent to which the selected technologies can alleviate poverty in the country. Section five makes an analysis of the factors which constrain

poverty alleviation through the selected technologies while at the same time trying to provide policy recommendations. Section six gives concluding remarks.

2. INSTITUTIONAL ASPECTS OF AGRICULTURAL TECHNOLOGY DEVELOPMENT IN TANZANIA

2.1. Agricultural research policy and organisation

2.1.1. Research Policy Objectives

The overall aim of agricultural research is to promote sustainable food security, income generation, employment growth and export enhancement through the development and dissemination of appropriate and environmentally friendly packages [URT (MAC) 1997:25]. According to the National Agricultural and Livestock Research Masterplan, NALRM, the objectives of NALR policy are (URT 1991:12):

- to improve the productivity and quality of agriculture and livestock production through the development of suitable crop varieties and livestock species
- to develop both biological and mechanical technological packages that can be adopted by producers
- to improve socio-economic returns, using low-cost input technologies
- to minimize environmental pollution by developing pest and disease-resistant varieties/species.
- to develop ways and means of judicious and sustainable utilisation of the nation's soils water and other renewable resources, so as to maintain the agricultural productive base.
- to exploit, as far as possible internationally or regionally available research results and other appropriate technologies
- to optimise exports and reduce foreign exchange expenditure to the nation and dependence on outside markets through import substitution

To achieve the above policy objectives, the NALRM emphasizes the following:

- the need to apply appropriate scientific and technical knowledge to local conditions
- effectively linking research with extension, training, NGOs and other national, regional and international institutions and associations involved in agricultural and livestock technology development and transfer.

- client oriented approach for planning and conducting agricultural research.
- the need for rehabilitating and strengthening the streamlined research network
- more private sector involvement independently or jointly in research planning and funding
- the need to provide packages of incentives in order to attract, motivate and retain competent research staff
- increase financial resources allocated to agricultural and livestock research.
- strengthening of information and documentation services.

2.1.2. Approaches to Agricultural Research and Development

After realizing the weaknesses of the conventional systems in agricultural R&D, the Ministry of Agriculture and Co-operatives is currently using the Participatory Rural Appraisal (PRA) approach where Farmers Research Groups (FRG) have replaced the best, model or contact farmer approach. Researchers involve the various stakeholders (i.e. producers, consumers, farm implement fabricators etc.) right from the problem identification stage, where village extension officers (VEOs) also take part when it concerns farming, to the stage of developing the technologies themselves. This approach has been very successful in paddy growing areas in Mwanza and Shinyanga regions with respect to weeding using an implement developed by the CARMATEC. Research in Tanzania is also doing away with the old tradition whereby researchers behaved like doctors (not like flying doctors) who waited for patients while agricultural extension officers also waited for technologies to be developed by researchers. The Farming Systems Approach, which the MAC is now using, ensures a two-way operation system (Mitawa 1999, pers.com).

The MAC is also emphasizing on the commercialization of the technologies being developed. Most technologies developed up till now could not be commercialized. Research in the country is now not only ending up with development of technologies but is also actively involved with aspects of their commercialization. This is taking place especially with post harvest technologies on roots and tubers, coconuts, oilseeds, maize and millet. Cassava and coconut graters and oilseeds rum-presses are now very popular in the cost regions and in Kilosa districts respectively.

Liberalization of crop markets has enabled producers to sell their produce freely to any buyer. Seed varieties developed for specific areas are now moving freely across ecological zones. This threatens research achievements made so far. To realign with this reality the MAC is introducing a new system of smallholder seed breeding aimed at ensuring sustainability and consistence in the availability and use of the varieties. This is basically a community based seed multiplication undertaking. Pilot or contract farmers, or on-farm seed producers in collaboration will produce seed with breeders and other organizations such as NGO's, if available. Currently NGOs such as the Christian Council of Tanzania (CCT) and the Italian LVIA (at Kongwa for maize and bean seeds) which are already involved in the exercise. In the case of cotton, for example, the Tanzania Cotton Lint and Seed Marketing Board (TCLSMB) will contract villages or farmers to grow a specific recommended variety of cotton, which will eventually be ginned at specific ginneries. The seed resulting from these ginneries will be distributed back to producers through the regional co-operative unions (Mitawa 1999, pers.com)

2.1.3. Organisation of Research

Agricultural and livestock research in Tanzania is currently the responsibility of the Department of Research and Development (DRD) in the Ministry of Agriculture and Co-operatives (MAC). The research system, which used to be based on a network of over 50 research institutes, stations, substations is now based on just over 25. Many others have been reduced to trial sites or have been closed outright in line with the restructuring and right sizing of the activities and services of the Ministry made necessary by economic reforms. The Tropical Pesticides Research Institute (TPRI) continues to be a semi-autonomous parastatal while the Uyole Agricultural Center (UAC) is now within the network of the DRD stations. The Sokoine University of Agriculture (SUA) has now been accorded a zonal status. The University of Dar es Salaam, also undertake agricultural research to a lesser degree. Some private estates undertake research activities to suit their own purposes.

The main research activities under the DRD are now operated by eight zonal Research and Training Centres located in the identified seven agro-ecological zones plus the SUA. In each zone there is a lead-research centre which has the responsibility for both applied and adaptive research and training.

The structure and organisation of the research system in the country has changed several times since 1980's when research was carried out mainly by four parastatals, namely Tanzania Agricultural Research Organisation (TARO), Tanzania Livestock Research Organisation (TALIRO), TPRI and the UAC. Each of these had its board of directors, research network programmes and the Directorate of Research and Training at the MAC only played the co-ordination role. In 1989, the government re-organized the system by merging the two research parastatals: TARO and TALIRO with the Directorate of Research and Training to form the present Department of Research and Development (DRD). In addition to government controlled research (institutes), crop authorities and estates (or private agri-businesses) also undertake agricultural research.

It is the policy of the MAC that all new crop varieties developed must pass through the national testing system whereby the National Varieties Release Committee appraises resistance to diseases, acceptability and adaptability of the various varieties that are produced or distributed. Currently there are 23 programmes of crop research programmes whose activities are carried out according to zonal priorities. There are five national Foundation Seed Farms in the country: Arusha (beans), Dabaga-Iringa, Msimba-Kilosa, Kilangali-Kilosa, and Mwere-Tanga. The last two are targeted for closure due to downsizing and rationalization of the MAC activities. Multinational firms are also actively involved in seed distribution. These are Cargil Hybrid Seed Company Ltd., Pioneer Hybrid International, and Pannar.

2.1.4. Major Constraints

Despite the sizable research network, Tanzania research services have not been able to fulfill their role in developing appropriate technological packages for farmers in the past few years (URT 1991:13). Research services were constrained by the following factors:

- Fragmentation of research system
- Poor co-ordination
- Inadequate funding:
- Lack of priorities

- Poor research-extension linkage
- Poor research management

2.2. Agricultural Extension and Training

Extension and training are among the core functions of the Ministry of Agriculture and Cooperatives (MAC) and the agricultural sector as a whole. The main objectives of the extension and training services is to transfer recommended agricultural technologies from breeders to farmers, livestock keepers and other stakeholders. The MAC has now evolved a National Agricultural Extension Programme (NAEP) where the services are now demand driven and will address the needs of the farmers. The focus is to merge crop and livestock extension services into a multidisciplinary system where management and organization will be strengthened.

Currently the MAC operates twelve training institutes whose total capacity are 2,100 students. This capacity has been rarely reached due to a number of reasons including the cost-sharing requirement and availability of specialized training within projects. The institutes are now changing their curricula and programmes and operating self-help accounts in order to cope with the existing realities of a market economy (URT, MAC: 1999).

3. THE ECONOMICS OF SELECTED AGRICULTURAL TECHNOLOGIES

Technology 1: **Improved Maize Varieties:** Kilima

Background Information

Maize is the most important food grain in Tanzania. It is not only a staple crop in surplus regions, it is also a cash crop. It is grown on about 45 percent of total arable land; the bulk of the maize produced (75 percent) is consumed on the farm; per capita maize utilization is about 114 kilograms per year; per capita maize feed use is about I kilogram per year; and it provides about 25 percent of the total calories required in diets (Nkonya et. al. 1998)

Maize production in the country averaged 2.36 million tones per annum in the period between 1984/85 and 1997/98 with the lowest and highest levels of 1.83 and 3.1 million tones registered in 1996/97 and 1988/89 respectively. Although maize is produced in almost all twenty regions, either as a source of income or for consumption, only nine regions produce annually at least 100,000 tones each. These are Arusha, Dodoma, Iringa, Mbeya, Rukwa, Ruvuma, Mwanza, Shinyanga and Morogoro (URT-MAC 1998b, p.6). Maize production problems in Tanzania include low soil fertility due to: inherent low soil fertility, land degradation and non-use of fertilizers; use of unsuitable varieties; moisture stress; pests and diseases; and weeds.

Though maize research in Tanzania started way back in 1940's it was only in 1974 that The National Maize Research Programme (NMRP) was initiated. Twenty-four varieties of white maize are produced in Tanzania, as is shown in Table 3.1, out of which the NMRP has released fifteen varieties. The most preferred varieties are, however, mainly eight due to the fact that they are high yielding, resistant to pests and diseases, resistant or tolerant to drought thus early maturing, low risk technologies, seed availability, relatively cheap, and palatability. These varieties, which are open pollinated, are *Staha, Staha-St, Kilima, Kilima-St, Katumai*, TMV-1, ICW, and UCA. They are recommended according to specific agro-ecological zones depending on whether it is a high, medium, or low altitude area in seven zones, namely Central, Eastern, Lake, Northern, Southern, Southern Highlands, and Western (Moshi et. al. 1997).

Table 3.1: Basic Characteristics of Maize Improved Varieties Cultivated in Tanzania

VARIETY/ HYBRIDS	YEAR RELEASED	POTENTIAL YIELD (t/ha)	EXPECTED YIELD UNDER GOOD HUSBANDRY (t/ha)	SPECIAL FEATURE	MATURES WITHIN (DAYS)
ICW	1960's	6.0	4.0		120 -150
UCA	1960's	7.5	5.0		120 -150
TUXPENO	1976		4.0		120 -150
H 6302	1977	11.0	8.0		160 - 180
H 614	1978	10.0	7.0		-
KILIMA	1983	7.0 - 7.5	5.0		-
STAHA	1983	6.0	4.5	Streak Tolerant	120 - 150
TMV-1	1987		3.5	Streak Resistant	120 -150
TMV-2	1987		4.5		110 - 115
KITO ST	1994	6.0	3.5	Streak Tolerant	-
KATUMANI ST	1994	4.5 - 5.5	4.3	"	-
UCA ST	1994	7.5	5.0	"	120 - 150
KILIMA ST	1994	7.0 - 7.5	5.5	"	120 -150
CH1	1992		5.5		-
CH2	1992		5.5		-
KITO	1983		3.5	Escapes Drought	90 - 100
CG 4141	1997				110 -115
CG 4142					
C 6222					
PAN 695					
PAN 6549					
PAN 6195					
PHB 3253					
H 511					

Source: Nkonya and others (1998) and Selian Agricultural Research Institute- Arusha, Maize Research Department

In view of the various climatic conditions different parts of Tanzania experience, agricultural research institutes recommend that early maturing varieties be grown in areas with short rain seasons while late maturing varieties in areas with long rainy seasons in order to maximize yields. Early maturing varieties take two and a half to three months while late maturing varieties take five to eight months to mature. There are varieties that take three to five months to mature and these are grown in medium altitude areas.

Recent studies show that maize farmers in all the zones grow both local and improved varieties. Identification of pure varieties is difficult due to recycling. The most preferred varieties grown, percentages of total production and adoption rates per zone are shown in Table 3.2. It can be observed from the table that the zones that have high adoption rates also have high shares in total maize production.

Table 3.2: Recommended Maize Improved Varieties per Zone and Adoption Rates

Zone	Varieties Recommended	% of Total Production	Adoption Rates
Western	Staha, Kilima, and TMV-1	11	36
Central	Staha, Kilima and TMV-1	3	28
Eastern	Staha, Katumani and TMV-1	9	66
Lake	Kilima, Katumani, and Imported varieties	17	44
Northern	Kilima, CG 4141, H 632, and H 622	11	66
Southern	Staha, Katumani, and ICW	2	24
Southern Highlands :	H 632, H614, and UAC	46	81

Source: Moshi and others (1997) and Nkonya and others (1998)

Moshi and others (1997) have established that the estimated rate of return for maize Research and Development (R&D) investment in Tanzania was 19 percent which demonstrates that past investments in the area are clearly profitable and generated competitive rates of return. The maize varieties released by multinational seed companies are: Cargill: CG 4141, CG 4142, and C 6222; Pioneer Hybrid International: Phb 3253 and Phb 3435.

PROFITABILITY OF THE *KILIMA* MAIZE VARIETY

The area selected for analyzing profitability of the variety is the northern and Lake Zones comprising of regions of Mwanza, Mara, Kagera, Arusha, Kilimanjaro and Tanga where the *Kilima* is a recommended variety. Figures from on-station trials for the variety (Table 3.3) indicate that if farmers grow maize as per recommendations, the gross margin per ha. is Tshs. 397,500 and return per labour is Tshs. 2,923 per man-day.

Table 3.3: On-station Profitability of *Kilima* Maize Improved Variety (1997/98)

ACTIVITY/INPUT	**PRICE/COST** (Tshs)	
A: Revenue:		
Yield per ha. 75 bags		
Producer price: Tshs. 10,000 per 100 kg. bag		
(Total Labour Input: 136 Man days)		
Realization: Tshs/ha.		**750,000**
B: Costs:		
1. Cultivation using tractor	25,000	
2. Harrowing	20,000	
3. Seeds (25 kgs)	25,000	
4. Seed sowing	15,000	
5. Thinning	7,500	
6. Weeding 1	17,000	
7. Weeding 2	17,500	
8. Purchase of Endosulfan (20kg)	30,000	
9. Labour charge for applying Endosulfan	15,000	
10. Purchase of Urea (4 bags)	48,000	
11. Purchase of TSP (4 bags)	52,000	
12. Labour charge for fertlization	15,000	
13. Harvesting	20,000	
14. Striping (75 bags)	45,000	
TOTAL COST		352,500
Gross Margin per ha.		**397,500**
Return to Labour: (Tshs. per Man Day)		**2,923**
		($)

Source: Selian Agricultural Research Institute-Arusha, Maize Department.

Table 3.4 presents the crop budget for maize, which is based on the prices of 1998 and rough estimates of the yields, and labour day inputs. The net revenues vary from Tshs. 615 to 1,358 per labour day and Tshs. 72,000 to 111,000 per hectare. The latter figure refers to inter-cropping maize and groundnuts, which is rather attractive in terms of maximizing the revenue per hectare.

Table 3.4: Crop budgets for maize for different types of soils in the Lake Zone

	1. Maize	2. Maize	3. Maize	4. Maize/groundnut	
Soil	*Luseni*	*Mbuga*	Not specified	*Kikungu* Maize	Groundnut
Yield in kg/ha	800	1,000	1,200	500	375
Gross revenue (Tshs/ha)	80,.000	100,000	120,000	50,000	93,750
Costs of inputs (Tshs/ha)					
Land preparation	0	1,500	1,500	0	0
Seed	2,500	2,500	2,500	2,500	15,000
Fertilizer/manure	0	0	35,000	5,000	5,000
Tools	5,000	5,000	5,000	2,500	2,500
Total costs of inputs (Tshs/ha)	7,500	9,000	44,000	10,000	22,500
Net revenue (Tshs/ha)	72,500	91,000	76,000	40,000	71,250
Labour days:					
Cultivation	40	10	10	20	20
Fertilizer application	0	0	2	0	0
Planting	6	6	6	6	6
Thinning/weeding	20	20	20	15	15
Harvesting	10	12	14	10	10
Shelling/bagging	9	12	14	9	10
Transport	5	7	8	5	4
Total labour input (days)	90	67	74	65	65
Net Revenue per labour day (Tshs)	806	1,358	1,027	615	1,096

Source: van der Linde et. al. (1998): Tanzania: Formulation of a Cotton Sector Development Strategy, pg. a21

Legend of columns:

1. *Luseni* soils: traditional hoe cultivation on ridges
2. *Mbuga* soils: ox ploughing, line sowing; hand weeding
3. Maize cultivation with fertilizer application (25 kg N and 25 kg P205), ox ploughing, line sowing and hand weeding
4. Maize and groundnuts inter-cropped. Hoe cultivation on ridges on *Kikungu* soils. Manure application.

Notes:

- Prices of 1998; maize producer price 100 Tshs/kg, groundnuts producer price 250 Tshs per kg.
- Costs of tools include depreciation of tools and bicycles, and various small expenditures.

Information provided in Table 3.4 could be used to compare profitability of the variety with that which is provided in Table 3.5 for other medium elevation regions such as Dodoma and Mpwapwa where Kilima is also grown. Data shows the gross margin in Mpwapwa is Tshs. 28,520 per ha. and return to labour is Tshs. 344 per labour day while the respective profitability in Tabora is Tshs. 44,360 and Tshs. 534. This clearly indicates that the market plays a big role in determining profitability of a technology. Price in Tabora is higher (Tshs. 80) while it is lower (Tshs.67) in Dodoma. This could be so because Dodoma is normally a maize surplus region. Comparison of figure in Table 3.5 with those in Table 3.4 shows that returns to labour are much higher to producers of the variety in the lake zone. They are actually even higher than when the crop is inter-cropped.

Table 3.5: On-Farm Profitability of Maize Improved Varieties for High, Medium, and Low Potential Areas (1997/98)

	High Potential Areas		Medium Potential Areas		Low Potential Areas	
	Ruvuma Songea (hand)	Arusha Mbulu (hand)	Dodoma Mpwapwa (hand)	Tabora Urambo (hand)	Shinyanga Maswa (hand)	Mwanza Sengerema (hand)
Yield (kg/ha.	2,000	2,000	1,200	1,200	750	750
Estimated Average Producer Price 97/98, Tshs/kg	61	66	67	80	100	77
Realization: Market price: Tshs/ha.	121,000	132,000	80,520	96,360	75,000	57,750
Labour Input: man Days/ha:						
Total	**136**	**123**	**83**	**83**	**73**	**73**
Land Preparation	30	30	10	10	28	28
Planting	10	10	5	5	1	1
Weeding	35	35	40	40	26	26
Fertilizer/ Manuring	8	10				
Harvesting/Shelling	44	30	20	20	10	10
Marketing/Transportation (oxen)	4	8	8	8	8	8
Inputs: (I) Seeds:						
Amount of seeds required: kg/Ha.	20	20	20	20	20	20
Price of seeds: Tshs/kg	1,200	1,200	1,200	1,200	1,200	1,200
Cost of seeds per Ha.	24,000	24,000	24,000	24,000	24,000	24,000
Bags obtainable per Ha.	20	20	12	12	8	8
(3) Bags:						
Cost of a new bag	400	400	400	400	400	400
Cost of bags per Ha.	8,000	8,000	4,800	4,800	3,000	3,000
(3) Fertilizer:						
UREA: Bags/Ha.	2	2				
Price per bag	13,000	13,000				
Cost of UREA per Ha.	26,000	26,000				
MANURE: Tones per Ha.	-	-	14	14	14	14
Price per tonne	-	-	1,500	1,500	1,500	1,500
Cost of Manure per Ha.	-	-	21,000	21,000	21,000	21,000
(4) Chemicals: Endosulfate (dust) 4%: 5 kg/Ha.	12,500		12,500	12,500	12,500	12,500
(5) Other: Tools (e.g. Hoe and matchet)	3,500	3,500	3,500	3,500	3,500	3,500
Transport	2,000	2,000	1,200	1,200	750	750
Actellic super dust: 100 gm per bag	10,000	10,000	6,000	6,000	3,750	3,750
Total Cost of Inputs	86,000	86,000	52,000	52,000	47,500	47,500
Gross Margin Tshs/Ha.	**35,000**	**46,000**	**28,520**	**44,360**	**27,500**	**10,250**
Return to Labour: Tshs/Man Day	**257**	**374**	**344**	**534**	**377**	**140**

Mdadila (1998): 1996/97 Market Review of Maize and Rice, p.42

Technology 2: **Improved Bean Varieties:** Lyamungu 90

BACKGROUND INFORMATION

Bean is an important source of vegetable protein and cash for smallholders in Tanzania. It accounts for about 80 percent of the total amount of pulses produced in the country thus being strategic crop in ensuring food security and alleviating malnutrition in the country. There are a large number of varieties of dry beans (both local and improved) grown in Tanzania but the most important ones are red, yellow medium sized, and gray spotted types. They grown throughout the country but major producing zones are the southern, southern highlands, northern, lake and western zones and Morogoro and Tanga regions.

Most of the beans are grown by subsistence farmers (predominantly women) and they are normally grown (inter-cropped) in association with maize, bananas, coffee and other crops including tree and root crops. Yields realized on these farms are low ranging from 200 to 750 kg/ha. partly due to the use of low yielding local varieties. Smallholder farms range between 1-5 hectares while large-scale commercial farms average 20 hectares. Women consistently contribute relatively more to the production of bean than to maize in Tanzania (Wortmann 1998, Mashamba 1998).

The National Agricultural Research System formed a National Bean Research Programme (NBRP) which is co-ordinated from Selian Agricultural Research Institute, (SARI) Arusha. The International Center for Tropical Agriculture (CIAT), with headquarters in Cali, Columbia, regional headquarters in Kawanda , Uganda and represented at SARI in Tanzania, collaborates with the NBRP in bean development. CIAT's main mission and focus in Africa is on beans. The NBRP is part of the Bean Network made up of the South African Bean Research Network (SABRN), the East and Central Africa Bean Research Network (ECABREN) which, together with CIAT, CIDA and USAID form what is called the Pan-Africa Bean Research Alliance (PABRA) which is co-ordinated from Kawanda ARI-Uganda. CIAT is dedicated to the alleviation of hunger and poverty in developing countries of the tropics. CIAT’s focus on bean in Africa and the involvement of the institutions mentioned above demonstrates that beans is an important strategic crop in Africa.

The main objective of the NBRP and the Bean Network in general is to sustainably improve bean production and efficiency by farmers through selecting and promoting improved-high yielding varieties with resistance to pests and diseases and which consumers appreciate. The bean technology centers in Tanzania are Selian, SUA, and Uyole which are responsible for developing varieties suitable to medium, low, and high altitude environments respectively. Table 3.5 shows the varieties released by the three bean centers since 1980.

Table 3.5: Bean Cultivars Released by Tanzanian NARS, 1980 - 1997

No.	Cultivar	Year Released	Origin	Seed Type and Remarks
		MID-ELEVATIONS (LYAMUNGU/SELIAN)		
1.	Lyamungu 85	1985	CIAT bank (=T23)	Large red/brown, Calima Type
2.	Lyamungu 90	1990	Colombia CIAT bank G 5621	Large red mottle, Calima Type
3.	Selian 94	1994	Tanzania local selection	Medium Pink with red sports
4.	Selian 97	Pre- rel. 1995	CIAT bred (TMO 110 x PVA 782)	Large dark red kidney
5.	G 133-69	Pre- rel. 1996	CIAT bank accession	Large purple kidney
6.	JESCA	1997	CIAT bank acc. G 14369	Large purple rounded
		LOW ELEVATIONS (SUA)		
7.	SUA 1990	Pre- rel. 1990	CIAT bank acc. G 5476 = TMO 101(=Jules? USA) Introduced 1979	Small beige
8.	EP4-4 (ROJO)	1997	CIAT bank acc. G 14369	Medium dark red
		HIGH ELEVATIONS (MARTI UYOLE)		
9.	Kabanima	1980	Uganda bred	Large red mottle, Calima Type
10.	Uyole 84	1984	CIAT intro (P304)	Medium Cream. Climber
11.	Ilomba	1990	Tanzania local selection	Small brown
12.	Uyole 90	1990	CIAT	Medium Cream/brown stripe, Carioca Type)
13.	Uyole 94	1994	Tanzania (= Red Kasukanywele)	Large Cream/dark red
14.	Njano	1996	Introduction = EA1 2525	Medium orange
15.	Uyole 96	1996	CIAT introduction	Large dark red kidney

Source: CIAT and SADC Bean Network, Arusha Tanzania

As Table 3.5 shows, Tanzanian NARI's have released about fifteen bean varieties since 1980's. Uyole has released seven of these while Selian released six. One of the popular varieties includes the Lyamungus. During 1990's, these varieties have become accepted in Tanzania markets and are cultivated in many parts of the

country as is shown in Table 3.6. The varieties were also traded in Kampala during Uganda's 1996 drought. On farm yield for Lyamungu 85 and 90 are respectively 915 kg/ha and 704 kg/ha.

Table 3.6: Selected Characteristics of Improved Bean Varieties Recommended for the medium altitude

Cultivar	**Maturing** (days)	**Potential Yield** (kg/ha.)	**Cooking time** (minutes, Mattson cooker.)
Lyamungu 85	80 - 85	2,000-3,500	40 - 49
Lyamungu 90	80 - 85	2,000-3,500	40 - 49
Selian 94	85	2,000-3,000	40 - 45
Selian 97	80 - 85	2,000-3,400	40 - 48
G 133-69	-	-	-
JESCA	80 -85	2,000-3,000	40 - 48
ROJO	67 - 74	2,151	38 - 43

Note: All varieties (1) are resistant to Anthracnose, BCMV and moderately resistant to ALS and rust
(2) have good and widely appreciated taste

SOURCE: Phaseolus Bean Programme, Selian ARI, Arusha and SUA CRS Project

Table 3.7: Studies of Farmer Adoption of Lyamungu 85 and 90*

District	percent of farmers who had adopted	Number of Farmers Surveyed	No. of years btwn seed distribution and adoption survey	Reference
Lushoto	35-47	93	2-6	Ndakidemi &Mushi, 1997
Bukoba	67	48	3	Mafuru et al 1996
Karagwe	96	23	3	Mafuru et al 1996
Muleba	57	23	3	Mafuru et al 1996
Babati	15	84	6	Nkonya, 1995
Arumeru	24	80	6	Nkonya, 1995

* Lyamungu 85 and 90 were selected by Tanzania's department of Research and Training for the mid altitude zones of Tanzania

Source: CIAT and SADC Bean Network, Arusha Tanzania

PROFITABILITY OF THE LYAMUNGU 90 **BEAN VARIETY**

The bean varieties selected are Lyamungu 90 (which has more or less similar characteristics with Lyamungu 85) and the traditional variety Masai Red. The two varieties are cultivated/recommended for cultivation in the medium altitude zone of Tanzania. Table 3.18 shows that high yielding bean varieties are much more profitable than traditional varieties. The gross margin per ha. for Lyamungu 90 is Tshs. 654,000 (about US$ 920) and 170,500 (about US$ 240) for the Masai Red variety. The respective returns to labour are Tshs. 4,247 ($ 6) and Tshs. 1,107 ($ 1.5) per man-day. Even if yields fall by 50 percent, the gross margin per ha. for the HYV will be Tshs. 204,000 ($287) and the return to labour per man-day will be Tshs. 1,325 ($1.9). This is about two times the estimated 1$ per capita/day poverty line for rural Tanzania. The impact of the 50 percent fall in yield on the gross margin and return to labour for the traditional variety farmers is considerably big. The gross margin falls from Tshs. 170,000 to Tshs. 10,500 per ha. while return to labour falls from Tshs. 1107 to Tshs. 68 (or $ 0.1) per man-day. This shows that farmers growing traditional bean varieties face high risks in case of crop failure due to say shortage of rain or outbreak of pests etc.

Table 3.8: Profitability of High Yielding Bean Varieties Versus **Traditional Varieties**

	LYAMUNGU 90 [a] (improved variety)	**Masai Red** [b] (traditional variety)
A: Revenue:		
Yield per ha. *(kgs)*	2,000	750
Price per kg (*Tshs*.)	450	400
Total revenue per ha. (*Tshs.)*	900,000	300,000
Labour input (*man-days*)	154	154
B: Costs:		
Costs of Inputs:		
Seeds per ha. 30 kgs (*Tshs. 800:450*)	24,000	13,500
Fertilizers:		
Sulphate of Ammonia (SA): 30 kgs	9,000	0
TSP: 20 kgs	4,800	0
Chemicals: 1.2 litre	14,400	0
Sub-Total:	*52,200*	*13,500*
Labour Costs:		
Field preparation	45,000[1]	25,000
Seed sowing	15,000	15,000
Weeding 1	17,000	17,000
Weeding 2	17,000	17,000
Fertilization	15,000	0
Harvesting	20,000	20,000
Transportation from farm and to market	4,000	4,000
Cleaning and sorting	30,000	12,500
Sub-Total:	*163,000*	*110,500*
Packaging Costs:		
Gunny bags @ Tshs. 500	10,000	4,000
Paper bags 300 @ Tshs. 50	15,000	0
Chemicals, gloves, and masks	3,300	0
Threads and labour charge	2,500	1,500
Sub-Total:	*30,800*	*5,500*
Total costs per ha.:	246,000	129,500
Gross Margin (Tshs/ha.)	**654,000**	**170,500**
	(US$ 920)	**(US$ 240)**
Returns to labour (Tshs/Man-day)	**4,247**	**1,107**
	(US$ 6)	(US$ 1.5)
Sensitivity: assume Yield ↓ by 50 %		
Gross Margin	**204,000** ($ 287)	**10,500** ($14.8)
Return to labour	**1325** ($ 1.9)	**68** ($ 0.1)

[1] Cultivation using tractor and harrowing

Source: [a] National Beans Research Programme, Selian Arusha.
[b] Adapted from: Mashamba (1998): 1996/97 Marketing Review of Pulses, p.11

Technology 3: **Animal Draught-power Technology and Weed Management**

Animal Draught-power Technology (ADT) can be used in four main agricultural activities: land ploughing, planting, weeding, and transportation. The contribution of draught oxen traction to agricultural GDP of SSA is estimated at US$ 500-1000 million. It is used for primary tillage on about 10-15 percent of total cultivated land (Mrema and Mrema, 1993). The advantages of using ADT in agriculture include increasing the productivity of labour, expanding the area under cultivation as well as increasing the intensity of land use, improving the quality and timeliness of performing key farming operations, reducing manual labour and drudgery and monetary savings (Shetto and Kwilligwa, 1992). In Tanzania (for most crops), 20 to 50 percent of labour costs are in weeding and land preparation. Technology which reduces these requirements, or which enhance labour capacity to deal with these demands is likely to be attractive (World Bank, 1994).

Tanzania has made little use of the rich livestock resources available to increase productivity and alleviate poverty. The country, whose population of draught oxen was 5.3 percent that of total cattle population of 162.5 million in Africa, uses animals for land tillage on only about 20 percent of total cultivated land, to an even lesser extent in transportation and rarely in weeding (Mrema and Mrema, 1993).

Weeds constitute one of the most serious barriers to increased agricultural production. In the Vertisols of the Ethiopian Highlands, losses due to weeds ranged from 30 to 88 percent and in Zambia, from 43 to 63 percent of yield potential. In the Southern Highlands of Tanzania, yield reduction in un-weeded plots ranges from 50 to 100 percent (Lyimo and Temu, 1992: 152). Studies undertaken have demonstrated that timing and frequency of weeding increases yield by 138 percent (Table 3.10).

Since weeding is a labour intensive activity, and following from the alarming losses demonstrated above, it is extremely important to avail farmers with economically viable weeding technologies that are labour and time saving. One solution to this problem is to make use of ADT.

Table 3.10: Yield effects of different times of weeding on maize grain yield in Southern Highlands

	Yield (t / ha^{-1})	**percent increase**
No weeding	2.28	0
One weeding at 10 cm stage	4.17	83
One weeding at 30 cm stage	3.88	70
One weeding at 50 cm stage	4.09	79
Two weedings at 10 and 50 cm stages	5.32	133
Two weedings at 30 and 70 cm stages	5.41	137
Three weedings at 10, 50 and 70 cm stages	5.42	138

Source: Adapted from Lyimo and Temu (1992), p.152

Efforts to develop ADT in Tanzania at the institutional level started in mid 1980's. An oxenization project was established in Mbeya in 1987 and institutions such as SUA, CARMATEC and SEAS have been involved in designing and producing ADT. In 1988, the CARMATEC developed an animal draught weeder that has the capacity of weeding 2 ha. per day. It is drawn by only two oxen, is made from locally available materials, and is easy to operate and maintain. Its price was Tshs.13,700 in 1990. When one compares the big losses that weeds can cause when not properly managed as has been demonstrated in Table 3.10, and when one compares its capacity of weeding 2 ha. per day and its price, the profitability of using this technology is obviously high, even after taking on board, the costs of acquiring the two oxen needed which can simultaneously be used for land ploughing and transportation.

PROFITABILITY OF ANIMAL DRAUGHT-POWER TECHNOLOGY

Table 3.11 summarizes the costs of investing in ADT where it is assumed that an entrepreneur farmer is investing in ADT after obtaining a loan from a credit institution. Two rates have been used: 12 percent for donor funds and 30 percent for commercial bank loans. It is assumed further that the farmer makes a constant repayment, amortized over six years. The costs of grazing the oxen all year round, and of feeding them with concentrates for the two months prior to the on set of the rainy season are also included.

Table 3.11: Cost of investing in animal draught technology, 1991/92 (TSh)

			Annual costs[1]	
Initial investment			**Including cart**	**Excluding cart**
Cultivator	7500	Hearding	6500	6500
Ridger	7500	Veterinary care	4000	4000
Chain	6000	Shelter	2000	2000
Plow	16400	Repayment on loan for initial investment at 12 %	31231	16637
Oxen	30000	Total	43731	29137
Harrow	6000	Repayment of loan for initial investment at 30 %	55385	32682
Yoke	2400	Total	68685	45982
Sprayer	23000			
Cart	60000			
Total	158800			

[1] At 1991/92 exchange rates, 300-400 TShs≈US$1

SOURCE: Shetto R. M. and E.M.B. Kwiligwa (1992): A Review of Animal Traction Research in the Southern Highlands of Tanzania. In Ekpere et al; Proceedings of the conference on agricultural research, training and technology transfer in the Southern Highlands of Tanzania: Past achievements and future prospects. Mbeya, Tanzania: Uyole Agricultural Centre, p.351

The effect of farm size on the profitability of ox-weeding, manual weeding and the use of herbicides, basing on data provided in Tables 3.12, and 3.13 is examined in Table 3.15. Figures from the table demonstrate that it is cheaper to weed with oxen than by hand if more than two hectares of land are cultivated each year. The use of herbicides for weeding is more expensive than ox-weeding if more than three hectares are cultivated each year. However, it is always cheaper to use herbicides than to weed by hand. Table 3.14 summarizes two farming systems situations. If family labour is not costed, the return to capital in the hand labour farming system is almost three times higher than in the animal draft system. Because many farmers do not see family labour as a cost, many are reluctant to invest in labour saving technology like ADT, preferring to increase the family labour force through marriage or increase in the number of dependents. However, with the use of animal draft labour productivity increases and if hired labour is used, the return on capital invested favours oxenization. Analysis based on the higher interest rate reduces the return to both capital and labour but still returns on oxenization are above 200 percent those of hand labour .

Table 3.12: Average labour inputs for various land management operations in the hand labour system in villages in Mbeya and Mbozi Districts.

(person h ha^{-1})

	Uyole	Wassa	Iyula	Isangu	Igunda	Mean	SD
Tillage	485	500	456	475	414	466.0	33.2
Planting	91	130	116	121	95	110.6	16.9
Weeding	300	230	156	209	270	233.0	49.7
Dusting	20	18	25	20	21	20.8	2.61
Side dressing	21	25	20	22	23	22.2	1.9
Harvesting	137	140	136	152	138	140.6	6.5
Total	1054	1043	909	961	993.2	59.9	6.0

SOURCE: Shetto R. M. and E.M.B. Kwiligwa (1992): A Review of Animal Traction Research in the Southern Highlands of Tanzania. In Ekpere et al; Proceedings of the conference on agricultural research, training and technology transfer in the Southern Highlands of Tanzania: Past achievements and future prospects. Mbeya, Tanzania: Uyole Agricultural Centre, p.352

Table 3.13: Average work rates for various land management operations in the oxenization system.

(ox-team h ha^{-1}. Figures in parenthesis indicate casual labour input)

	Uyole	Wassa	Iyula	Isangu	Igunda	Mean	SD
Ploughing	14	15	14	15	16	14.8	0.8
Harrowing	5	10	6	7	8	7.2	1.9
Planting using plough	10	20	14	12	15	14.2	3.8
Weeding	(20)	(40)	(28)	(24)	(30)	(28)	(7.6)
Interrow at 10-15cm	8	10	8	10	9	9	1.0
Hand how at 10-15 cm	(60)	(68)	(58)	(57)	(82)	(65)	10.4
Interrow at 40-45 cm	7	10	6	11	8	8.4	2.1
Ridge weeding at 80-90 cm	7	10	8	9	8	8.4	1.3
Dusting	(20)	(18)	(25)	(20)	(21)	(21)	(2.6)
Side dressing	(21)	(25)	(20)	(22)	(23)	(22)	(1.9)
Harvesting	(137)	(140)	(136)	(152)	(138)	(141)	(6.5)
Transport: total labour input (person h)							
Operator	140	200	152	172	176	168	23.2
Casual	258	291	267	275	294	277	15.4
Total	398	491	419	447	470	445	73.5

SOURCE: Shetto R. M. and E.M.B. Kwiligwa (1992): A Review of Animal Traction Research in the Southern Highlands of Tanzania. In Ekpere et al; Proceedings of the conference on agricultural research, training and technology transfer in the Southern Highlands of Tanzania: Past achievements and future prospects. Mbeya, Tanzania: Uyole Agricultural Centre, p.352

Table 3.14: Income analysis for animal draught technology versus **hand labour weeding**

	Oxen		Hand labour		Oxen		Hand labour	
	- cart	+ cart	2 weed	3 weed	- cart	+ cart	2 weed	3 weed
	Family labour not costed				Family labour costed			
	12% interest rate							
Labour input (h ha^{-1})	445	497	1206	1460	445	497	1206	1460
Annual cost	29.7	44.7	0.7	0.7	29.7	44.7	0.7	0.7
Input cost	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
Oxen cost	2.0	3.0	-	-	5.8	8.6	-	-
Casual labour	-	-	-	-	16.2	11.0	53	65
Transport cost	5.2	-	5.0	5.4	5.2	-	5.0	5.4
Total cost	60.0	70.8	28.8	29.2	80.0	87.4	81.8	94.2
Maize yield (t ha^{-1})	5.2	5.2	5.0	5.4	5.2	5.2	5.0	5.4
Maize revenue	156	156	151	162	156	156	151	162
Cart revenue	-	50	-	-	-	50	-	-
Total revenue	156	206	151	162	156	206	151	162
Net revenue	96.0	135.1	122.8	132.8	75.0	118.6	69.2	67.8
Return to capital (TSh Tsh^{-1}	1.6	1.9	4.2	4.6	1.0	1.4	0.9	0.7
Return to labour (TSh h^{-1}	216	272	101	91	171	239	57	46
	30 % interest rate							
Labour input	445	497	1206	1460	445	497	1206	1460
Annual cost	46.7	69.7	0.7	0.7	46.7	69.7	0.7	0.7
Input cost	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
Oxen cost	2.0	3.0	-	-	5.8	8.6	-	-
Casual labour	-	-	5.0	5.4	5.2	-	5.0	5.4
Transport cost	5.2	-	-	-	16.2	11.0	53	65
Total cost	77.0	95.8	28.8	29.2	97.0	112.4	81.8	94.2
Maize yield	5.2	5.2	5.0	5.4	5.2	5.2	5.0	5.4
Maize revenue	156	156	151	162	156	156	151	162
Cart revenue	-	50	-	-	-	50	-	-
Total revenue	156	206	151	162	156	206	151	162
Net revenue	79.0	110.2	122.2	132.8	59.0	93.8	69.2	67.8
Return to capital	1.0	1.2	4.2	4.6	0.6	0.8	0.9	0.7
Return to labour	177	222	101	91	133	188	57	46

(Labour inputs are given in person h ha^{-1}; costs and returns are estimated in TSh x 10 ha^{-1}; maize yields are in t ha^{-1}; returns to capital are in TSh Tsh^{-1} and returns to labour in TSh person h^{-1})

SOURCE: Shetto R. M. and E.M.B. Kwiligwa (1992): A Review of Animal Traction Research in the Southern Highlands of Tanzania. In Ekpere et al; Proceedings of the conference on agricultural research, training and technology transfer in the Southern Highlands of Tanzania: Past achievements and future prospects. Mbeya, Tanzania: Uyole Agricultural Centre, p.353

Table 3.15: Comparison of the effects of area cultivated on costs and savings of ox-weeding, manual weeding and the use of herbicide, for weed control in maize

	Area cultivated (ha)					
	1	2	4	6	8	10
	Three ox-weedings					
Fixed costs (oxen, weeder, ridger)	40.4	40.4	40.4	40.4	40.4	40.4
Operator cost	1.58	3.17	6.34	9.5	12.7	15.8
Supplementary hand weeding x2	2.49	4.97	9.94	14.9	19.9	24.6
Total	44	48.8	56.7	64.8	73	81.1
	Three hand weedings					
500 person h ha^{-1}	36	72	144	216	288	360
	Herbicide application					
Sprayer	9.9	9.9	9.9	9.9	9.9	9.9
Labour (16 h ha^{-1})	0.28	0.57	1.14	1.7	2.27	2.84
Total	24.4	41	72	103	134	161
	Savings					
Savings using oxen instead of hand hoe	-6	23.4	87.3	161	215	279
Savings using oxen instead of herbicide	-17	-7.6	15.3	38.3	61.2	79.7
Savings using herbicide instead of hand hoe	10.6	31	72	113	154	199

SOURCE: Shetto R. M. and E.M.B. Kwiligwa (1992): A Review of Animal Traction Research in the Southern Highlands of Tanzania. In Ekpere et al; Proceedings of the conference on agricultural research, training and technology transfer in the Southern Highlands of Tanzania: Past achievements and future prospects. Mbeya, Tanzania: Uyole Agricultural Centre, p.354

CONSTRAINTS TO WIDE-SCALE ADOPTION OF ADT IN TANZANIA

A number of studies have identified the factors that inhibit wide-scale adoption of ADT in Tanzania. They include those by Shetto and Kwiligwa, 1992; Mrema and Mrema 1993; Hatibu and Shetto, 1997; etc. The major constraints include: (1) inadequate promotion, extension and training, (2) low purchasing power of farmers (3) lack of animals for traction, (4) competing demands for livestock products, (5) lack of implements, (6) lack of agricultural mechanization policy and political/donor commitment and seriousness, (7) poor image of ADT, (8) environmental factors, (9) threat of animal diseases: lack of affordable veterinary services can lead to high animal mortality rates, (10) low power capacities of animals due to type of breed or poor nutrition. Farmers, especially in the southern highlands rarely give draft animals supplementary feed such as maize bran and salt prior to or after the working period (11) inadequate distribution and dealership (after-sale services) for implements,

caused partly by poor rural infrastructure, (12) social tradition, gender issues and taboos biased against ADT.

Technology 4: **Dairy Farming**

BACKGROUND INFORMATION

Dairy production in Tanzania is classified into systems that reflect the genotype, the major product or objective s of production and the physical (climate), biological (flora and fauna), and social-economic environments. The production systems are either large scale (intensive or extensive) or small scale (intensive, rural, intensive urban). Marketed dairy is concentrated near consumers and in the highlands with a suitable agro-climate and high population density such as Arusha and Kilimanjaro regions (MAC, SUA and ILRI, 1998).

The total number of cattle has gone down from 15.6 million heads in 1995 to 13.8 million in 1998. Out of the total cattle, 90 percent is of indigenous breed, namely the Tanzanian short-horn Zebus and only 303,704 are of improved type. Improved dairy cattle were about 212,999 or 1.4 percent in 1995 but increased to 346,312 or 2.5 percent in 1998. Over 90 percent of the improved dairy cattle are mainly found in six regions of Kilimanjaro, Arusha, Kagera, Dodoma, Tanga, and Mbeya (see Appendix 1).

Despite its large cattle and successive government efforts to promote dairying, Tanzania is a net importer (15 million liters annually) of dairy products. The national per capita milk consumption is between 20 and 28 liters per annum compared to 35 liters for Africa, 44 liters in Kenya and 105 liters for the whole world. About 70 percent of the milk is produced by traditional small producers in rural areas (URT, MAC: 1997; Kurwijira et al. 1996; MAC, SUA and ILRI, 1998).

Keeping of improved cattle can significantly contribute to alleviating poverty in the country. It can create both income and employment, and provide food to households involved in dairying thus contributing to enhancing household food security. Dairy cattle kept under zero grazing management also contributes manure for improvement of soil fertility and the production of biogas as fuel source thus contribute to halting deforestation. There are abundant land resources and good climate to support grass and fodder for the industry and there is a big market potential. Where a market for dairy products exists, dairy farming has high prospects. Recent experience shows that the integration of dairying on 2-5 ha smallholdings has proved to be very profitable in Zanzibar, and many farmers are striving to enter

this business. A systematic approach, which included trials of various forage grasses and legume on-station, demonstration of crop-livestock integration on-station followed by on-farm research, created the necessary awareness and preparedness for the adoption of the dairy production technology. The rate of dissemination of the technology was high. Over 1000 smallholders kept crossbred or purebred dairy cattle in a semi-intensive or zero-grazing system; some have become progressive farmers owning up to 10 dairy cattle instead of the usual 2 to 5 head of cattle. Average milk yield in the zero-grazing system is 8 kg/cow per day, with a maximum of 22 kg/cow per day. In the semi-intensive system, average milk yield is 6 kg/cow per day with a maximum of 15 kg/cow per day. In both situations income is adequate to sustain a farm family (Biwi, Kategile, and Mubi, 1993).

PROFITABILITY OF DAIRY FARMING

This study has used two types of data sets to assess the profitability of dairy farming in the country. The first set (Table 3.16), presents information for three most important production systems: small scale intensive (Arusha/Kilimanjaro and Southern Highlands), small scale intensive urban dairy (represented by Dar es Salaam) and small scale semi-intensive dairy with zebu cattle (Chalinze area). This data was collected during a rapid appraisal carried out in 1997, April-July. The second set (Table 3.17) presents data from the Tanga Dairy Development Programme (TDDP) which is supported by the government of Netherlands. The TDDP started in 1985 with 5 farmers and seven cows. In 1998 a total of 2471 farmers with a total of 7768 cows were members of and reported to the TDDP. The overall aim of the TDDP is to improve the living condition of the population in Tanga region through strengthening the dairy sub-sector. Two data sets were used to compare the profitability of two systems: one is supported in terms of extension services, market development etc. through a dairy development programme supported by donors while the other has no such support. The advantage of the second data set is that it gives information over some years, something which allows analysis of factors that influence profitability over time.

Table 3.16: Gross Returns to Dairy Production for the most Important Small scale Production Systems. (TSh./cow/year)

Cost Parameter	Dairy Production System		
	Semi-intensive dairy with Zebu cattle	Intensive rural dairy with exotic crosses	Intensive urban dairy with exotic crosses
Variable costs:			
Purchased feed	0	41,969	210,848
Minerals/molasses/salts	0	30,938	8,571
Acaricide/spray	20,000	9,375	25,714
Drugs, vet. Services	25,500	14,891	6,071
Other costs (hired labour, water, electricity)	30,000	59,063	197,143
Total variable cost	75,500 (US$126)	156,234 (US$260)	448,348 (US$747)
Revenues:			
Value of milk[a]	70,080	318,577	574,875
Value of manure	0	46,766	31,321
Sale of animals	50,000	90,625	87,991
Increase in herd value	25,000	156,250	357,143
Total revenue	145,080 (US$242)	612,217 (US$1,020)	1,051,330 (US$1,750)
Gross margin	69,580 (US$116)	455,983 (US$760)	602,982 (US$1,000)
Gross margin/litre	159	230	315

[a]Calculation for value of milk based on production of 2 kg/day, calving rate of 60 % and milk price of Tshs. 160/kg for the semi-intensive dairy zebu cattle. Similar calculation for intensive rural and urban production is based on production of 7.5kg.day, calving of 70 % and milk price of Tshs. 160/kg and Tshs. 300/kg for rural and urban production, respectively.

Source: MAC, SUA and ILRI (1998):The Tanzania Dairy Sub-Sector: A Rapid Appraisal, Vol. 1, p15

Table 3.16 shows that intensive dairying in a rural set up using exotic crosses can be very profitable. The profitability of US $ 760 per cow per year is more that three times higher than the national poverty line of US $ 211. Even dairying using the traditional cattle is profitable as possession of only two dairy zebus bring the farmer above the poverty line. Profitability in medium scale dairy farm under the TDDP is considerably high even when milk price fall and/or input prices increase. Small scale farmers are more affected with such changes just as was the case for beans.

Table 3.17: Gross Margin (GM) figures for small and medium size smallholder dairy farmers under the TDDP from 1995-1998

	1998		1997		1996		1995	
	Small Farms	Medium Farms	Small Farms	Medium Farms	Small Farms	Med. Farms	Small Farms	Medium Farms
Milk income	344,925	1,576,800	383,250	1,75,000	402,412	1,839,600	344,925	1,576,800
Cattle income	42,887	171,550	51,328	205,312	41,062	164,250	34,218	136,875
Total	387,812	1,748,350	434,578	1,957,313	443,474	1,003,850	379,143	1,713,675
Feeding Costs	134, 137	537,006	120,450	479,975	109,500	434,350	98,550	388,725
Labour costs	78,000	156,000	78,000	156,000	72,000	144,000	60,000	120,000
Acaricide	30,420	106,470	30,420	106,470	25,740	90,090	23,400	81,900
Breeding cost	6,843	27,375	5,703	0	4,562	0	3,421	0
Misc. costs	24,940	82,685	23,457	74,244	2,180	66,844	18537	59,062
Total costs	274,341	909,336	258,030	816,689	232,982	735,284	203,908	649,687
Gross Margin/yr	113,471	838,813	176,548	1,140,623	210,522	1,268,566	175,235	1,063,988
GM/month	9,455	69,901	14,712	95,051	17,541	105,713	14,603	88,665
GM/cow/month	9,455	17,475	-14,712	23,761	17,541	26,428	14,603	22,162

Source: Tanga Dairy Development Programme (TDDP): Respective Annual Progress Reports.

Herdsize small farm: 1 cow,1 heifer, 1 bull calf
Herdsize Medium scale farm: 4 cows, 2 heifers, 2 heifer calves, 1 bull calf, 1 bull

Lactation length: 360 days; Calving interval: 480 days
Calf mortality: 6 % Average yield/day: 7 litre at a small farm
8 litre at a medium scale farm

Table 3.18: Annual increase in Gross Margin since 1994

	1995		1996		1997		1998	
Small farm	175,235	(+20 %)	210,492	(+20 %	176,547	(-16%)	113,471	(-35%)
Medium farm	1,063,188	(+29 %)	1,268,566	(+19%)	1,140,623	(-10%)	838,813	(-26%)

Source: Table 3.17

Table 3.17 and 3.18 show that the gross margins for both farm types increased by between 19 percent to 29 percent during the 1995-1996 period. In 1997 gross margin figures for smaller and medium size smallholder farms were Tshs 14,712 and Tshs 95,051 per month respectively. The efficiency of production is 60 percent higher at larger farms (gross margin dairy cow is Tshs 23,762 compared to Tshs 14,712 at smaller farms). Means of production (labour, equipment) are more efficiently used while production figures are better at larger farms (calving interval is shorter, average daily milk production is higher). Gross margin figures for smaller and medium size smallholder farms in 1998 were Tshs 9,455 and Tshs 69,901 per month respectively. In both cases the gross margin dropped tremendously. The gross-margin figures decreased by 35 percent at smaller and by 26 percent at bigger

smallholder farms during the year. Both a difficult milk market and therefore stagnant milk prices and increased price of inputs as Table 3.19 demonstrates caused the decrease in the two years (1997 and 1998).

Table 3.19: Prices of milk and inputs for TDDP dairy farmers, 1994 -1998 (Tshs)

	1998	1997	1996	1995	1994
Milk price:	180/ltr	200/ltr	210/ltr	180/lt	140/ltr
Acaricide:	26,000/ltr	26,000/ltr	22,000/ltr	20,000/lt	18,000/ltr
Labour:	13,000/month	13,000/month	12,000/month	12,000/month	5,000/month
Concentrates:	92/kg	80/kg	70/kg	60/kg	50/kg
Mineral:	600/kg	600/kg	600/kg	600/kg	400/kg
Bull service:	3000	2500	2000	1500	1000
Calves:	75,000	75,000	60,000	50,000	30,000

Source: Tanga Dairy Development Programme (TDDP): Annual Progress Reports.

This clearly indicates the importance of a reliable milk price for dairy farmers to continue doing profitable business. Although dairy farming was less profitable over the previous year, dairying is still very popular as many farmers still opt to start a dairy unit. The lower gross margin might have caused farmers economize on feeds thus causing the slight drop in milk production per cow over the last year. Reality suggests that if farmers are to get a high gross margin, they must in future learn on how to produce more efficiently with lower input costs. The future does not indicate any signs for higher milk prices.

Comparison of Profitability from the two Systems

Since Table 3.16 presents data collected in 1997, they can be compared with data for 1997 from Table 3.17. It should be mentioned here that the TDDP deals with crosses only and no zebus. Data shows that the gross margin per cow per year in the non-TDDP farms is Tshs. 455,983 in intensive rural dairy system and Tshs. 602,982 in intensive urban dairy farming. In the TDDP farms the margins are Tshs. 176,548 for small farms and Tshs. 1,140,623 for medium scale farms. These figures suggest that intensive rural dairy farming with exotic crosses can be more profitable (by more than 100 percent) compared to small scale dairying under a “supported” system.

4.0 POTENTIAL OF THE SELECTED TECHNOLOGIES IN ALLEVIATING POVERTY IN TANZANIA

4.1. The Poverty Situation in Tanzania

Poverty not only includes material deprivation but also isolation, lack of decision making power, lack of assets and security. Its manifestations include lack of income and productive resources sufficient to ensure sustainable livelihood; hunger and malnutrition; ill health; limited or lack of access to education and other basic services; increased morbidity and mortality from illness; homelessness and inadequate housing; unsafe environment; and social discrimination and exclusion. It is also characterized by lack of participation in decision making and in civil, social, and cultural life (UN 1995: 41) Two types of poverty can be identified: relative poverty and absolute poverty. While relative poverty compares who are poor relative to others on terms of a set level of indicator, absolute poverty is anchored on attainment of certain basic capabilities such as being able to lead a healthy and active life. Income should be such as to satisfy basic needs required to fulfill capabilities.

The poor in Tanzania mainly live in rural areas. Rural households account for 92 percent of the poor and depend on agriculture as their main source of income. At present about 60 percent of the 80 percent of the Tanzanian population which lives in rural areas lives below the poverty line. Rural households accounted for 85 percent of the poor in 1991. This ratio rose to 92 percent in 1993 (Narayan 1997).

The most important source of income in Tanzania (mainland) is agriculture. Crop production is the most important source of income to about 73 percent of Tanzanian households, 84 percent of the poor and 83 percent of rural population. 3 percent of the households in Dar es Salaam and 50 percent of those living in urban areas depend on income from crop production (World Bank, 1996).

Currently, no official poverty line exists for Tanzania. The poverty line (or expenditure level) in Tanzania which is often used and quoted is US $ 211 or about Tshs. 150,000 at the current exchange rate of Tshs. 710 per US $. Other sources use 1 US $/day as the rural poverty line. Based on the 1 $ per capita poverty line, the proportion of the rural population living below the poverty line was 65 percent in 1983 and 59 percent in 1995. In income terms the poverty line in Dar es Salaam is twice that of the rural areas. On average the rural person spends only about US$

193 while the urban (Dar Es Salaam) one spent about US$ 587 per year. The poor consume only 1654 calories per adult equivalent a day compared with an impressive 4500 calories for the non-poor. Consumption of 1500 Kcal is considered as severe under-nourishment whereas those consuming below this level are referred to as being very poor (Bagachwa 1994, Cooksey 1994). The poverty gap is widest in rural areas where the average income of the poor is 16 percent below the poverty line (World Bank 1996).

Significant inter-regional differences in human development performance is evident in Tanzania. According to the Tanzania Human Development Report (UNDP 1998) and the World Bank (1996), Dar es Salaam appears to be the most better of while Lindi, Kigoma, Mtwara and Rukwa the worst off. Poverty is severe in regions with unreliable rainfall, poor infrastructure development and poor access to markets (Bagachwa 1994:6).

It is estimated that 90 percent of the rural labour force is employed in direct farm activities and the remaining 10 percent, in rural non-agricultural activities (RNAs). Estimates of the share of RNAs to rural income in the mid 1980s was 33 percent. This share apparently declined to 10 percent in 1990. Less than 10 percent of the working people are employed in RNAs (Collier et al 1990). This means that agriculture has increasingly remained the main source of rural income.

One of the difficult realities is that agriculture makes those preoccupied in it vulnerable due to unreliability of income flows. The chances of being poor while relying on a farm income are much higher than with more solid sources of income. Given the present level of agricultural productivity, the insignificant non-farm activities and the rather bleak outlook for improved terms of trade for exports of agricultural commodities, there is potential threat for poverty in rural Tanzania to deepen. This is partly reflected by the high rate of rural-urban migration in the recent years. The neglect of the rural people by the bureaucracy, manifested in various mal-functionings and failures of established systems, has overtime led to a dangerous vicious circle of effects: low productivity; little production, reduced income; diminishing purchasing power; economic and social deprivation; degeneration of incentives; frustration and apathy; less production; less income; growing poverty, and low productivity.

The economic reforms that were introduced in mid-80's were aimed at redressing, among others, falling rural incomes. The impact of the agricultural

recovery on rural incomes has varied. Generally, cash crop producers, areas close to urban markets and those connected to transport infrastructure gain most (Lugalla, 1993). Variations in the gain reflect differences in access to inputs, proximity to markets and infrastructure, and in resource endowments. The relatively well-off areas include those with the most intensive agricultural systems, especially the coffee, maize and legume systems of the Southern Highlands, and coffee, banana and dairy systems of the North. On the other hand, the relatively poorer regions include the agro-pastoralist zone of the semi-arid central plains and the cashew and cassava areas of the South. Evidence shows, however, that the overall rural poverty situation is better now that it was in the early 1980's (World Bank, 1996).

4.2. The Potential of Selected Technologies to Alleviate Poverty

It is unrealistic to assume that poverty in Tanzania can be alleviated by improved agricultural technologies alone. But it may be wise to argue that since poverty in Tanzania is a rural phenomenon, then improving the income, food security and nutrition situation of the majority poor will contribute significantly to alleviation of overall poverty in the country. Improving farm productivity in itself is not enough. Agricultural production effort should be accordingly remunerated. If production increases and the producers to not get a market or good prices for their produce, then improved technologies will fail to enhance rural incomes and poverty will not be alleviated.

4.2.1. The Potential of High Yielding Maize Varieties

The on-station profitability of improved maize varieties as provided in Table 3.3 is very impressive: the gross margin per ha. is Tshs. 397,500 and the return to labour is Tshs. 2,923 per man day. The on-farm data from Table 3.4 shows that the net return per ha. for three types of soils viz., *mbuga, luseni* and *kikungu* are respectively Tshs 91,000, 72,500, and 40,000 and the corresponding returns per man-day are Tshs. 1,358, 806, and 615. According to the 1996/97 expanded agricultural sample survey, the average area planted maize was 0.6 ha. per agricultural holding, i.e. an economic unit of agricultural production under single management having or operating at least 25 square meters of arable land (URT: MAC and Bureau of Statistics 1998b, p.4). This means that a holding can get only 60 percent of the returns, i.e. Tshs 54,600; 43,500 and 24,000 per ha. for maize

grown in *mbuga, luseni,* and *kikungu* soils respectively and realize as return to labour only Tshs 815; 483; and 369 per man day for the respective soil types. These figures show that because these realizations are per holding, whose average is 5.3, the per capita realizations per ha. are Tshs. 10,300; 8,207; and 4,530,adult equivalencies not taken into consideration. These are, by all standards, too low levels of income realization from maize farming. The lesson one learns here is that however profitable technologies may be, they can not alleviate poverty if the scale of production is so low.

4.2.2. High Yielding Bean Varieties

As noted earlier, the poverty line or expenditure level in Tanzania is US $ 211 or about Tshs. 150,000. The analysis of the profitability of high yielding bean varieties technology has revealed that at the current low levels of yield of 1200 and 1000 kgs/ha. in Mbeya and Arusha regions respectively (Table 4.1) the gross margins are respectively Tshs.197,800 and 144,500 per hectare. The average area under maize per holding in 1996/97 in Mbeya and Arusha regions were respectively 0.14 and 0.3 (URT: MAC and Bureau of Statistics 1998b, p.77). If farmers grow beans according to recommendations the gross margins will be only 14 percent or Tshs. 27,692 and 30 percent or Tshs. 43,350 per ha. per holding. The corresponding per capita realization will be Tshs. 5,225 and 8,179 respectively. Still, this amount is too small compared to the poverty line of Tshs.150,000. Increase in area under beans will definitely benefit farmers because the technologies are profitable.

4.2.3. Animal Draught Technology

Information available has shown that ox-weeding is more profitable than manual weeding and weeding using herbicides even when farmers take loans at interest. It has been demonstrated, however, that it is cheaper to weed with oxen than by hand only if more than two hectares of land are cultivated each year and the use of herbicides for weeding is more expensive than ox-weeding if more than three hectares are cultivated each year. However, it is always cheaper to use herbicides than to weed by hand. Farmers tend to see returns of ADT to labour are low mainly because they do not cost the family labour, but evidence shows that use of animal draft power increases productivity. Because many farmers do not see family labour as a cost, many are reluctant to invest in labour saving ADT. The main problem here

is that of lack of extension and training to farmers so that they recognize the potential of ADT in alleviating their poverty.

4.2.4. Dairy Farming

Profits in dairy farming appear to be positive for all types of dairy systems. It was shown in Table 3.16 that the profitability of intensive dairying in a rural set-up using exotic crosses is US $ 760 per cow per year. This is more that three times higher than the national poverty line of US $ 211. Even dairying using the traditional cattle is profitable as possession of only two dairy zebus bring the farmer above the poverty line. Small scale farmers seem to be more affected by changes in milk price and in prices of inputs. Data shows that the gross margin per cow per year in the private farms not supported by other institutions is Tshs. 455,983 in intensive rural dairy systems and Tshs. 602,982 in intensive urban dairy farming. There is clear evidence to show that dairy farming, especially using improved cattle is highly profitable. The current low levels of milk consumption appear to be constrained mainly by low income levels on the part of consumers. Improvement of peoples incomes in general and enhancement of milk production, processing and marketing will most likely lead to poverty alleviation through dairy farming in both fronts: enhancing incomes as well as improving food security and nutrition status.

4.2.5. Relative profitability of competing crops

Farmers' decision whether they grow one crop or another and how much of each will depend on the net revenue per labour day (return to labour) and the net revenue per hectare. They will compare the net revenues of growing a crop(s) with the net revenues of growing other crops and with the wages of unskilled labourers in the rural areas.

The Domestic Resource Costs (DRC) ratio is used to measure both the product's international comparative advantage and the domestic comparative advantage. The DRC ratio of a particular product is defined as the domestic production costs of that product (expressed in foreign exchange) divided by the foreign exchange earned or saved. When the DRC ratio of a crop is lower than one, the domestic production costs are lower than the foreign exchange earned (or saved), and it is worthwhile to produce crop in Tanzania. In that case Tanzania can compete on the international markets for that crop. When the DRC ratio of a crop is

relatively low compared to other products, that crop is said to have a (domestic) comparative advantage compared to other products produced in the country. This is essentially so because the domestic production costs of that crop in order to earn or save one unit of foreign exchange is relatively low (van der Linde et. al. 1998).

In Tanzania in general the DRC ratios for food crops (using 1992 prices) indicate that it is more profitable to produce beans than paddy, which is in turn more profitable than maize. The respective financial DRC ratios are 0.59, 0.77, and 0.95 while their respective ranks in terms of profitability are 5, 8 and 13 (World Bank 1994:106). In other parts of the country such as the western cotton growing area, rice is the most profitable crop, and that the revenues of cotton, maize and chick peas are generally roughly in the same range. A recent study by has come out with the finding that in the Southern areas of Tanzania, production of maize is more profitable than that of beans. The net incomes from production of the crops are respectively Tshs. 54,438 and Tshs. 21,489 (Isinika and Mdoe 1999).

5.0 FACTORS HINDERING POVERTY ALLEVIATION THROUGH IMPROVED AGRICULTURAL TECHNOLOGIES IN TANZANIA

It has been revealed from the preceding section that improved maize and bean varieties are profitable and have an undoubtedly high potential to alleviate poverty in the country. One goes back to the basic question: if they are profitable, why do producers not adopt them? To answer this question one starting point would be to make an inquiry into the factors that hinder the adoption of these technologies. Agricultural technology adoption studies have revealed that the factors that influence farmers adopt the technologies are: availability and prices of inputs, labour requirements, inferior tools and equipment, credit, teaching methods, markets, farming experience, level of education of household head, farm size, number of extension visits, lack in preferred characteristics (Machumu 1995, Nkonya et. al. 1998). This section provides an account of the cross-cutting factors that are responsible for the failure of the technologies to alleviate poverty.

5.1. Scale of Production

However high yields from improved seeds and dairy cattle may be, if the scale of production is low, poverty will not be alleviated. Nkonya and others (1998:39) established, for instance, that average maize under improved maize seed in Kilimanjaro region during the 1992-94 period ranged from 0.17 to 1.00 ha with a mean of 0.89 and a standard deviation of 0.21 ha. A positive effect of land shortage is that producers will most likely be motivated (forced) to adopt intensification practices something which will lead to yields approaching the varieties' potential. But even if this happened, it is probable that production costs will remain high. Economies of scale usually lead to a fall in production costs on average.

Policy recommendations include: formation of farmers associations is expected to lower unit costs of inputs; promote rural non-farm activities and industrialization so that less people remain on the farm and expand farm size; make use of marginal land by adopting technologies such as irrigation.

5.2. Low producer prices

HYV's bring about double poverty alleviation: they increase incomes of producers and lower food prices to the urban consumers thus improving food

security and nutrition. The irony is, however, that the resulting huge harvests flood the markets and producers end up receiving lower prices. Farmers start to dis-adopt the technologies and produce mainly for their food and marketing requirements. When marketing requirements are higher, producers tend to sell even what they had set aside for food. A region (such as Rukwa) ends up being faced with severe malnutrition though it produces big food surpluses.

Policy recommendations include: widen markets for the crops through (a) diversification of use of the products, (b) encouraging and motivating local animal feed industries to purchase locally produced crops rather than let them import the same. Breeders have done a good job, somebody else should take over and add value on the product. For example, encourage change of eating habits. The *Chaggas*, who traditionally eat bananas, are now also good eaters of *ugali*, a product of maize; (c) encourage new products from the crops. It is also recommended that improvement of infrastructure: roads, communication, information, credit, markets etc. should be in the top of the public investment agenda. This will bring about market integration and improve efficiency. Efforts should also be intensified and look for ways and means through which more agro-products are exported.

5.3. Availability of technologies (seeds)

Farmers either use hybrids or improved (composite) seeds. Research recommendation is that hybrids should not be recycled and composites should be recycled for a maximum of three years. Farmers do not follow the recommendations. After partial collapse of the formal seed system, *viz*.:

BREEDER SEED (NARS)
↓
FOUNDATION SEED
↓
CERTIFIED SEED
↓
TANSEED
↓
FARMER

especially the limping functioning of the TANSEED, a parastatal that used to be the sole improved seed producer, distributor and importer in the country, farmers have big difficulties in obtaining seeds. Farmers obtain seeds from various sources: agents→stockists→retailers, farmers associations and co-operative unions. The

private sector operators are impatient as they normally want quick returns. But quick returns can not be realized when farmers recycle hybrids and composites for up to 5 years. CARGIL, a private international seed company that was licensed since early 90's to produce, import and distribute improved seeds, has closed its business in Tanzania and in its place is another multinational seed giant called MONSANTO.

High prices of technologies is one reason why farmers do not adopt the technologies. Farmers recycle (hybrids and composites) seeds mainly due to high prices (Hella 1993, Nkonya et. al. 1998:35, Majengo 1998). Between 1995/96 and 1996/97 hybrid maize seeds retail price changed by 38-52 percent while that of composite seeds changed by 39-42 percent. Beans retail prices registered the lowest percentage change of about 24 percent between the two seasons. The retail price of the maize hybrid seed (H32/6302) increased by 52 percent during the period. The high seeds prices, coupled with higher fertilizer prices produce a downward spiral in the use of maize HYV's. Hybrid seeds are highly responsive to fertilizer application. A decline in fertilizer use implies a decline in the use of hybrid seeds as evidence from Iringa region shows (Majengo 1998: 9, 29).

Table 5.1: Seed Consumption in Iringa Region, 1990/91-1996/97

Year	Hybrid	Composite
1990/91	117	78
1991/92	357	267
1992/93	360	143
1993/94	216	101
1994/95	129	27
1995/96	38	92
1996/97	31	82

SOURCE: Majengo, O. (1998): Agricultural Inputs Review, 1996/97, p.9

5.4. Lack of Credit Facilities

Improved agricultural technologies are usually released as a package. Farmers have to follow the researchers recommendations on seed, fertilizer, chemical use and practices. Often these need cash, something which most farmers do not have at the time they need the inputs and are required to undertake specific practices, say number of weedings, plant population etc. Because of lack of cash, most farmers end up adopting technologies rather than packages. Evidence

suggests that credit facilitates the adoption of improved agricultural technologies (Lyatuu 1994, Machumu 1995, Nkonya et al.).

5.5. Lack of aspirations and institutional weaknesses

A number of suggestions or reasons have been advanced as to why the majority people in Tanzania are poor. In a study on problems related to rural development in Sukumaland, Larsen (1974) found that development in the area was hampered by (i) insufficient incentives to make improvement, (ii) limited aspirations, (iii) lack of resources and knowledge about improvements. The author considers the inefficiency of public and semi public organizations particularly regarding dissemination of new knowledge and distribution of new inputs. Ishumi (1984) has forcefully argued that the neglect of the rural people by the bureaucracy, manifested in various mal-functionings and failures of established systems, has overtime led to a dangerous vicious circle of effects: low productivity; little production and reduced income; diminishing purchasing power; economic and social deprivation; degeneration of incentives; frustration and apathy; less production; less income; growing poverty, and low productivity.

5.6. Recommended/profitable varieties that have been dis-adopted

Research effort in Tanzania has developed several potentially and good crop varieties. Some of these varieties mostly maize and bean varieties have been reasonably well adopted and some sorghum, paddy and coconut varieties could not. The East African Agricultural Research Organization (EAARO) under the defunct East African Community developed the famous *Serena* sorghum variety. It was recommended because it was high yielding, early maturing, not easily attacked by birds. Two features of the variety that ended up making it unpopular was its red colour and unpalatability. The variety was not accepted and thus discontinued, despite big popularization campaigns by politicians. The *Selemwa* rice variety, like Serena was discontinued because it was also not palatable. The coconut variety, called CAWA MAWA is another case which was dis-adopted by growers. Substantial resources have gone into its development as well as in commercializing it. Enthusiastic investors, including the Benetictine Fathers in Mtwara region, planted large areas of the crop but ended up being disappointed. Some were even asking for compensation. CAWA MAWA is an early maturing variety, only three years

compared to seven years for the traditional tall, and is obviously very high yielding. It, however, has two problems: it requires adequate water all the year round which is not sustainable, and is not resistant to litho disease.

Palatability, colour and other characteristics, however, should not be left to make the good results of research effort be discarded because of one or two negative features of a specific recommended variety. Researchers have done a wonderful job, they have played their part in breeding the varieties such as *Serena* etc. that have some good desirable characteristics other varieties do not have including that of high yield. Somebody else should add value on these products through developing the appropriate post harvest technologies that can ultimately improve palatability and colour. Not only that these crops may also be gainfully used by the animal feed industry to the benefit of both producers, traders and consumers.

6.0. CONCLUDING REMARKS

Evidence from this study has demonstrated that research effort has undoubtedly produced agricultural technologies that are potentially very profitable. Research has developed crop varieties and species that are high yielding and this is a commendable contribution towards poverty alleviation, food security enhancement and nutrition improvement. Even if farmers can not get a market for their products they will be assured of adequate food to eat. This itself is poverty alleviation. The problems that make these technologies fail to contribute to improving the income levels of farmers are essentially technical and institutional. Technically, few producers are fully aware of the availability and profitability potential of the recommended technologies (2) they do not adequately follow the breeders recommendations, i.e. they adopt technologies rather than packages. The institutional support that can effectively motivate producers lacks. Availability of technologies, price of inputs, markets for the products produced are some of the key areas that are important in adoption of technologies.

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Appendix 1:
Table 1.1: Estimated Total Cattle (Heads) by region, 1993-1998

Region/Year	% change 1991-2000	1993	1994	1995*	1996	1997	1998
Total	**0.7**	**13,322,740**	**13,416,000**	**15,664,802**	**13,604,481**	**13,699.712**	**13,795,610**
Dodoma	0.6	1,051,206	1,060,720	1,587,094	1,079,209	1,088,178	1,096,962
Arusha	0	1,855,695	1,855,695	1,477,588	1,855,695	1,855.695	1,855,695
Kilimanjaro	0.85	447,312	452,482	464,126	462,660	477,664	472,611
Tanga	1.6	576,261	587,257	653,549	609,431	620,604	631,832
Morogoro	1.6	405,365	413,100	237,857	428,698	436,558	444,456
D' Salaam	5.35	12,780	13,504		15,068	15,910	16,796
Pwani	0.975	97,673	98,924	40,490**	101,400	102,624	103,838
Iringa	0.975	533,877	540,717	2,853	554,251	560,941	567,577
Lindi	1.6	7,577	7,721	364,693	8,013	8,160	8,308
Mtwara	2.35	20,450	20,994	15,119	22,110	22,682	23,262
Ruvuma	1.6	47,535	48,443	75,027	50,272	51,193	52,120
Mbeya	0.975	405,365	413,100	924,725	428,698	436,558	444,456
Tabora	0	928,791	928,791	1,009,571	939,822	939,822	939,822
Rukwa	3.35	615,360	637,904	426,329	928,791	928,791	928,791
Kigoma	0.975	69,231	70,118	62,609	684,990	709,564	73,602
Shinyanga	0	1,890,187	1,890,187	2,262,809	71,873	72,741	1,890,187
Kagera	2.35	495,263	508,439	354,119	1,890,187	1,890,187	563,364
Mwanza	0	1,357,535	1,357,535	1,357,535	535,455	1,357,535	1,357,535
Mara	0	969,766	1,291,576	969,766	969,766	969,766	969,766

Source: URT, MAC (1998): Basic Data: Agriculture and Livestock Sector, p.34

Table 1.2: Estimated Total indigenous Cattle (Heads) by region, 1993-1998

Region/Year	% change 1991-2000	1993	1994	1995*	1996	1997	1998
Total	**6.5**	**252,767**	**269,197**	**212,332**	**305,329**	**325,176**	**346,312**
Dodoma	5.75	3,453	3,645	2,944	4,061	4,284	4,520
Arusha	5.75	42,230	44,587	49,217	49,668	52,405	7,345
Kilimanjaro	5.5	98,371	103,614	113,437	114,879	120,922	127,255
Tanga	8.25	20,403	22,051	13,745	23,826	25,739	27,799
Morogoro	8.25	11,176	12,078		14,099	15,227	16,443
D"Salaam	8.25	3,963	4,283		4,999	5,399	5,830
Pwani	8.25	4,992	5,395		6,298	6,802	7,345
Iringa	7	15,721	16,794	5,930	19,153	20,447	21,824
Lindi	8.25	1,605	1,735		2,025	2,187	2,361
Mtwara	8.25	3,646	3,940		4,599	4,968	5,364
Ruvuma	8.25	3,102	3,352	1,325	3,913	4,226	4,564
Mbeya	9.25	11,498	12,541		14,910	16,252	17,712
Singida	5.75	931	982		1,094	1,155	1,218
Tabora	5.75	1,436	1,516		1,689	1,782	1,880
Rukwa	9.25	3,010	3,283	448	3,903	4,254	4,636
Kigoma	8.25	874	945		1,103	1,191	1,286
Shinyanga	5.75	4,218	4,454		4,961	5,235	5,522
Kagera	10.75	12,565	13,894	9,361	16,975	18,758	20,722
Mwanza	5.75	4,543	4,797		5,343	5,638	5,947
Mara	5.75	5,030	5,311	1,890	5,606	5,916	6,242

Source: URT, MAC (1998): Basic Data: Agriculture and Livestock Sector, p.35

Table 1.3: Improved Dairy Cattle (Heads) by Type by Region (1994/95)

Region	Mature Cows	Heifers	Calves	Total
Total	**139,298**	**26,044**	**46,990**	**212,332**
Dodoma	1,920	512	512	2,944
Arusha	31,742	5,370	12,105	49,217
Kilimanjaro	77,247	14,150	22,040	113,437
Tanga	7,036	1,911	4,798	13,745
Ruvuma	317	672	336	1,325
Iringa	4521	-	1,339	5,930
Mbeya	8274	1772	3,990	14,036
Rukwa	6436	1278	1,647	9,361
Mara	1512	378	-	1,890

Source: URT, MAC (1998): Basic Data: Agriculture and Livestock Sector, p.38

Appendix 2 : List of Experts Consulted:

Dr. G.M. Mitawa	Acting Commissioner for Research and Training, Ministry of Agriculture and Cooperatives, (MAC)
Dr. T. Kirway	Asst. Commissioner, Farming Systems Research, (MAC)
Dr. G. Sempeho	Project Manager, TARP II Department of Research and Training, MAC
Dr. Mvea	Extension Department, Sokoine University of Agriculture (SUA)
Dr. S. Nchimbi-Msola	Department of Crop Science and Production, (SUA)
Dr. M. Kilasara	Department of Soil Science, (SUA)
Prof. L.D.B. Kinabo	Director of Research and Postgraduate Studies, (SUA)
Prof. L. Msambichaka	Economic Research Bureau, UDSM
Dr. V.C Silayo	Agro-Processing Department, (SUA)
Dr. A Tarimo	Irrigation Expert, (SUA)
Dr. Kwasi Ampofo	Entomologist, International Center for Tropical Agriculture (CIAT) Arusha
Herman Akonaay	Breeder, Selian Agricultural Research Institute, SARI, Arusha
Dr. R. Ndondi	Breeder, Selian Agricultural Research Institute, SARI, Arusha
Mr. I J. Swai	Manager, Arusha Seed Farm
Mr. Ndekiro Maimu	Brach Manager Tanzania Farmers Association, Arusha
Dr. S.B. Likwelile	Research and Training Coordinator Research on Poverty Alleviation, (REPOA), Dar es Salam
Ms Ruth Kamala	Agricultural Research Officer Ministry of Agriculture and Cooperatives

Mr. Julius Shoo	Tanga Dairy Development Programme Tanga
Mr. Geofrey Kirenga	Plant Protection Department Ministry of Agriculture and Cooperatives
Dr. James Msechu	Principal Livestock Research Officer Ministry of Agriculture and Cooperatives