ADOPTION AND IMPACT OF DAIRY AND IRRIGATED RICE TECHNOLOGIES ON POVERTY ALLEVIATION IN DODOMA, TANZANIA

By

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ABSTRACT

This study was conducted in Mvumi and Bahi, Dodoma Rural District, Tanzania. The general objective of the study was to assess adoption and impact of improved dairy and irrigated rice production on poverty alleviation. The specific objectives were to assess adoption and determine factors influencing adoption of improved dairy and irrigated rice technologies, to assess the impact and recommend policies, which will promote dairy and irrigated rice production for poverty reduction. The study comprised a random sample of 164 project farmers and 46 non- project farmers for Mvumi. For Bahi village it comprised of 164 project farmers and 164 non-project farmers. Data were collected using a structured questionnaire and analysed using descriptive statistics, logistic regression and paired sample T-test. Factors that significantly ($P<0.01$) influenced adoption of improved dairy technologies were age of household head, number of pupils in the household, type of cattle breed owned before the project and daily milk consumption. On the other hand, factors that significantly ($P<0.01$) influenced adoption of improved irrigated rice technologies were household working days during the rainy season, rice yield before introduction of improved irrigated rice technologies, number of pupils in the household and amount of irrigation water. The results of impact assessment indicated that average annual per capita income and purchasing power parity increased by 432% and 567% respectively after improved dairy Project. With regard to improved rice production, average annual per capita income and purchasing power parity increased by 20% and 25% respectively after the Project. Implementation of Mvumi dairy project increased calories intake and milk consumption by 15% and 206% respectively while implementation of Bahi rice project increased calories intake by 4%.

Furthermore, improved dairy project and irrigated rice project increased significantly (P <0.01) material assets and financial ability to meet various social services after introduction of improved dairy cattle and irrigated rice production. The major conclusion is that both projects have significantly contributed to poverty alleviation in the study area. Therefore, it is recommended that similar development projects be promoted in other rural areas but attempts be made to make sure they target the poor.

DECLARATION

I, Robert Wankanya Kisusu, hereby declare to the Senate of Sokoine University of Agriculture, that this thesis is my own original work and has not been submitted for a higher degree award in any other University.

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Signature..................................

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DEDICATION

To my late parents, Mr. and Mrs. Wankanya Kisusu who cared for my educational background, May God rest their souls in eternal peace.

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ABBREVIATIONS AND ACRONYMS

ac	-	Acre
AI	-	Artificial Insemination
BCR	-	Benefit Cost Ratio
CBO	-	Community Based Organization
CBPP	-	Contagious Bovine Pleuroneumonia
CIAT	-	Centro International de Agriculture Tropical
CIMMYT	-	Centro International de mejoramiento de maiz y rigor (international Centre for Maze and Wheat Improvement)
CUM	-	Cummulative
DANIDA	-	Danish International Development agency
DCT	-	Diocese of Central Tanganyika
ECF	-	East Coast Fever
EFS	-	Economic Farm Surplus
EIA	-	Environmental Impact Assessment
FAO	-	Food and Agricultural Organization
FMD	-	Foot and Mouth Disease
Freq	-	Frequency
GDP	-	Gross Domestic Product
GEB	-	Gross Economic Benefits
GM	-	Gross Margin
GNP	-	Gross National Product
ha	-	Hectare
HBS	-	Household Budget Survey

HDI	-	Human Development Index
HPI	-	Heifer Project International
HRDS	-	Human Resource Development Survey
IFAD	-	International Fund for Agricultural Development
IIED	-	International Institute for Environment and Development
IITA	-	International Institute for Tropical Agriculture
ILCA	-	International Livestock Centre for Africa
ILRI	-	International Livestock Research Institute
IR	-	International Rice
IRR	-	Internal Rate of Return
IRRI	-	International Rice Research Institute
Kg	-	Kilogram
LSD	-	Lumpy Skin Disease
MOA	-	Ministry of agriculture
MOAC	-	Ministry of Agriculture and Cooperative
MOAF	-	Ministry of Agriculture and Food
MRTC	-	Mvumi Rural Training Centre
N	-	Nitrogen
NEMC	-	National Environment Management Council
NGO	-	Non Government Organization
NPV	-	Net Present value
PA	-	Particiaptory approach
PhD	-	Doctor of Philosophy
PQLI	-	Physical Quality Life Index
PRSP	-	Poverty Reduction strategy Programme

QaEIA	-	Qualitative Environmental Assessment
QnEIA	-	Quantitative Environmental Impact Assessment
RALDO	-	Regional Agriculture and Livestock Development Officer
REPOA	-	Research on Poverty Alleviation
SADC	-	Southern African Development Countries
SF	-	Smallholder Farmer
SIA	-	Social Impact Assessment
SPSS	-	Statistical Package for Social Science
SRS	-	Simple Random Sampling
SSA	-	Sub-Saharan Africa
SDDP	-	Small Scale Dairy Development Project
SUA	-	Sokoine University of Agriculture
TARP II	-	Tanzania Agricultural Research Project Phase Two
TBD	-	Tick Borne Disease
TDDP	-	Tanga Dairy development Programme
ton	-	Tonne
Tsh.	-	Tanzania shillings
UNDP	-	United Nations Development Programme
UNEP	-	United Nation Environmental Programme
URT	-	United Republic of Tanzania
USA	-	United State of America

CHAPTER ONE

INTRODUCTION

1.1 Background

Available literature shows that governments of many developing countries put a lot of efforts in developing rural areas because majority of their people live in rural areas (Lugeye, 1991; Wambura, 1993; Mlambiti, 1994). According to Todaro (1989), about 70% of Asians, over 75% of Africans and 50% of Latin Americans live in rural areas. Based on these facts, emphasis on developing rural economy is of paramount importance (Lele, 1975; Todaro, 1989; World Bank, 2000). In the case of Tanzania, whose economy is heavily dependent on peasant agriculture, the rural sector has a significant role to play on national development. Available statistics indicate that about 85% of total population live in rural areas and most of them employed in the agricultural sector. It is estimated that 55% of foreign exchange earnings and about 50% of Gross Domestic Product (GDP) are derived from rural areas. Moreover, the sector accounts for the livelihood of over 90% of the population and a source of raw materials to the agro-allied industrial sector and a market for the manufactured goods (Bagachwa, *et al.*, 1995; World Bank, 1996; Amani, 1996; Moshi *et al.*, 1997; Turuka, 1998; Mbiha and Mdoe, 1998; Mlambiti, 1985; 1998b,c; URT, 1995; 1999, 2000a; Kisusu *et al.*, 2000).

Despite the vital role played by the sector, majority of rural people in Tanzania are poor (URT, 2000b). URT (1998) reported that 92% of the poor reside in rural areas while 8% are in urban centres. The report by the International Fund for

Agricultural Development (IFAD) (1988), cited by Bagachwa (1994), disclosed that majority of Tanzanians living in rural areas are very poor. This is because their income levels are low, making them unable to acquire basic needs. The definition of basic needs varies according to location and economic status but the common ones include availability of food, clothing, shelter, health care, necessary material assets, good environment, safe water, education and freedom (Shanmugasundaram, 1980; Glewwe and van der Gaag, 1990; Jain, 1992; Clements 1993; Blackwood and Lynch, 1994; World Bank, 1990, 1994; URT, 1998, 2000b).

Moreover, various socio-economic surveys in Tanzania confirm the existence of high degree of poverty in rural Tanzania. Among these is the Poverty Reduction Strategy Paper (PRSP), which reported that only 68% of the urban population and 45% of rural population have access to safe water (URT, 2000 b). The Household Budget Survey (HBS) carried in the year 1991/92 in the country found that 57% of rural people could not afford to get basic needs while 32% were unable to get food requirements. The Human Resource Development Survey (HRDS) conducted in the year 1993/94 also found that within the rural areas, most farmers are poor because their main source of income is subsistence agriculture which faces a lot of constraints such as small acreages, inefficient production techniques, poor marketing system and lack of agricultural credit facilities (Mlambiti, *et al.*, 1990; Lugeye, 1991; Mbata, 1994; Lazaro., 1996; Berdegne and Escobar, 1997; Moshi *et al.*, 1997). Other studies on poverty in Tanzania show that 59% of rural people in Tanzania with adjusted adult equivalency incomes are living below poverty line against 39% of urban dwellers (Bagachwa, 1994; Amani, 1996). Poverty line is equal to having purchasing power parity of US $ 1 a day

(Amani, 1996; World Bank, 1990, 2001a). Another problem is shown by expenditure variation. Table 1.1 shows that rural per capita expenditure was below the national average for 1991/92 and 2000/2001 but urban per capita expenditure was above the national average for both 1991/92 and 2000/2001. This suggests that overtime poverty is declining relatively faster in urban areas than in rural areas.

Table 1.1: Average household expenditure and per capita expenditure (Tshs)

Area	1991/92		2000/01	
	Household expenditure	Per capita expenditure	Household expenditure	Per capita expenditure
Dar es Salaam	73,531	13,268	91,012	17,237
Other Urban areas	70,023	11,276	70,719	12,719
Rural	50,996	7,110	54,735	8,305
National	54,598	7,954	59,009	9,423

Source: URT (2001) Table VII. P. 100

In addition to per capita expenditure, Table 1.2 shows that income inequality in rural areas was constant for the periods 1991/92 and 2000/01 but was better compared to the national level. However, urban income inequality increased from 0.35 to 0.36 between the two periods and was worse than the national average.

Table 1.2: Income Inequality measure (Gini Coefficient)

Area	Income Inequality Index	
	1991/92	2000/01
Dar es Salaam	0.30	0.36
Other Urban Areas	0.35	0.36
Rural	0.33	0.33
National	0.34	0.35

Source: URT (2001) Table VII. P. 101

Besides comparison between rural and urban centres, other key areas like gender are also in terrible situation. For instance, female labour involvement in national employment was 47.6% while male labour involvement was 52.4% (African Development Bank, 2001). Moreover, female literacy as a percentage of males was low (76% in 1999) (UNDP, cited by World Bank, 2001b). Similarly, women are poorer than men despite the fact that women are the major actors in productive and reproductive activities in the economy. This implies that there is no gender balance in development in the country. Furthermore, URT (1998) reports that 30% of youths are unemployed. With this trend, tentative estimates for the year 2000 and beyond suggest that the incidences of poverty in rural areas might increase, if appropriate measures are not taken to address the situation.

Although poverty is widespread in the whole country, its intensity varies from region to region. Reports on poverty levels in Tanzania, indicates that average number of poor people in Dodoma is higher than the national average. The composite index ranked Dodoma among the five poorest regions in the country (URT, 2000b). The other regions with highest level of poverty in Tanzania include Coast, Lindi, Kigoma and Kagera. For example, in 1994, about 58% of the population in the region lived below the poverty line compared to the national average of 51% (World Bank, cited by Amani, 1996). URT (1997) reports that Dodoma's GDP per capita in 1994 was lower (Tshs 39,604) than national average (Tshs 62,138). The situation was worse for the various indicators shown in Table 1.3 but more interesting is that Dodoma regional per capita GDP in 1997 was less than Tshs 95,623 as compared to less deprived regions of about Tshs. 371.811. Moreover. food securitv (cereals eauivalent in ka) was extremelv lower

(177 kg) than less deprived regions (590 kg). With these variations, it suggests that efforts to combat poverty in Dodoma Region must be taken seriously.

Table 1.3: Dodoma Regional Poverty Indicator

Indicator	Indicator for least deprived regions	Indicator for Dodoma Region
Per capita GDP in 1997 (Tshs)	371,811	< 95,62 3
Gross primary school enrolment rate (%)	100	< 63
Boys enrolled (%)	99	< 65
Girls enrolled (%)	100	< 60
Life expectancy (years)	59	< 45
Men life expectancy (years)	57	< 44
Women life expectancy (years)	62	< 45
Infant mortality rate per 1,000	52	130
Under-five mortality rate per 10000	78	220
Food security cereal equivalent (590 Kgs)	590	177

Source: URT (2000) Box 3. p. 12-13.

1.2 Problem Statement and Justification

Existing literature shows that governments of many developing countries have been very much concerned with the problem of rural poverty. As a result billions of dollars have been spent every year financing various rural development projects (Baker, 2000). Although efforts to fight poverty in rural areas have been great and a lot of funds have been committed to that effect, very little is known with respect to the impact of these projects on improving the income levels of the target groups and the resultant effect on alleviating rural poverty in developing countries. However, this has not stopped developing countries to continue investing funds in rural poverty reduction projects.

In trying to address the problem of rural poverty in the regions, the Tanzanian government has also employed different strategies. Among them was the introduction of various rural development projects such as the dairy project in Mvumi Division and irrigated rice project in Bahi Village of Dodoma Region. The main objective of these projects were to alleviate poverty and improve people's welfare in the region by increasing their income through sale of dairy products and rice (DCT, 1992; URT, 1999). Other objectives were to attain household food security so as to enable rural people acquire and consume required calories per adult equivalent and to enable households to acquire domestic assets as well as support environmental conservation measures (DCT, 1992, 1994; URT, 1999; Kisusu, *et al.*, 2000, 2001a). However, to date no studies have been done to evaluate the impact of these projects to the target groups. Thus, it is not clear whether the two projects have had impact on poverty alleviation or not.

This study, therefore, has been undertaken to assess adoption of technologies introduced in these two projects and their consequent impact on raising farmers' income and reduction of poverty.

1.3 Objectives of the study

1.3.1 General objective

The overall objective of the study was to assess adoption and impact of dairy and irrigated rice technologies on poverty alleviation in Dodoma Rural District.

1.3.2 Specific objectives

Implied in the overall objective were the following specific objectives: -

(i) To assess adoption of dairy and irrigated rice technologies and determine factors which influence their adoption,

(ii) To assess the impact of dairy and irrigated rice technologies on poverty alleviation, and

(iii) To draw necessary policy recommendations emanating from the analysis of the study. In particular to enumerate policies, which will further improve development of agricultural technologies geared towards reduction of rural poverty.

1.4 Research Questions

Based on the above objectives, the key research questions to be answered include:

1. What is the extent of use of improved dairy and irrigated rice technologies in the study area?
2. What are the most important socio-economic factors that influence farmer's decisions to use or not to use improved dairy and irrigated rice technologies?
3. If improved dairy and irrigated rice technologies have been adopted, have they brought significant increase in outputs?
4. Have the increases in dairy and rice outputs increased food production and improved nutritional status at the household level?
5. Have the increases in dairy and rice outputs increased income levels among farmers who adopted the technologies?
6. To what extent has the increased income reduced poverty and improved welfare among household in the study area?
7. Are there any other impacts of the dairy and irrigated rice technologies at the household and community level?

1.5 Research Hypotheses

(i) A farmer usually accumulates knowledge and experience before attempting to adopt and use a new technology. Therefore, farmers require adequate time to assess the new technology and the time between introduction of the technology and its adoption may vary among farmers. Provided that a technology is profitable (beneficial), the accumulation of favourable experiences will eventually induce most farmers to adopt the new technology. Since it is about 10 years since improved dairy and irrigated rice technologies were introduced, farmers have had adequate time to decide whether to adopt or not to adopt the technologies. It is therefore postulated that improved dairy and rice technologies are beneficial and widely used by farmers in the study area.

(ii) The growing literature on adoption provides insights into factors that influence adoption of agricultural technologies. A multitude of factors are said to influence adoption and these can be categorised into socio-economic characteristics of household head, institutional/policy, farm factors, and technological and environmental related factors. It is postulated that socio-economic factors of household, are the major determinants of adoption of improved dairy and irrigated rice technologies in the study area.

(iii) Improved agricultural technologies are introduced with the aim of increasing agricultural output. The increase of yield due to adoption of technologies may have positive and/or negative impact at the household and community level. It is postulated that the introduced technologies have increased dairy production and have positive effect on households' income and poverty reduction. Similarly, the introduced rice technologies have increased rice production and positively increased households' income and poverty reduction.

1.6 Organisation of the remainder of the thesis

The remainder of the thesis is organised into five chapters. Chapter two presents literature review. The review describes the concept of poverty, poverty situation in Tanzania, strategies to combat poverty in rural areas and adoption of technologies. The same chapter presents literature on impact of technologies. Chapter three gives the conceptual framework and methodology of the study. The contents in this chapter are conceptual framework, methodology and analytical techniques of determining adoption of technologies and impact assessment. Chapter four provides a description of the economic status of Dodoma and socio – economic characteristics of project beneficiaries. Chapter five presents the results of adoption and impact analysis while chapter six provides conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This Chapter reviews literature on various aspects such as concept of poverty, poverty situation in Tanzania and strategies used to combat poverty in Tanzania. It also reviews literature on adoption of technologies with emphasis on dairy and irrigated rice technologies and impact assessment of various technologies focusing more on dairy and irrigated rice technologies. Finally, this chapter presents a review of methodologies used to assess impact of technologies on poverty alleviation.

2.2 Concept of Poverty

Poverty has been an attractive terminology to a lot of scholars in both developing and developed countries. Poverty is defined in either absolute or relative terms. According to World Bank (1990, 1993) absolute poverty is referred to as inability to attain a specified (minimum) standard of living. Minimum standard of living comprises basic needs such as shelter, clothing, food and nutrition, health care, safe drinking water, education and freedom. In addition, income is used as an indicator of measuring poverty. The advantage of using absolute poverty is that the position of the poor can be traced and measured. Thus, many studies on poverty have used the absolute poverty approach (Semboja, 1994).

On the other hand, relative poverty focuses on the economic well being of the poor in relation to total population in the specific location (Semboja, 1994). Generally, relative poverty is a more useful assessment of poverty than absolute poverty on social and political consideration as it deals with distributional aspects. Poverty under the context of relative poverty measures, is conceptually referred to as a circumstance where a person is experiencing a state of deprivation, prohibitive of decent life, meaning that such people have no income to attain the basic needs.

Various measures of absolute poverty exist. These include poverty line, headcount index, poverty gap and Sen index. According to Semboja (1994) poverty line is referred to as minimal purchasing power parity which can enable a person to acquire basic needs in a day. In the interpretation, those living above and below poverty line are known as non-poor and poor respectively. The advantage of poverty line is that it can measure easily the poor in the society. Headcount index is defined as the proportion (percentage) of the population below poverty line (Semboja, 1994). This measurement relies on the poverty line. Similarly, Semboja (1994) defines poverty gap as amount of income required to raise the poor to the poverty line and thus eliminating poverty. Determination of poverty gap is essential as it enables the policy makers to devise strategies to combat poverty. Furthermore, Sen index shows proportion (%) of income which can enable the poor to be above poverty line (Semboja, 1994).

The above absolute and relative poverty measurement techniques utilizes household income and /or expenditure. Consequently, they fail to capture some important dimensions of welfare such as health, education, clean water, access to public goods, democracy and gender balancing. As such, Physical Quality Life Index (PQLI) and Human Development Index (HDI) are considered useful. According to Larson and Wilfred (1980), PQLI is based on unweighted average of scale values, ranging from 0 to 100, involving life expectancy, infant mortality rate and literacy rate. The low PQLI means the welfare of the society is poor and is non poor when PQLI approaches 100. Also according to Brahmananda (1993) and UNDP (1990), HDI works as PQLI but involves unweighted average of life expectancy (years), education (literacy %), years in school and income per capita. Both the PQLI and the HDI suggest that the rich (poor) do not always enjoy higher (lower) quality of life (Semboja, 1994). Regardless of the usefulness of the means of measuring poverty, this study will use only poverty line and headcount index. This is due to the fact that the study aims to establish whether the adopted dairy and irrigated technologies alone have the capacity to make beneficiaries live above poverty line.

2.3 Poverty situation in Tanzania

The trend of poverty in Tanzania is worse and several studies compare its worseness with other developing countries. For instance, health statistics show that the average life expectancy of Tanzanians was 50 years compared to 77 years and 62 years in developed and developing countries respectively URT (1998). Infant mortality rate was higher (96 per 1000 live births) compared to 7 in developed countries and was higher (90 per 1,000) than the average of developing economies (64 per 1000). About 200 to 400 per 100,000 pregnant women die out of maternal complications compared to 95 deaths out of 100,000 in other developing countries. (World Bank, 1996; URT, 1999; World Bank, 2000).

Moreover, the per capita income in Tanzania is lower than other developing countries. In 1995, Tanzania GNP per capita income of US $ 120 was lower than the average in developing countries of US $ 430. Although GNP per capita income improved to US $ 240 in 1999, it was still lower than the African average of US $ 684 (World Bank, 2000). It is also reported that approximately 12% of children born die before reaching the age of 5 years compared to 0.9% in developed countries (URT, 1998,1999, 2000b).

Besides knowing the repercussion of poverty to Tanzanians, it is equally important to analyse the causes of poverty. According to URT (1998), the causes of poverty have included ineffective economic policies, insufficient support to the agricultural sector, inadequate support to rural industries, and disruption of local institutional structures. Other reasons of increasing poverty have been low level of technology, gender imbalance in division of labour, laziness and irresponsibility, diseases and big families (World Bank, 1997, 2001a). Moreover, external causes of poverty include existence of debt burden, unequal exchange in international trade and refugee influx. According to URT (1998), Kagera and Kigoma Regions are hosting a refugee population of over 700,000 people.

2.4 Strategies to combat Poverty in Rural areas

Although many approaches were used to develop rural areas in the country, about 7 approaches are historically known. These approaches were used separately and at different periods. The first approach used by the government was known as statute, followed by community development, progressive, transformation, ujamaa villagization, integrated rural development and participatory approaches in that order.

The statute approach was used during the German colonization in the 19th century (then Tanganyika) as a strategy to develop rural areas where farmers were encouraged to grow cash crops, mainly for export. The approach was not successful because it excluded non-export crops, which were also useful for rural population. The approach did not give favourable returns to the rulers and the ruled, as a result it was discarded in the 1920s (Rutachokozibwa, 1985).

It was substituted by community development approach, which was used by most of the British colonies in Africa in the 1920s. In this approach, groups of people performing designated economic, social and productive work, were assisted in order to increase returns to agriculture. However, the approach was not effective because it lacked incentive packages and was abandoned by the end of 1950s (Rutachokozibwa, 1985).

The community development approach was replaced by progressive approach in 1960. The basic principle of this approach was that poor farmers would emulate achievements of the progressive (rich) farmers through induction. However, the poor farmers could not gain the necessary technical and managerial skills from the progressive farmers. The rate of adoption of the technologies or managerial skills was extremely low. The approach was therefore unsuccessful and was discontinued in 1966 (Freyhold, 1979; Hyden, 1980).

Transformation approach started in 1966 by establishing village settlement schemes and block farms (Rutachokozibwa, 1985). The approach promoted mechanised farming with high technical standards. The results were very poor because the projects were poorly planned, had inadequate management and recruited unsuitable settlers. In addition, the approach had serious social, economic and political repercussions. For example, it relied heavily on capital which was lacking and could not be maintained and neglected the fundamental rules of supply and demand. Consequently it was shelved away in 1967 (Kjekshus, 1977; Mlambiti, 1985).

After being discontented with the transformation approach in 1967, the Arusha Declaration policy was promulgated in February 1967. The Arusha Declaration ignored all past approaches and adopted socialism and self-reliance policy in 1967 (Nyerere, 1967, 1968a, 1968b). Between 1967 and 1975, socialism and self-reliance philosophy was the only thinking used to develop rural areas (Nyerere, 1974; Mlambiti, 1985).

The package of Arusha Declaration of 1967 included Ujamaa Villagization approach, which was established in 1975 by the Villagization Act of 1975. The villagization Act of 1975 formulated directives which forced villagers to live together and perform their activities on communal basis, receiving free social and economic services. Returns accruing from the economic activities were supposed to be shared proportionally according to membership participation in the communal production (McKinsey, 1971; URT, 1975; Shivji, 1975; Kapinga; 1981). Initially, the approach made progress on economic and social development. For example, by 1980, the Tanzania literacy level was 79% compared to 52% in other low-income countries; life expectancy was 52 years compared to 50 years in other low-income countries (World Bank, 1983). However, the approach failed largely due to implementation problems and lack of realism.

Integrated rural development approach emerged in 1975/76 to replace the failed approaches excluding ujamaa villagization approach (Mlambiti, 1985; Rutachokozibwa, 1985). Ruttan (1984) reported that many development agencies considered that the success of rural development programmes was a function of integrating elements of top-down co-ordination, and commitment of bottom-up participation. Most of the integrated rural development programmes relied on foreign support and in most cases implementation was done without full participation of the rural communities. Donor agencies contributed almost all of the required inputs while beneficiaries contributed very minimal costs coupled with low accountability. Due to financial constraints encountered by donor agencies, l-ess and less was contributed to the programme culminating to the failure of the approach. As a result, the approach was substituted by participatory approach in 1982 (URT, 1982).

The participatory approach was considered desirable as it operates from bottom to the top, which is different with other approaches that favoured top – down system. In the 1960s and 1970s rural development approaches tended to be rather top-down and based on delivering technical solutions to the farmers without considering their needs, aspirations and priorities (FAO, 1995). The solutions may have been technically feasible but could not fit farmer's circumstances. As a result, in the 1980s and 1990s increasing efforts were made by rural development agencies to seek involvement of target groups in all stages of development programmes (Abdallah, 1991). This was implemented by introducing participatory approach, which started operating in Tanzania after the establishment of the Local Government Authority in 1982.

Several authors have reported the contribution of participatory approach on development. URT (2000c, 2001b) advocate that through participatory approach, poverty can be reduced when communities identify available opportunities and resources as well as obstacles, which hinder their development, while Rajandran, (2000) and United Nation Centre for Regional Development (2000) reported that rural poverty could be reduced by involving the target group. Deng (1995) argues that combating poverty requires that the poor themselves be empowered to initiate, design, execute and manage their own priorities.

There are several other strategies, which have been used to address the question of poverty. Deng (1995) asserts that education can be one of the instruments for combating absolute poverty. World Bank (1990) reported that countries which have succeeded in combating poverty promoted efficient use of the abundant labour along with policies which harnessed market incentives. This includes focusing on social and political institutions, technology and providing basic social services to the poor, including nutrition. Wonnacott and Wonnacott (1984) argued that increasing production might be one of the most effective ways of fighting poverty, while Oludimu (1991) argues that rural poverty can be reduced by developing the non-farm sector to increase income levels and living standard. This is also emphasized by Kayunze (1998) who observed that non farm rural sector contributed up to 30% of total rural income in Tanzania.

Studies carried out by the African Development Bank show that rural poverty reduction can also be attained by improving women's situation as they are the majority of the poor (Buvinic and Gupta, 1997). This view is supported by Rajandram (2000) who argues that poverty alleviation can be achieved through community participation, with emphasis on women. However, Buvinic and Gupta (1997) argue that female headship should not be used as the main targeting criterion for poverty alleviation because female headship is not always correlated with poverty.

Furthermore, it is widely reported that poverty can be tackled by using development projects initiated through participatory approach (Chambers 1983; Devavaran *et al.*, 1991; Oakley, 1991; Shah, 1993; Chambers, 1994; Temu, 1998;

URT and UNDP, 1999). Jazairy *et al., (*1992) argue that the approach is able to reduce costs of project development and implementation, as well as promoting sustainability and replicability. It can also take advantage of traditional practices, which are suited to the environment, and the absorptive capacities of the people. Lisk (1985), Mdoe, *et al.*, (1999) and URT (2000a, 2000b, 2000c) report that participation should involve people in the decision making at all levels and forms including political and socio-economic integration.

Participatory approach is a multi-dimensional process, which varies from location to location and according to circumstances (Oakley and Marsden, 1984). Since participatory approach is a multi-dimensional process, when using it one needs to take into account other factors such as people's skills, awareness, their needs and aspirations (Jazairy, *et al.,* 1992, Chambers, 1994). Participatory approach has been found to be advantageous and its outcome can be measured in terms of impact on poverty alleviation.

It is argued that participation is effective as it encourages sustainable development, involves local communities in solving their own problems and this helps to reduce the dependency syndrome (Kallabaka, 1989; Chambers, 1994). Communities contribute labour, capital, and participate in monitoring and evaluation work, while external assistance is provided as a catalyst (URT, 1982). According to Rutachokozibwa *et al.* (1992), the participatory approach has increasingly been accepted nationally and institutionally, as a necessary condition for attaining sustainable rural development.

2.5 Adoption of technologies

2.5.1 Previous studies on adoption of technologies

Several studies have reported issues related to adoption of technologies and factors that influence adoption of technologies. Nkonya (2001) reported that the rate of adoption for farmers using chemical fertilizer in Northern Zone of Tanzania was 64% and 44% on moderate rainfall zone and low rainfall zone respectively. The reasons for different rate of adoption was associated with income differential in these zones (Nkonya, 2001).

In general the factors that influence adoption can be grouped into four main sections, namely; household head characteristics, farm characteristics, institutional factors and technological factors (Jones, 1967; Jan ES, 1983; Feder, *et al.* 1985; Feder and Umali, 1993; Bisanda and Mwangi, 1996; Msuya, 1998; Semgalawe, 1998). Several studies indicate that characteristics of household head such as age influence the rate of adoption of technology (Lapar and Pandey 1991; CIMMYT 1993; Adesina and Forson 1995; Abdelmagid and Hassan 1996; Adugna 1997; Sanginga 1998; Nicholson *et al.*1999; Kalineza *et al* 1999; Sanginga *et al.*, 1999). Specifically, it has been found that older farmers have low rate of adoption but use improved technology intensively as compared to young farmers (Sanginga, 1998). Similarly, younger farmers tended to be more educated and innovative than older farmers and have a lower level of risk averse towards technology adoption (Lapar and Pandey, 1991; Abdelmagid and Hassan 1996; Adugna 1997; Kaliba *et al* 1997; Sanginga *et al.*, 1999; Kalineza *et al.*, 1999).

Gender is another factor that influences adoption of technologies either positively or negatively. For instance, Adugna, (1997) and Sanginga (1998) found that gender had significant negative influences on the rate of adoption of technologies in several development projects. Also Adesina *et al.*,(2000) found that gender had significant and positive influences on technology adoption. Thus, this creates a complexity of understanding the influence of gender on technology adoption. Despite the complexity, the term gender does not show which sex group is referred. For example, it has been reported that male children positively influences adoption of new technologies (Kaliba *et al.*, 1997). Based on this observation, generalising that gender influence adoption of technology can be misleading. It is proper therefore, to distinguish between male or female or a particular type of sex group. Moreover, Boserup (1983) reported that female headed households are lesser exposed to various inputs as compared to male headed households and have less education (Van den Ban, 1996). Due to these barriers, the possibility of adopting technology might be low. Moreover, women are less privileged to essential economic activities and therefore may not be sharp in adopting technologies (Shayo, 1991; MOA, 1993). Madulu (1995), Machumu (1995), CIMMYT (1993) reported that educational level of head of household and income do influence adoption of technology.

A study conducted by Senkondo *et al.*, (1998) found that the number of years in farming influences adoption of new technologies. It is possible that the number of years of working in the farm develops technical know how which is useful on adoption. Studies show that the way a farmer perceives a new technology influences positively and significantly the adoption rate of that particular technology in various development projects (Adesina and Forson 1995; Senkondo *et al.,* 1998). Not withstanding this observation, it should, however be noted that perception is very subjective .

Institutions affect the rate of adoption of technology through supporting services offered to farmers. For instance, Kauzeni (1988), Minde and Mbiha, (1993), MOA (1993), Machumu (1995), Kuzilwa and Mushi (1997) have reported that well established credit system, research and marketing stimulate small businesses which later enable adoption of new development in the community. Several studies also indicate that farmer's contact with extension staff increases the probability of adopting the introduced technologies (Mbata 1994; Abdelmagid and Hassan 1996; Adugna 1997; Sanginga 1998;. Kalineza *et al.,* 1999; Nicholson *et al* 1999; Forson 1999; Adesina *et al.,* 2000; Rutatora and Mattee, 2001). The reason is that extension services create awareness on the availability and importance of new innovation to economic development of the smallholder farmers. However, some studies show that extension service influences negatively adoption of technologies (Dimara and Skuras, 1998). The negative relationship between extension services and adoption of new technology could be attributed to inappropriateness of technology brought to the target group.

Mbata (1994) found that transport cost has significant negative influence on adoption of technologies. This is based on the experience that high transport cost increases cost of production, reduces market access and therefore discourages farmers to purchase the technology in question.

Farm characteristics that influence the rate of adoption of technologies are farm size and farm implements. Available literature indicates that farm size influences adoption of new technologies (CIMMYT, 1993; Mbata 1994; Abdelmagid and Hassan 1996; Senkondo *et al.*, 1998; Kalineza *et al.*, 1999). Farmers with large farm sizes have high rate of adopting new technologies than farmers with small farm sizes because it pays to do so (Tarimo 1994; Abdelmagid and Hassan 1996). Geographical location has also been reported to influence adoption of new technologies (Obinne and Jojo, 1991; Mwanga et al., 1999; Regassa et al., 1998).

Type of technology has been also reported to influence adoption because of the technology characteristics including; relative advantage, compatibility, complexity, trainability and observability (Rogers 1983). Most farmers behave rationally and therefore can adopt the introduced technology if yields will be increased and if the technology is easy to apply and affordable. It has been found in several studies that higher yield influences positively and significantly the adoption of technologies (Adesina and Forson 1995; Sanginga 1998). On technological factors, Nell *et al.* (1999) reported that introduced veterinary surgeon services on sheep and goat were adopted due to easiness.

Despite efforts of introducing technologies, which aimed at boosting production, various studies have indicated that a large number of farmers reject introduced technologies (Gladwin, 1980; Fujisaka, 1993). Proportions of farmers who reject technologies are large and this depends on the type of that technology. For instance, those who rejected using nitrogen fertiliser were estimated between 88 to 100% of total farmers in upland agriculture in Japan (Fujisaka, 1993).

Technologies are rejected due to several reasons. Among the reasons reported for not adopting technologies include a tendency of innovation addressing the wrong problem, farmer practice is equal or better than the innovation, innovation does not work, extension fails, the innovation is too costly and social factors (Fujisaka, 1994).

Due to the above reasons, farmers tend to continue using their traditional practices on the assumption that they can live comfortably. In some cases, it has been found that farmers are right on rejecting the technology. For example, it has been reported that economic impact on adopters and non-adopters of nitrogen fertilizer was not significantly different (Fujisaka, 1993). This means the practice used by farmers are as suitable as those recommended by scientists.

2.5.2 Studies on adoption of dairy technologies

Most studies on dairy development emphasize on adoption of technologies which include breeding, feeding, animal health, husbandry and production. Concerning breeding, two types of breeding are practiced by adopters of dairy technologies. These are referred to as bull service and artificial insemination (AI). Hanyani – Mlambo *et al* (1997) reported that 95% of large-scale farmers adopted. At but most of the smallholder farmers adopted using exotic bulls for breeding. In most cases farmers tend to prefer bull service due to their easiness of getting a bull, high charges on AI and farmers avoiding risk of missing a cow on heat. Moreover, Massae (1993) reported that AI services are done poorly due to lack of transport for semen distribution and for inseminators. Also preference on the type of the breed could influence farmers to use AI or bull service. However, adoption of breeding technology also varies with farming types. Mdoe (1993), Mchau (1996), de Wolff (1996), Rutamu (1996), SSDDP (1996) and Survey (1997) reported that bull (insemination) service is adopted more by smallholder farmers who own exotic/cross bred cattle than small farmers who raise traditional zebu cattle.

Moreover, breeding type could be of high value but its adoption is constrained by various factors. Studies by Vaccaro (1974) reported that 40% or more of temperate bred heifers born in hot climates do not survive up to first carving. As such, superior survival rate of native and cross bred cattle in the tropics has been consistent in many reports. Also Freeland (1992) reported that most dairy farmers like to improve their indigenous cattle by crossing with exotic breeds. The reason for this is that farmers are more knowledgeable on traditional cattle and therefore would not want to make losses by adopting breeds which they are not familiar with. Furthermore, adoption of dairy technologies could be based on agronomical factors. For instance in Tanzania, distribution of dairy cattle is skewed as about 64% are in Kilimanjaro and Arusha Regions and are mainly found on commercial farms and on smallholdings near urban centres (Balikowa, 1997). Other regions with good number of dairy cattle are Iringa, Mbeya, Tanga, Kagera and Dodoma. However, a large number of smallholders also own dairy cattle in Dar es Salaam and Coast Regions. Such distribution is influenced by several factors.

According to the socio-economic profiles of these regions, they receive rainfall between 1,000 and 1,500 mm per year, as a result of this, the rate of growth of pasture grasses for feeding dairy is highly, hence readily available. Besides rainfall, these regions experience low temperatures of about 15^0 C to 30^0 C per year which are favourable for dairy production. Hence, climate has influence on livestock distribution and productivity. Worse still improved dairy cattle normally face problems in areas with high heat stress and high humidity (Bianca, 1961; Lee 1965; Gates 1968; Ingram and Mount 1975; Yousef 1985; Johnson 1985; Msechu, 1994).

Institutional factors are among the reasons for expanding dairy cattle in certain localities. For instance, establishing Heifer Project International (HPI) in Arusha and some big parastatal farms available in the region may have contributed to the easiness in getting improved dairy cattle. Adoption of dairy feeding technology is reported to be associated with dairy productivity. Butterworthm (1967), Kusekwa and Kidunda (1988) asserted that quality of feeding is the major reason for milk variation Walshe (1993), Massae (1993) and Pedersen (1997) reported that insufficient fodder supply with low nutritive value are major constraint to cattle production. Poor nutrition causes starvation, depressed growth rate, infertility and low milk yields.

According to Urassa (1999) adopting dairy technology without emphasis on feeding would result into poor performance of the cow. Several studies have reported that milk yield depends on different grazing level (Sarwatt and Njau 1990; Biwi 1993; Aboud *et al.,* 1995; Mulangila 1997). In most cases three types of grazing are practiced. These include use of either zero-grazing, partial and free grazing systems. The more effective, feeding system, which discern animals from diseases, stress and inadequate amount of grazing, is zero-grazing (Kimambo *et* al., 1990, Sarwatt and Njau, 1990). The common grasses used in zero grazing include napier grass, giant Setaria and Guatemala. The advantage of zero-grazing is that it ensures that adequate amount of recommended grasses are used for feeding. Despite the importance of fodder, supplementing feeding with necessary minerals help the animal to increase growth rate, milk yield and against diseases. As such, Matthewman (1993) argues that regular mineral feeding can not be avoided in adoption of dairy technology. Studies by Church (1991) reported that lack of minerals is depicted by observing poor growth rate and fall in milk volume. The common necessary minerals include iron, phosphorus, calcium and magnesium. Other feeds include concentrates like cotton cakes, sunflower cake, and molasses. Feeding dairy with cereal residues (maize rice and wheat) is also practiced (Survey 1997, Mdoe and Wiggins 1997).

Studies by Mahoo *et al.,* 1994; Hanyani – Mlambo *et al* (1997), MOAC and SUA (1998) reported that most adopters of dairy technology face disease problems especially Tick Borne Diseases (TBD) and trypanosomosis. These diseases are reported to be endemic in most dairy rearing areas. However, practicing zero-grazing and encouraging use of dips can reduce TBD. Although dips are useful on killing ticks, it is reported that dips are used by only 21% of livestock keepers in Tanzania (Bureau of Statistics, 1996). This implies that efforts must be made to educate livestock keepers on the advantage of dips. Despite the spread of TBD, several reports show that TBD is low in high altitude and more in humid areas. Other diseases such as East Coast Fever (ECF), Foot and Mouth Disease (FMD), lumpy skin disease (LSD), Contagious Bovine Pleuropneumonia (CBPP) and rinderpest are controlled through vaccination. Another outstanding issue is that animal health husbandry is not maintained to the recommended standard due to high cost of operation. Golomela *et al.* (1993) reported that adoption of dairy technology is low due to high cost of chemicals and lack of knowledge by farmers.

Despite the importance of dairy technology, its development is hampered by various factors. For instance, several studies reported that adoption of dairy technology in Sub-Saharan Africa is constrained by milk marketing (Bath 1985, Brokken, 1990, ILCA 1993, Matthewman, 1993; Thorpe *et al.,* 1993; Greenhalgh 1993; Zylstra *et al* 1995; Mdoe 1993b; Nyange and Mdoe, 1995; Mdoe and Wiggins, 1996; 1997).

Apart from milk marketing problem, various studies report that adoption of dairy technologies is influenced by other several factors. These factors are grouped into four parts, namely socio – economic characteristic of household head, institutional factors, farm characteristics and technological factors. Nicholson *et al.* (1999) reported that socio – economic characteristics of household head affect adoption of technology and these include age and educational level of household head, family size, income, price and gender. Nicholson *et al.* (1999) found that institutional factors such as market, extension visit, credit and storage facilities do affect adoption of dairy technologies. Technological factor such as type of breeding (using the bull or AI) were also reported as factors influencing the adoption of dairy technologies.

2.5.3 Previous studies on adoption of irrigated rice technologies

Rice (*Oryza sativa L.*) is an important food crop, which is consumed by more than 51% of the world's population (Nguyen and Tran, 1998; Fageria and Baligar, 1999). Moreover, most of consumers are the main producers. According to Mae (1997), rice production is concentrated in Asia where more than 90% of the world's supply is produced and consumed. The remaining 10% is produced in part of USA, Latin America, Mediterranean countries and in Africa. Tanzania is the second largest rice producer in the Southern African Development Countries (SADC) region (IRRI, 1994). Although Tanzania is ranked high in terms of production in Africa, national average production per hectare is between 1.5 and 2.0 (MoAC, 1995), which is lower compared to that of Japan (6.3 t/ha), Korea (6.6 t/ha), USA (6.3 t/ha), Bangladesh (4.6 t/ha), Yap, (1992) and IRRI (1996) cited by Hossain (1999).

In order to increase rice yield in Tanzania, various strategies have been adopted. These include developing potential areas which are suitable for rice production. In the effort to develop potential areas, irrigated rice technologies have been encouraged. Among the well known irrigated rice areas in the country are Usangu and Kyela in Mbeya, Kilombero, Wami River Basin, Rufiji River basin, Ruvu River valley, Lower Moshi, Southern part of Shinyanga, Dakawa, Lake Kalimawe plains, Mombo and other small scale types. The small scale types are practiced by smallholder farmers who practice improved irrigated rice technology through rain fed. According to Kihupi (1984) and FAO (2001) the irrigated rice technology is carried under specific package which involves key subcomponents. These are known as agronomical practices (pest control, land preparation, weeding, planting by spacing), water management, adopting improved inputs (seeds, use of fertilizer and chemical for plant protection) and production (rice yields).

Concerning agronomical practices, studies have shown the importance of each item. In case of soil leveling, Kihupi (1984) reported that adoption of leveling land would ensure uniform water depth, permitting good growth of rice seedling. This is based on the fact that most aquatic weeds have been found abundant in shallow water, below 5 cm deep. With regard to spacing, (Kihupi, 1984), found that closer spacing in lowland rice is an important method of increasing crop's ability to compete with weeds (Kihupi, 1984). It is further reported by De Datta (1978) that chemical weed control in upland rice is effective and economical. Further observation is remarked that the use of pesticides should be limited only at the time of pest outbreak. This is because pesticides can create damage on crop and users (Kihupi, 1984).

On water management, Kihupi (1984) reported that maximum yield potential of rice exists when the soil is maintained under flooded or saturated condition. This is supported by several other studies that water is one of the most important factors in rice production because water affects the physical characteristics of rice plant, nutrient status of the soil and the nature and extent of weed growth (De Datta, 1970; 1981). The advantage of water is that as water level increases from 2.3 to 20 cm, there is decrease in plant count, tiller count and weed count. Water management enables control of weed and herbicides use (De Datta, 1972; De

Datta and Banasor, 1973). This suggests that abundant water for irrigation is a necessary item, which cannot be ignored.

With regard to improved inputs, Kihupi (1984) reported that use of inorganic fertilizer, especially nitrogen helps to increase rice yield. Monyo and Kanyeka (1978) reported that without fertilizer, rice output would be low. Use of fertilizer in irrigated rice is important as weed competition is less severe in fertilized than unfertilized fields (Akobundu and Fagade, 1978). Dibwe (1984) has reported that irrigated rice contributes to management of water and fertilizer use while Conception *et al.* (1999) have indicated that irrigated rice enabled balancing fertilizer use technology. Wanjara (2001) found that management of fertilizer is easier in places where irrigation is practiced. This implies that avoiding the use fertilizer may be a result of poor water management. Moreover, Mnguu (1997) found that soil fertility status was good in areas where irrigated rice was practiced. Apart from inorganic fertilizer, organic manure was found to increase paddy yield more than double (Kihupi, 1984). It implies that organic manure is suitable for increasing soil fertility and therefore could be recommended for use, especially in places where cow dug is abundant. In regions where the number of livestock is big in Tanzania could benefit from this suggestion. According to livestock census of 1994, regions such as Shinyanga, Mara, Mwanza, Tabora, Morogoro, Arusha, Mbeya. Tanga and Singida could benefit.

Use of improved seed has also been found to increase rice yield. CIAT (2001) and Chandhary (2002) reported that increased rice yields is possible through use of improved seed and increasing irrigated area. Although farmers like to use improved rice varieties, majority could not use the improved ones because are not available (Kihupi, 1984). It is also reported that farmers who do not adopt improved rice varieties would remain producing low yields (Chandler 1979; Doggett 1965, Monyo, 1974; Chang and Vergara, 1972). The studies on improved seeds also noted that irrigated rice had advantage on using different types of seeds. Mwakalila (1992) reported that several varieties of improved rice seeds were considered useful when irrigated rice is practiced. The reported seeds include Kahogo Red, Afaa, Mwanza, Supa India, Ganti, Faya Thereza, IR8, IR579, Taiwan 14 and Surinaam.

2.5.4 Methodological aspects on adoption

Since the earlier work of Rodgers (1962), cited by Senkondo *et al.* (1998) efforts have been spent to explain determinants of technology adoption. Basically the adoption of a new technology is a choice between two alternatives, the traditional technology and the new one and farmers are assumed to make decisions by choosing the alternative that maximises their perceived utility (Mattee, 1994; Howard and Cransfied, 1995; Senkondo *et al.*, 1998). The farmer is likely to adopt the new technology if the utility of that technology is higher than utility derived from the traditional technology.

Nkonya *et al.* (1997) defines the rate of adoption as the percentage of farmers who have adopted a given technology. In addition, Ruiz de Londono and Janssen (1990), Smale *et al.* (1991) and Spurling *et al.* (1992), cited by CIMMYT (1993) indicated that adoption rates were an effective technique of measuring impact of introduced technology. Intensity of adoption is a rate which measures actual adoption as compared to recommended rate or level (Nkonya *et al.* (1997).

There are many ways of measuring the rate of adoption of technologies. The common two are either based on logistic function model or calculating the number of adopters against the total number of all people who were involved in the technology. The logistic function model operates in the form of non-linear regression method where natural logarithm is used. (Amemiya, 1981; Gujarati, 1995). In order to compute the logistic function, the model must possess the necessary conditions such as showing the cumulative percentages of adopters, time of adoption process, either at given hours, days, weeks, months or year. Other unknown parameters such as the constant term and upper limit are to be estimated during the process (Kelejian and Oates, 1989; CIMMYT, 1993; Gujarati, 1995).

The second method is computing percentages of adopters without considering the time period. This is more preferred as it does not require time but gives immediate effect on the measured innovations. For example, CIMMYT, CIP and CIAT (1992) study, cited by Mkenda (1997) on farm research project on maize/beans rotation system in Panama found that after 4 years of introducing the practices, 61% of farmers adopted improved weed control. About 43% of farmers adopted some form of reduced tillage while 35% adopted improved varieties by 1985. Similarly, use of row planting increased from 30% to 80%.

Beside adoption rate, there is an issue of intensity of adoption. When technology is adopted it is important to understand to what extent has the technology adopted been based on the recommendations. This is necessary as adopters may claim that they have adopted the technology but comparatively they have not met the required standards (CIMMYT, 1993).

The intensity of adoption is determined by taking the level of adopted units against the recommended amount. Expressions of intensities of adoption are many but the common one is based on the percentage (Nkonya *et al.*, 1997). Determination of intensity of technology adoption helps to adjust the gap between the actual and the recommended amount. Similarly, intensity use normally provides correct measure on policy reform. For instance, low intensity may indicate that the technology introduced is not effective although it has been adopted. This avoids the generalization of technology having been adopted but in actual fact only a small amount is actually being used.

As pointed out earlier available literature shows that many factors do influence adoption of innovations of any kind. These factors could be measured using various models. The commonly used ones are logit, probit and tobit which all have equal application (Derbertin *et al.*, 1980; Gujarati, 1995). The models are also known as dichotomous (having a numerical value greater than 1) or binary (having a numerical value either 0 or 1) (Tobin, 1958; Shakya and Flinn, 1985; Gujarati, 1995). The advantage of these models is that they can determine the impact of socio-economic parameters in relation to other factors (Amemiya, 1981;

Capps and Kramer, 1985; Lee and Steward,. Empirically, tobit, logit and probit models give resembling results (Gujarati, 1995).

The logit model operates in the form of simple least square regression. For example, probability of adopting technology is either 1 (to adopt) or 0 (not to adopt) and these acts as a dependent variable while regressor could either have a value of 0, 1 or more depending on the nature of independent variables (Kelejian and Oates 1989; Gujarati, 1995). For example, Mkenda (1997) used logit model to determine factors affecting adoption of SUA 90-bean variety in Kilosa and Morogoro Districts and Senkondo *et al.* (1998) used the same model to determine factors affecting the adoption of rainwater harvesting technologies in Western Pare Lowlands of Tanzania. Adugna (1997) used the logit model to determine factors affecting adoption of inorganic fertiliser in Lume district in Ethiopia. Abdelmagid and Hassan (1996) used the model to determine factors affecting the adoption of wheat production technology in Sudan.

Besides the logit model, factors affecting adoption of technology can be determined using probit model. Akinola (1987) used probit model to determine factors affecting adoption of hiring tractor service in Nigeria while Polson and Spencer (1992) used the same model to determine factors affecting improvement of cassava varieties in Nigeria. Adesina and Baidu-Forson (1995) used the model to assess the effect of farmer's perception on adoption. Shakya and Flinn (1985) used tobit model to derive factors, which influenced use of fertiliser on rice in Eastern Terrai of Nepal.

2.6 Impact of technologies

2.6.1 Concept of impact

Different people interpret the term impact differently. In this context, impact is conceived as output/benefits which are generated from the introduced technologies which have effects to the beneficiary. The effect may be in the form of economic, social, institutional or environmental effects (Moshi *et al.*, 1997, Anandajayasekaram, 2000; Anandajayasekaram *et al.*, 2001; URT, 2001a).

2.6.2 Previous studies on impact of dairy technologies

2.6.2.1 Impact of improved dairy technologies on productivity

An average milk yield per lactating cow in the traditional sector is estimated at 100 litres per year while improved dairy cattle produced above 1597 litres per cow per lactation (MOA, 1993). Moreover, it is reported that milk yield per dairy cow per day in the lactation period ranged between 5.6 and 10 litres (Sarwatt and Njau 1990, Mdoe, 1993a; Biwi 1993; Aboud *et al.*, 1995; Mchau 1996; de Wolff 1996; Rutamu 1996; SSDDP 1996; Minja, 1997; Mulangila, 1997 ; SHDDP, 1999). Previous studies elsewhere have also reported significant differences in milk yield between indigenous and improved cattle (for example Mdoe and Wiggins, 1997 in Hai, Kanuya *et al.*2000 in Arumeru). However, irrespective of cattle type, the yield levels in Mvumi division were lower than those reported by Mdoe and Wiggins (1997) and Kanuya et al. (2000). This could be explained by differences in production systems as well as differences in management practices. It is also reported by Kisusu *et al.* (2002) that improved and non-improved dairy cattle at

Mvumi division Dodoma produced about 7.44 and 1.77 litres per cow per day respectively. In addition to differences in milk yield, the results of the analysis showed differences in milk yield between cattle kept by project participating farmer and non-project participating households. Kisusu *et al* (2002) reported that the mean milk yield was 7.9 litres/cow/day for project participating farmers as opposed to 4.5 litres/cow /day for non – project participating farmers. This may be largely explained by differences in management practices since project participating households received assistance in terms of dairy inputs and training on various aspects of animal husbandry practices. Syrstad (1988) estimated the mean milk yield for non-improved and improved breed as 714 and 1414 kg per year, respectively. Moreover, Collin - Lusweti (1990) reported that lactation milk yield of Friesians and Ayrshire in Kenya was 2341 – 2925 and 1912 – 2463 kg respectively while Holsteins and Jersey in Zimbabwe ranged 3803 – 4453 and 3123 – 3461 kg respectively. Lactation length also varies with genetic and non-genetic influences. Studies by Mkonyi *et al*, (1991), Msanga (1994) reported that lactation period for cross breed or exotic cows in Tanzania ranged from 300 to 334 days. But Agyemang and Nkhonjera (1986) reported that lactation period for similar cattle breeds in Malawi was 391 days. However, adoption is recognized when the value of a dairy cow is more appropriately expressed on the basis of lifetime production than on single lactation record (Gopal and Bhatnagar, 1969).

2.6.2.2 Impact of improved dairy cattle on income

As a result of milk yield and marketing, Nicholson *et al.,* (1999) found that adopters of smallholder dairy technology earned more cash from dairying than non-adopters. Moreover, the study found that gross margin per cow was higher for intensive urban dairy producers with exotic animals (Tshs 602,982 per cow/year) compared to intensive rural dairy production with exotic cross (Tshs.455,983/cow/year) or semi-intensive dairy with zebu cattle (Tshs 69,580/cow/year). Rugambwa *et al.* (1995) reported that gross margin per month per farm in Bukoba /Tanzania in 1994 was Tshs .8,973 and production per cow per month was Tshs 107,680. In the Southern Highlands Tanzania, Minja (1997) found that gross margin per month per cow was Tshs 14,712. Kisusu *et al.*, (2001a) found that average monthly gross income from farmer adopting dairy technology in Mvumi/Dodoma ranged from Tshs 6,000 to Tshs 70,000 per household.

Moreover, Kisusu *et al.* (2002) reported that the average income of Tshs.12,580 per month earned by dairy producing households from sale of milk in Mvumi division, if converted into per capita income per day is obviously below one US dollar per capita par day, suggesting that the households in the study area are still below the poverty line. The main argument is that income poverty among the dairy cattle keeping households has declined since introduction of dairying, although most of them may still be below the poverty line. This range was almost the same as that observed by DCT (1992, 1999), which recorded gross margins ranging from Tshs 4,000 to Tshs. 60,000. Regardless of any range, Netherlands Economic Institute (1999) reported that income from milk is realized throughout the year, unlike crop income, which is seasonal.

Overall, it was noted that total household income was higher for adopters than non-adopters of improved dairy cattle. This implies that adoption of improved dairy production technology provides an opportunity to earn more income. Furthermore, the findings with regard to the contribution of smallholder dairy production to the incomes of the poor households are not surprising since there is a brad variety of anecdotal evidence from case studies in Africa, Asia and parts of Latin America that the poor derive a higher share of their household income from livestock sources (for example Adams and He, 1995 in Pakistan, Fitch and Soliman, 1983 in Egypt, Von Braun and Pandya-Lorch (1991). In addition to the importance of livestock to household income, the particular importance of livestock for women's income in developing countries has been widely stressed (Quisumbing et al., 1995, Validivia, Dunn, and Sherbourne, 1995). Dairy cooperatives have in fact been a major theme in successful efforts to bring women in poor areas into the cash economy in East Africa (Brokken and Seyoum 1992), India (Scheneider, 1995), and Bolivia (Valdivia, Dunn, and Sherbourne, 1995).

Although dairy sector can provide attractive economic returns, it was reported that there are outstanding barriers to dairy technologies which include poor milk market, unreliable milk collection and delivering systems (Mdoe and Nyange, 1995; Mbiha and Ashimogo, 1998; Mdoe *et al.,* 2000). Report by MOAC, SUA and ILRI (1998) also found that economic impact of keeping dairy was higher in Southern Highlands zone than other zones in Tanzania. The reason was that net marketing margin which is found by taking gross marketing margin divide by selling price was 32% and that was higher as compared to Arusha/Kilimanjaro (27%), Coastal zone Tanga (18%), Dar es Salaam (24%) and Kagera/Mwanza

(23%). Apart from net marketing margin, the study also reported that gross margin for dairy keeping was higher in Rungwe than other areas studied.

2.6.2.3 Social impact of improved dairy cattle

Nicholson *et al.* (1999) reported that adopters of improved dairy cattle hired more permanent labour than non-adopters. Besides permanent labour, adopters were more able to hire casual labour than non-adopters. Kisusu *et al.* (2001a) also reported that dairy technology created employment to rural labour force in Mvumi Dodoma. The employment created include engaging hired labour in collection of animal feeds, cleaning of cowshed and milking. In addition, livestock serve as forms of insurance against agricultural risks, savings and wealth, social function, and through employment generation (Mdoe and Temu, 1994).

In addition, it was reported by Kisusu *et al.* (2002) that improved dairy production increased rural households ability to acquire assets through income from sale of milk and other dairy products. The ability of a large number of households to meet cost of various social services such as medical expenses, educational expenses, primary school fees, buying school uniform, paying development levy and hiring labour was also increased (Kisusu *et al.*, 2002).

2.6.2.4 Impact of improved dairy cattle on food security

Mdoe and Temu (1994) reported that increased livestock production is important in achieving food security in three ways:- (i) Directly through increased food production that adds directly to household nutrition. (ii) Indirectly through increased cash income that can be used to purchase food of plant origin, as well as other household items.

Other contribution of improved dairy technology is to narrow the gap between supply and demand of milk in the households. Although supply of milk might be inadequate in various localities, several reports noted that households owning dairy cattle consume more milk than those without dairy cattle. Kisusu *et al.* (2001a) reported that farmers who keep dairy cattle in Mvumi Division consumed more milk per capita (61.57 litres per year) than their counterparts. This consumption level was higher than national average which was reported to be 25.3 litres per year (Massae, 1993; URT, 1999; Malewas and Rwezaula, 1999). Nicholson *et al.* (1999) reported that the nutritional status of children among dairy producers was better than non- dairy producers. However, adoption of improved dairy technology also has some negative impacts. ILCA (1993) reported that zero grazing increases the workload of women farmers more than that of men but the management of female managed farms is either equal or superior to that of male managed farms.

2.6.2.5 Impact of improved dairy cattle on environment

Dairy cattle production has also several environmental impacts. Kisusu *et al.* (2001a) have reported that number of trees planted increased after the introduction of improved dairy cattle in Mvumi Dodoma. According to Holtland (1996), in his study of zero-grazing by smallholders in destocked in Mvumi Division reported that trees were planted in large quantity as government campaign on improving environmental conservation. Rutamu *et al.* (1997)

reported that dairy technology practiced on zero grazing enabled construction of biogas plants and therefore saved cutting trees for fuel wood in Dar es Salaam Tanzania.

2.6.3 Previous studies on impact of irrigated rice technology

Several studies have reported the impact of adopting irrigated rice technology. On yield impact, Pretty *et al.* (1996) reported that rice yield was 3.05 tonnes per hectare before adoption but increased by 115% for high yielding and 111% for low yielding varieties in East and Southern Africa. According to IRRI (1985), irrigated rice in Tanzania produced 3 t/ha while yield in non-irrigated upland culture ranged between 0.4 and 1.0 t/ha.. However, the same report indicated that irrigated rice could produce 2.5 t/ha. Mwakalila (1992) reported that yield at Mbarali irrigated rice project dropped from 7 ton/ha to 4.5 t/ha. The low yield was due to minimal use of inorganic fertilizer (Giller *et al.*, 1997).

Charan (1973) reported that gross farm output was significantly higher in canal-irrigated areas as compared to the rainfed areas. Apart from yield, it was reported by Tagarimo and Torres (1978) that farmers with irrigated rice cultivated more acreages as compared to farmers without irrigated rice. This substantiates that having irrigated rice contributed to expanding cultivated acreages. Furthermore, irrigated rice enabled farmers to practice water cropping system (Pandya and Sharma, 1986). It was reported by Dibwe (1984) that rotational irrigation crop makes high possibility of growing other crops which formerly were not practiced. Orota (1993) also found that irrigated rice had several economic benefits such as positive net present worth (NPW), higher internal rate of return (IRR) and benefit -

cost ratio greater than one. According to Orota (1993), return per hectare on project farms was higher than on non-project farms for both paddy and maize. This was attributed by the fact that project farms were exposed more to extension agents and other support activities than non-project farms.

With regard to social impact of the project it was reported by Dey (1990) that irrigated rice contributed to social conflict between women and m en. This was due to the fact that irrigated rice generated more income which was controlled more by men than women. In a worse situation, Siriwardena (1981) reports that social conflicts were high between men and women as the former cultivated paddy on irrigated land while the later cultivated sorghum on rain fed land. Irrigated rice generated more income than sorghum but the income was not properly distributed in the household. As a result, women were financially unable to support t heir c hildren. Gosh (1984) r eported t hat i ntroduction of i rrigated r ice ensured employment among farmers throughout the year. This was possible because irrigation enabled permanent employment. Clayton (1970) also reported that irrigated rice increased employment twice as much as compared to non-irrigated rice production. It was reported by IRRI (1985) that introduction of irrigated rice in various countries contributed to improving common skills through training, a nd a fter f acilitation e xtension s ervices, conducting r esearch i n several centres.

On environmental impact it has been reported by Mwakalila (1992) that construction of irrigated rice schemes tends to reduce soil erosion around the cultivated area. This is based on the fact that the speed of water is controlled. Moreover, Mwakalila (1992) reported that irrigated rice enabled proper maintenance of water balance in the paddy fields. As reported earlier, the advantage of water balancing helps to control weeds and retaining soil nutrient.

2.6.4 Impact assessment methodologies

2.6.4.1 Economic impact assessment

Various studies have adopted economic approach to examine impact of development projects (Moshi *et al.*, 1997; Marasas *et al.*, 1997; and TARP II-SUA Project, 2001). The economic approach uses measures like benefit-cost analysis, economic surplus models, economic efficiency estimation and gross margin or gross profit (Norton and Davis, 1981; Jahnke *et al.*, 1986; Adesina and Zinnah, 1992; Turuka, 2000a; Alston *et al.*, 1995; Walker and Crissman, 1996; Kormawa, 1996; Coulibaly, *et al.*, 1998).

The strengths of economic analysis approaches is that encourage the use of policy decisions that are based on quantitative assessments (Van de Walle, 1998). Sen (1976) argues that the approach is useful because it measures poverty or welfare changes through use of income or gross net product. Despite the aforementioned strengths, the approach has certain drawbacks. It has been reported by many researchers that the approach fails to capture the distribution of goods and services among people in the country. Blackwood and Lynch (1994) argue that the approach cannot measure consumption of government provided goods and services that do not require personal income to purchase necessary commodities. Similarly, Savers (1988) argues that change of income or GNP does not represent majority on poverty but favours the rich and neglects the poor households. In addition to biasness, data used for income assessment are liable to discrepancy, and therefore become unreliable. Unreliability of data, especially in most developing countries is reported to be a serious problem (Rahman, 1985 and Van de Walle, 1998). Regardless of the weakness of the approach, the most popular methods used in economic analysis are gross margin analysis (GM), economic farm surplus (EFS), internal rate of return (IRR), benefit cost ratio (BCR) and net present value (NPV).

Although all methods are used, the common and simple one is gross margin analysis, which is sometimes known as gross profit analysis. Johnson (1985) defines gross margin as the difference between the value of an enterprise's gross revenue and the variable cost of that production. The merit of gross margin includes enabling assessment of profitability of most economic activities. An added advantage of GM is that it can easily be understood and it has logical interrelation between economic and technological parameters. Studies by Mlay (1987) and Sibanda (1998) found that gross margin analysis supported assessment of economic profitability of dairy enterprises in Tanzania and Zimbabwe respectively. Moreover, several studies done by Alvarez and Fransisco (1990), Diocese of Central Tanganyika (1992), Holtland (1996), Kormawa, (1996), Thippawal and Mollel (1998), Limbu (1998), O'Neill and Mathews (1999), Shah *et al.* (2000), Manyong *et al.* (2000) and Philip (2001) adopted gross margin as analytical technique. Despite the advantages of GM, it also encompasses several shortcomings. These include inability to accommodate or account variations in fixed costs structure within or among businesses and it does not make allowances for complementary and supplementary relationship between enterprises.

2.6.4.2 Social-cultural impact assessment

Socio-cultural method focuses on peoples' parameters such as their attitude, belief, resource distribution, status of women, income distribution, nutritional implications, health level, shelter, democracy and adoption of the technique (Moshi *et al.,* 1997; Marasas *et al.*,1997; Sanginga *et al.,* 1999; Turuka, 2000b; TARP II-SUA Project 2001). This method is very appropriate because it touches directly the welfare of a person.

Within socio-cultural context, Social Impact Assessment (SIA) can be used as it incorporates social and economics of the project (Carley and Derow, 1980; Campbell, 1990; Cernea, 1991). SIA uses many indicators, which cover household welfare. The approach could be useful for evaluating impact of development projects on poverty alleviation. This approach uses income as a measure of welfare improvement or poverty reduction.

Despite the criticisms levelled against income as an indicator of poverty, income is of paramount importance in addressing the issue of poverty situation. Various studies show that improved income levels enable households to (i) achieve household food security (Hemmer, 1987; World Bank, 1990; Orota, 1993; Sanginga, 1998; Sanginga *et al.*, 1999; Kisusu, *et al.,* 2002), (ii) improve nutritional levels (Walshe *et al.,* 1991; Huss-Ashmore, 1992;. Kurwijila *et al.*, 1996; Survey, 1997; MOAC and SUA, 1998; Nicholson *et al.*, 1999;. Melewas and Rwezaula, 1999; Kisusu *et al.,* 2002), (iii) acquire material assets and meet household obligations (Tyler, 1983; Leen and Koekkoek, 1993; Lazaro, 1996;

Ayad *et al.,* 1997; URT, 1998; Sanginga, 1998; Kisusu *et al.*, 2001a), (iv) create employment opportunities (Clayton,1970; Rao 1987), (v) have leisure hours (Ellis, 1988; Johnsson *et al.,* 1993; Lazaro, 1996; Sanginga *et al.,* 1999; Kisusu *et al.*, 2001a, b) and (vi) adopt improved technologies (Mattee, 1994; Howard and Cransfied, 1995; Nkonya, *et al.,* 1997; Senkondo *et al.,* 1998).

2.6.4.3 Environmental impact assessment

Environmental impact assessment (EIA) is defined as the systematic reproducible and interdisciplinary identification, prediction and evaluation, mitigation and management of impacts from a proposed development and its reasonable alternatives (UNEP, 1996; Mwalyosi, *et al.,* 1997; Moshi *et al.*, 1997; Marasas *et al.*, 1997 and TARP II-SUA Project, 2001). Environmental impact assessment (EIA) involves analysis and evaluation of adverse and/or beneficial effects of human actions on the environment (Westman, 1985; Bisset, 1987; 1992; Gopalan *et al.,* 1992; Biswas and Agarwala, 1992; Hinchcliffe *et al.*, 1995). According to Thanh and Tam (1992), many of the development projects in the past, and even as recent as in the 1970s have been implemented with little environmental concern. This is mainly due to several reasons, one of them is the fact that knowledge of environmental impact and impact assessment techniques was not fully developed. As a result, a number of small and large scale development projects have contributed to environmental destruction of high magnitude. These include soil erosion, deforestation, diseases outbreak such as schistosomiasis, malaria, diarrhoea, eye infection and skin disease (URT, 2001a). Moreover, adverse impacts have created strong feelings among people who are aware of environmental problems and have bred movements that promote environmental protection and protest against development (Thanh and Tam, 1992; Kamukala, 1992).

The negative impact of projects on environment can be reduced using complementary activities. The most common ones which have resulted to progressive outcomes include planting trees, control of soil erosion, land use planning, use of organic fertiliser and less use of chemicals (Bunch and Lopez, 1995; Buckles, 1995; Marasas *et al.*, 1997; Mlambiti 1998a; Carsky *et al.*, 1998, Buckles *et al.*, 1998, Kisusu *et al.*, 2001a).

Environmental impact assessment can be carried out using two different methods (FAO, 1989; Chiplunkar, 1992). The first is qualitative environmental impact assessment (QaEIA) method which needs to list every conceivable effect on the environment that might be attributed to each alternative, then make a qualitative judgement of each effect, whether positive or negative. For example, major positive impact (+3), moderate positive impact (+2), minor positive impact (+1), no impact (0) as major negative impact (-3), moderate negative impact (-2) and minor negative impact (-1) (Turnbull, 1992; TANAPA, 1994; Jambiya and Sosovele, 2000). Gopalan *et al.* (1992) asserts that the method is less expensive, uses local experience, encourages people participation during the assessment and gives immediate results. Despite the usefulness of the method, it has some disadvantages. For example, it cannot predict the environmental disturbance that may harm or benefit all the living species of an ecosystem including the human being. Moreover, the method is not sensitive to the continuous time dependent changes occurring in the environmental parameters.

The second method is quantitative environmental impact assessment (QnEIA) (FAO, 1989; Turnbull, 1992; NEMC; 1997; Mwalyosi *et al.*, 1997 and Hambrey *et al.*, 2000). It operates by building quantitative model of the relationships between management practice and environmental factors thereby generating quantitative estimates of environmental impact. At least some of these predictions can, in turn, be subjective to economic analysis. For instance, comparing benefits and costs, assessing net present value of development project in relation to environment, considering internal rate of return in relation to cost of capital. Also, benefit–cost analysis can be incorporated. The advantage of this method is that it can predict future outcomes.

However, the disadvantage of the QnEIA is that it relies on market prices, which in most developing countries are distorted. It is argued by Dixon *et al.* (1994) that distortions of market prices are commonly a result of changes of taxes, subsidies, fixed exchange rates or mandated wage or interest rates. Other disadvantages of QnEIA include failure to maintain income distribution, intergenerational equity to other areas or within areas, cannot measure risk and uncertainty, irreversibility to other natural resources, can not determine value of human life, failure to estimate cultural, historical and aesthetic resources (Bisset, 1992 and Dixon *et al.*, 1994).

Regardless of methodologies used to assess environmental impacts, an assessment of environment is subdivided into four parts. First, physical environment (e.g. soil erosion, wetlands and groundwater quantity). Second, ecological/biological environment (habitat change, loss of vegetation, etc). Third, scenic/aesthetic environment (e.g. scenic quality, in view shed and out view shed). Lastly is socio- economic aspects such as potential risks and hazards, cultural life style, humiliation, employment, benefit–cost to community (FAO, 1989; Dixon *et al.*, 1994; Mwalyosi *et al.*, 1997; Jambiya and Sosovele, 2000).

CHAPTER THREE

CONCEPTUAL FRAMEWORK AND METHODOLOGY

3.1 Overview

This chapter comprises three sections. The first section presents the conceptual framework of adoption and impact assessment. The framework composes technology packages of dairy/irrigated rice, factors influencing adoption of such technologies and impact of technologies on poverty alleviation. The second section describes the methodology of the study. In this section, the sampling techniques and procedures used for data collection are discussed. The last section presents the analytical techniques. Methodologies of measuring adoption, determining factors which influence adoption of the technology as well methodologies used for analysing the impact of improved technologies on poverty alleviation are also discussed.

3.2 Conceptual framework

Under normal circumstances, the level of income determines poverty level. For example, it is expected that the higher the level of income an individual possesses, the lesser the degree of poverty other factors being held constant. The assessment of poverty alleviation in a given community is tantamount to evaluating changes in income levels in that community. However, changes in income levels are influenced by a host of other factors which affect production efficiency such as availability of inputs, markets for the products, level of education, age of the individual, availability of extension and credits services. The effects of improved incomes on poverty alleviation are supposed to be reflected in the changes of individual's welfare through increased material assets, food security and overall well-being of those individuals.

As such most of rural development projects, therefore aim at among others things, the improvement of peoples income through establishing income-generating projects such as the Mvumi dairy and Bahi irrigated rice projects. Figure 3.1 shows the relationships between the technologies in these two projects and the expected combined effect of each project's technologies on the farmer's welfare. The framework shows that when the technologies are introduced, the farmer may adopt or reject them, resulting into adopters and non –adopters. As shown in figure 3.1, adoption of the technologies is influenced by several factors. When the technology is adopted the ultimate outcome is impact of the technology from economic, food security, social and environmental view points (Figure 3.1).

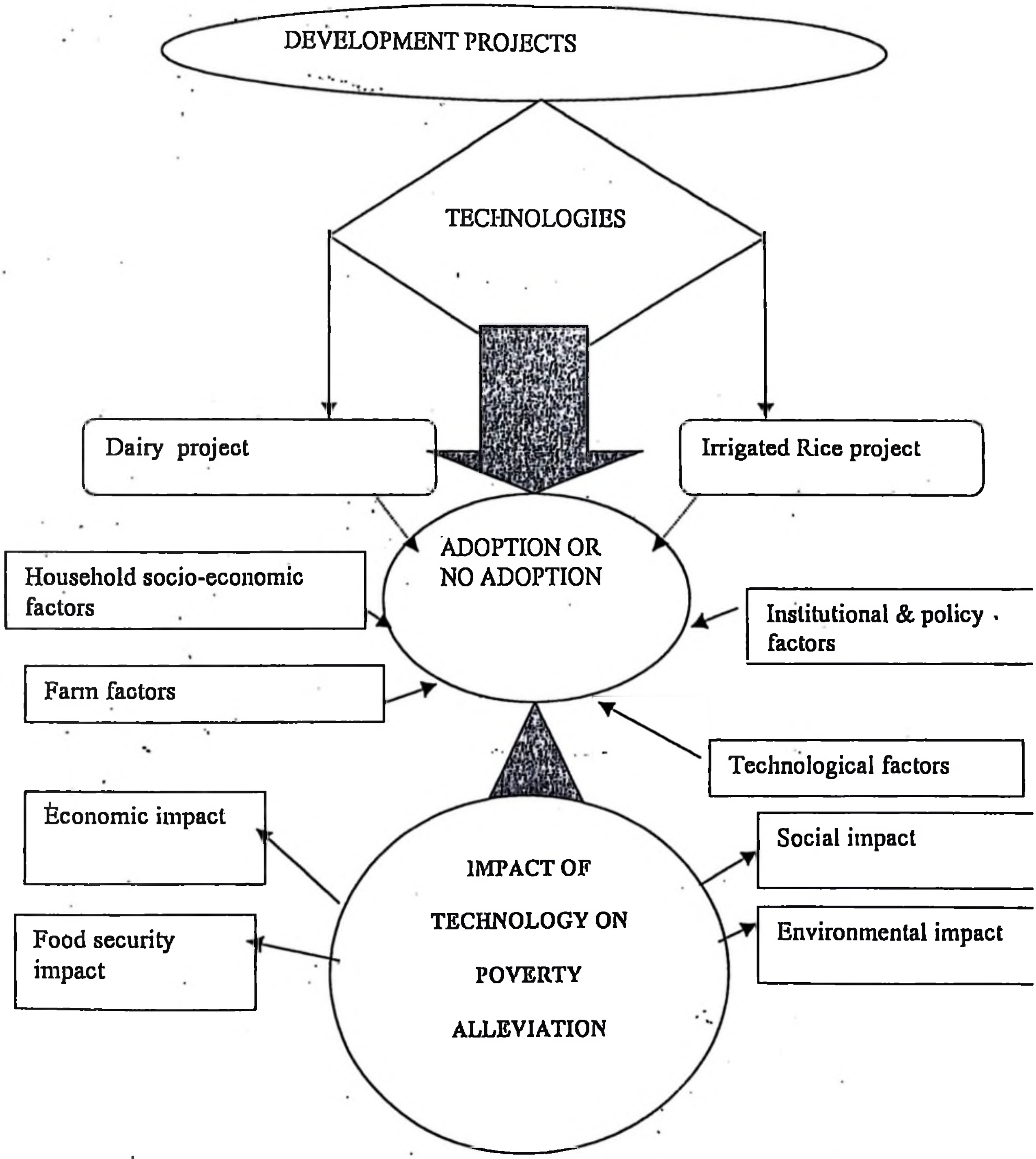

Figure 3.1: Conceptual framework for assessing the impact of technologies on poverty alleviation

3.3 Methodology:

3.3.1 The Study area

The study was carried out in Mvumi and Bahi, Dodoma Rural District, Dodoma Region. Dodoma Region is among the 21 regions in Tanzania mainland. It lies between latitude 4^0 –7^0 South of the Equator and longitude 35^0 -37^0 East of Greenwich. The region covers an area of about 41,311 km^2, which is 1.52% of Tanzania mainland area. According to URT (1997) the region has 5 administrative districts i.e. Dodoma rural District, Dodoma Urban, Kongwa, Mpwapwa and Kondoa (Figure 3. 2).

Dodoma rural District occupies 33.9% (14,004 km^2) of region's total area (41,311 km^2). For administrative purposes, Dodoma rural District is divided ino 8 divisions namely, Mvumi, Bahi, Chilonwa, Chipanga, Mundemu, Makang'wa, Itiso and Mwitikira. Each Division is further divided into wards and villages. There is a total of 48 wards and 124 villages. This study was carried out in Mvumi Division and Bahi Village where the two development projects have been implemented.

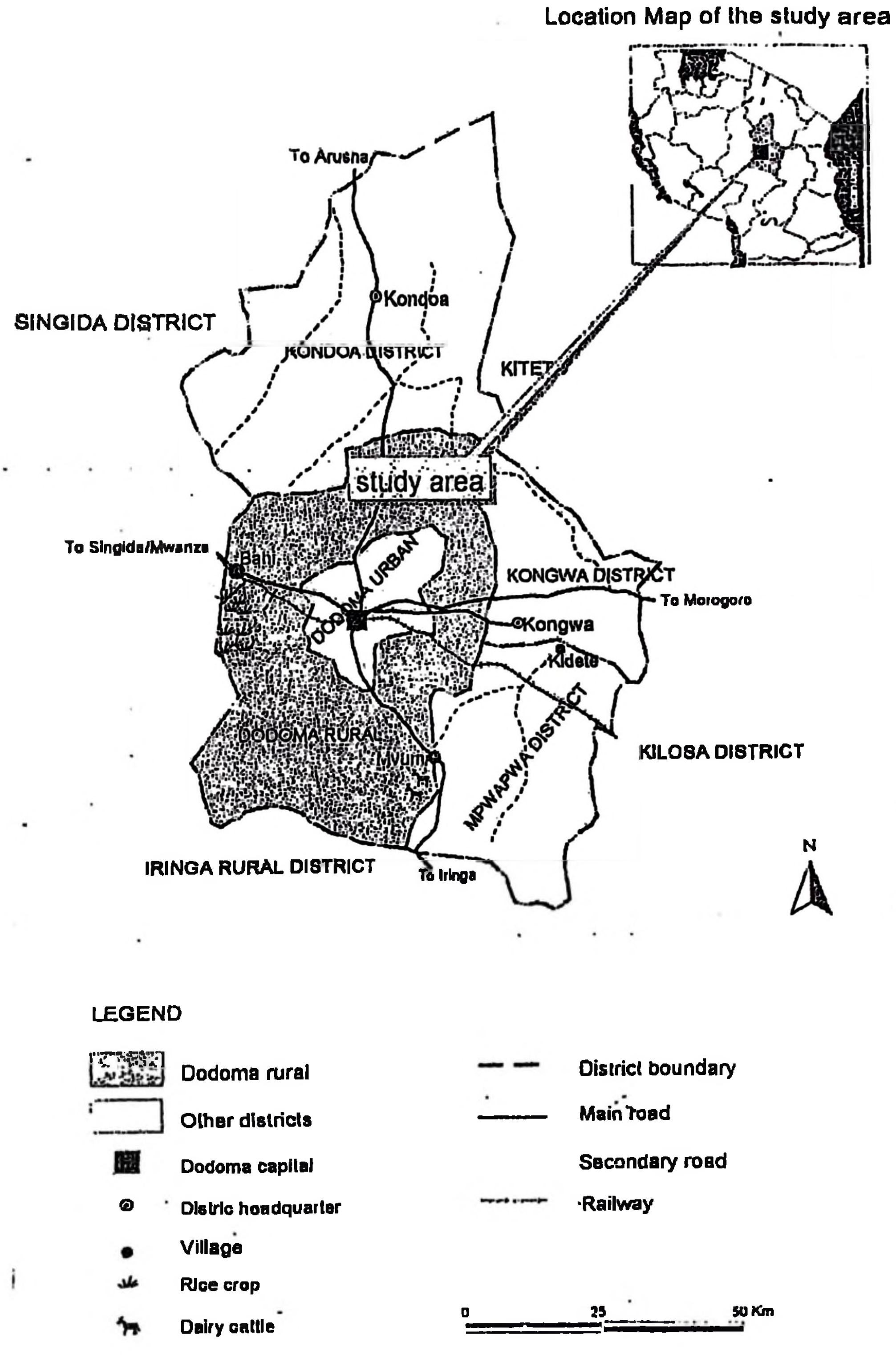

Figure 3.2: Map of Dodoma Region showing location of Dodoma Rural District

The climate in Dodoma rural District is of semi arid type with average annual rainfall of a bout 570 mm. Due to inadequate rainfall, people work mostly during the rainy season which runs for 4-6 months a year between November and April. Therefore, unemployment is high during off-farming season (August– October). The majority rely on agriculture. Average cultivated area per household is between 1-2 hectares which is relatively low compared to the national average of 2.1 – 3.5 ha.

Annual population growth rate of the District was estimated at 2.4% (URT, 1988) and therefore the population could reach 469,077 by 2000. About 93% and 7% of total population in the District live in rural and urban areas respectively. This shows that majority of population in the District reside in rural areas. About 164,975 (47%) and 188,155 (53%) of people in the District are males and females respectively (1988 census). This indicates that females exceed males by 6.56%.

The household size in the District was 4.9 in 1978 and 4.7 in 1988 while the regional figures are 4.9 in 1978 and 5.0 in 1988 and national average was 5.2 in 1988. This shows that household size in the District is below the regional and national averages.

3.3.2 Sampling:

3.3.2.1 Selection of sample villages

Mvumi Division is composed of 13 villages and all villages are practising improved dairy technology and therefore all villages had equal chance of selection. Out of 13 villages, six were selected. The selected villages are approximately 50% of total villages and this could make a fair representation and reliable reflection of the study results in the whole division. The selected villages are Mvumi Mission, Mvumi Makulu, Handali, Ilolo, Idifu and Mzula. The villages were purposely selected based on the number of households keeping dairy cattle. Table 3.1 shows that Mvumi Mission had more dairy farmers than other villages. Bahi village was purposely selected since improved traditional irrigated rice production is undertaken only in that village.

Table 3.1: Mvumi Division: Names of Villages and Number of Villagers Sampled

Village	Sampled Dairy Project Farmer	As % of total sample	As % of total village population (1998)
Mvumi Mission	57	35	0.5
Mvumi Makulu	52	32	0.5
Handali	16	10	0.2
Ilolo	16	10	0.5
Idifu	12	7	0.2
Mzula	11	7	0.5
Total	164	100	-

Source: Survey data (1999/2000) and abstract from DCT, 1999 Table 7 page 12

3.3.2.2 Selection of sample households

Sample size was computed using the formula used by Casley and Kumar (1988). The formula is used because it computes the required sample size without bias. It was used for determining the sample size of improved dairy (project participating farmers) and improved irrigated rice (project participating farmers). The formula is expressed as follows: -

$$N = K^2 R(100 - R) / D^2 \quad (1)$$

Where,

N = calculated sample size

K = constant associated with selected confidence level (confidence level was 90%, then K = 1.28). Normally in social science, confidence levels of either 90% or 95% are commonly used in sample issues. In this study it was taken as 90%.

R = assumed to be the proportion of adopters (R= 40%). Level of adoption varies between 0% and 100%. Any proportion is a valid assumption but various literatures show that in most cases adoption of technologies varies from 30% to 80% and in this case proportion of adopters was 40%.

D = error margin (D = 10%). Error lies between 0% and 100% but assumed to be low; in this case it was 10%. With this formula, a sample size of 164 farmers was computed and this was applicable for both improved dairy and improved traditional/indigenous irrigated rice farmers. After getting the size for each sample, the selection of smallholder farmers in the project was carried out. The required households were randomly selected from the list of each village register. In Bahi, required households were also selected randomly from the village register. The village register had about 325 farmers who were participating in the improved traditional irrigated rice project.

To assess if the technologies (dairy/irrigated rice) have diffused to farmers who were not participating in the projects was carried. The same formula applied for sample size of project participating farmers (dairy /irrigated rice) was used to determine the sample size for non-project participating farmers in Bahi. For that reason the number of non-project participating households selected was the same as the project participating households, which is 164 households. These households were selected to explore the extent of diffusion of improved traditional irrigated rice technologies to other farmers.

In Mvumi, the formula was not employed because very few households were not participating in the improved dairy project. Instead 46 non project participating households were purposely selected to explore extent diffusion of improved dairy technologies to farmers other than those originally involved in the Project.

3.3.3 Data collection

3.3.3.1 Secondary data collection

Secondary data were collected from various sources. The data sources and type of data collected are shown in Table 3.2.

Table 3.2: Sources of secondary data and type of information collected

Source of data	Type of the data
Sokoine National Library	Dairy/ irrigated rice production, poverty, impact assessment, Population statistics
Dodoma Regional/District Rural Offices	Socio – economic profile of the region/districts, technologies introduced in rural areas, various projects
IFAD projects in Dodoma Rural district	Bahi irrigated rice technology, impact assessment
Mvumi Rural Training Centre (MRTC)	Information on dairy technology at Mvumi division.
National Planning Commission and Privatisation	The Economic Survey 1998 to 2001
World Bank in Tanzania	Poverty situation statistics
REPOA	Poverty situation statistics
MOAF	Dairy and irrigated rice production information
Internet	Adoption/impact of dairy/irrigated rice and other projects on poverty alleviation

3.3.3.2 Primary data collection

A structured questionnaire of the format shown in Appendix I was designed and used to capture both qualitative and quantitative data. It consists of both open and closed ended questions. The questionnaire contains questions seeking information about household characteristics, dairy and rice irrigation production and issues related to impact of the projects. Questionnaire pre-testing was carried out for ten days. The major objectives of pretesting the questionnaire were to know estimated average time for interviewing a respondent, to check relevancy of the questions and improve the questionnaire accordingly. The questionnaire was administered to the sample households between June 1999 and May 2000. Interviews started with sample farmers in Mvumi Division and then Bahi Village improved traditional irrigated rice project. Prior to the day of interviews, the researcher visited each village to meet village Chairpersons, Secretary and extension agents and informed them on the purpose of the study. The researcher using Kiswahili language administered the questionnaire. In all cases, households were the units of investigation.

Farmers were interviewed at their homes or village offices after making appointments through the village leaders who also introduced the researcher to all farmers to be interviewed. Moreover, some respondents were interviewed at trading centres where they carry petty business activities after performing agricultural activities.

3.4 Analytical techniques

3.4.1 Methodologies for measuring adoption and determining factors influencing adoption

Adoption rate was computed without considering time span of introducing the technologies. It was calculated by dividing number of adopters for each specific technology by the total number of participants in that project as shown below:

$$A = N/R*100 \quad (2)$$

Where

A= percentage of adopters,

N= number of adopters

R= number of all participants in the project

Factors influencing adoption of improved dairy and improved traditional irrigated rice technologies were determined using logistic regression models using the Statistical Package for Social Science software (SPSS, 1998). The models for the dairy and irrigated technologies are as described below:

(a) Logistic Model I: Determination of factors influencing adoption of improved dairy cattle.

The adoption of the various technologies were assessed as a package because a farmer will not get the full benefit if he or she adopts one or only some of the technologies in the package. For example raising a high yielding improved cow without proper feeding and animal health care will not result into high milk yields. Similarly, feeding concentrates and proper medical care for a traditional zebu cow will not exceed its potential for milk production. In general a farmer is assured of high output if he/she adopts a high yielding breed together with improved feeding and animal health care. For this reason dairy farmer in Mvumi is categorised as an adopter of improved dairy technologies if he/she obtained milk yields per cow per day of 7.9 litres and above. Those obtaining less than 7.9 litres per cow per day are considered to be non-adopters of improved dairy technologies.

The model used to determine factors influencing adoption of improved dairy cattle technologies (as a package) was specified as:

$$prob(P/(1-P)\} = Z = \alpha + \sum_{i=1}^{n} \beta n Xn + \sum_{i=1}^{n} \varphi n Kn + \omega \qquad (3)$$

Where

Z = Vector of probabilities of adopting improved dairy cattle production (where 1= for milk yield of 7.9 litres per cow per day and above, 0= for milk yield of less than 7.9 litres per cow per day)

Xn =Is a vector of continuous independent variables such as

X_1= HHAGE= Age of Head of household (years)

X_2=NPLSHH = Number of pupils in the household (number)

X_3=AVMKYLP= Average milk yield at end of lactation period (litres)

X_4=DMCOHO = Daily milk consumption at home (litres)

X_5=TMALESHH= Total males in the household (number)

X_6=THWDRS = Total household working days during rainy season

X_7=AGRFCD = Amount of grass fed per cow per day (kg)

Kn=is a vector of binary independent variables such as

K_1= TRMGRCO = Means of Transport used to collect grass (1= bicycle/ wheel barrow, 0 = by head)

K_2= HEIBOBD = Heifer breed type owned before dairy project {1= improved (Friesian, Ayrshire, Cross breed, Jersey), 0 =less improved}

K_3= VEOCOM= Village extension contact (1= regular contact, 0= irregular contact)

K_4=GHHHD = Gender of household head (1= females, 0=males)

α= Intercept or constant term,

β= Regression coefficient explaining importance of variable X.

ω= Standard error or disturbance term.

φ= Regression coefficients explaining power of variable K.

(b) Logistic Model II: Determination of factors influencing adoption of improved traditional Irrigated rice production

Like the case of improved dairy technologies, the adoption of improved irrigated rice technologies was also assessed as package because a farmer will not get the full gains if she or he adopts one or only some of the technologies in the package. For instance, a farmer who has adopted improved traditional irrigation system without using improved seed varieties, use of inorganic fertiliser, practising optimum spacing, water control and management will not achieve high rice yields. Similarly, using inorganic fertiliser and improved seed varieties in indigenous irrigation system not lead to realisation of maximum rice output achievable. A farmer is guaranteed of high rice output if she/he adopts the improved traditional irrigation system together with improved seed varieties, use of inorganic fertiliser, practising optimum spacing, water control and management. For this reason a farmer is categorised as an adopter if she/he realised high rice yields of 2855 Kg/ha and above. Those obtaining less than 2855 Kg/ha are considered to be non-adopters of improved irrigated rice technologies.

Like the case of dairy technologies, a logistics model of the form shown below was specified to determine factors influencing adoption of improved irrigated rice technologies (as a package). The two models differ in the variables being studied due to the fact that dairy production and rice production are two different enterprises.

$$prob[P(1-p)] = W = b + \sum_{i=1}^{n} dnQn + \sum_{i=1}^{n} uV + q \quad (4)$$

Where

W = vector probability of adopting improved traditional rice yield production technology (where 1= for rice yield of 2855 kg/ha and above, 0= for rice yield of less than 2855 kg/ha)

Qn = is a vector of continuous independent variables such as

Q_1= NHWRAS= Number of household working during rainy season (numbers)

Q_2=RYBEIP = Rice yield before irrigated project (kg/ ha)

Q_3=NPLSHH = Number of pupils in the household (number)

Q_4=HHYSCH= Head of household years in school (years)

Q_5=HRBIRP = Hectares of rice before irrigated project (ha)

Q_6=HRAIRP =Hectares of rice after irrigated project (ha)

V= is a vector of binary independent variables such as

V_1=TRMENS = Means of Transport (1= bicycle, 0= head)

V_2=TRANEF = Transport effective (1=effective, 0= ineffective)

V_3= SUIRWTR =Sufficiency of irrigated water (1= sufficient, 0=insufficient)

V_4= EWMGTCO = Effectiveness of water management committee (1= effective, 0=ineffective)

V5=TRANMD = Transplanting method (1=spacing, 0= non-spacing)

b = Intercept or constant term,

d= Regression coefficient explaining importance of variable Q.

q= Standard error or disturbance term.

u= Regression coefficients explaining power of variable V.

3.4.2 Analysis of impact of improved dairy and improved irrigated rice production

3.4.2.1 Economic impact

As pointed out in section 2.6.4.1, economic impact can be assessed using different methods including benefit cost ratio, economic surplus models, economic efficiency estimation and gross margin analysis. This study used gross margin analysis and purchasing power parity before and after the Project to determine if improved dairy and improved irrigated rice production have had economic impact at the household level.

Gross margins were calculated as the difference between total revenue and total variable cost. The formula used is as shown below:

$$GM = TR - TVC \quad (5)$$

Where,

GM= gross margin (gross profit),

TR= Total revenue from the sale of dairy products or rice output.

TVC= Total variable cost for dairy production or irrigated rice production

For dairy production, two sources of revenue were considered. These were sale of milk and sale of dairy stock. Therefore, total average revenue for dairy was calculated by adding milk revenue and revenue from sale of livestock obtained per month (30 days). In the case of rice, revenue was obtained by calculating the value of rice produced by using the 1999/2000 average selling price.

Total variable costs for dairy include cost of hired labour, veterinary services such as drugs, cost for feeds and transport. The calculation was done per farmer per 30 days and finally average total variable cost was estimated. On the other hand, variable costs for improved irrigated rice production were labour for cultivation, transplanting, weeding and harvesting. Other costs comprised costs of inputs such as seeds, chemicals (pest/vermin control) and transportation incurred during the 1999/2000 season.

As stated in the literature review, fixed costs have not been included because for most of poor rural people fixed costs are not reliable. In most cases, farmers do not have permanent working tools. Tools such as hoes, machetes, buckets and utensils possessed by farmers and then used in the project are not properly recorded in terms of money value and purpose of purchase. Similarly, family labour is not easily valued in most cases due to inadequate development of the labour markets in most rural areas.

The purchasing power parity was calculated by converting the annual per capita into a dollar equivalent per day. The purchasing power parity was calculated as follows:

$$PPP = AP \Big/ ER * Y \quad (6)$$

Where

PPP= Purchasing power parity

AP = Annual per capita income

ER = Average exchange rate in 1999/2000 was Tshs 800 per one US dollar.

Y = Year (365 days)

The figure obtained was then divided by household average size (average of 4 in Bahi and 5 in Mvumi Division).

3.4.2.2 Impact on food security

The average amount of calories intake before and after introduction of the technologies were compared to determine impact of improved dairy and improved irrigated rice production on food security. This was carried out by comparing amount of calories intake per adult equivalent. The independent T test, paired sample T-test and cross-tabulation were used to test for significance deference between the two periods (before and after).

3.4.2.3 Social impact

Type and number of assets owned before and after introduction of dairy and improved irrigated rice were compared. The average number of assets owned before and after introduction of both projects were computed for the comparison. The independent T-test and paired T-test were employed to test for significance difference between the two periods (before and after).

3.4.2.4 Environmental impact

Assessment of environmental impact focused on the number of planted trees before and after the projects. Similarly, the number of pit latrines was compared before and after introduction of improved dairy cattle/improved irrigated rice. Paired sample T-Test was employed to test for significance difference between the two periods.

CHAPTER FOUR

THE ECONOMY OF DODOMA AND SOCIO- ECONOMIC CHARACTERISTICS OF PROJECT BENEFICIARIES

4.1 Overview

This chapter is divided into four main sections. The first section gives an overview of the economy of Dodoma Region with emphasis on major economic activities, Which play significant role on improvements of regional economy. The second section provides a description of the development projects, which were introduced in Dodoma Rural District while section three discusses the socio-economic characteristic of project beneficiaries. The last section discusses the technical and economic aspects of improved dairy production and improved traditional irrigated rice production.

4.2 An overview of the economy of Dodoma

4.2.1 The economy of Dodoma Region

The economy of Dodoma Region depends mainly on agriculture. Agriculture refers to the combination of crop production, livestock and natural resources. The major crops grown in the Region are maize, sorghum, millet, paddy, beans, sunflower, groundnuts, simsim and castor. Other crops are tomatoes, onions, vegetables and fruits. Production of maize from Dodoma was low and contributed only 0.9% to the national economy between 1986/87 – 1992/93. This was relatively lower than other regions such as Iringa (21%), Mbeya, (13%), Ruvuma (10%) and Rukwa (10%) (URT, 1997). However, production of drought resistant crops such as sorghum and millet was higher than other regions. In 1991/92, Dodoma produced 21.2% of national sorghum output which was higher than other regions like Singida which produced 18%, Rukwa (1.2%), Shinyanga (14.9%), Mara (5.8%) and remaining regions (38.9%). The production of millet was also good as Dodoma Region produced about 41.4% of total national output and this was relatively higher as compared to Singida which produced 22.1%, Rukwa (13.2%), Shinyanga (6.1%), Mara (4.5%) and other regions (25.9%) (URT, 1997). Table 4.1 shows that the values of major crops grown were higher in the year 1994/95 (except maize) as compared to the year 1990/91. In the recent years, the region recorded significant increase in sorghum and millets production. This suggests that increased effort on sorghum and millet production would have significant improvement in the economy of Dodoma as compared to production of other crops.

Table 4.1: Values of selected crops produced in Dodoma region in 1990/91 and 1994/95 (Tshs)

Crops	Value in Tshs (000)	
	1990/91	1994/95
Maize	627,104	480,273
Sorghum	492,200	8,036,430
Millet	530,040	4,144,350
Paddy	33,956	88,171

Source: RALDO, Dodoma (1997)

Apart from crop production and natural resources, livestock also supports the Regional economy. According to the national sample census of agriculture of 1993/94, Dodoma region ranked third in terms of cattle numbers after Shinyanga and Mwanza (URT, 1996b, 1997). It is also reported that goats contribute significantly to the economy of Dodoma Region. The Region had about 954,611 goats and 274,561 sheep in 1993/94 but these were lower than other regions such as Arusha which had 1,238,432 goats, and 469,232 sheep, Shinyanga had 1,112,590 goats and 404,955 sheep, Singida had 676,518 goats and 377,388 sheep, Mwanza had 627,202 goats and 144,495 sheep while Tanga had 606,361 goats and 176,827 sheep.

Despite the importance of agriculture on the regional economy, statistics show that the contribution of the Region to national economy is low. The Region was ranked 16 out of the 20 regions in the country between 1980 and 1994 and contributed 3.07% to the national GDP (URT, 1997). The highest GDP contributor was Dar es Salaam followed by Arusha Region.

Moreover, by 1994 the per capita GDP in Dodoma Region was Tshs 9,604 and that was lower than other regions such as Arusha (Tshs.91,024), Iringa (Tshs 64,502), Singida (Tshs.55,644) and Morogoro (Tshs.59,370) (URT, 1997). These facts show that Dodoma region is relatively a poor region and concerted efforts are required to develop the regional economy.

4.2.2 The economy of Dodoma Rural District

Dodoma Region comprises five Districts namely Dodoma Urban, Kondoa, Kongwa, Mpwapwa and Dodoma Rural. In all these districts, the common feature is that agriculture is the main economic activity. Despite the fact that all districts rely on agriculture, the economy varies from district to district. The possible reasons for economic variation could be due to differences in features such as climate, soil type, established institutional set up, existing infrastructure, and level of farm management. Consequently, each district has its own economy. Table 4.2 shows that in the year 1993/94 Dodoma Rural ranked third in production of maize but ranked first in production of millet, sorghum, sunflower while ranked second in groundnut production.

Table 4.2: Selected crop productions in the Region in tonnage by District in 1993/94.

District	Production in tones				
	Maize	Millet	Sorghum	G/Nuts	S/Flower
Kondoa	14031	2652	5907	2606	3070
Mpwapwa/Kongwa	8340	4512	10001	11628	2953
Dodoma Urban	3864	21900	2600	1604	89
Dodoma Rural	6649	50568	16802	4210	4803
Total	32900	109638	35800	20048	10915

Source: RALDO, Dodoma (1997)

Moreover, Table 4.3 shows that households in Dodoma Rural owned 45%, 34% and 46% of regional cattle, goats and sheep in 1984. Also Table 4.4 indicates that Dodoma Rural was second in terms of number of cattle, goats and chicken but third in terms of number of sheep. From these two tables, it can be concluded that livestock plays a significant role in improving livelihood of Dodoma Rural District residents.

Table 4.3: Number of livestock by districts

District	Cattle	%	Goats	%	Sheep	%
Kondoa	251405	25	196455	36	47265	28
Mpwapa/Kongwa	214714	21	107045	20	33704	20
Dodoma Rural	448102	45	182054	34	78229	46
Dodoma Urban	85965	9	54094	10	10081	6
Total	1,000,184	100	539,688	100	169279	100

Source: Livestock Census Report; (1984)

Table 4.4: Number of livestock in surveyed households by districts in 1998/99 (000)

District	Cattle	Goats	Sheep	Chicken
Kondoa	319	360	83	327
Dodoma Urban	n.a	32	4	61
Dodoma Rural	274	123	14	229
Mpwapwa/Kongwa	142	106	20	150
Total	775	621	121	767

Source: District Integrated Agricultural Survey, (1998/99)

4.2.3 Development projects in Dodoma Rural District

As stated in the literature review, a large number of development projects are implemented in the country with the intention of raising the well – being of the people. According to URT (1997), development projects executed in Dodoma Rural District include water supply, health, education and community development, land development, environmental conservation and construction of bridges, roads and buildings.

Other development projects include improved dairy production and improved irrigated rice. The improved dairy project was executed in Mvumi Division and was introduced in order to replace indigenous dairy cattle, locally known as Zebu which have low productivity. Before the introduction of improved dairy cattle, Mvumi Division had large number of Zebu cattle, which created high environmental destruction. However, Zebu cattle still dominate in other areas of Dodoma Rural District and the District ranks second in terms of numbers of zebu cattle in the region.

Since development of improved dairy cattle project was considered more feasible as compared to Zebu cattle, the available literature suggests that over time the number of improved dairy cattle has increased considerably. For instance, in 1989, 3 improved heifers were distributed to 2 farmers and after a period of 10 years (in 1999), the number of improved dairy cattle reached 522 while the number of farmers owning such cattle increased to 520. Based on this trend, it was estimated that the number of improved dairy cattle by 2002 would be between 700 and 1,000. On the other hand, improved traditional irrigated rice production was introduced at Bahi Village to substitute indigenous irrigated rice production method which was applied by residences in the village for a long time. Low output and returns from indigenous irrigated rice production prompted the introduction of improved traditional irrigated rice in Bahi area. According to Tarimo (1994), the distinction between improved traditional irrigation rice system technology and indigenous irrigation system is that the former manages and controls water source while the later does not.

4.3 Socio – economic characteristics of projects beneficiaries

The socio–economic characteristics of the sample households are summarised in Table 4.5. These include gender, age, educational level, marital status and household size. The table shows that about 70% of interviewed respondents in both projects were male-headed households. The domination of male-headed households in rural areas has been observed by different studies including Lazaro (1996), Ishengoma (1998) and Philip (2001). According to DCT (1994), people of Dodoma follow the patrilineal culture where male children are the ones expected to inherit from their parents. As a result, de jure, household heads in Dodoma Region are men although de facto women are also household heads, particularly widows and singles.

The results in Table 4.5 show that the average age of household heads of sampled farmers in Mvumi was 51 years but 53% of the sampled farmers were in the age group between 46 and above 65 years. This shows that most of the respondents were relatively old. In Bahi, the average age was 40 years and 71% of respondents were aged between 18 and 45 years.

Table 4.5 shows that about 38% and 41% of the respondents in Mvumi Division possess informal education and upper primary school level respectively. In contrast, about 18% and 68% of the respondents in Bahi Village had informal education and upper primary school education respectively. This indicates that more than a third of dairy cattle owners in Mvumi have no formal education while over two thirds of farmers practicing improved traditional irrigation rice production possess upper primary school education . The same table shows that 80% and 71% of total sampled respondents in Mvumi Division and Bahi Village respectively were married. Studies done by Lazaro (1996) and Ishengoma (1998) observed similar trends. The advantages of married household heads managing development projects are several but the major one being to provide required labour force, using effectively the owned funds and sharing managerial skills within the family.

Table 4.5 further shows that 8% and 29% of respondents in Mvumi division and Bahi Village respectively have household sizes between 1 and 2 people. Cumulatively, 65% of respondents in Mvumi and 74% of respondents in Bahi have household sizes ranging between 1 and 5. However, average household size in Mvumi dairy and Bahi are 5 and 4 respectively. These are almost equal to the average regional household size of 5 persons based on the 1988 population census. It also shows that Mvumi Division has higher family size than Bahi Village. This may be due to the fact that improved dairy production requires labour almost throughout the year as compared with improved traditional irrigated rice production.

Table 4.5: Mvumi Division and Bahi Village: Proportion f respondents by socio-economic characteristics

	Mvumi		Bahi	
Gender	Frequency	Percent	Frequency	Percent
Male	119	73	116	71
Female	45	27	48	29
TOTAL	164	100	164	100
Age distribution				
18 – 35	16	10	76	46
36 – 45	40	24	41	25
46 – 55	47	28	27	17
56 – 65	41	25	13	8
Above 65	20	12	7	4
TOTAL	164	100	164	100
Education level				
No formal education	63	38	29	18
Lower P/School (Std. 1 – IV)	28	17	21	13
Upper P/School (Std. V – VIII)	57	21	110	68
Ordinary Secondary School (Form I – IV)	3	2	2	1
Advanced Secondary School (Form V – VI)	1	1	1	1
College	2	1	1	1
TOTAL	164	100	164	100
Marital Status				
Married	129	80	115	71
Single	10	6	31	19
Widowed	14	9	11	7
Divorced	1	1	0	0
Separated	8	5	6	4
TOTAL	162	100	163	100
Household size				
1 – 2	13	8	47	29
3 – 5	93	57	73	45
6 – 8	47	29	38	23
9 – 11	11	6	6	4
TOTAL	164	100	164	100

Source: Survey data (1999/2000)

4.4 Dairy cattle production

4.4.1 Technical aspect of smallholder dairy production

Table 4.6 shows the cattle breed type, breeding practices, source of bulls, and the feeding practices among the sample households in Mvumi. The results in Table 4.6 reveal that most (59%) of the farmers keep Friesian cattle. When farmers were asked about their breeding practices, majority (99%) of farmers reported that they used natural breeding (bull service) instead of artificial insemination (AI) (Table 4.6). This result tallies with findings by Hanyani – Mlambo *et al.* (1997) that most smallholder farmers in Zimbabwe adopted use of bull services for breeding their cattle. Despite the advantage of AI, its use is low and this may be due to unavailability of the service. With respect to the source of bull services, Table 4.6 shows that 68% of the respondents acquired the bull services from the Mvumi Rural Training Centre (MRTC) while 31% obtained them from neighbours.

A large proportion of respondents in the study area use bulls from the MRTC because the centre supervises the dairy project, owns reliable and best bulls. Moreover, the fact that the majority of respondents acquired the bull service from MRTC reflects the vital role that institutions can play in order to promote the sustainability of improved dairy development projects in rural areas.

Table 4.6: Mvumi Division: Proportion of Respondents by Breed Type, breeding practice, bull source and feeding levels

Cattle Breed type	Frequency	Percent
Mpwapwa	18	12
Friesian	93	59
Ayrshire	30	19
Cross – breed	14	9
Zebu	2	1
TOTAL	157	100
Breeding practice		
Natural conception (bull service)	159	99
Artificial insemination (AI)	1	1
TOTAL	160	100
Bull source		
Bull source		
Own	2	1
Bull center	108	68
Total	159	100
Using minerals/concentrates		
Not using	9	6
Using	142	94
TOTAL	151	100
Fodder feeding level		
Above 25Kg/cow/day	94	57.3
Below 25 Kg/cow/day	70	42.7
Total	164	100

Source: Survey data (1999/2000)

With regard to use of minerals/concentrates, 94% of the farmers used minerals/ concentrates (Table 4.6). This implies that many farmers are aware of the merits of using minerals/concentrates in dairy production. Feeding dairy cattle with recommended amount of fodder is an important factor on milk yield. Table 4.6 shows that about 57% of the farmers feed their dairy cattle with at least the recommended amount of fodder. The remaining 43% feed quantities below the recommended amount. This suggests that interventions in the form of extension advice on proper feeding are required.

4.4.2 Milk production levels

Table 4.7 presents results on the comparison of milk yield levels achieved by dairy project farmers and non-project participating farmers. On average, project participating farmers achieved higher milk yields (7.9 litres per cow per day) than non-project participating farmers (4.5 litres per cow per day). The maximum yield achieved by project participating farmers was also higher (18 litres per cow per day) than non- project participating farmers). The minimum yield achieved was equal in both participating farmers. As depicted in Table 4.7, most (73%) project participation farmers produced between 5.1 and 10 litres of milk a day while most (83%) non project participating farmers produce below 5.0 litres per cow per day. In general, cattle kept by project participating farmers yield more milk than those raised by non-project participating farmers. This difference could be explained by differences in cattle breed kept as well as management practices (Kisusu, *et al.,* 2002).

Table 4.7: Mvumi Division: Milk yield in litres per cow per day

Milk yield litres per cow /day	Project Participating Farmers	Non-Project Participating Farmers
Average yield	7.9	4.5
Standard deviation	2.9	2.7
Standard error	0.2	0.4
Minimum yield	2.0	2.0
Maximum yield	18.0	16.0
Percent of farmers with milk yield levels (litres)		
Below 5.0	15	83
5.0-10.0	73	14
10-15.0	8	0
Above 15	4	3
Total	100	100

Source: Survey data (1999/2000)

4.4.3 Economic aspects of smallholder dairy production

Since benefits from dairy cattle normally accrue over several years (over their useful economic life), the appropriate analytical approach for analyzing economic returns to dairying is to use the approach that takes into account future benefits and costs associated with dairy production. Such approach was not used in this study. Instead benefits were estimated as average monthly incomes from sale of milk and live animals. The costs of dairy production included in the analysis are costs of feeds, transport, drugs and labour utilisation. The structure of income and costs per household per month for project and non –project participants are shown in Table 4.8. The results in the table indicate that milk is a major source of income accounting for more than 83% of the total monthly income from dairy cattle for project participating farmers and 79% for non-project participating farmers. Regarding cost structure, labour costs account for about 55% of the total variable cost for project participating farmers and 53% for non project participating farmers. The difference in costs of labour utilisation between project and non-project participating farmers is due to differences in the level of dairy intensification. Despite high costs of production incurred by the project participating farmers, their monthly gross margin is almost 7 times more than the non – project participating farmers (Table 4.8). The results suggest that dairy development projects have the potential of increasing income and hence reduce poverty among resource poor farmers.

Table 4.8: Mvumi Division: Monthly milk income in shilling for project and non project participants.

Variables	Project participating farmers			Non- project participating farmers		
	N	shillings	% of total	N	shillings	% of total
Monthly income from	150	41,279	82.8	43	23,142	79.2
Sale of milk						
Sale of live animals	86	8,599	17.2	22	6,069	20.7
Total monthly income		49,878	100		29,211	100
Variable costs						
Dairy feeds costs	148	4,662	16.6	37	5,100	19.7
Transport costs	148	6,322	22.5	42	6,233	24.0
Drug expenses	133	1,755	6.2	31	990	3.8
Labour costs	142	15,363	55.0	43	13,611	52.5
Less: Total variable costs		28,102	100		25,934	100
Monthly gross margin		21,776			3,277	

Source: Survey data (1999/2000)

4.5 Irrigated rice production

4.5.1 Technical aspects of irrigated rice production

Improved traditional irrigation is more advanced as compared with indigenous irrigation. According to Tarimo (1994) the key feature that distinguish improved traditional and indigenous irrigation is that improved traditional irrigation system water source is constructed in order to control its irrigation channels. On the other hand indigenous irrigation system operates without the construction of water source to control water. Because of this improved traditional irrigation is more superior than indigenous irrigation. The respondents were asked to indicate whether they had water management committee or not. The responses summarised in Table 4.9 show that 97% of the respondents who used improved traditional irrigation system have water management committee. The committee is responsible for distributing irrigation water and helps to resolve conflicts related to water use that may arise due to water shortage.

Table 4.9: Bahi Village: Proportion of respondents resporting presence or absence of water management committee by irrigation system

Percent of farmers reporting	Improved traditional Irrigation system %	Indigenous Irrigation system %
Presence of water management Committee	97	29.4
Absence of water management Committee	3	70.6
Total	100	100

Source: Survey data (1999/s000)

With respect to water management, respondents were asked to give their views on the relative availability of water for irrigation. Table 4.10 indicates that about 50% of respondents using improved traditional irrigation system reported that water for irrigation is sufficient while 48% of their counterparts.

Using indigenous irrigation system indicated that water was sufficient. However, the results do not indicate any significance difference in terms of Availability of water and water sufficiency between the irrigation systems.

Table 4.10: Bahi Village: Availability of water for irrigation

Water sufficiency	Traditional Irrigation system		Indigenous Irrigation system	
	Freq	%	Freq	%
Sufficient	82	50.0	78	47.6
Insufficient	76	46.3	82	50.0
No response	6	3.7	4	2.4
Total	164	100	164	100

Source: Survey data (1999/2000)

Regarding the use of improved rice seed varieties, most of the farmers interviewed used local seed varieties. Table 4.11 indicates that most farmers practicing improved traditional irrigated rice system use more local seed than those practicing indigenous irrigated system. Literature shows that smallholder farmers use more local seed than hybrid seed (Kihupi, 1984).

This is due to the fact that hybrid seed are not readily available and in some cases are relatively expensive for resource poor farmers.

Table 4.11: Bahi Village: Use of improved rice seeds

Rice seed variety	Traditional Irrigation system		Indigenous Irrigation system	
	Freq	%	Freq	%
Local	162	98.8	158	96.3
Hybrid	2	1.2	6	3.7
Total	164	100	164	100

Source: Survey data (1999/2000)

Extension advice is important in enhancing adoption of improved technologies by smallholder farmers. The results in Table 4.12 show that majority of farmers wait for extension officers to visit them for advice. Those who take the initiative of looking for extension staff for advice are very few (6%).

Table 4.12: Bahi Village: Extension advice among farmers practicing improved traditional and indigenous irrigated rice production

VEO means of providing advice to farmers	Improved traditional Irrigation system		Indigenous Irrigation system	
	Freq	%	Freq	%
Extension staff visit farmers at their own time	130	80.2	131	82.9
Farmers call staff when in need	14	8.6	9	5.7
Extension staff have specific time/place to meet farmers	18	11.1	18	11.4
Total	162	100	158	100

Source: Survey data (1999/2000)

Attempts were made to compare the performance of improved traditional irrigation system with indigenous system. Comparison was made on the rice yields obtained by farmers practising the indigenous and improved traditional irrigation system as shown in Table 4.13. The results in Table 4.13 show that average rice yields were higher in improved traditional irrigation system (2855 kg/ha) than in indigenous irrigation system (2794 kg/ha). The maximum yield for farmers practising improved traditional system was also higher (3056 kg/ha) than maximum rice yield obtained by farmers practising indigenous irrigation system (2854 kg/ha). Similarly, more proportion of farmers (41%) practising improved traditional irrigation system were producing above 3000 kg/ha as compared to only 38% of farmers practising indigenous irrigation system. The increase of crop yields after introducing various projects has also been documented in several studies (Charan, 1973; Sandford, 1973; Pandya and Sharma, 1986; Lutatina et al 1998; Manyong *et al.* 2000; FAO, 2000; Mkavidanda, 2001; CIAT, 2001; CIAT 2001).

Table 4.13: Bahi Village: Rice yield levels in Kg/ha by various irrigated system

Rice yields levels (kg/ha)	Improved traditional irrigation system	Indigenous irrigation system
Average	2855	2794
Standard deviation	1557	2108
Standard error	140	230
Minimum	240	262
Maximum	3056	2854
Percent of farmers obtaining:		
Below 1000	12	9.4
1000-2000	16	16.4
2000-3000	31	36.7
Above 3000	41	37.5
Total	100	100

Source: Survey data (1999/2000)

4.5.2 Economic aspects of irrigated rice production

Table 4.14 shows income and costs structure for production of rice under improved traditional irrigation and indigenous irrigation system. It can be seen from the Table 4.14 that improved traditional irrigation system generates more income than indigenous irrigation system and the difference is about Tshs 11,087 which is about 5.53%. The results also indicate that total variable cost incurred by farmers practicing improved traditional irrigation was lower than those incurred by farmers who practiced indigenous irrigation. This may be due to efficient management of irrigation water. In both irrigation system, labour costs account for more than 80% of the total variable costs. As a result of relatively higher gross income and the relatively low variable costs, farmers who practised improved tradition irrigation realized higher gross margins compared to those who practiced indigenous irrigation.

Table 4.14: Bahi Village: Income and Cost structure per hectare in Tshs. Under improved traditional irrigation/indigenous irrigation systems

Variables	Improved traditional Irrigation System			Indigenous Irrigation system		
	N	shillings	%	N	shillings	%
Rice income	158	211,430	100	164	200,343	100
Total rice income	168	211,430	100	164	200,343	100
Variable Costs						
Production Costs						
Seed Expenses	158				10,981	10.2
Inorganic fertilizer	7	6,936	6.9	164	800	0.7
Pest and VerminControl	136	250	0.3	40	6,114	5.7
Purchase of a bag withcapacity (85 Kg)	164	6,252	6.2	164	2,006	1.9
Labour Inputs:		2,006	2.0	164		
Plot clearance Cultivation and Levelling	161	4,500	4.5	164	4,600	4.3
Nursery Planting	164	26,001	25.9	164	27,091	25.2
Transplanting	164	2,615	2.6	164	2,782	2.6
	164	12,786	12.8	164	13,166	12.2
Other Labour Expense:						
Irrigation Works	158	5,818	5.8	164	5,914	5.5
Harvesting, packing, transporting from field to homestead	160	33,048	32.9	164	34,176	31.8
Total Variable Costs		100,213	100		107,630	100
Rice gross margin		111,217			92,713	

Source: Survey data (1999/2000)

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Overview

This chapter presents results of the adoption and impact analyses. The chapter is divided into four main sections. The first section discusses the extent of adoption of improved dairy technologies while the second section discusses the extent of adoption of improved irrigated rice technologies. Factors influencing adoption of improved dairy production and improved irrigated rice production technologies are discussed in section three. The last section presents the results of the impact analyses.

5.2 Extent of adoption of improved dairy technologies

Adoption of four types of dairy technologies was analysed. These include use of improved cattle breeds, breeding practices, feeding and use of animal health services as discussed in subsequent sections.

5.2.1 Adoption of improved dairy cattle breeds

Prior to the introduction of improved dairy cattle by the project, farmers in Mvumi were raising traditional Zebu cattle. Following the introduction of improved dairy cattle by the project, farmers replaced their zebu cattle with improved dairy cattle. Table 5.1 shows that after introduction of the improved dairy cattle, most project participating farmers are now raising improved dairy cattle. About 1% of the project participating farmers are still keeping traditional Zebu cattle while 18% of the non- project participating farmers are raising traditional Zebu cattle. This suggests that the technology has diffused to farmers other than those in the project. Most (78%) project participating farmers have pure dairy cattle breeds (Friesian and Ayrshire) and most non–project participating farmers have adopted Cross-bred cattle (61%) (Table 5.1).

Table 5.1: Mvumi Division: Distribution of respondents by type of dairy cattle kept and breeding practice.

	Project Participating farmers	Non- Project Participating farmers
Cattle breed		
Mpwapwa	11.5 (18)	11.4 (5)
Friesian	59.2 (93)	9.1 (4)
Ayrshire	19.1 (30)	0 (0)
Cross – breed	8.9 (14)	61.4 (27)
Zebu	1.3 (2)	18.2 (8)
Total	100 (157)	100 (44)
Breeding Practice		
Bull Service	99.4 (159)	100 (46)
Artificial Insemination	0.6 (1)	0 (0)
Total	100 (160)	100 (46)

Number in the parenthesis indicate number of respondents

Source: Survey data (1999/2000)

5.2.2 Cattle breeding practices

The popular breeding practice in the study area is use of bull services. Only one respondent reported using Artificial Insemination (AI) as breeding practice (Table 5.1). After introduction of the improved dairy cattle, an overwhelming numbers of farmers use natural breeding (bull) services due to the fact that the services are readily available from Mvumi Rural Training Centre (MRTC). Furthermore, use of AI is considered to be risky by most farmers as a result most of them prefer using bull services. Besides risk, Golomela *et al.* (1993) reported that high cost of AI operation could discourage its use.

5.2.3 Improved feeding practices

With respect to fodder, recommended amount of fodder for dairy feeding is estimated at 25 kg/ per cow per day (personal communication with Dodoma District Livestock Officer). It implies that any farmer feeding above that level is referred to as an adopter. Table 5.2 shows that 57.3% of project participating farmers use at least the recommended amount of dairy fodder while 45.7% of non-project farmers use at least the recommended level. The findings indicate that more project participating farmers adopted the recommended fodder than non-project participating farmers.

In the case of mineral supplements, any farmer who gives a cow mixture of a mineral block weighing 0.5 kg a month is considered as an adopter. Table 5.2 shows that 94% and 87% of project and non-project participating farmers adopted mineral feeding respectively. The importance of using minerals supplements is stressed by Sarwatt and Njau (1990), Church (1991) and Mathewman (1993).

Table 5.2: Mvumi Division: Proportion of respondents who use recommended amount of fodder for their cattle

Components	Dairy project participating farmers	Non- dairy project participating farmers
Use of improved fodder:		
Below 2kg/cow/day	42.7 (70)	54.3 (25)
Above 25 Kg cow/day	57. 3 (94)	45.7 (21)
Total	100 (164)	100 (46)
Farmers using mineral supplements	94.0 (142)	87 (40)

Number in the parenthesis indicate frequency of respondents

Source: Survey data (1999/2000)

5.2.4 Use of animal health services

The proportion of interviewed farmers using animal health services is shown in Table 5.3. The results in Table 5.3 show that 17% of project participating farmers vaccinated their cattle against diseases. However, non-project participating farmers did not practice vaccination. The same table shows that most (78%) of project participating farmers dewormed their cattle while all non – project participating farmers practiced deworming. This is contrary to expectation since one would expect project participating farmers to be more aware of the benefits of deworming than non- project participating farmers. Dipping is not popular in the study area. Only 5% of the project participating farmers practiced dipping and none of the non-project participating farmers used dip (Table 5.3).

Table 5.3: Mvumi Division: Proportion of respondents who used animal health services

Animal health service	Dairy project participating farmers	Non–project participating farmers
Farmers practicing:		
Vaccination	16.9 (10)	0 (0)
Deworming	78.0 (146)	100 (21)
Dipping	5.1 (3)	0 (0)
Total	100 (159)	100 (21)

Number in the parenthesis indicate frequency of respondents

Source: Survey data (1999/2000)

5.3 Extent of adoption of improved irrigated rice technologies

During the study, improved irrigated rice technologies, were examined including use of improved seed varieties, plant spacing, and inorganic fertiliser use and irrigation water management.

Table 5.4 shows that there is low adoption of improved seed varieties in the study area. Only 1% and 4% of the farmers practising improved traditional irrigation and indigenous irrigation used improved seeds respectively. Reasons given for low use of improved seed varieties include unavailability and high cost of seeds. Kihupi (1984) reported that majority of farmers do not use hybrid seeds because the seeds are not readily available. Fujisaka (1993) in his study on why farmers reject innovations in upland agriculture reported that a technology is not adopted because of being expensive. Besides use of improved seed varieties, establishing optimum plant population can maximize yield. In the study area, few farmers practiced optimum plant spacing. Only 8% and 7% of the farmers practising improved irrigation and indigenous irrigation used optimal plant spacing (Table 5.4). A farmer who uses 15 kg of nitrate fertiliser per hectare is an adopter but recommended amount in Bahi area is about 75 kgN/ha. Only 4% and 24% of the project participating and non-project participating farmers respectively applied inorganic fertilizers.

There are several reasons for low use of fertilizer among smallholder farmers. Nkonya (2001) found that farmers in low rainfall zones use low rate of fertiliser as compared to high rainfall zones. Dodoma Region experiences semi-arid climate with low rainfall and this could be one of the reasons for low fertilizer use in the study area. Mnguu (1997) reported that soils in irrigated rice production are normally fertile. This might have been the major reason why inorganic fertilisers are not widely used in Bahi. Turuka (1995) and Hawassi *et al.* (1998) reported that farmers fail to use inorganic fertilisers because they are expensive. Mbata (1994), Forson (1999) and Adesina *et al.* (2000) reported that ineffective extension advice could also cause less use of agricultural inputs by farmers. Mbata (1994) further reported that high transport cost sometimes lead to less use of fertiliser.

Proper water management is essential in irrigated rice production. Farmers were asked to indicate whether they practice some kind of water control during irrigation. The responses are summarized in Table 5.4. According to the results in Table 5.4, water control was practiced by most farmers interviewed but more so by farmers practising improved traditional irrigation.

Table 5.4: Bahi Village: Proportion of respondents on using improved irrigated rice technologies

Technologies	Improved traditional irrigation system	Indigenous irrigation system
Seed variety used:		
Local	98.8 (162)	96.3 (158)
Hybrid	1.2 (2)	3.7 (6)
% of farmers practising optimum spacing	7.9 (13)	6.7 (11)
% of farmers using fertilizer	4.3 (7)	24.4 (40)
% of farmers indicating presence of water management	97.4 (151)	70.6 (108)

Number in the parenthesis indicate frequency of respondents.

Source: Survey data (1999/2000)

5.4 Factors influencing adoption of improved dairy production technologies

Table 5.5 summarizes results of the logistic regression analysis. The model has predicted correctly at 97.85% and significantly (P<0. 05). Negelkerke R square shows the coefficient of determination between adopting the improved dairy production technologies and various independent variables, which is above 50%. This suggests that the selected independent variables sufficiently explain the probability of adopting the improved dairy production technologies.

With regard to the factors influencing adoption of improved dairy production technologies, the results in Table 5.5 show that 6 out of the 11 factors examined significantly influence adoption of improved dairy production technologies in the study area. Four out of the 6 factors have positive influence on adoption of improved dairy technologies. These are age of household head, number of pupils in the household, type of heifer breed owned after introduction of improved dairy cattle and daily milk consumption at home. The positive relationship between age of household head and probability of adoption suggest that aged farmers have more experience than young farmers in understanding technologies. Similar findings have been reported by Adesina and Forson (1995), Adugna (1997), Kalineza *et al.* (1999) and Nicholson *et al.* (1999). However, the results of this study differ with other studies which found that age is inversely related with the probability of adoption (see for example Lapar and Pandey, 1991; Abdulmagid and Hassan, 1996; Sanginga, 1998; Abdelmagid and Hassan, 1996; Kisusu *et al.*, 2001c).

The positive relationship between the number of pupils in the household and probability to adopt improved cattle can be explained by the fact that pupils provide required labour for caring dairy cattle. The type of dairy heifer owned increases possibility of adoption. This is based on the fact that a better breed is associated with high milk yield and high income. Farmers with high income before project will have a high purchasing power that enable them to acquire new technologies introduced by the project. The positive relationship between daily milk consumption and the probability to adopt improved dairy technologies can be explained by the fact that farmers would be compelled to keep cattle with high productivity in order to satisfy household milk consumption needs.

The factors with negative influence on the probability to adopt improved dairy production technologies are increase in the volume of grass used by a cow per day and time or days devoted to work during the rainy season. Available literature indicate that increase in the quantity of fodder for feeding a cow is among the indicators of adoption. However, the results of this study shows that increase in grass fed to cattle reduces the probability of adopting improved dairy technologies. The inverse relationship between amount of grass fed to cattle and the probability of adopting improved dairy technologies can be explained by the fact that high feed requirements would imply more labour requirements for feed collection and feeding and this may discourage farmers to adopt improved dairy technologies. The inverse relationship between total household working days during the rainy season and probability of adopting improved dairy show that increase of household working days during the rainy season reduces probability of adoption. This can be explained by the fact that there are many crop production activities that compete with dairy cattle for the household labour. Farmers would be inclined to adopt production activities with relative low labour requirement. Therefore, the probability of adopting improved dairy cattle production which is labour intensive declines with increase in the number of household working days during the rainy season.

Table 5.5: Mvumi Division: Results of logistic regression model

- 2 Log Livelihood	Chi – Square 14.162		
Model Chi – Square #			18.837**
Negelkerke R Square			0.614
Cox & Snell R. Square			0.183
Overall cases Predicated correctly			97.85%
Explanatory Variable on dairy	B	SE	T
HHAGE	0.254	0.150	2.871**
N PILSHH	3.445	2.334	2.178*
AVEMKYLP	1.914	1.650	1.345
TRMGRCO	3.686	2.902	1.614
HEIBOAD	2.667	1.899	1.973*
VEOCOM	1.064	2.018	0.278
DMCOHO	20.258	12.012	2.844**
GHHHD	17.576	54.201	0.105
TMALESHH	1.504	1.819	0.684
AGRFCD	-8.042	5.722	1.975*
THWDRS	-2.251	1.613	1.947*
Constant	-53.746	61.612	0.761

** and * are level of significances at 0.05 and 0.10 respectively, # (11) are degrees of freedom in selected cases for Chi-square test.

Source: Survey data (1999/2000)

5.4.1 Factors influencing adoption of improved irrigated rice production technologies

Factors influencing adoption of improved irrigated rice production technologies have been examined using logistic regression model. Results in Table 5.6 shows that the model has predicted correctly the cases at 79.31% and statistically significantly at P< 0.05. Moreover, the coefficient of determination between dependent variable and other independent variables are almost above 50%. The model has been tested using Negelkerke R square which is above 50% but lower than 50% as based on Cox and Snell test (Table 5.6). The results in Table 5.6 show that 3 out of the 11 factors examined have significant influence on adoption of improved irrigated rice production technologies. Out of these three factors, 2 influence adoption positively and one factor has negative influence on the probability of adopting improved irrigated rice technologies.

Factors with positive influence are rice yield before introduction of improved irrigated rice technologies and number of pupils in the household. The positive relationship between amount of rice yield before introduction of improved irrigated rice production technologies and the probability of adopting the technologies can be explained by the fact that high rice yield before the technologies enables the farmer to adopt the new technologies. This is based on the fact that farmers with high rice yield have more income that can enable them to meet cost of improved technologies. The increase in the number of pupils in the household encourages a farmer to adopt improved technologies. Since improved irrigated rice production is labour intensive, the probability of adopting it increases with the increase in the number of pupils that can provide part time labour to assist in the farm.

On the other hand, increasing supply of irrigated water has a negative relationship with adoption of improved irrigated rice technologies. This is based on the fact that excessive supply of water creates floods and unwanted water during cultivation. The argument is based on the reality that Bahi irrigated rice project does not possess well controlled water source and water management is not much effective due to having poor committee management.

Table 5.6: Bahi Village: Results of logistic regression model

- 2 Log Livelihood	Chi – Square 21.250		
Model Chi – Square #	18.641*		
Negelkerke R Square	0.635		
Cox & Snell R. Square	0.474		
Overall cases predicated correctly	79.31%		
Explanatory Variable	B	SE	T
TRSMENS	0.642	0.915	0.492
RYIBEIP	0.932	0.636	2.145*
NPLSHH	5.001	2.623	3.636**
HHYSCH	0.276	0.378	0.533
HRBIRP	8.465	6.331	1.788
HRAIRP	-3.426	9.642	0.126
SUIRWTR	-4.322	2.302	3.526**
EWMGTCO	5.006	60.473	0.007
TRANEF	2.142	2.998	0.510
TRANMD	2.898	2.683	1.167
Constant	-31.163	62.083	0.252

** and * are level of significances at 0.05 and 0.10 respectively, # (11) are degrees of freedom in selected cases for Chi-square test

Source: Survey data (1999/2000)

5.5 Results of Impact Analysis

5.5.1 Impact of improved dairy cattle

The results of the impact analysis indicate that improved dairy cattle had positive impact at the household and community level as discussed in the following sections.

5.5.1.1 Impact on household income and purchasing power parity

Table 5.7 shows the average per capita income and purchasing power parity of the project participating households before and after introduction of improved dairy cattle. The results in Table 5.7 indicate that per capita income has increased to 432%, that is from Tshs 9,831 before introduction of improved dairy cattle in 1989 to Tshs 52,262 in 1999/2000.

Table 5.7: Mvumi Division: Average gross margin, annual per capita income and (Tshs) and purchasing power parity, before and after project

Income Indicators	Before Project	After Project
Average gross margin (Tsh)	3,277	21,776
Annual per capita income (Tsh)	9, 831	52, 262
Purchasing power Parity US $	0.03	0.20

Source: Survey data (1999/2000)

Similarly, purchasing power parity from milk alone has increased by 566%, from US $ 0.03, before introduction of improved dairy cattle in 1989 to US $ 0.20 in 1999/2000. Although some other factors might have contributed to the increase in per capital income and purchasing power parity of the households in the study area, adoption of improved dairy cattle has significantly contributed to their increase. Further evidence of the significant contribution of improved dairy cattle is provided through increased milk yields, dairy income, increase in cultivated crop acreages and crop yields among the dairy project-participating farmers.

As indicated earlier in section 4.4.3, average milk yield after the introduction of improved dairy cattle of about 7.9 litres per cow per day was significantly higher than the average yield before the introduction of improved dairy cattle of about 1.77 litres per cow per day. Prior to the introduction of improved dairy cattle, farmers in Mvumi were raising indigenous zebu cattle with low milk production potential. Comparison of monthly incomes from milk with and without improved dairy cattle indicate that introduction of improved dairy cattle has had significant impact on household incomes and consequently higher per capita income and purchasing power parity. The per capital income of Tsh 52,262 is higher than the average GDP per capita income of Tsh. 39,604 for Dodoma Region in 1997 (URT, 1997). Several studies also provide evidence of impact of improved dairy production on household incomes (see for example Syrstad, 1988; Orota, 1993; Greenhalgh, 1993; Staal and Thorpe, 1999).

5.5.1.2 Impact on crop production

Impact of the introduction of improved dairy cattle on crop production was assessed by comparing average crop acreages and crop yields before and after the introduction of improved dairy cattle in the study area. The results in Table 5.8 show that with the exception of sorghum crop acreages for the major crops grown in the study area have increased after the introduction of improved dairy cattle. However, the mean difference in the yield between the period before and after introducing improved dairy cattle is not significant. Although the difference is not significant the results are in line with findings of several studies that cultivated acreages increased after introducing improved dairy cattle (see for example Tagarino and Torres, 1978; Marasas, *et al.*, 1997; Manyong *et al.*, 2000). The increase in cultivated crop acreages with introduction of improved dairy cattle, may be explained by the fact that dairy production increases household incomes which can be reinvested in crop production.

Table 5.8: Mvumi Division: Mean crop acreages (ha) before and after introduction improved dairy cattle.

Crop	Average crop acreages	
	Before Project	After Project
Maize	0.79 (131)	0.85 (131)
Rice	0.53 (4)	0.60 (4)
Sorghum	0.60 (96)	0.57(96)
Millet	0.73 (93)	0.76(93)

Note: Numbers in the parenthesis indicate frequency of respondents.

Source: Survey data (1999/2000)

Equally important, crop productivity has increased with the introduction of improved dairy cattle. Evidence for increased crop productivity is provided by significant increases in crop yields after the introduction of dairy cattle when compared with the yields before introduction (Table 5.9). As can be seen from Table 5.9, the mean differences between crop yields before and after introduction of improved dairy cattle are highly significant ($P<0.05$). Other studies undertaken in different areas have also found that dairy development projects contribute to increases in crop yields (see for example Herdt and Capule, 1983; Msambichaka, et al., 1983; Benad, 1987; Turuka, 1995; Moshi *et al.*, 1997; Marasas, *et al.*, 1997; URT, 1997; Mdoe, *et al.*, 1998; Temu and Ashimogo, 1998; Mlambiti, 1998b; Manyong *et al.*, 2000). The increase in crop yields with introduction of improved dairy cattle is possible due to several reasons. These include (i) increased manure production and use for crop production as compared to the situation before when farmers were keeping indigenous zebu cattle with low manure production, and (ii) increase in income from improved dairy cattle might have increased farmers' access to other improved husbandry practices. For example, the increased income increase households ability to hire labour and purchase other inputs for crop production.

Table 5.9: Mvumi Division: Mean crop yields before and after introduction of improved dairy cattle.

Crop	Crop yields (kg/ha)			
	Before Project		After Project	
	N	Mean	N	Mean
Maize	131	814	131	991***
Sorghum	96	789	96	1198**
Millet	76	571	76	872***

Note: ***, ** Significant at 0.01 and 0.05 respectively, N = Number of respondents

Source: Survey data (1999/2000)

5.5.1.3 Impact on food security

The impact of introduction of improved dairy cattle on food security was examined by comparing (i) the calories intake per adult equivalent before and after introduction of improved dairy cattle and (ii) per capita milk consumption before and after introduction of improved dairy cattle. The calories intake per adult equivalent was computed using standard conversion rate shown in Appendix 2.

The results in Table 5.10 show that households were able to consume more calories intake after (2521 calories) than before (2200 calories) introduction of improved dairy cattle. In Tropical Africa, calories intake ranges between 2350 and 2790 (Latham, 1979; West *et al.*, 1988; Wagara, 1988; Wagao, 1991; Latham, 1997). The calories intake by project participating farmers after introduction of improved dairy cattle fall within this range while the coverage intake before introduction fall below the range. This suggests that introduction of dairy cattle has improved household calories intake in the study area.

Table 5.10: Mvumi Division: Amount of calories intake before and after introduction of dairy project

Period	N	Mean	Standard deviation	Standard error
Before project	123	2200	532	48.02
After project	162	2521	2739	215.27

Source: Survey data (1999/2000)

Increase in calorie intake alone does not ensure food security among household members. Food security is improved if all household members have access to safe and nutritious food to maintain healthy life. Households raising improved dairy cattle might sell all the milk and purchase starchy food items to increase calories intake. In this case members of the household are denied consumption of milk which is one of the nutritious food items. Table 5.11 shows average annual per capita milk consumption before and after the introduction of improved dairy cattle. The results indicate that annual per capita milk consumption was higher after than before the introduction of improved dairy cattle. This consumption level of milk was even above the Tanzania national average of 23 litres per capita. Previous studies in Tanzania have also found that raising improved dairy cattle enable consumption of more milk compared with traditional cattle (see for example MOAC and SUA, 1998; URT, 1999; Melewas and Rwezaula, 1999; Nicholson, *et al.*, 1999; Kisusu, *et al.*, 2001a; Kisusu *et al.*, 2002).

Table 5.11: Mvumi Division: Average annual per capita milk consumption (litres) before and after improved dairy project

Seasons	Respondents	Mean (litres)	Standard deviation	Standard error
Before dairy project	54	17.9	0.99	8.276 E-02
After dairy project	147	54.8	35.4	2.9

Source: Survey data (1999/2000)

5.5.1.4 Social impact of improved dairy cattle

Evidence of the social impact is provided by comparing possession of material assets, ability to meet costs of social services and amount of leisure before and after the introduction of improved dairy cattle.

(a) Possession of material assets.

Material assets acquired before and after the introduction of improved dairy cattle are shown in Table 5.12. The results in the table indicate that project participating households had more material assets after introducing improved dairy cattle than before and the mean difference is highly significant ($P < 0.01$). Studies done by various researchers had similar findings (see for example Tyler, 1983; Ayad *et al.*, 1997; Sanginga 1998; Kisusu *et al.*, 2001a). Although income from sources other than improved dairy cattle might have been used to acquire assets, the fact that the material assets owned after introduction of dairy are significantly higher than before suggests that income from dairy has enabled household to acquire more assets.

Table 5.12: Mvumi Division: Mean number of owned material assets before and after introduction of improved dairy cattle

Assets owned	Before dairy project		After dairy project	
	N	Mean	N	Mean
Chairs	124	4.52	124	7.40 **
Table	63	1.37	63	1.73 **
Beds	108	1.92	108	2 .91 **
Bicycle	47	1.11	47	1.21*
Radio	62	1.06	62	1.27**
Shoe	106	1.21	106	1.69**
Lamps	94	1.49	94	2.39**
Axe	119	1.87	119	2.80**
Land (ha)	92	1.78	92	2.04**

Note: ** Significant at 0.01, * Significant at 0.10, .N= Number of respondents

Source: Survey data (1999/2000)

(b) Ability to meet cost of social services

Respondents were asked to indicate if their ability to meet costs of necessary social services has increased or decreased or remained unchanged after the introduction of improved dairy cattle. The responses of the respondents are summarized in Table 5.13. The results indicate that over 50% of respondents replied that improved dairy cattle have increased their financial ability to meet social services such as medical expenses, hiring labour, paying school fees, school uniform and development levy (Table 5.13). Several studies had similar results (see for example Clayton, 1970; Gosh, 1984; Rao, 1987; Leen and Koekkoek, 1993; URT, 1998; Nicholson *et al.*, 1999; Kisusu *et al.*, 2001a).

Table 5.13: Mvumi Division: Respondent's opinion on impact of dairy project on selected household services

Level Obligation	Medical Hiring	Hiring Labour	School fees	School Uniform	Development Levy	Acquire Drinks
	%	%	%	%	%	%
Increased	89	68	82	76	55	49
Decreased	3	1	2	2	1	1
Unchanged	8	31	16	22	45	50
Total	100	100	100	100	100	100

Freq.= Frequency, % = Percentage

Source: Survey data (1999/2000)

(c) Leisure time

Respondents were asked to indicate number of hours used for leisure before and after the introduction of improved dairy cattle. The results in Table 5.14 show that farmers used to have more leisure hours prior to the introduction of improved cattle than after the introduction during both rainy and dry seasons. The results suggest that introduction of improved dairy cattle has reduced leisure hours. The reduction of leisure hours could be due to the fact that improved dairy cattle enterprise is labour intensive. Furthermore it has been shown earlier that the project participating farmers were cultivating more crop acreages after than before the introduction of improved dairy cattle. It implies that leisure hours were also used for expansion of crop acreages. The mean difference in leisure time between the two periods is highly significant ($P<0.1$).

Table 5. 14: Mvumi Division: Mean hours on leisure before and after dairy project by season

Season	Before dairy project		After dairy project	
	N	Mean	N	Mean
Rainy period	90	3.41	90	2.65 ***
Dry periods	89	1.98	89	1.69 ***

*** significant at 0.01 level, N= Number of respondents

Source: Survey data (1999/2000)

5.5.1.5 Impact of improved dairy cattle on environment

Evidence of impact of improved dairy cattle on environment was provided by comparing the extent of tree planting and level of sanitation. before and after the introduction of improved dairy cattle. The results in Table 5.15 show that the average number of trees planted per household before the project was 9 as compared to 21 after the project and the mean difference highly statistically highly significant (P< 0.01). The increase in the number of planted trees is not surprising since the campaign of conserving environment in Dodoma Rural District popularly known as "Hifadhi Ardhi Dodoma" involved all smallholders in Mvumi Division (DCT, 1992; Holtland, 1996; URT, 1997). Besides this campaign, the increase in treee planting with development projects has also been reported by Bunch and Lopez (1995); Rutamu, *et al.*(1997); Turuka, *et al.*, (1997); Mlambiti, (1998a) and Kisusu, *et al.*, (1999a). Tree planting is considered to be one of the measures to improve soil fertility and soil erosion control. The other benefits of tree planting include source of energy, supply of building poles and retaining soil moisture.

Table 5.15: Mvumi Division: Average number of planted tree before and after introduction of improved dairy project

Trees	Before project	After project
Average	9	21
Standard deviation	6	36
Standard error	1	3
Minimum	1	2
Maximum	36	300

Source: Survey data (1999/2000)

Apart from increase in the number of planted trees, the level of sanitation among the project participating households has slightly improved. Table 5.16 shows that the proportion of households without pit latrines has declined from 52% of respondents before the introduction of improved dairy cattle to 50% of the farmers after introduction of improved dairy cattle.

Table 5.16: Mvumi Division: Proportion of respondents with and without pit latrine before and after project

Item	Before dairy project		After dairy project	
	Freq.	%	Freq.	%
Without pit latrine	82	52	79	50
With pit latrine	76	48	79	50
Total	158	100	158	100

Note: Freq. = Frequency, % Percentage

Source: Survey data (1999/2000)

5.5.2 Impact of improved Irrigated rice production

5.5.2.1 Impact on household income and purchasing power parity

The results in Table 5.17 show that the average gross margin and annual per capita income of project participating households have increased with the introduction of improved irrigated rice production. Similarly, the purchasing power parity after project is higher than before the project. A number of previous studies reported similar results that improved irrigated rice technology increases household income (see for example Charan 1973; Chambers and Moris, 1973; IRRI, 1979, 1985; Orota, 1993; Petty *et al.*, 1996; Manyong *et al.*, 1998).

Table 5.17: Bahi Village: Average gross margin, annual per capita income and purchasing power parity after project and before project

Income Indicators	Before Project	After Project
Average gross margin (Tsh)	92713	111,217
Annual per capita income (Tsh)	23178	27,804
Purchasing power parity US $	0.08	0.10

Source: Survey data (1999/2000)

5.5.2.2 Impact on cultivated crop acreages and rice yields

Cultivated acreages before and after improved irrigated rice project have been examined and the results are as shown in Table 5.18. The results demonstrate that mean cultivated acreages have slightly declined from 0.52 ha before to 0.48 ha after the introduction of improved irrigated rice production and the mean difference is significant (P< 0.10). The findings by Moshi *et al.*, (1997) and Ishengoma (1998) show that most of smallholder farmers in Tanzania cultivate between 0.5 and 2.5 hectare. Even though, it is reported that new technologies can lead into reduction of crop area cultivated because poor farmers can not manage large farms (Rahm and Huffman, 1984; Adesina and Zinnah 1993). The results of this study differ with those previous studies due to two reasons. First, the supporter of the irrigated rice project (IFAD) encouraged farmers to own small plot sizes so that they can get technical assistance. Second, farmers were unable to manage large farms due to lack of required resources.

Table 5.18: Bahi Village: Mean cultivated acreages (Ha) and rice yield before and after irrigated rice project

Crop	Before irrigated rice project		After improved traditional irrigated rice project	
	N	Mean	N	Mean
Rice acreage (ha)	157	0.52	157	0.48*
Rice (kg/ha)	164	2269 (1083)	164	2923 (1591)***

Note: ***, * Significant at 0.01 and 0.10 respectively,. N= Number of respondents

Source: Survey data (1999/2000)

With regard to rice yields, the results in Table 5.18 indicate that rice yield has increased significantly after the introduction of improved irrigated rice technologies when compare to yields before the project. This has also been reported by Kihupi (1984), IRRI (1985), Orota (1993), Turuka (1995) and Petty *et al.* (1996) who found that adoption of irrigated rice technology normally leads to more rice yield.

5.5.2.3 Impact on food security

The respondents were asked to indicate quantity of various foods they consume per day per household. The amount of food consumed per household was later converted into calories using standard conversion rate shown in Appendix 2. The amount of calories consumed before and after the introduction of improved irrigated rice production is shown in Table 5.19. The results show that consumption of calories intake increased by about 4% from 2406 calories before to 2507 calories after the project. The increase of calories is an evidence that the project has increased rice output and enabled households to consume more calories. Several studies in the literature have also reported that adoption of improved technologies contribute to the improvement in nutritional status at the household level (see for example Walshe *et al.*, 1991; Huss – Ashmore, 1992; Kurwijila *et al.*, 1996; Survey, 1997; Milich, 1997; MOAC and SUA, 1998; Sanginga, 1998; Nicholson *et al.*, 1999; Sanginga *et al.*, 1999; Nicholson *et al.*, 1999; Kuliwaki – Mvuna, 2002).

Table 5.19: Bahi Village: Consumption of calories intake before and after improved traditional irrigated rice project

Period	N	Mean calorie intake	Standard deviation	Standard error
Before project	112	2406	492.7	46.6
After project	112	2507	570.2	44.5

Source: Survey data (1999/2000)

5.5.2.4 Social impact of improved irrigated rice production

Evidence of the social impact is provided by comparing possession of material assets, ability to meet cost of social services and amount of leisure time before and after the introduction of improved irrigated rice technologies as discussed under subsequent section.

(a) Possession of material assets

Results in Table 5.20 shows the material assets acquired before and after irrigated rice project. The results indicate that the mean number of material assets acquired after project was more than before and the mean difference is highly statistically significant ($P< 0.01$) for all assets except land. Other studies also found that new technologies normally enables households to increase material assets (see for example Marasas *et al.*, 1997; Sanginga, 1998; Sanginga, *et al.*, 1999).

Table 5.20: Bahi Village: Average number of assets owned before and after introduction of improved irrigated rice production

	Before project		After project	
Assets acquired	N	Mean	N	Mean
Chairs	102	2.12	102	3.23 ***
Tables	71	1.18	71	1.56***
Beds	112	1.62	112	2.12***
Shoe	151	1.07	151	1.46***
Lamp	121	1.23	121	1.56***
Land (ha)	39	0.58	39	0.56

Note: ** *Significant at 0.01 level, N= Number of respondents

Source: Survey data (1999/2000)

(b) Ability to meet cost of social services

Respondents were asked to give their opinion on whether improved irrigated rice production has increased their ability to meet costs of household services or not. Their responses are depicted in Table 5.21. It is shown in the table that over 70% of the project participating farmers reported that the project has increased their ability to meet household services such as health, education, hiring labour and buying food. Available literature also show that the introduced technologies tend to increase the ability to meet other household obligations (see for example DCT, 1992; Holtland, 1996; DCT, 1999; Sanginga, *et al.*, 1999).

Table 5.21: Bahi Village: Respondent's opinion on impact of Irrigated rice project on ability to meet selected household services

Level of services	Medical	School fees	School uniform	Hiring labour	Buying food
	%	%	%	%	%
Increased	72	87	88	93	93
Decreased	8	2	1	1	2
Unchanged	20	11	10	6	5
Total	100	100	100	100	100

Note: Freq. = Frequency, % = Percentage

Source: Survey data (1999/2900)

(c) Impact on Leisure time

The times used by farmers on leisure during the rainy and dry periods before and after introduction of improved irrigated rice production were computed and the results are shown in Table 5.22. The results show that during the rainy season, 6 hours were used for leisure before the project. On the other hand, 8 hours were used for leisure after the project. The mean difference in leisure time between the two periods is highly statistically significant ($P< 0.01$). Similarly, during the dry season, 4 hours were used for leisure before the project and 5 hours used after the project with the mean difference being highly statistically significant ($P< 0.01$). The increase in leisure time is likely to have been contributed by several factors. These include significant reduction of cultivated acreages from 0.50 to 0.48 ha. Moreover, using improved irrigation system saved more farmer's hours as compared to indigenous irrigation system, which used a lot of hours before intervention.

Table 5.22: Bahi Village: Mean leisure hours before and after irrigated rice in different seasons

Season	Before project N	Mean	After project N	Mean
Rainy period	153	6	153	8 ***
Dry period	153	4	153	5***

Note: *** Significant at 0.01 level, N= Number of respondents

Source: Survey data (1999/2000)

5.5.2.5 Environmental impact

Evidence of the impact of improved irrigated rice production on environment is provided by comparing the extent of tree planting and level of sanitation before and after the improved traditional irrigated rice production project. The results in Table 5.23 show that number of planted trees per household have increased after than before the project and the mean difference is highly statistically significant (P< 0.01). Similar findings have been reported by Bunch and Lopez (1995), Rutamu, *et al.* (1997), Turuka, et al., (1997), Mlambiti, (1998a) and Kisusu, *et al.*, (1999a).

Table 5. 23: Bahi Village: Average number of planted trees per household before and after irrigated rice project

Trees	Before Project	After Project
Average	4	7***
Standard deviation	3.0	3.0
Standard error	0.4	0.3
Minimum	1	1
Maximum	20	23

*** Significant at 0.01 levels, N= Number of respondents.

Source: Survey data (1999/2000)

With regard to sanitation facilities, Table 5.24. shows that before the project 53% of project participating farmers had no pit latrines but the proportion without pit latrine decreased to 16% after project. These observations indicate that sanitation has improved after introduction of the improved irrigated rice production. This is probably due to increased incomes from sale of rice which increased the ability of the farmers to purchase latrine materials and hire labour for construction.

Table 5.24: Bahi Village: Proportion of respondents with and without pit latrines before and after improved traditional irrigated rice production project

Item	Before project		After project	
	Frequency	Percent	Frequency.	Percent
Without pit larine	82	53	24	16
With pit latrine	73	47	130	84
Total	155	100	154	100

Source: Survey data (1999/2000)

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

The overall objective of this study was to assess the adoption and impact of improved dairy and irrigated rice technologies on poverty alleviation in Dodoma Rural District, Tanzania. More specifically the study was undertaken (i) to determine adoption of improved dairy and improved irrigated rice technologies and factors influencing their adoption, (ii) to assess the impact of improved dairy and irrigated rice technologies on alleviation of poverty at the household level, and (iii) to draw necessary policy recommendations emanating from the analysis of the study. This chapter presents conclusions and policy recommendations.

6.1 Conclusion

The major conclusion that can be drawn from the findings of this study is that the introduction of improved dairy production and irrigated rice production have had positive impact on incomes of households, food security and improvement of the environment. Overall both developments projects have contributed significantly to alleviation of poverty in the study area.

6.2 Recommendations

6.2.1 Policy recommendations

The following are recommendations emanating from the major findings of the study:

(i) The findings of this study have showed that annual per capita income, and household food security after the development projects were significantly higher than before the projects. The findings suggest that rural poverty can be reduced substantially if development projects are encouraged. Therefore, the technologies introduced through improved dairy and irrigated rice projects should be promoted in other rural areas of Dodoma Region with similar weather conditions. It is however, recommended that they should really target the poor especially the rural women. If not properly targeted to the resource poor the projects may benefit the rural better off and widen the gap between the better off and the resource poor farmers.

(ii) The results of the study have also showed that most of the project participating farmers are raising pure exotic cattle such as Friesian and Ayrshire with a high potential for milk production. Furthermore the results have showed that improved dairy technologies are increasingly diffusing to farmers who were not originally involved in the Mvumi Dairy Development Project. The implication from this is that milk output is likely to increase to quantities beyond those which can be sold locally in Mvumi Division. To avoid future problems of marketing surplus milk that can not be absorbed locally, it is important to establish an organized system of marketing the surplus milk to distant markets outside Mvumi. The best strategy is to establish a system of collecting milk from individual smallholder producers and transport the milk in bulky to take advantages of economies of scale and reduce transactions costs that would have been incurred if individual producers were to look for buyers for their small quantities of milk.

Therefore, the local government or NGOs/CBOs, operating in the area should encourage formation of farmer groups or associations. The groups or associations should be voluntary rather than mandatory through creating awareness about the benefits of such associations. Once the associations are formed training on leadership and management should be conducted because experience shows that failure of most farmer organisations or cooperatives is due to poor management including financial management.

Besides ensuring that milk from members and other producers is marketed, farmer groups/associations have the advantage of collective bargaining and therefore can purchase dairy inputs from input suppliers at discounts. In order to further reduce the cost of marketing of milk in Dodoma municipality farmers groups should strategically manage transport in such a way that the same vehicle transporting milk to Dodoma is used to transport dairy inputs such as concentrates and mineral supplements back to Mvumi. Formation of farmers groups or associations should also be encouraged among the irrigated rice producers in Bahi for reasons similar to those indicated above.

(iii) Findings of the study further show that although most farmers in Mvumi and Bahi are currently using improved technologies introduced through development projects, the rate of adoption of technologies as a package is still low. To increase productivity requires use of all the technologies associated with improved dairy cattle (improved feeding, animal health services etc) and with improved irrigated rice (improved rice seed varieties, plant spacing, use of fertilizer, water management) not partial adoption of the packages. In most cases the use of these technologies by smallholder farmers is constrained by their unavailability, high cost and lack of extension advice on how to use them properly.

Therefore, the role of government intervention is crucial in terms of the following:

(a) Investment in infrastructure, extension and delivery services and

(b) Prices of agricultural inputs and products.

6.2.2 Suggestions for future research

The following are suggestions for future research:

(i) Improved dairy technology is labour intensive and would likely increase women's workload than the workload of men in the study area. Since the current study did not examine labour demand in detail, it is suggested that further research be carried out to assess labour demand by season and division of labour by gender before and after introduction of dairy.

(ii) No attempt was made in this study to assess differential access and adoption of technologies by farmers with different levels of income. It is therefore suggested that future research should assess adoption and impact of agricultural technologies among farmers of different wealth categories.

(iii) This study used gross margin analysis to assess income from improved dairy production. However, the benefits from dairy cattle accrue over their useful economic life. Therefore an analytical approach which takes into account the future benefits and costs is deemed appropriate for assessment of economic impact of dairy cattle. It is therefore, suggested that future research should use models that take into account the returns and costs during the useful economic life

(iv) This study did not examine the demand for dairy products and rice as well as marketing systems for dairy and rice in the study area. Improved dairy and rice technologies would likely increase production to the extent of exceeding local demand and even demand in nearby towns. It is therefore suggested that further research be carried out to assess demand and marketing systems for dairy products and rice.

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APPENDICES

Appendix 1

QUESTIONNAIRE FOR DAIRY AND RICE PRODUCING HOUSEHOLDS

(DODOMA RURAL DISTRICT)

General information (circle or fill)

1. Name of Enumerator..

2. Name of Respondent..

3. Respondent Identification No..

4. Date of interview...

5. Division: Mvumi = 1, Bahi = 2.

6. Ward: M/Mission = 1, Makulu = 2, Handali =3, Ilolo=4, Idifu=5, Mzula=6, Bahi=7

7. Village: Mvumi Mission=1, Mvumi Makulu =2, Handali =3, Ilolo =4, Idifu=5,

   Mzula = 6, Bahi Sokoni = 7.

8. Production: Dairy project = 1, Rice irrigation scheme =2.

Section 1.0 Household head Characteristics:

9. Gender of household head: Male=1, Female = 2.

10. Age of household head.....

11 Marital status of household head: Married=1, Single = 2, Widowed=3

   Divorced = 4, Separated =5.

12 Marriage type of household head: Monogamist =1, Polygamist = 2

13 If polygamist, how many wives..............................

14 Education level of household head: no formal education =1, lower primary school =2, upper primary school =3, ordinary secondary school = 4, advance secondary school =5, college =6.

15 (a) Years spent in school by household head......................
15. (b) Occupation of household head....................................
15. (c) Occupation time: full time =1, part-time =2
15. (d) Working Season of household head: rainy=1, dry=2, both =3

16 Characteristics of members of household:

Item/Members	Wife/husband	1	2	3	4	5	6	7	8	9	10
Age											
Sex: M=Male, F = Female											
Years spent at School											
Educational Level											
Work at farms Yes or No											
Disable/crippled: Yes or No											
Sell labour: Yes or No											
Occupation											
Occupation time											
Working seasons											

Note: **1 – 10 are numbers of household members**

(i) Codes: no formal education =1, lower primary school =2, upper primary school =3, ordinary secondary school =4, advanced secondary school =5, college=6, child = 7.

(ii) Occupation: a farmer =1, petty business =2, trader =3, fisherman =4, charcoal seller =5, wage/salaries=6, labour =7, pupils =8, not working =9, child =10.

(iii) Working seasons: rainy season = 1, dry season =2, Not applicable =3

(iv) Occupation time: Full time =1, part time = 2, not applicable =3.

Section 2.0 Livestock production for 1998/99 season (tick or fill)

Section 2.1 Dairy productions:

17 When did you start dairy production?.........................

18 What was milk output per zebu cattle before adopting dairy production?
....

19 . Indicate other activities you relied on before and after adopting dairy production.

Activities	Before project	After project
Farming		
Fishing		
Non-farming others		

20 If farming, indicate crop yields before embarking in dairy production and in 1998.

Crop	Acreage		Yield/acres (bags)	
	Before project	1998	Before project	1998
Maize				
Rice				
Sorghum				
Millet				
Groundnuts				
Potatoes				

Section 2.2 Breed Practices

21. Indicate the number of animals that you acquired and number currently owned on your farm?

Animals	Breed type		Number Acquired		Total No. owned	How acquired	Average Cost
	Before project	After project	Before project	After project			
Female calves							
Male calves							
Heifers							
Steers							
Bulls							
Cows in milk							
Dry cows							
In calf heifer							
Other animals:							
Goats							
Pigs							
Poultry							

Acquirement: paying cash = 1, on credit =2, grant =3,
Breed type: Mpwapwa =1, Friesian =2, Ayrshire =3, Jersey =4,
Cross breed =5, Zebu =6, A = 1998, B=before.

22.(a) What are your breeding practices? Natural=1, AI=2, both (1&2)=3,
22.(b) If natural, where do you get bulls? Own bull =1, neighbours=2, bull Centre=3.
22 (c) If number 2 or 3, is it difficulty to get a bull? Yes/No
22 (d) If Yes, how do you address this difficulty?....................................
22 (e) If you use bull centres, at what stage of lactation/age/time of the year do you take animals to the bull? Lactation..................age................time............

23. Indicate the following information for dairy cows:

Item/No of cow	1	2	3	4	5	6	7
Age of cow							
Age at first calving							
Calves born to date							
Calves died within 6 months							
Weaning age of calf							
Lactation period							
Average milk yield							
Beginning of lactation							
End of lactation							

Section 2.3 Feeding practises

24. What type of feeding do you practice?
ero grazing =1, semi grazing=2.

25. (a) If zero grazing, give type of grass, crop residue and amount used per cow per day (1998).

Type of grass/residue	Amount per day/per cow		Cost per day per cow	
	Before project	1998	Before project	1998
Elephant				
Ndilo (cycrmodon dactylon)				
Ihungo (African fox tail)				
Maize Stover				
Rice Straw				
Groundnut haulms				
Sorghum Stover				
Sweet potato leaves				
Bean straw				

25. (b) If semi grazing, indicate acreage of established cultivated fodder............
25. (c) If no, why?..., ...

25 (d) When do you normally get easy/difficulty on grass/fodder supply.

Season	Rainy	Dry	All season
Season of easy			
Season of difficulty supply			

25 (e) According to your experience, is supply of grass/fodder sufficient per year?
Yes/No

25. (f) If No, do you supplement? Yes/No.

25 (g) If yes, how?..

25 (h) If no, why?..

26. (a) Do you feed the cows with minerals and concentrates? Yes/No.

26. (b) If yes, indicate type, amount purchased and price in 1998.

Feed Type	Amount purchased	Unit Price
Maclick salt block		
Maclick salt powder		
Common salt		
Sunflower cake		
Maize bran		
Cereal waste (machicha)		
Molasses		

26. (c) If No, why?..

Section 2.4 Water sources:

27. Indicate distance from water sources, amount cows drink per day, and cost for carrying water (1998).

Water Source	Distance from Water source	Amount per day (drinking)	Cost incurred for Carrying water
Piped			
Spring			
Dam			
Well			
River			

28. (a) Is amount of water used per day sufficient? Yes/No................
28. (b) If Yes, how much is required per day? (litres).........................

Section 2.5 Transport facilities

29. What means of transport did you use and cost incurred per month in 1998.

Items	Transport means	Cost per month	Effectiveness (Yes/No)
Purchase of feeds			
Grass collection			
Marketing			

Means of transport = 1, bicycle =2, on foot =3, ox=carts =4, tractor =5.

30 According to your experience, is means of transport reliable? Yes/No
31. If No, how do you tackle this problem?..

Section 2.6 Cow Shed Construction:

32 Indicate type and cost of materials used for cow shed construction.

Type	Cost of Materials
Corrugated iron sheet	
Block brick	
Mud brick	
Poles	

33 Can current cow shed last for more than 4 years? Yes/No

34. If No, why?...

Section 2.7 Labour utilisation

35 (a) Indicate labour sources and cost incurred on the following activities in 1998.

Activities	Family	Hired	Cost per Month
Shed cleaning			
Feed collection			
Feeding			
Milking			
Marketing			
Security			

35 (b) Indicate number of labour required, hours spent before starting dairy production and for 1998.

Activities	Number of labour before	Hours before dairy	Number of Labour 1998	Hours 1998
On farm				
Off farm				
On dairy				

Section 2.8 Common livestock diseases

36. Indicate frequency occurrence of major cattle diseases in your farm in 1998?

Diseases	Frequency of Occurrence	Treatment
1. Black quarter (chambavu)		
2. FMD (midomo na miguu)		
3. Heart water (kizunguzungu)		
4. Mastitis (kuvimba kiwele)		
6. Brucellosis (kutupa mimba)		
7. Foot rot (kuoza miguu)		
8. Lumpy skin diseases (ugonjwa wa ngozi na vidonda)		
9. Retained placenta (kubaki kondo)		
10. Pneumonia		
11. Calf scour (kuharisha kwa ndama) (0-3 months)		
12. Worms (minyoo)		

Note: Some of possible answers for treatment are vaccination =1, de worming=2, dipping =3.

Section 2.9 Livestock Treatment

37 How frequent do you have drug and medicine? Regular...............irregular............

38 What were the costs incurred in such services in 1998.

Services/medicines	Quantity	Unit cost/month
Vaccination		
Deworming		
Dipping/Spraying		
Charges for the drug		

Section 2.10 Animal death cases

39. Indicate the number and causes of animals deaths since you started dairy production up to 1998.

Animals category	Number of deaths	Causes
Calves		
Heifers		
Steers		
Bull		
Adult cows		
Goats		
Poultry		
Pigs		

Section 2. 11 Livestock sales

40 (a) Indicate the number and price of the following animals sold in 1998.

Animals Type	Number	Unit Price
Female calves		
Male calves		
Heifers		
Steers		
Bulls		
Culls		
Goats		
Pigs		
Poultry		

40. (b) Do you face any problem in disposing your milk? Yes/No.

If Yes, what are they?..
....

41 How did you dispose fresh milk in 1998?

Uses	Litres	Price/litre
Daily milk output		
Calf feeding		
Consumed at home		
Sold to local market		

Section 2.12 Sales of others crop products

42 Indicate other sources of your income before starting dairy production in 1998 (tick or fill).

(a) From agricultural output

	Before project	1998	Quantity Produced 1998	Unit price 1998
(i) Sale of maize				
(ii) Sale of groundnuts				
(iii) Sale of sun flower				
(iv) Sale of bulrush millet (Uwele)				
(v) Sale of sorghum (Mtama)				
(vi) Sale of sweet potatoes				
(vii) Sale of vegetables				
(viii) Sale of Grapes				

Section 2.13 - From Off – farm sources

43 From Off-farm sources

	Before project	1998	Quantity Produced 1998	Unit price 1998
(i) Shop owning				
(ii) Sewing/tailoring				
(iii) Brick making				
(iv) Charcoal making				
(v)Firewood collection				
(vi)Making local brew				
(vii) Others (specify)				
(viii) From Salary/Wage				
.(ix) From other sources				
(x) Sale of manure				
(xi) Sale of Crop residue				

Section 2.14 Livestock Production risks

44 What risks to you face in dairy production?

Risks	Regularly/irregularly
Theft	
Swallowing, poisonous, materials (nylon, chemicals)	
Diseases	
Drought	
Losing money for treatment	
Insufficient supply of feeds	
Lack of marketing	
Much more work for household	

Section 3.0 Rice production for 1998/1999 season (Tick or Fill)

Section 3.1 Crop production and sales

45 Indicate crops, acreage's grown before starting rice production and in 1998.

Crops	Acreage's (ha)		Yields per hectare (bags)		Total (bags) Production	Selling price/bag
Sorghum						
Rice						
Millet						
S/potatoes						

46 a) Do you have other plots that are not currently cultivated? Yes/No

46 (b) If yes, what is the size of the acreage? .....

47 Indicate number of animals owned before starting rice production and in 1998.

Animals	Before project	In 1998
Zebu cattle		
Goats		
Sheep		
Pig		
Poultry		
Donkey		

48 What type of irrigation did you practice before rice production?
Traditional=1 , indigenous=2

49 Is water for irrigation sufficient? Yes/No.
50 When did you start cultivating rice?.................

Section 3.2 Management of water for irrigation

51 (a) Do you have water control system? Yes/No
51 (b) If Yes, who controls the system?.......................................
51 (c) If No, how do you control water for irrigation?.......................
51 (d) Do you have irrigation water management committee? Yes/No
51 (e) If Yes, indicate its role:..
51.(f) Is the committee effective? Yes/No
51.(g) If No, why?..

Section 3.3 Seed

52.(a) Which type of rice seed do you normally plant? Local=1, hybrid=2.
52.(b) Why such seed?...
52.(c) Where do you get the seed? Local market=1, agent =2, form town =3.
52 (d) Is it easy to get such seed from the source? Yes/No.

Section 3. 4 Fertiliser

53. (a) Do you use UREA fertiliser? Yes/No
53. (b) If Yes, where do you get the urea? Local supply=1, agent =2, from town =3.
53. (c)If No, why?..

Section 3.5 Pest and weed control

54. What types of pests attack rice plants? Web worms=1, rice stem borers=2.

55. Which chemicals do you use to control pest? Thionex=1, thiodan=2, none=3.

56. Where do you get chemicals for pest control? Local market =1, agent=2, town =3.

Section 3.6 Disease control

57. What types of diseases do attack the rice plants? Yellow mottling virus=1, leaf spot=2.

57. What chemicals do you use to control the disease?...

58. Where do you get the chemicals for disease control? Local market=1, agent=2, town=3.

Section 3.7 Input costs

59. Indicate quantity of input used before starting and cost per unit in 1998.

Input used (seed)	Before (quantity)	Quantity purchased (1998)	Unit cost 1998
Rice			
Millet			
Sorghum			
UREA			
S/Potatoes			
Rice pest control			
Rice bird control			
Others (specify)			

Section 3.8 Labour utilisation

60 (a) Indicate number of labour per grown rice area and unit cost.

Type of operation	Labour		Days/Weeks spent		Total Cost	
	Before	After	Before	After	Before	After
Bund clearance						
Nursery preparation						
Nursery seed planting						
Bund cultivation						
Puddling						
Rice transplanting						
Weeding						
Irrigation						
Harvesting						
Threshing						
Winnowing						
Transport (field-home)						
Packing						
Marketing						

Note: After means 1998.

60 (b) Indicate number of labour per grown other crops, area and unit cost.

Type of operation	Labour		Days/Weeks spent		Total Cost	
	Before project	1998	Before project	1998	Before project	1998
Millet						
Off farm						

Section 3.9 Periods for rice cultivation practises and farm implements used

61. Indicate months and facilities used to execute the following activities during production of rice.

No	Activities and facilities	Response
1.	When do you start clearing the bund (jaruba)?	
2.	When do you prepare nursery?	
3.	When do you sow seed in the nursery?	
4.	When do you start cultivation (pudding)?	
5.	Which means do you use for cultivation? Hand hoe=1, oxen plough =2.	
6.	When do you start transplanting?	
7.	How do you transplant? Spacing =1, non spacing=2	
8.	When do you start weeding?	
9.	Which tools do you use for weeding? Hand hoe=1, by hand=2.	
10.	How do you control bird? Scaring=1, guarding=2, Queleatox =3.	
11.	Which type of birds destroy rice? Quelea-quelea=1, Bata maji =2.	
12.	When do you start harvesting or cutting?	
13.	How do you transport harvested rice from field to home? Hand/head=1, ox=cart=2, bicycle=3, vehicle=4, tractor=4.	
14.	Is transportation from field to home satisfy ? Yes=1, No=2.	
15.	Do you have storage facilities? Yes=1, No=2.	

Section 3.10 Marketing problems

62. (a) Indicate the pressing problems that you faced in marketing major crops/milk in the last season 1998 (Yes/No).

Marketing problem	Food crops	Cash crops	Milk	Others
Transport cost too high				
Could not get buyer at selling time				
Insufficient marketing agents				

62. (b) Indicate selling price of rice according to the following years:-

Years	Price per bag of 90 kg.
1999	
1998	
1997	
1996	

Section 4.0 Extension Services (dairy and rice Production)

63. How do you contact the VEOs?
They visit at their own time = 1, farmer calls them when in need=2,
They have specific time/place to meet farmers=3

64. How many times do VEO visit your dairy/rice production a month ?...............

65. What types of advice do you get from the VEOs?

On disease control =1
On fertiliser use =2
On crop production =3
On storage =4
On feed utilisation =5
On animal health =6
On drug/vaccination issues =7

Section 5.0 Other sources of income for rice producers only

66. Indicate other sources of your income before starting rice production and in 1998
(tick or fill)

(a) From Agricultural output

Agricultural output	Before project	In 1998	Quantity Produced 1998	Unit Price 1998
(i) Sale of maize				
(ii) Sale of groundnuts				
(iii) Sale of millet				
(iv) Sale of bulrush millet				
(v) Sale of sorghum				
(vi) Sale of sweet potatoes				
(vii) Sale of vegetables				
(viii) Sale of fishing				
(ix) Sale of others (specify)				

(b) From Livestock sector

Livestock	Before project	In 1998	Quantity produced 1998	Unit Price 1998
(i) Sale of zebu cattle				
(ii) Sale of goat				
(iii) " " Sheep				
(iv) " " Pig				
(v) " " Donkey				
(vi) " " Poultry				
(vii) " " others (specify)				

(c) From off-farm sources

Off-farm	Before project	In 1998	Quantity produced 1998	Unit Price 1998
(i) Shop owning				
(ii) Sewing/tailoring				
(iii) Brick making				
(iv) Charcoal making				
(v) Firewood				
(vi) Cooked food				
(vii) Making local brew				
(viii) Others (specify)				

(d) From salary/wage...

(e) From other sources ....

(i) Sale of manure...
(ii) Sale of crop residue...............................

Section 6.0 Household wealth status before starting rice/dairy production and in 1998.

Section 6.1 Material Assets

67 How many of the following assets did you own before and after starting dairy/rice production?

Assets	Number before	Number in 1998
Chairs		
Tables		
Beds		
Bicycle		
Ox-cart		
Radio		
Good clothes		
Shoes		
Lamp		
Axe/bush knife		
Land		
Others (mention		

Section 6.2 Environment

68 State conditions of your environment before and after starting dairy/rice production:

(a) **Planted trees**

Trees	Acreage's		Number of trees	
	Before project	1998	Before project	1998
Number of planted trees				

(b) Did you have pit latrine before starting dairy/rice production? Yes/No...

(c) Did you have pit latrine after starting dairy/rice production? Yes/No

(d) If No, Why?

Section 6.3 Soil conservation

69 What has been the trend in soil fertility before and after dairy/rice production?

Trend	Before project	In 1998
Decline a lot		
Decline a little		
It is about the same		
Improved a little		
Improved a lot		
I don't know		

Section 6.4 Food consumption pattern

70. How frequent did you consume the following food stuff before and after dairy/rice Production?

Food Stuff	Daily		Weekly		Monthly		Daily Quantity	Weekly quantity	Monthly Quantity	Unit cost (Tshs)
Rice	B	A	B	A	B	A				
Maize flour										
Sorghum flour										
Bulrush millet										
Bananas										
Meat										
Fish										
Beans										
Egg										
Milk										
Cowpeas										
Vegetable										
Sugar										
Cooking fat										
Fruits										
Salt										
Other (specify)										

A=1998, B= before

Section 6.5 Food deficit

71 When did you experienced food deficit? (Year)

Before starting dairy/rice production................

After starting dairy/rice production..................

72(a) Has dairy/rice production improved nutritional level for pre-school age children? (Yes/No) or not applicable.

72 (b) If yes, at what level? Highly =1, moderately=2, .slight moderately=3 not applicable=4

72(c) If irregular, why?........................, ...

Section 6.6 Financial ability

73 Indicate whether your ability to pay for the following has increased, decreased or remained the same?

Obligations	Increased	Decreased	Remained unchanged
Medical expenses			
School fees			
Development levy			
School uniform			
Hire labour			
Acquired drink			
Save money for emergency			
Reinvest in any project			
Buying food during deficit			

Section 6. 7 Allocation of time

74 How many hours did you allocate per day on the following activities, before and after starting dairy/rice production?

Activities	During rainy season		During dry season	
Leisure	Before project	After project	Before project	After project

Section 6.8 Employment

75 (a) Does dairy/rice production generate any employment to a household? Yes/No.

75 (b) If Yes, at what level before and (1998).

Seasons	Before project	1998
During dry season		
During rainy season		
All the time		

Highly = 1, moderately =2, slight moderately=3.

Thank you for your co-operation and best wishes.

Appendix 2: FOOD CONVERSION TABLE IN CAL/100 GM

No.	Type of Food	Cal/100 gm.
	Yellow Cereals and grain products	
1	Maize (Unga wa mahindi)	340
2	Maize, white (dona)	345
3	Millet, finger, flour	320
4	Millet, bulrush, whole grain	340
5	Millet, bulrush, flour	335
6	Rice, milled	335
7	Sorghum, flour	335
8	Sorghum, whole grain	335
	Starchy Roots, Tubers and Fruits	
1	Cassava, meal	320
2	Cassava, bitter, fresh	140
3	Plantain, ripe	130
4	Potato	75
5	Sweet potato (yellow/pale)	110
6	Yam (Flour)	310
	Grain Legumes and Legume Products	
1	Beans/peas, fresh, shelled	105
2	Beans, dried	320
3	Beans, green in pod, raw	35
4	Cowpea	320
5	Pigeon pea, dried	310
	Nuts and Seed	
1	Bambara groundnuts, fresh	345
2	Groundnut, dry	570
3	Pumpkin seeds	575
4	Sunflower seeds	590
	Vegetable	
1	Carrots, raw	35
2	Cassava, leaves, raw	90
3	Amaranth, leaves, raw	45
4	Cowpea leaves	45
5	Egg plant, raw	30
6	Mushrooms, fresh	29
7	Okra, leaves	58
8	Onion	38
9	Pumpkin leaves	25
10	Sweet potato, leaves	49
	Fruits	
1	Bananas	82
2	Papaya, raw	30
3	Tomato	22
4	Water melon	22

No.	Type of Food	Cal/100 gm.
	Sugar and Syrups	
1	Sugar cane	54
2	Sugar	375
	Meat, poultry and eggs	
1	Beef (moderate fat)	235
2	Egg, hen	140
3	Goat	170
4	Poultry (chicken)	140
	Fish and Fish products	
1	Fish dried	255
2	Small dried fish	320
	Milk and milk products	
1	Milk cow	79
2	Milk goat	84
	Oil and Fats	
1	Ghee	885
2	Sunflower oil	900
	Other	
1	Beer, local	25

Source: CTA and ECSA (1988). The Composition of Foods Commonly eaten in East Africa. P.12-28.