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Optimising Behaviour of Round Potato Farmers in Southern Highlands of Tanzania

Hosea Mpogole, Reuben M. J. Kadigi, Melchior E. Mlambiti

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ABSTRACT

Production and consumption of round potatoes have been increasing in Tanzania. This is evidenced by the increase of the urban street chips vendors; local smallholder crisps processors; and large scale processors such as CRISPO Company at Iringa. The increase in consumption of round potato is due mainly to increased economic activities, population increase, urbanisation, increase in number of fast food restaurants, and tourism which change eating habits and consumer preferences towards easy to cook, pre-prepared and processed foods such as potato chips and crisps. It is also known that there are various round potato varieties with different characteristics such as size, shape, taste, yield, and processing qualities. Thus, different varieties may have different markets and hence profitability.

According to economic theory, a farmer is expected to grow varieties that promise to yield the maximum profit. However, studies done in other countries indicate that smallholder farmers were guided by factors other than profit maximisation. Therefore, this study analysed the optimisation behaviour of smallholder round potato farmers in Southern Highlands of Tanzania basing on four questions. How do farmers allot land to various crops? What guides farmers' selection for the round potato varieties they grow? Are there variations in profitability among round potato varieties? And are round potato farmers maximisers of profit? Results show that there were variations in profitability among varieties. Also, farmers' decisions regarding variety selections, time of sale and acreage decisions were not guided by profit maximisation. Selling price of the previous season and profitability did have any effect on variety selections. The study concludes that smallholder round potato farmers were not optimisers of profit. Understanding farmers' optimisation behaviour and variety preferences is important in informing relevant policies as input to the current government effort of commercialising smallholder production, poverty reduction, and future variety development and diffusion.

1.0 INTRODUCTION

1.1 Challenges of agricultural sector in Tanzania

Agriculture is by far the largest sector and the backbone of the Tanzanian economy. It accounts for about 45% of the nation's GDP with a growth rate of 4.1% and about 60% of the country's foreign earnings (URT, 2006; URT, 2009a). Farming is practiced in rural areas where about 80% of the population lives giving agricultural employment to over 70% of the entire nation's population (URT, 2008a; URT, 2009a). Smallholder farming dominates agricultural production, and a large proportion is for subsistence (URT, 2008a). These smallholder farmers usually farm on small and fragmented plots. The average plot size currently ranges from 0.9 to 3 hectares (Wolter, 2008 ;Sokoni, 2007).

Productivity of smallholder farming is very low. For example, the average food crop productivity in Tanzania is 1.7 tonnes per hectare, whereas good management and optimal fertiliser use should result in yields of 3.5 to 4.0 tonnes per hectare. Only about 15% of all farmers are said to be using fertilisers (Wolter, 2008). The use of traditional farming tools and the heavy reliance on traditional rain-fed cropping methods further hamper productivity.

Despite the important contribution of the agricultural sector to the economy, Tanzania is still far from the agricultural production levels, which are possible with existing technologies and available resources (URT, 1997; URT 2008b; URT, 2009a). This is mainly due to: limited access to extension services; inputs and credit facilities necessary to stimulate product diversification; weak market linkages due to poor infrastructure; and lack of market knowledge and information necessary to facilitate market diversification (URT, 2003). In terms of infrastructure, a good proportion of agricultural harvest is lost because farmers cannot get their produce to the market. Furthermore, because of lack of storage facilities they are unable to store their products after harvest. Regarding access to finance and/or credit, agribusinesses are not able to obtain the financial means to buy productivity enhancing inputs, such as seeds, fertilisers, chemicals and pesticides. Only about 3% of agricultural households have access to credit. Agricultural lending is viewed negatively by financial institutions and too few banks are located in rural areas (Wolter, 2008).

Farmers are lacking the incentives to produce for the market and economies of scale are absent. The marketing systems, road infrastructure, and storage facilities do not guarantee producers of reliable and timely buyers of their crops taking into account perishability and other risks associated with these arrangements (URT, 2008a). Also, agribusiness is still in its infancy and commercial ventures are found mostly in traditional export crops such as coffee, tea, cotton, cashews, tobacco, and on smaller scale, cloves and sisal (Wolter, 2008). As a result of declining world market prices for agricultural commodities, traditional agricultural exports accounted for only 20% of total merchandise exports in 2006 as compared to over 55% in 1995/96.

The declining contribution of the traditional export crops, calls for alternative commercial crops such as food crops whose prices have been increasing over the past decade because of increasing global food crises (Sadik, 2001; FAO, 2009; The Economist, 2009). Indeed, Tanzania has a potential of becoming the major food exporter, able to feed itself and the whole of East Africa (URT 1997; OECD, 2008; URT, 2009a). However, currently it still struggles to meet its own food requirements due to low productivity and the predominance of

subsistence farming (Wolter, 2008). In fact, Wolter (2008) describes Tanzania as a '*Sleeping Giant*.' But higher food prices, driven by higher energy costs and rising consumption in developing countries, provide Tanzania with ample opportunities to develop its agro-industry to tap into regional markets.

Food exports are a promising option for Tanzania as it has abundant natural resources. It shares borders with eight African countries that are Burundi, Democratic Republic of Congo, Kenya, Malawi, Mozambique, Rwanda, Uganda and Zambia. Tanzania's arable land is estimated to be 44 million hectares, but only about 10 million hectares (23%) are currently under production (URT, 2009a). The planted area has remained relatively the same for many years which imply that land expansion could also be a major source of agricultural growth (URT, 2009a).

The current situation shows that Tanzania is not taking advantage of its agribusiness opportunities and is far from being a major food exporter (Wolter, 2008). The capacity of agribusiness actors, particularly in marketing of the agricultural outputs and inputs are constrained by entrepreneurial skills, inadequate capital, un-conducive legal and institutional framework, as well as inadequate competition (URT, 2008a). As a result, agricultural imports have been increasing, with food imports, including wheat, rice, and dairy products, taking the largest share of about 80% of total merchandise imports. Since the 1999/2000 season, the Food Self Sufficiency Ratio (SSR), which compares the volume of domestic food production against the food requirements of the country's population, has fluctuated between a low of 88% in 2003/04 and a high of 112% in 2006/07. Also, significant variations in food security between different regions and districts have been experienced.

Tanzania, therefore, needs to tackle these challenges in order to improve the agricultural and agribusiness sector in the country. Since the majority of smallholder farmers are engaged in food crops, one of the challenges ahead is to move beyond subsistence farming by commercialising food production (Sokoni, 2007; Wolter, 2008). Making food crop profitable is the biggest challenge for Tanzania. Currently, one of the major problems is that smallholder farmers in Tanzania basically maximise food self-sufficiency rather than profits to extensively reduce poverty in the country (Wolter, 2008). One way of increasing farmers' income is to produce food crops such as round potato (*solanum tuberosum*) in areas of favourable climatic conditions as it is increasingly becoming an important food and cash crop (Kelly, 2006; Namwata *et al*., 2010). According to FAO (2006), round potato is considered as a 'buried treasure' for low-income people both in rural and urban areas. The crop grows fast, it is adaptable, high yielding and responsive to low inputs. It provides nutritious food per unit land in less time and often under adverse conditions than most of other food crops (FAO, 2006).

1.2 Policy Framework related to Agricultural Sector

The government of Tanzania recognises the challenges and constraints facing the agricultural sector. A number of measures and strategies have been taking place including the establishment of various policies such as the Agricultural and Livestock Policy (ALP) of 1997, the Agricultural Marketing Policy (AMP) of 2008, the Food and Nutrition Policy for Tanzania of 1992, the National Trade Policy of 2003, Cooperative Development Policy of 2002, Rural Development Policy, Agricultural Sector Development Strategy (ASDS) of 2001, and Agricultural Sector Development Programme (ASDP) of 2005 to mention but a few. Also, the National Development Vision (NDV) 2025 and the National Strategy for Growth and Reduction of Poverty (NSGPR or commonly known as MKUKUTA) recognise

that agriculture is the main source of livelihoods for the majority and that it determines the overall improvement in people's living standards as well as the development of the economy. In this section, the two policies that are directly related the agricultural sector, i.e. Agricultural and Livestock Policy of 1997 and the Agricultural and Marketing Policy of 2008 are briefly discussed.

The focus of the Agricultural and Livestock Policy of 1997 was to commercialise agriculture so as to increase income levels and well being of the people whose principal occupation and way of life is based on agriculture (URT, 1997). In this policy, the government sought to assure basic food security for the nation, and to improve national standards of nutrition by increasing output, quality and availability of food commodities. Also, to collect and disseminate market information in order to integrate the domestic markets and make foreign markets accessible, to improve the agricultural extension services, and to facilitate the provision of a good infrastructure, especially transport and storage facilities.

Regarding the Agricultural Marketing Policy, the overall objective was to facilitate strategic marketing of agricultural products while ensuring fair returns to all stakeholders based on a competitive, efficient, and equitable marketing system (URT, 2008). The policy was set to overcome the agricultural marketing challenges such as: inadequate value addition in agricultural produce; inadequate adherence to grades, standards, and quality in agricultural products marketing; weak legal, regulatory, and institutional framework on agricultural marketing; inadequate access to financial services for agricultural marketing activities; inadequate marketing linkages; and inadequate capacities to utilise opportunities emerging in the local, regional, and international markets including preferential markets.

On value addition, the government sought to promote and support value addition in agricultural produce by putting in place special programmes and incentives to investors in agro-processing firms, to invest in Research and Development for agro-processing, and to promote the consumption of locally processed agricultural products in the domestic market. While on entrepreneurial and marketing skills, the government sought to enhance the same by supporting and promoting training in entrepreneurial and marketing skills for agricultural marketing stakeholders, to encourage the participation of private sector in the training on entrepreneurial and marketing skills, strengthen the agricultural marketing extension services, and to review and to strengthen entrepreneurial and marketing curricula in vocational training centres, colleges and learning institutions.

While a number of policies are in place, there appears to be an overlap and lack of coordination among various government ministries and/or authorities. For example, while the Agricultural and Livestock Policy of 1997 extensively addresses about marketing issues, the Agricultural and Marketing Policy of 2008 does the same, and both discuss about agricultural extension services. However, the Agricultural and Livestock Policy was established under the Ministry of Agriculture and Food Security while the Agricultural Marketing Policy was established under the Ministry of Industry, Trade and Marketing. Also, the Food and Nutrition Policy of 1992 was established under the then Ministry of Health. But there are no clear provisions for which ministry does what, thus leaving a vacuum in terms of implementation.

Poor coordination and lack of implementation strategies is not a new phenomenon in Tanzania. As such, the agricultural sector has continued to face numerous problems. Gabagambi (2009) argues that policy response to agricultural problems has, in most cases, been a shortcut. For example, banning cross border trade so as to assure for food security, and

dictating time and the form in which the product should be marketed and waving import duty. Also, while the Agricultural and Livestock Policy of 1997 focuses on commercialisation of agriculture, efforts appear to be directed towards major staples where most of the input subsidies are concentrating. However, commercialisation of agriculture in Tanzania means commercialising food crops because smallholder farmers are engaged in the production of such crops. But the government focus has predominantly been on maize and rice production, which means that the government is till concerned about food security rather than commercialisation.

Although other sub-staples such as round potatoes and bananas have been mentioned in the Agricultural and Livestock Policy of 1997, implementation efforts are towards the traditional staples. Subsidies on fertilisers and other agricultural inputs have also been directed to maize and rice production. However, it is increasingly seen that other sub-staples such as round potatoes are becoming popular in terms of production and consumption. Round potato is a good income earner to smallholder farmers as it matures earlier than maize and rice, and assures for food security (UARC, 1990; FAOSTAT, 2008; CIP, 2008).

Anecdotal evidence shows that round potato is being exported to neighbouring countries such as Zambia and Malawi, where it fetches higher prices. Also, domestic markets and consumption of round potatoes has been increasing as evidenced by the increase in street chips vendors and the emergence of chips/crisps processing factories. With increasing economic activities, tourism, and changing life styles, people tend to change their food preferences and eating habits towards easy to cook and processed foods such as round potato chips and crisps. Hence, there is a need for the government to provide for policy measures to improve the production and markets of non-traditional food crops such as round potatoes and hence improve the well being of the smallholder farmers. If promoted, round potatoes will contribute to food security and increase the income of rural farmers.

1.3 Background of the study

Round potato is one of the most important food and commercial crop in the world. Round potatoes produce remarkable quantities of calories even in comparison to cereals (Scott *et al*., 2000). Unlike in the past years when cereals were regarded as the most important staple and commercial crops in the world, currently production and consumption of round potatoes have been increasing (FAOSTAT, 2008; CIP, 2008). For example, round potato production in the world is increasing at an annual rate of 4.5% and area planted at 2.4% (CIP, 2008). In contrast, round potato production in developing countries is increasing while declining in developed countries (FAOSTAT, 2008).

Round potato is the most important root and tuber crop and the third most important food crop in the world after rice and wheat (CIP, 2008). Annual production exceeds 320 million tons, where China, the world's biggest producer of round potatoes produces over 70 million tons a year. The crop is grown in over 125 countries and over a billion people eat it (CIP, 2008). Africa produces 6% of the world's round potatoes. Egypt, Malawi, South Africa, Algeria and Morocco produce more than 80% of all round potatoes in the region (CIP, 2008).

Consumption of round potato is increasing in developing countries from 9kg/capita in 1961-63 to 14kg/capita in 1997 (FAOSTAT, 1998). However, this consumption is still very low compared to Europe (86kg/capita) or North America (63kg/capita) suggesting that an ample room exists in business for continued consumption increases (CIP, 2008). Changes in consumer preferences and eating habits are due to expanding economic activities, population

increase and urbanisation, growing number of fast food restaurants, and tourism (Anderson, 2008; FAOSTAT, 2008; CIP, 2008).

Tanzania produces over 500 000 tons of round potatoes per year (URT, 2007). The regions which are major producers of round potatoes in Tanzania are Iringa, Mbeya and Kilimanjaro. Iringa, for example, produces over 300 000 tons, which is about 60% of all round potatoes produced in Tanzania (URT, 2007). Minor production also occurs in Ruvuma, Rukwa, Mara, Tanga, and Kigoma regions (Macha *et al*., 1982; UARC, 1990). Round potatoes are grown in specific climatic areas such as in mountainous and/or highlands areas. For this reason the Southern Highlands of Tanzania (SHT) is very much suitable for round potato production.

Round potato has increasingly been commercialised in some parts of Tanzania including Iringa and Mbeya (URT, 2007; Kabungo, 2008). This is evidenced by the rise of the urban street round potato chips vendors; local smallholder crisps processors and large scale processors such as CRISPO Company at Iringa. The increasing use of round potatoes and changes in eating habits and consumer preferences towards easy to cook, pre-prepared and processed foods such as round potato chips and crisps makes it an interesting area for research. For instance, a study by Anderson (2008) revealed that smallholder round potato farmers have high potential to national and regional markets due to the growing demand for chips and crisps and the availability of high yielding varieties with processing quality. Despite the growing demand on round potatoes it is still not known whether farmers are optimising their production to reap these benefits in order to increase their income.

1.4 Problem statement and justification

In SHT there are various round potato varieties such as *Kikondo* (CIP 720050), *Arka*, *Kagiri*, *Kidinya*, *Tigoni*, *Baraka*, and *Sasamua* (UARC, 1990; S. Kyando, M. Kitigwa, personal communication, 2009). Different varieties of round potatoes have different characteristics such as size, shape, colour, taste, dry-matter content, processing qualities, yield, storability, and resistance to diseases such as late blight and bacterial wilt (UARC, 1990). Some varieties are good for boiling, others for chips (French fries), and others for processing into snacks or crisps. The variations in round potato varieties indicate that there could be different markets for respective varieties and hence different profitability. Yet previous studies in round potato production and marketing performance in Tanzania such as that by Namwata *et al*. (2010), Kabungo (2008), Mwakasendo *et al*. (2007), Anderson (1996), Shao *et al*. (1988), and Macha *et al*. (1982) treated round potatoes as one variety. As such, factors guiding farmers' selection for the varieties they produce have not been well studied and documented.

According to the economic theory that treats the economic person as a maximising agent of short-run profit, farmers would grow crop varieties that subject to probabilities, promise to yield the maximum profit in production (Rudra, 1983; Asrat *et al*., 2009; Nagarajan *et al*., 2005; Soleri and Cleveland, 2004). Such farmers would also allocate more acreage to profitable crops or crop varieties and produce optimal harvest per unit of land in order to realise maximum profit (Rudra, 1983; Chavas and Holt, 1990). However, empirical studies done in other countries such as India, Nigeria, Jamaica, Nepal, Mexico, and Sri Lanka by Rudra (1983), Kudi and Abdulsalam (2008), Beckford (2002), Joshi and Bauer (2006), Smale *et al*. (2001), and Herath *et al*. (1982) respectively, showed that smallholder farmers were guided by considerations other than profit maximisation.

The optimising behaviour of smallholder farmers in Tanzania has not been empirically studied. This raises questions of the factors that guide smallholder farmers in their decisions

relating to variety selections, acreage allocation, and the optimality of their production. The present study, therefore, analysed the optimisation behaviour of smallholder round potato farmers in SHT. Specifically, the study attempted to answer the following questions: how do farmers allot land to various crops? Are there variations in profitability among round potato varieties that farmers produce? What guides farmers' selection for the round potato varieties they grow? And, are round potato farmers maximisers of profit?

Understanding farmers' optimisation behaviour and variety preferences is important in informing relevant policies as input to the current government efforts of commercialising smallholder production and future variety development and diffusion. Currently, smallholder farmers are subsistent and most of the experimental works in crop improvement evaluate varieties often using yield as the sole criterion. However, according to Joshi and Bauer (2006), the choice of crop varieties differs depending upon the concerns of farmers.

2.0 LITERATURE REVIEW

2.1 History of round potato production in Tanzania and SHT

Production of round potato in Tanzania has been documented by Macha *et al*. (1982), UARC (1990), Nyange (1993), Anderson (1996), Namwata *et al*. (2010), Kabungo (2008), Mwakasendo *et al*. (2007), and Shao *et al*. (1988). It is said that round potato was introduced in Tanzania by German missionaries around 1920s (Anderson, 1996; Koizumi, 2007). It was first brought to SHT where local farmers began its cultivation in small plots (Macha *et al*., 1982). Since then the crop has been popular among smallholder producers, especially during the past 20 years (Anderson, 1996). Round potato is grown in areas between 1 700 and 2 800 metres above sea level although according to UARC (1990), recent research has shown that it can be grown even in areas below 1 700 metres. The crop grows well in relative cold areas with rainfall of not less than 600 millimetres per season. The cold areas with relative high rainfall favourable for round potato production include: Mporoto, Kikondo, Kawetere, Ileje, and Mbozi in Mbeya; Kitulo and Bulongwa in Makete; Njombe; and Mufindi. Others include: Ndengo and Miyao in Mbinga; Matai, Songambele, Msanga, Muungano, Molo, Kantawa, Nkundi, and Kipande in Rukwa; Uluguru; Usambara; Kilimanjaro; Arusha; and Mara (UARC, 1990).

Round potato is produced by smallholder farmers and it is used as food and as source of income (UARC, 1990). In SHT, round potato is considered as potential as maize, rice, and wheat. It is preferred by smallholder farmers and poor families because of its short maturity period and can be grown throughout the year. Round potato has more potential in relative cold areas with high altitude, where maize, for example, takes 8 to 10 months to mature while round potato takes only about 3 months (UARC, 1990).

Data on annual output for round potato in Tanzania are not readily available and when they do they are contradictory. For instance, FAOSTAT (2008) report that the annual production of round potato in Tanzania is 240 000 tonnes while the Sample Census of Agriculture (URT, 2006) and the Iringa Region Socio-economic Profile (URT, 2007) report round potato annual production in Tanzania exceeds 500 000 tonnes. According to Horton (1987) as cited by Kabungo (2008), the presence of information gaps surrounding the round potato production and marketing in developing countries are due to unreliability of data whereby governments

and statisticians usually give priority to collection and documentation of data on most important cash crops like coffee, tea and cotton which are traded in international markets.

Using the data published by NBS (URT, 2006; URT, 2007), Tanzania produces about 504 000 tonnes of Irish potatoes per year. The major regions producing potatoes are Iringa, Mbeya and Kilimanjaro (Table 5). Iringa, for example, produces about 325 840 tonnes, which is over 60% of all round potatoes produced in Tanzania (URT, 2007).

Table 1: Important regions producing round potatoes in Tanzania

S/N	Region	Area under potato in '000 hectares	Production in '000 tonnes	Yield in kg/ha
1	Iringa	65.33	281.36	4,306.75
2	Mbeya	20.10	264.54	13,166.17
3	Kilimanjaro	18.55	18.55	1,000.00

Source: Data from URT (2006) and URT (2007)

Although there are variations in production and yield of round potatoes, general trends show that there has been a positive increase (FAOSTAT, 2008). Given that Tanzania is the least producer of round potatoes as compared with other Eastern Africa countries such as Rwanda, Kenya and Uganda despite its ample land conducive for round potato production, a lot has to be done to improve the situation. This may include improving farming practices to increase yield per unit of land, facilitating farmers' access to input and output markets, expanding the area of cultivation, and improving the transport and storage infrastructure.

2.2 Variety selections among smallholder farmers

A number of studies have been conducted in various countries about farmers' choice for crop varieties. Such studies include: Kudi and Abdulsalam (2008); Joshi and Bauer (2006); Asrat *et al*., (2009); Smale *et a*l., (2001); Linnemann and Siemonsma (1989); and Rudra (1983). Although results vary to some extent among those studies, there appears to be some similarities in the criteria that farmers use to choose certain crop varieties. For example, Kudi and Abudlsalam (2008) found that the main reason for farmers' choice over certain varieties of maize were high yield and tolerance to diseases and pests. However, a good number of other farmers were attracted to good taste (19.04%) and about 5% were attracted to beautiful seed colour. These findings are interesting in the sense that some farmers choose certain crop varieties primarily because of the attractiveness of the seed colours. In a study by Beckford (2002), size of produced yam tubers was an important factor for adoption of improved yam varieties. The larger tubers produced using the traditional yam stick methods were more desirable. Farmers perceived a direct relationship between tuber size and overall yields. Since improved yam produced smaller tubers than the traditional ones, they perceived that its yields were lower. In fact, improved yam had a higher density of planting, yields per unit area were greater than the traditional ones. Also, Linnemann and Siemonsma (1989) had argued that farmers do not necessarily select for a uniform type of seed. They may choose seed so as to maintain a certain variation in earliness, shape, colour, and taste of product.

Joshi and Bauer (2006) used multinomial logit model to determine factors for farmers' choice over modern rice varieties. They found that apart from education and experience of farmers, seed source, early maturity and less irrigation requirements were important factors. Seeds from formal sources were more preferred and trusted than seeds from other non-formal sources.

Another study by Asrat *et al*. (2009) found that adaptability and yield stability were important attributes for farmers' choice of crop varieties. Also, other things such as household resource endowments (e.g. land), years of farming experience, and contact with extension services were major factors causing the variations in crop variety preferences among farmers. Smale *et al*. (2001) found similar results. But also, Smale *et al*. (2001) had compared the variations in preferences for crop varieties in terms of region where farmers came from and in terms of infrastructure development. They found that infrastructure development and the interaction of productivity potential with infrastructure were the most important in terms of magnitude of the share of the area allocated to certain maize varieties. However, the most significant factor for maize variety choice were related to family's consumption of maize rather than to the suitability of the variety for market sale or that it was cheap to produce. Although farmers cited the suitability for market sales and cost of production as important variety attributes, these did not contribute statistically to explaining variation in area shares. The choice of crop varieties basing on family consumption can reflect the subsistence farming practices among smallholder farmers in many developing countries. Subsistence farmers farm for food self sufficiency rather than for market although they sell the surplus or small quantities of produce when in need of cash. Also, according to Rudra (1983), most farmers desire to achieve self sufficiency in all crops which they need for home consumption.

Other studies have discussed about farmers' crop variety selection basing on household factors and location. According to Heisey and Brennan (1991), seed variety replacement choice differs from decision about inputs such as fertiliser or agrochemical because seeds can be reproduced by farmers for the next crop season. However, at the household level there are certain variables such as aversion to risk and uncertainty; social networks and organisation; age, and education; and intrahousehold interaction that affect the choice of a variety (Pingali *et al*., 2005). Such factors influence the costs of information seeking, negotiating, monitoring, and enforcement and hence variety choice and use. The presence of social networks and organisations such as farmers' associations or cooperatives may substantially increase the likelihood to purchase improved and high yielding varieties (Ortman and King, 2007). Age, gender, and education can affect variety choice in different ways (Luh, 1995). Age can be an indicator of farming experience, which makes certain informational and search costs easier. According to Luh (1995), it is a widely accepted proposition in economics of production that there is a positive relationship between efficiency and accumulated experience. Empirical studies by Nkumba (2007) and Hawassi (2006) find similar relationship. Nkumba (2007) finds that household characteristics such as age of the family head influence the adoption of new banana varieties in Kagera. Also, Philip (2001), Nkumba (2007), Lockheed *et al*. (1980), and Phillips (1994) find that education level of the farmers influences productivity through the decisions to use purchased inputs and adoption of new varieties.

In terms of location, smallholders are generally dispersed over wide areas and infrastructure connecting farms with the availability of both input and output markets is often poor (Omamo, 1998). This certainly has a negative effect on prices of input factors including those of improved seeds. Omamo (1998) argues that location matters in explaining crop choices. Also, according to Pingali *et al*. (2005), variations across regions matter in determining the

level of transaction cost and hence input use decision. Farmers in high potential areas (i.e. area with high access to input and output markets) may experience lower total transaction costs than those in low potential areas. They argue that higher-potential areas have more reliable access to production inputs and markets and hence face lower costs and risks associated with the switch to high-value crop production. Also, high potential areas generally have better transport and communication infrastructure. Where road density is low, especially in low potential areas, accordingly transaction costs associated with accessing input and output markets and information tend to be high. In the same token, distance to a paved road can have a significant but negative effect on the use of purchased inputs and access to output markets (Gabagambi, 2003; Ahmed, 1994).

In the preceding discussion, the idea of profitability in crop variety choice has not been mentioned. This raises questions of the factors that guide farmers in their decisions relating to crop selections. If profitability does not guide crop selection then what are the considerations that do? According to Rudra (1983), profit maximisation would make the farmer cultivate only such crops or crop varieties that promise to yield the maximum profit in production. In the following section, we would like to discuss more on that assumption.

2.3 Profit maximising behaviour of smallholder farmers

The question of whether smallholder farmers are maximisers of profit or utility has been widely discussed (Nyikai, 2003; Tauer, 1995). Although the classical theory of the firm assumes that only corporate business firms can maxime profit, according to Nyikai (2003), recent theories in peasant economics depict the farmer as both a profit maximiser and a utility maximiser. If perfect information is available then profit maximisation or cost minimisation is an important and/or a primary objective of most farmers. However, in the absence of perfect information, alternative theories may be required, which generally fall under bounded rationality. Bounded rationality means that farmers are rational but since they do not have perfect information they use decision criteria other than profit maximisation as a result their decisions deviate from optimising paradigm (Tauer, 1995; Zietz and Seals, 2006). For example, a study by Rudra (1983) in India showed that farmers were guided by factors other than profit maximisation or cost minimisation. Most farmers desired to achieve self sufficiency in all crops which they needed for home consumption.

The common assumption is that a producer or a seller is a maximiser of short-run profit (Maredia and Minde, 2002). Therefore, it would be expected that farmers would produce less of crops needed for home consumption and more of the most profitable crops and selling a greater part of them and using the cash to purchase the remaining crops needed for family consumption (Rudra, 1983). This is the behaviour that would be considered rational from a point of view of standard economic theory. But the preceding discussion shows that smallholder farmers are not guided by profit maximisation in their farming decisions. This is a clear contradiction with the principle of profit maximisation for the most profitable set of crops cannot coincide with all crops needed for home consumption (Rudra, 1983). Citing Wigley (1988), Beckford (2002) argues:

> "*...Tropical small-scale farming should be recognised as a unique farming system. Examined in this context, it would become evident that, unlike commercial farmers in developed countries, small-scale farmers are influenced by factors more important than the market and hence their decisions, whilst seemingly backward, generally have a rational basis...*" (Beckford, 2002; 251)

This discrepancy in the practice of farmers of using criteria other than profit maximisation is important in informing policies especially in the efforts of commercialisation of smallholder production. In this study it is assumed that utility maximisation for a proprietor who is, in fact, a smallholder farmer means profit maximisation for him. This assumption is appropriate in order to be able to study the optimisation behaviour of smallholder farmers in a Tanzanian context. Such an assumption is, in fact, not new. According to Nyikai (2003), the famer is assumed to be a profit maximiser but subject to minimum subsistence production. In this regard, given a set of available crops and/or crop varieties, a farmer is expected to grow crops or crop varieties that subject to probabilities, promise to yield the maximum profit. Such a farmer is also expected to allot more acreage to more profitable crops or crop varieties (Rudra, 1983). The profit maximisation assumption of farmers is also consistent with the current government effort of commercialising smallholder production (Agricultural Policy (URT, 1997)).

2.4 Empirical methods

2.4.1 Profitability analyses

In carrying out profitability analyses, a number of studies use gross margins (GM) and net margins as indicators to estimate crop and farm profitability (Al Said *et al*., 2007). Usually net margins are different from net returns because the cost of management, cost of capital, and the opportunity cost of the land are not accounted for. Studies that have used GM analysis in measuring profitability include: Al Said *et al*. (2007); Kadigi (2006); Rudra (1983); Batt (2003); Monlruzzaman *et al*. (2009); Ojo and Ehinmowo (2010); Sulumbe *et al*. (2010); Takele (2001); and Ortega-Ochoa *et al*. (2007). For example, Al Said *et al*. (2007) used the GM (1) to estimate the crop and farm profitability of farms specialising in vegetable production.

$$GM_i = Yield_i \times \Pr ice_i - Variable\cos ts_i \quad (1)$$

Where, $yield_i$ is the output in kg/unit of land for crop *i*; $price_i$ is the price of output *i* in units of money/kg; variable $costs_i$ are the cost of seeds, fertilisers, agrichemicals, occasional labour and transport to market for crop *i* in units of money/unit of land. In this study, GM analysis was used to determine the profitability of round potato production.

2.4.2 Crop variety selections

In crop variety selection, Joshi and Bauer (2006) used the multinomial logit (MNL) model to analyse factors affecting the choice of rice varieties among smallholder farmers in Nepal. They assumed that the utility U to an adopter from choosing a particular alternative is specified as a linear function of the farm and farmer characteristics (β) and the attributes of that alternative (X) as well as a stochastic error component (e):

$$U = \beta X + e \quad (2)$$

Supposing that the observed outcome (dependent variable) is choice *j*, then for a given adopter: $U_{alternative\,j} > U_{alternative\,k}\ \forall k \neq j$, or

$$\beta X_j + e_j > \beta X_k + e_k\ \forall k \neq j \tag{3}$$

The probability of choosing an alternative is equal to the probability that the utility of that particular alternative is greater than or equal to the utilities of all other alternatives in the choice set. Let the probability that the i^{th} farmer chooses the j^{th} variety be P_{ij} and denote the choice of the i^{th} farmer by $Y_i^{/} = (Y_{i1}, Y_{i2}, ..., Y_{iJ})$ where $Y_{ij} = 1$ if the j^{th} variety is selected and all other elements of $Y_i^{/}$ are zero. If each farmer is observed only once, the likelihood function of the sample values $Y_{i1}, Y_{i2}, ..., Y_{iJ}$ is:

$$L = \prod_{i=1}^{T} P_{i1}^{Y_{i1}} P_{i2}^{Y_{i2}} ... P_{iJ}^{Y_{iJ}} \tag{4}$$

Assuming that the errors across the variety (e_{ij}) are independent and identically distributed leads us to the following multinomial logit (MNL) model.

$$P\{y_i = t\} = \frac{\exp(X_{it}^{/}\beta)}{1 + \exp(X_{i2}\beta_2) + ... + \exp(X_{iJ}\beta_J)} = \frac{\exp(X_{it}^{/}\beta)}{1 + \sum_{j=2}^{J} \exp(X_{ij}\beta_j)} \tag{5}$$

The MNL model (equation 5) is used to predict the probability that a farmer demands a certain variety and how that demand is conditioned by different farm and farmer characteristics and attributes of the variety valued by the farmer (Joshi and Bauer, 2006). This model is generally enough to be used as a tool for studying different circumstances faced by farmers and different problems encountered in the context of choice among multiple varieties.

Other commonly used models in variety selection are logit and probit models. For instance, Asrat *et al.* (2009) applied a logit regression model to a random utility framework since farmers preferences were observed in terms of their choices. However, logit and probit models usually provide similar results, hence, the choice between them depends upon the researchers' interests (Gujarati, 2006; Gujarati and Sangeetha, 2007). Further, the choice between MNL and logit models depends on the number of possible responses in the categorical dependent variable. If there are binary responses then either logit or probit model is used. But if there are three or more responses then either a multinomial logit or multinomial probit model is used (Gujarati, 2006; Gujarati and Sangeetha, 2007). In this study the logit regression model is used to analyse factors for smallholder farmers' selection of round potato varieties. Details on the selection of the logit regression model for this study are provided in the following methodology section.

3.0 METHODOLOGY

3.1 Study Area

This study was carried out in Njombe, Mbeya Rural and Nkasi Districts. According to the available statistics, Iringa was the leading round potato producer in Tanzania, Mbeya ranks second while Kilimanjaro is the third (URT, 2007). There is also some minor production in Ruvuma, Tanga, Rukwa, and Mara regions. Hence Nkasi in Rukwa was chosen for comparison purposes with Njombe and Mbeya Rural in terms of access to input and output markets, extension services, and transport infrastructure. According to the National Sample Census of Agriculture of 2002/2003, Iringa and Mbeya are the leading regions in terms of access to agricultural extension services (URT, 2006).

3.2 Sample, size and procedure

Round potato growing villages included in this study were purposely selected basing on their volume of production and the distance from all weather roads. To get farmers for interviews, the following procedure was adopted. First, Village Executive Officers (VEOs) or Chairpersons were informed of the visit at least one day before. Then village officers called for round potato farmers' meeting on the day of the visit. Practically, all farmers who showed up to the meeting were interviewed, one after the other. Three to five research assistants were present to assist in order to reduce farmers' waiting time. No incentives were given to respondents, except that one of the research assistants was an experienced agricultural officer so farmers had a chance of asking him questions regarding round potato production and farming in general.

Using a statistical formula with 95% confidence level and 0.05 precision, we arrived at a sample size of 385 farmers. Since we sought for an equal sample size in all districts, we added 2 farmers to get 387, which is divisible by 3. This sample size was considered adequate for this study because according to Hair *et al*. (2006), any sample size usually suffices for descriptive statistics. But a good sample size between 200 and 500 is needed for multiple regression, analysis of variance (ANOVA), or log-linear analysis. Our sample size of 387 farmers is within the required range that is suitable for rigorous statistical and econometric analyses. Also, Sudman (1976) suggests that if comparative analysis is to be performed between or among groups then a minimum of 100 elements is needed for each group. Our sample size satisfies this criterion as well.

Questionnaires that were found to contain insufficient data were excluded making a total of 370 farmers that were included in the analysis. Therefore, results reported in this study are based on sample size of 370 farmers. This sample size is still adequate for any statistical/econometric analyses and comparisons. As seen in Table 1, cases of insufficient data in questionnaires were more pronounced at Nkasi District than Njombe or Mbeya. This is perhaps, because of interviewers' fatigue as it was the last district and that farmers at Nkasi were not very informed about round potato varieties and production as compared to Njombe or Mbeya. Table 1 shows the sample of the study with the analysed areas and villages.

Table 2: Sample of the study

Njombe			*Mbeya*			*Nkasi*		
Village	Freq	%	Village	Freq	%	Village	Freq	%
Igagala	30	24	Igoma	34	26.8	Kantawa	41	34.7
Magoda	27	21.6	Kikondo	19	15	Kipande	42	35.6
Makoga	13	10.4	Kimondo	28	22	Nkundi	35	29.7
Njoomlole	19	15.2	Simambwe	24	18.9			
Uhekule	17	13.6	Usoha	22	17.3			
Usalule	19	15.2						
Total	125	100	Total	127	100	Total	118	100

3.3 Data and collection procedure

Primary data were collected using both close- and open-ended questionnaire. The questionnaire together with the initial study proposal were presented and reviewed during the proposal presentation at the Department of Agricultural Economics and Agribusiness at Sokoine University of Agriculture in August 2009. Later, the proposal was sent to Research on Poverty Alleviation (REPOA) where it was reviewed following a double-blind peer review process.

There were two types of questionnaires, one for round potato farmers and the other for traders/wholesalers and retailers. Detailed results of the traders/wholesalers and retailers' interviews are presented in a thesis. Farmers' questionnaire included questions on: demographic and socio-economic characteristics; types of crops produced; variety(ies) of round potato grown, knowledge of other round potato varieties, usage and markets; considerations for acreage decisions among crops/varieties, main reasons for selected round potato variety(ies), production costs per acre; yield per acre; selling price of variety(ies) produced in the current and previous seasons; access to extension services; availability and costs of agricultural inputs; and access to market information.

The questionnaire was pre-tested during a preliminary survey that was carried out in two villages, one in Njombe and the other in Mbeya. This helped to validate the relevance of the questions, to familiarize with the study area and to determine the best way of carrying out the main survey. Some questions were revised after the pilot survey. These included the number of bags of fertiliser 'used per acre' rather than 'required per acre'; 'average price' of selling round potatoes rather than 'selling price' because farmers sold round potatoes at different times at different prices; also the question on distance of the farm from market centre was removed since traders brought the trucks to the fields. Farmers' questionnaires were administered by trained enumerators together with the researcher in the period between March and May 2010.

3.4 Analytical techniques

In this study, four types of analyses were conducted. These were descriptive statistics such as means, standard deviations, frequencies and percentages; gross margin (GM) analysis to determine the profitability of round potatoes by location and then by varieties; analysis of variance (ANOVA) to determine if significant variations existed in terms of profitability of round potato by varieties; and logistic regression model (6) to determine factors for round potato variety selection. Descriptive statistics and ANOVA tests were carried out with the *Statistical Package for Social Sciences* (*SPSS*) while the logistic regression model was estimated with *STATA*. Here we provide a brief account of the logistic model used in this study.

$$VARIETY = \alpha_0 + \alpha_1 AGE + \alpha_2 EDUC + \alpha_3 EXT + \alpha_4 LOCAT + \alpha_5 PRICELS + \alpha_6 YIELD + \alpha_7 SEEDSC + \alpha_8 GM + \varepsilon_i \quad (6)$$

Table 3: Definition of the variables used for variety selection analysis

Variable	*Definition*	*Type*	*Measurement*	*Mean*
VARIETY	Dependent variable used in the logit model	Binary	1 = Kikondo/Arka/Kagiri/ Kidinya /Tigoni 0 = otherwise	-
AGE	Age of the respondent	Number	Years	40.00
EDUC	Number of years in school	Number	Years	6.75
EXT	Extension services	Binary	1 = if consulted 0 = otherwise	0.23
LOCAT	Location of the respondent	Binary	1 = Njombe/Mbeya 0 = otherwise	0.68
PRICELS	Price last season	Number	TZS/100kg bag	21,150
YIELD	Yield	Number	100kg bags/acre	31.40
SEEDSC	Source of seed tubers	Binary	1 = if from own reserve 0 = otherwise	0.53
GM	Profitability	Number	TZS/acre	364,010

The variables that were included in the logistic regression model (6) are shown in Table 2. There were over 10 varieties of round potatoes grown in the study area. Since the variable, VARIETY, would have many categories each with relatively small sample size (Table 4), running a multinomial logit model could not provide meaningful results. According to Gujarati (2006) and Gujarati and Sangeetha (2007), it is up to the researcher(s) to decide on the number of categories to be used. Where many categories exist, merging some of them is a common practice. Hence, the varieties of round potatoes were divided into two (binary variable), one group representing the commonly grown improved varieties such as *Kikondo*, *Kagiri, Kidinya*, *Tigoni,* and *Arka*, and the other with older varieties such as *Malita*, *Sasamua*, and *Baraka* and a mixture of varieties.

4.0 RESULTS AND DISCUSIONS

4.1 Description of respondents

Respondents were both male and female round potato farmers. Out of the 370 respondents, 66.2% were male while 33.8% were female farmers. However, there were more female farmers in Njombe District than Mbeya Rural and Nkasi Districts as seen in Table 3. It was expected that there would be more female round potato farmers than are males reflecting the traditional culture where women are assigned more farm activities than men. The higher percentage of men in round potato farming might be a result of the commercial nature of round potato production in the study area. Since the majority of round potato farmers were doing so for commercial purposes it is likely that more men would be involved leaving women with important food crops for home consumption and other household activities.

Age was expected to affect round potato farming. According to Luh (1995), age can be an indicator of farming experience, which makes certain informational and search costs easier. Also, a positive relationship is often expected between efficiency and accumulated experience. In this study, round potato farmers were predominantly in the 30-44 year age group, which accounted for 54.6% of the total respondents, followed by the 45-64 year age group (24.9%) and the 14-29 year age group (18.4%). This indicates that direct school leavers, for example, primary and secondary school leavers were not immediately involved in farming activities or were doing so under parents supervision but did not have independent fields.

Respondents were predominantly primary school leavers. About 88% of the total sample had primary education, 6% had O-level secondary education, and nearly 6% had no formal education, while only 0.3% had A-level secondary education. It was hypothesised that farmers with higher education would be more optimisers of round potato production than those with lower levels of education.

Table 4: Characteristics of respondents

	Njombe		Mbeya		Nkasi	
	Frequency	%	Frequency	%	Frequency	%
Sex						
Female	50	40.0	31	24.4	44	37.3
Male	75	60.0	96	75.6	74	62.7
Total	125	100.0	127	100.0	118	100.0
Age						
14-29 years	12	9.6	26	20.5	30	25.4
30-44 years	74	59.2	68	53.5	60	50.8
45-64 years	35	28.0	30	23.6	27	22.9
65 years and above	4	3.2	3	2.4	1	.8
Total	125	100.0	127	100.0	118	100.0
Education level						
No formal education	6	4.8	11	8.7	4	3.4

Primary education	106	84.8	106	83.5	113	95.8
O-level secondary education	13	10.4	9	7.1	1	.8
A-level secondary education	0	.0	1	.8	0	.0
Total	125	100.0	127	100.0	118	100.0
Marital status						
Married	108	86.4	106	83.5	110	93.2
Single	7	5.6	9	7.1	6	5.1
Separated/widowed	10	8.0	12	9.4	2	1.7
Total	125	100.0	127	100.0	118	100.0

About 88% of respondents were married while the rest were single, widowed or separated. It was expected that respondents who were leaving single would be more involved in commercial agriculture than those who are married having children, who would be more concerned with food security than profit.

4.2 Ownership of land, use and relative acreage allocation

Table 4 shows the size of land owned/rented by respondents in the study areas, land under cultivation, and proportion of land allocated for round potato production. Since cases of outliers were present, the median, which if free from extreme values was also included as an alternative measure for the mean. As seen, there were variations in terms of the size of land owned/rented by respondents in the three Districts. In Njombe, the average land size owned or rented by a respondent was 6.6 acres, while in Mbeya Rural it was 4.4 acres, and in Nkasi it was nearly 11 acres. The size of land owned reflects the magnitude of land availability in those locations. The problem of land availability was much severe in Mbeya rural as compared to Njombe and Nkasi Districts. As seen in Table 4, the proportion of land under cultivation to total land owned was very high in Mbeya, where on average about 96% of the total land owned was under cultivation with a smaller standard deviation of 15%.

Table 5: Relative acreage allocation

District	Land ownership and use	Min	Max	Mean	Median	Std. Dev
Njombe	Total farmland owned/rented by respondent (acres)	1.00	30.00	6.64	5.00	4.44
	Total land under cultivation (acres)	1.00	13.00	4.71	4.00	2.32
	Proportion of land under cultivation	.17	1.00	.82	-	.24
	Land size under maize production (acres)	.50	6.00	2.17	2.00	1.12
	Land under round potato production (acres)	.25	7.00	1.99	2.00	1.21
	Proportion of land under round potato to total land under cultivation	.08	.67	.42	.40	.14
Mbeya	Total farmland owned/rented by respondent (acres)	1.00	40.00	4.42	3.00	6.20
	Total land under cultivation (acres)	1.00	40.00	3.74	3.00	4.74
	Proportion of land under cultivation	.13	1.00	.96	-	.15
	Land size under maize production (acres)	.50	10.00	1.69	1.00	1.47
	Land under round potato production (acres)	.50	40.00	2.63	2.00	4.35
	Proportion of land under round potato to total land under cultivation	.10	1.00	.71	.67	.28
Nkasi	Total farmland owned/rented by respondent (acres)	4.00	28.00	10.83	10.00	6.26

	Total land under cultivation (acres)	3.00	21.00	7.08	5.00	4.08
	Proportion of land under cultivation	.20	1.00	.71	0.70	.23
	Land size under maize production (acres)	1.00	14.00	3.87	3.00	2.73
	Land under round potato production (acres)	.50	3.00	1.14	1.00	.69
	Proportion of land under round potato to total land under cultivation	.03	.75	.20	.17	.15

Farmers in Mbeya Rural area reported to own fragmented plots. Land form was characterised by mountain slopes and valleys. Also, as a result of shortage of land in Mbeya Rural, some farmers contracted their land for another person to farm round potatoes while themselves planting maize in the same field at the same time. In this case they mix crops in the same field but round potato belongs to one person and maize to the other. The land problem was less pronounced in Njombe and Nkasi Districts than in Mbeya Rural. For instance, in Njombe the proportion of land under cultivation was about 82% with standard deviation of 24% while in Nkasi average proportion of land under cultivation was as low as 71% with a standard deviation of 23%. Some farmers in Nkasi District were not able to estimate the total land size they owned but were able to estimate land that was under cultivation. This is because when a farmer has to hire someone to cultivate his/her field then it must be measured, in most cases by counting foot steps as a proxy to a metre.

The acreage that was cultivated with round potatoes was compared against the total land under cultivation in order to determine the relative importance of round potatoes over other crops. Also, Table 4 shows the land size currently under cultivation, land size under round potatoes and maize in acres, and the percentage of cultivated land that was allocated to round potato production. In Njombe, about 8% to 67% of the total land under cultivation was allocated to round potato production. On average, about 42% of the total land under cultivation was allocated to round potato in Njombe. This indicates that round potato is relatively very important and popular in Njombe District. Since the relative land allocation for maize and round potatoes are almost the same in Njombe, it means that farmers are increasing becoming commercialised by moving from maize to round potato production. According to BOT (2010), in August 2010 the average wholesale price of maize was TZS 28 187 per 100kg bag while that of round potatoes was TZS 49 185 per 100kg bag. Given that maize take up to eight to ten months to be ready for harvest while round potatoes take up to three months, and that one acre of maize yields up to 30 100kg bags while one acre of round potato may yield up to 120 100kg bags (UARC, 1990), then round potatoes may be considered as more profitable than maize.

Relative land allocation for round potatoes highly varied in Mbeya Rural ranging from 10% to 100% of the total land that was under cultivation with a standard deviation of 28% as compared with the standard deviation of 14% for Njombe. On average, 71% of the total land that was under cultivation was allotted to round potato production in Mbeya. However, this mean value might have been affected by the presence of outliers whereby three farmers had up to 40 acres of land under cultivation completely devoted to round potato production. In this case median values, which are free from outliers were computed. As seen in Table 4, the median for relative land allocated to round potato production in Mbeya Rural was about 67%.

Also, as mentioned earlier, some farmers in Mbeya planted round potatoes in the fields they grew maize. This might have increased the proportion of land allotted to round potato production.

Comparatively, more land was allocated to round potatoes in Mbeya Rural than in Njombe. However, this might be a result of shortage of land for cultivation in Mbeya rural. For instance, the average land under cultivation in Mbeya Rural was 3.00 acres while in Njombe it was 4.00 acres. Also, because of weather, in Mbeya Rural, maize takes much longer to mature than in Njombe making them prefer to grow short term maturing crops such as round potatoes, which makes it possible for two farming seasons per year.

In Nkasi District, the land size that was allotted to round potato production was much smaller than Njombe and Mbeya Rural Districts. Here, the proportion of land under cultivation that was portioned to round potato production ranged from 3% to 75% with an average of 20% or a median of 17% with a standard deviation of 15%. Farmers in Nkasi showed to cultivate many different crops at the same time hence having smaller pieces of land for each crop. A relatively bigger land was allocated to maize production.

4.3 Round potato varieties grown in the study area

There were many round potato varieties grown in the study. Some of the common varieties include Kikondo (CIP 720050 or commonly known *Kiazi cha Njombe*), *Arka*, *Kagiri*, *Kidinya*, and *Tigoni*. Others include *Sasamua*, *Baraka*, *Tana*, *Loti*, *Kala*, and *Malita*. *Kikondo* was predominantly grown in Njombe, while *Arka*, *Kagiri*, *Kidinya* and *Tigoni* were mostly grown in Mbeya. *Sasamua*, *Baraka*, and *Malita* are some of the old varieties and were still grown mostly in Nkasi District in Rukwa. Since farmers recycle the seed tubers in the same field, the characteristics of some varieties usually change over time (Shao *et al*., 1988).

Table 5, shows the typical varieties grown by respondents by location. As seen, Njombe produces predominantly one variety that is *Kikondo* for commercial purposes. However, respondents indicated that they also grew other local varieties such as *Loti* and *Kala* for home consumption. Round potatoes for home consumption were grown in the maize fields. Such round potatoes were not regularly planted but germinate automatically as volunteer plants from the previous year's tubers, which remained in the fields.

Farmers in Mbeya area grew a number of varieties including *Kikondo*, *Arka*, *Kagiri*, *Kidinya* and *Tigoni*. However, as seen in Table 5, many farmers in Mbeya grew two or more varieties in separate fields. This is so for three main reasons: one is because of the fragmented nature of the plots, and the other is because of shortage of seed tubers. Unlike in Njombe where seed tubers can remain or be store in the field until the next season, that is not the case in Mbeya. Generally, soil at Mporoto area in Mbeya was wet almost throughout the year. Hence, seed tubers remaining in the field usually sprout and germinate in no time. So, farmers had to buy seed tubers almost every season from villages around Kikondo near the Kitulo Conservation Area, where soil conditions are said to be similar to Njombe. The third reason is that Mbeya is within the catchment of Uyole Agricultural Research Centre (UARC), which sometimes

distributes improved seed tubers. Also, some researchers at UARC were themselves round potato farmers.

Plate1: Farmers selling round potatoes by road side at Nkundi Village in Nkasi in 2010

The case of Nkasi District in Rukwa is quite different and unique in its own. Many smallholder farmers in this District were not even aware of the varieties they grew because they failed to name them. However, this is not a surprise because after all, over 32% of respondents at Nkasi were growing mixed varieties in same plot. Further, respondents at Nkasi were growing older varieties as compared to Njombe or Mbeya. As such they did not have reliable markets, except selling by the road side that runs from Sumbawanga to Mpanda (Plate 1). No traders go to get round potatoes from this area. Even street chips vendors at Sumbawanga and Namanyere preferred the round potatoes from Mbeya rather than those from Nkasi for the reason that they were hard to peel.

Table 6: Varieties of round potato grown by respondents

Njombe			*Mbeya*			*Nkasi*		
Variety	Freq	%	Variety	Freq	%	Variety	Freq	%
Kikondo	125	100	*Kikondo*	21	16.5	*Kikondo*	1	0.8
			Arka	32	25.2	*Arka*	17	14.4
			Kagiri	4	3.1	*Malita*	34	28.8
			Kidinya	2	1.6	*Sasamua*	12	10.2
			Tigoni	2	1.6	*Baraka*	10	8.5
			2 or more varieties on separate plots	66	52	2 or more varieties on separate plots	6	5.1
						Mixed varieties in same plot	38	32.2
Total	125	100	Total	127	100	Total	118	100

In Table 6, we summarise some of the important varieties, their characteristics and potential markets.

Plate 2: A lorry just loaded round potatoes at Usalule Village in Njombe in 2009

Table 7: Characteristics of selected round potato varieties

Variety	Characteristics	Usage	Markets
Kikondo (CIP 720050)	- It is reddish in colour - Can be stored for a longer time - Higher dry matter content - Relatively better taste	- Very good for boiling - Very good for chips - Good for industrial processing into crisps	- Almost everywhere, but mostly Tanzania mainland - Most preferred or popular variety
Arka	- It is also reddish in colour - Has deep eyes - It is mostly affected by bacterial wilt - It is an older variety when compared to *Kikondo* and at times it is considered as a local variety	- Mostly similar to *Kikondo* in terms boiling and chips	- Mostly Tanzania mainland - Second preferred after *Kikondo*
Kidinya	- It is reddish in colour	- Can be made into chips but have lower	- Mostly in Zanzibar

	- Beautiful and attractive in shape - High yielding - Early sprouting - Easy to peel - It came to Mbeya from Lushoto	dry matter content - Not good for boiling	- It is very popular in Lushoto and Moshi - It is also said to be exported to Arab countries from Zanzibar
Kagiri	- Whitish skin with reddish or dark pink surface eyes - To some extent resembles *Kidinya* - Completely roundish, hence easy for peeling by a machine	- Suitable for chips - Not good for boiling - Some believe that it is used for purposes other than food in Zambia because of its sour taste	- Mostly in Zambia and Malawi - Also Dar es Salaam area and Zanzibar
Tigoni	- It is whitish in colour - Irregular roundish in shape - Resistant to late blight but highly affected by bacterial wilt - Easy to cook and very tasty - Highly yielding - It came to Tanzania from *Tigoni* Research Institute in Kenya	- Very good for chips - Very good for boiling and mashing into *paste* - *Tigoni* chips are very tasty and attractive in colour	- It is highly marketable especially in Zanzibar and Dar es Salaam

Source: Field observation and discussion with S. Kyando and M. Kitigwa

Other older varieties such as *Baraka*, *Sasamua*, *Tana*, *Subira* (EAI 2329), and *Bulongwa* (K59 a [26]) have been documented in UARC (1990). However, these varieties are currently disappearing mainly because of fewer yields, taste, or difficult in preparation especially boiling or preparing for chips. For example, *Baraka* produces large but hollow tubers.

From the farmers' survey we see that *Kikondo* and *Arka* were mostly grown varieties. However, farmers who grew *Tigoni* were very few because it is a relatively new variety in Tanzania originating from Tigoni Research Institute in Kenya. *Tigoni* is higher yielding and tasty compared to *Kikondo*. However, it is highly perishable especially when exposed to moisture or wet places. It is early sprouting and hence cannot be stored for a long time as compared to *Kikondo*. It quickly changes colour into greenish and sprout earlier than *Kikondo*. *Kikondo* on the other hand is comparatively less perishable and can be transported to big distances without considerable effects (Plate 2). For these reasons, *Kikondo* will continue to prevail in the market for quite some time although *Tigoni* is also being spread in other areas such as Mufindi and Kilolo districts in Iringa region and Songea in Ruvuma region (S. Kyando and M. Kitigwa, Personal Communication 2010).

4.4 Profitability analysis of round potato production

Profitability analyses were conducted by using the gross margin (GM), first by location and then by varieties. Table 7, shows the GM of round potato production by location, i.e. Njombe, Mbeya and Nkasi. As seen, highest weighted gross income of TZS 791 540 was found in Njombe and the least weighted gross income of TZS 301 960 per acre was found at Nkasi. Also, Njombe leads in terms of yield, whereby the average yield was about 49 bags/acre as compared to 33 bags/acre in Mbeya and about 12 bags/acre at Nkasi. Although Njombe leads in terms of yield and gross income, Mbeya leads in terms of contribution or gross margin. This is because the operating costs highly varied in Njombe than in Mbeya.

Table 8: Gross Margin Analysis by Location

	Njombe			Mbeya			Nkasi		
	N	Mean	Std. Dev	N	Mean	Std. Dev	N	Mean	Std. Dev
Land size under round potato production (acres)	125	1.99	1.21	127	2.62	4.35	118	1.14	.67
Round potato output for 2009 (100kg bags)	123	111.39	195.76	126	119.32	357.63	118	13.81	13.40
Yield (100kg bags/acre)	123	48.57	59.41	126	32.84	22.35	118	11.95	6.84
Selling price of round potato (TZS per 100kg bag)	122	16,139	4,800	123	22,146	5,614	116	25,362	4,380
Gross Income (TZS/acre)	122	791,540	932,517	123	759,330	567,176	116	301,960	168,928
Seed tubers (TZS per acre)	100	169,250	46,080	62	176,000	51,980	86	66,070	22,981
Farm clearing (TZS per acre)	92	7,391	3,936	48	6,083	6,687	81	4,593	4,639
Tillage (TZS per acre)	105	27,971	4,282	78	49,436	42,518	84	12,988	4,893
Sowing (TZS per acre)	105	24,514	4,952	79	30,519	9,219	84	12,524	3,668
Weeding (TZS per acre)	105	34,486	10,832	78	33,359	11,270	84	19,548	7,928
Fertilisers (TZS per acre)	104	108,390	46,049	79	107,250	50,128	97	835	4,699
Average cost of agrochemicals per acre (TZS)	114	23,443	11,760	105	14,662	7,744	115	309	1,327
Pesticide applications (TZS per acre)	101	11,198	3,382	67	12,821	4,506	100	20	200
Harvesting/carriage to loading place (TZS per acre)	105	44,476	18,044	80	73,350	47,068	84	20,411	19,025
Total Operating Costs (TZS/acre)	118	393,930	166,712	110	334,660	244,012	115	101,500	69,032
Gross Margin (TZS/acre)	**116**	**416,770**	**921,533**	**107**	**481,040**	**471,587**	**113**	**199,040**	**190,830**

Table 9: Gross Margin Analysis by Variety

	KIKONDO	ARKA	KAGIRI	KIDINYA	TIGON	MALITA	SASAMUA	BARAKA	2 OR MORE VARIETIES*
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Land size under round potato production (acres)	2.16	1.41	1.25	1.50	2.00	1.15	1.79	.80	2.88
Round potato output for 2009 (100kg bags)	113.10	34.96	86.50	49.00	80.00	13.71	14.42	7.40	143.18
Yield (100kg bags/acre)	44.34	23.02	65.25	32.00	40.00	11.83	10.62	9.40	33.84
Selling price of round potato (TZS per 100kg bag)	16,729	22,333	28,750	18,000	25,000	2.64	24,000	24,050	22,606
Gross Income (TZS/acre)	745,720	519,650	1,870,000	576,000	1,000,000	323,080	220,100	230,700	770,290
Seed tubers (TZS per acre)	165,890	109,620	177,500	150,000	120,000	57,786	78,000	71,750	180,320
Farm clearing (TZS per acre)	7,121	4,667	3,000	15,000	6,000	5,520	9,583	4,500	5,677
Tillage (TZS per acre)	28,425	31,367	47,500	30,000	60,000	13,214	10,000	13,750	51,167
Sowing (TZS per acre)	24,752	24,333	27,500	24,000	50,000	13,929	9,333	10,000	28,653
Weeding (TZS per acre)	34,389	24,767	41,250	24,000	40,000	17,679	18,250	18,750	32,771
Fertilisers (TZS per acre)	107,050	51,000	115,000	109,000	170,000	.00	.00	.00	104,300
Average cost of agrochemicals per acre (TZS)	21,569	7,761	16,667	16,250	25,000	.00	.00	.00	16,345
Pesticide applications (TZS per acre)	11,092	6,552	11,250	9,000	10,000	.00	.00	.00	12,659
Harvesting/carriage to loading place (TZS per acre)	44,509	54,433	97,500	52,000	60,000	20,054	20,167	9,125	69,480
Total Operating Costs (TZS/acre)	365,960	203,210	533,000	222,750	541,000	105,070	145,330	102,300	376,690
Gross Margin (TZS/acre)	**406,970**	**323,830**	**1,337,000**	**353,250**	**459,000**	**211,440**	**74,767**	**128,400**	**473,280**

In terms of profitability by varieties, *Kagiri* was highly profitable followed by *Kikondo*. Although *Kagiri* was most profitable, only a few farmers grew it mostly because its market and/or demand was not stable and reliable as *Kikondo*. The biggest markets for *Kagiri* were Zambia and Malawi, which were not always reliable. This observation partly reflects the argument by Beckford (2002) that sometimes smallholder farmers consider other factors more important than profits in crop and/or crop variety selections.

Farmers who grew more than one variety in separate fields enjoyed higher margins on average as seen in Table 8. For example, during the interviews with farmers at *Kikondo* village in Mbeya Rural, one farmer said "*Nimebalansi, wakitaka Tigoni ninayo, wakisema, Kagiri ninayo, wakisema Kikondo nawapa.*" Meaning in the researchers' own interpretation "*I have balanced, if they ask Tigoni I have, if they ask Kagiri I have, if they ask Kikondo I give them*." According to this farmer, growing multiple varieties minimises risks of sale problems.

In order to ascertain whether or not there were significant variations in profitability among varieties, a one way analysis of variance (ANOVA) was carried out as in Table 9. Results show that the variations in profitability among varieties were highly significant at 0.1%.

Table 10: ANOVA test for the differences in profitability by variety

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4044.690	221	18.302	4.305	.000
Within Groups	484.640	114	4.251		
Total	4529.330	335			

4.5 Factors guiding round potato variety selections

Respondents were asked to indicate the most important reason or criterion they used in selecting the variety(ies) they were producing. Results are as shown in Table 10. As seen, the criteria for variety selections varied greatly among respondents. While only 30% mentioned market demand as the most important criterion, others (22%) mentioned of seed availability. Basically, farmers in Mbeya, for example, were greatly affected by seed availability because the weather and/or soil condition did not guarantee them for storing own seed tubers for the next season. As such the majority were getting seed tubers from villages around Kikondo near the Kitulo conservation area. Since such tubers were not abundant, they were forced to purchase whatever was available. In some cases different varieties were only available in small quantities, hence farmers had to take different varieties but sowed in different plots to distinguish them. Looking back at Table 5 and on the varieties grown in the study area, we find that about 52% of the respondents from Mbeya grew two or more varieties but in

separate plots. Although a few farmers wanted to minimise risk of sales, the majority were forced to do so because of shortage of seeds for a particular variety they were interested in.

About 23.5% of the respondents mentioned either of the popularity of the variety at their village or of the common practices as a cause for using particular varieties. This percentage is very high, knowing that a considerable number of farmers grew certain varieties just because it was what everybody else did at the village or because it is a common practice. The logic behind this behaviour is that this is what they have been doing all the years, so they continue doing the same. This may have two implications. First, it could be a result of seed availability. If farmers were reproducing own seed tubers, then automatically this results into a common practice because the available seed tubers are the remains from previous season, hence same seed variety every other season.

Another possible implication is that of extension services. From Table 10 it can be seen that farmers who grew certain varieties because of the recommendation from extension officers were very much negligible. Many times extension services are considered to have a very positive impact in adoption of improved varieties. For example, Joshi and Bauer (2006) find that farmers trust more the seeds from official or formal sources than from other non-formal sources. Extension officers in this case could be a valuable source of both formal information/education as well as helping farmers find improved seed varieties. Therefore, the possible explanation could be because we asked only the main reasons. Possibly extension services was important but not the main criterion. This is so, because even the regression results in Table 12, indicates that extension services was a significant factor in explaining farmers' variety choices.

Table 11: Main reason for varieties grown

Main reason for variety(ies) selected	Frequency	Percent
High selling price for the variety	46	12.4
High yielding variety	26	7
Most demanded in the market	111	30
The most popular in our area	60	16.2
Resistant to pests and diseases	2	0.5
Seed tubers availability	82	22.2
Recommended by extension officers	2	0.5
Good for home consumption	14	3.8
Common practice	27	7.3
Total	**370**	**100**

In order to ascertain the extent to which farmers seek consultation with extension officers, we made a cross-tabulation between farmers' consultation with extension officers and the presence of the extension officer(s) at the village. Results are shown in Table 11. While about 83% of respondents reported of the availability of the extension officer at their villages, only about 22% had made consultation with them. Other studies, for example, Kabungo (2008)

and Namwata *et al*. (2010) showed that access to extension services among round potato farmers in Mbeya was about 50% and 58% respectively. However, access and actual contact between the farmer and the extension officer are two different things. When an extension officer is available at the village then there is access to him/her. What is needed is not only the presence of him/her but also his contact with farmers. The question is: why is the contact between farmers and extension officers so low even where such officers are present? May be farmers are reluctant to seek information from the extension officers or the officers do not avail themselves to farmers or farmers are just not aware of the roles of extension officers.

Table 12: Consultation with extension officer vs presence of extension officer at the village

			Presence of extension officer(s) at the village		Total
			No	Yes	
Consultation with extension officers	No	Count	61	224	285
		% of Total	16.5%	60.5%	77.0%
	Yes	Count	3	82	85
		% of Total	.8%	22.2%	23.0%
Total		Count	64	306	370
		% of Total	17.3%	82.7%	100.0%

In an attempt to analyse the determinants of seed variety choice among smallholder farmers we developed a logistic regression model (6). The factors that could affect famers' variety selections using the logistic regression model are presented in Table 12. Results show that the estimated logit model is significant in explaining smallholder farmers' variety selections. The *Pseudo R-square* was 0.373. Also, the log-likelihood ratio was highly significant. We find that price of the variety in the previous season (PRICELS) and profitability (GM) did not have any effect on the probability of choosing one variety over the other. At this point, this result could be expected, especially because the majority of the farmers use certain varieties because of availability and/or basing on common practices. Also, some farmers at Nkasi, for example, were not able even to name the varieties they were growing, in that case they cannot rationally choose. Many previous studies, for example, Rudra (1983), Beckford (2002), and Josh and Bauer (2006) found similar results, where profit was not significantly considered when it comes to crop variety selections among smallholder famers.

Table 13: Results of the logit model

Logistic regression					No. of obs =	324
					LR chi2(8) =	166.03
					Prob > chi2 =	0.000
Log likelihood = -139.33153					Pseudo R2 =	0.373
Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
LOCAT	2.315	0.393014	5.89	0.000	1.544307	3.084894
AGE	-0.005	0.0162652	-0.31	0.758	-0.0368888	0.0268694
EDUC	0.145	0.0908546	1.6	0.110	-0.0328082	0.3233352
PRICELS	0.000	0.0000418	-4.78	0.000	-0.0002818	-0.000118
SEEDSC	0.534	0.3377609	1.58	0.114	-0.1277036	1.196295
EXT	-1.229	0.3635912	-3.38	0.001	-1.941637	-0.516386
YIELD	-0.025	0.0136038	-1.83	0.067	-0.0516091	0.0017168
GM	0.000	8.37E-07	2	0.045	3.41E-08	3.31E-06
constant	2.428	1.366464	1.78	0.076	-0.2501525	5.106289

Location (LOCAT) and extension services (EXT) were significant factors in explaining round potato variety selections among smallholder farmers. In terms of location, results show that farmers from Nkasi were less likely to choose improved varieties such *Kikondo*, *Kagiri*, *Kidinya*, or *Tigoni*. Again this result may be expected because such varieties require regular use of fertilisers and agrochemicals whereas farmers at Nkasi did not practically apply fertilisers or agrochemicals in round potato farming (Table 13). Previous studies such as that by Smale *et al*. (2001), Omamo (1998) and Pingali *et al*. (2005) had similar contention. According to Omamo (1998) location is said to have a negative effect on input factors including those of improved seeds. Also, Pingali *et al*. (2005) argue that variations in locations affect the level of transaction cost and hence input use decisions. Farmers in high potential areas may experience a lower total transaction costs than those in low potential areas. Certainly, in this case Nkasi is a relatively lower potential area as compared to Njombe or Mbeya. Also, farmers in Mbeya and Njombe were more exposed to extension services than Nkasi. Other studies, for example, Gabagambi (2003) and Ahmed (1994) explained location in terms of access to paved roads. They find that distance to a paved road has a significant but negative effect on the use of purchased inputs and access to output markets.

Table 14: Input use by location

		Njombe		Mbeya		Nkasi	
		Freq	%	Freq	%	Freq	%
Use of fertilisers	Yes	121	96.8	108	85	6	5.1
	No	4	3.2	19	15	112	94.9
	Total	125	100	127	100	118	100
Use of agrochemicals	Yes	120	96	114	89.8	10	8.5
	No	5	4	13	10.2	108	91.5
	Total	125	100	127	100	118	100

Farmers with access to extension services (EXT) were more likely to choose among *Kikondo*, *Kagiri*, *Kidinya*, *Arka*, or *Tigoni* than those who are not. From the regression results in Table 12, we deduce that farmers who were exposed to extension services were more than 3 times likely to choose seed varieties from among *Kikondo*, *Kagiri*, *Kidinya*, *Arka* and *Tigoni* than farmers who were not exposed to such services.

Other factors such as age, education, yield, and sources of seeds (in terms of whether from own reserve or bought from other sources) were not significant in explaining round potato variety selections among smallholder farmers. This is contrary to previous studies such as those by Joshi and Bauer (2006), Luh (1995), Nkumba (2007), Hawassi (2006), Lockheed *et al*. (1980), and Phillips (1994). For example, Joshi and Bauer (2006) found that education level and source of seed (formal vs non-formal) were significant factors in variety selections. They found that farmers with higher levels of education and experience preferred certain improved seed varieties. This discrepancy could be a result of the characteristics of study respondents. For instance, in this study respondents were predominantly (88%) primary school leavers. Hence, there was practically no variation in terms of education level of respondents. This level of education is typical in rural areas in Tanzania (URT, 2009b). Also, similar situation happens for age. Majority of respondents were clustered around the 30 to 44 years of age with a mean of about 40 years, which again results into minor variations. This was attributed to the fact that either youth did not directly engage in agricultural production or did so under parent supervision but do no have own farms.

Finally, since farmers rely on their own stored seed tubers, sources of seeds (SEEDSC) or yield (YIELD) cannot be expected to significantly affect variety selections. The mere fact that farmers store own seeds means that they do not actually choose varieties.

4.6 Maximising behaviour of round potato farmers in the study areas

In this section we give a brief account of the maximisation behaviour of round potato farmers in the study area. We use Tables 14 and 15, and the preceding results and discussions. First, we start on how farmers decide on acreage for various crops. As seen in Table 14, about 40%

of respondents were concerned with food security and about 28% were concerned with the cost of production. Since, maize was the important cereal and staple in SHT, then much land was allocated for maize production although respondents were of the opinion that round potatoes were more profitable than maize. Apart from profitability, round potatoes were early maturing allowing farmers to re-plant other crops such as wheat and peas. Only about 21% of the respondents considered profitability in their acreage decisions. According to Rudra (1983), if farmers were maximisers of short-run profits they would allocate more acreage to profitable crops or crop varieties and use the accumulated cash to buy food for home consumption. Other things being equal, using Tables 4 and 14, regarding acreage allocation, we find that farmers in the study area did not consider profits in their land use decisions.

Table 15: Acreage decisions and time of sale of produce

Time of sale of round potatoes			Acreage decisions		
	Freq	%		Freq	%
When matures	168	45.4	Food security	148	40
When in need of cash	109	29.5	Profitability	79	21.4
When buyers/traders ask	27	7.3	Cost of production	105	28.4
When price is reasonable	16	4.3	Availability of seeds	38	10.3
When others are selling	50	13.5			
Total	370	100	Total	370	100

Also, we asked respondents of the time they usually sell their produce. As seen in Table 14, about 45% of all respondents were selling their produce immediately when it matures. Farmers in Mbeya, for example, did so to prepare for another planting cycle. As mentioned earlier, the Mporoto area in Mbeya was almost wet all the year round making it possible for two farming seasons. In Njombe, farmers usually re-plant wheat or peas after harvesting round potatoes. This practice helps to reduce instances of the common round potato diseases such as bacterial, fungi and viral diseases. So, crop rotation is highly recommended in reducing incidences of diseases. This discussion lends us to Beckford (2002; 251) citing Wigley (1988) that small-scale farmers in developing countries are influenced by factors more important than the market or profits.

The other thing that explains the non-maximising behaviour of round potato farmers in the study area is variety choice. We have seen in the preceding discussion that variety selections among round potato farmers were not guided by the principles of profit maximisation. However, this relates to availability of such seed tubers. Since, in most cases farmers were recycling own tubers, then the issue of selection was rare. It should be noted that unlike other crops such as maize and legumes, where one can buy improved and clean seeds from shops it is not the case with round potatoes. Practically, there were no shops or agents that sold improved and/or clean round potato seeds or seed tubers.

Table 16: Optimal Gross Margin for round potato production**

	On-season	Off-season	Average
Land size under round potato production (acres)	1.00	1.00	1.00
Round potato output for 2009 (100kg bags)	80	80	80
Yield (100kg bags/acre)	80	80	80
Selling price of round potato (TZS per 100kg bag)	15,000	25,000	20,000
Gross Income (TZS/acre)	1,200,000	2,000,000	1,600,000
Seed tubers (TZS per acre)	150,000	150,000	150,000
Farm clearing (TZS per acre)	10,000	10,000	10,000
Tillage (TZS per acre)	30,000	30,000	30,000
Sowing (TZS per acre)	25,000	25,000	25,000
Weeding (TZS per acre)	50,000	50,000	50,000
Fertilisers (TZS per acre)	200,000	240,000	220,000
Average cost of agrochemicals per acre (TZS)	25,000	20,000	22,500
Pesticide applications (TZS per acre)	15,000	15,000	15,000
Harvesting/carriage to loading place (TZS per acre)	120,000	120,000	120,000
Total Operating Costs (TZS/acre)	625,000	650,000	637,500
Gross Margin (TZS/acre)	**575,000**	**1,350,000**	**962,500**

*** based on 2009 estimations*

In Tables 7 and 8, we analysed the profitability of round potato production by location and by varieties. Generally, both cases indicated that round potato production was highly profitable. Such results were consistent with Kabungo (2008). However, we further ask, were those GM the maximum possible? We have to negate this question. In a detailed discussion with S. Kyando, a Soil Scientist at UARC and a round potato farmer, we analysed the optimum conditions for round potato production as shown in Table 15. Although according to UARC (1990), up to 150 bags of 100kg each is possible from one acre of round potatoes, we assumed an optimal amount of 80 bags per acre. Comparing Tables 7, 8 and 15, we find that farmers did not enjoy the optimum possible GM, except for those who grew Kagiri. In all respects, therefore, we can conclude that round potato production in SHT has not been fully optimised.

4.7 Policy implications

Round potato has a very big potential of becoming one of the major food and commercial crops. Although the exact number of people who are employed or employing themselves in the round potato crop sub-sector is not known, many are benefiting from it. This includes farmers themselves, traders, wholesalers, retailers, processors, and street chips and crisps vendors. Potential also exists for exportation to neighbouring countries as well as Europe where production is continuously declining (FAOSTAT, 2008; CIP, 2008). Given this potentiality and in the light of the results of this study key policy issues appear to be how to produce, certify and supply clean round potato seed-tubers; infrastructure development; input supply and subsidies; extension services and marketing.

Regarding clean round potato seed production, certification and supply, it is important that an enabling environment be put to agricultural research centres/institutes and other seed agencies so as to produce the clean and improved tubers for farmers. Given the current shortage of clean seed tubers, some farmers mix different varieties together so that at the end of the day the characteristics of each individual variety are lost. This current practice is also said to increase incidences of round potato diseases because the already affected tubers are used in the next season thereby transmitting the disease.

In terms of infrastructure, road network is very important for round potato production. Round potato tubers are highly perishable. Since there are no storage facilities, farmers usually sell their produce at the farm immediately after harvest. Usually the trader brings the truck to the farm. In most cases farmers wait for the trader to bring the empty bags for packing to be sure that the harvested round potatoes will be sold. This reduces the bargaining power of the farmers. Practically, a farmer cannot reject to sell after he had harvested because such potatoes cannot be stored longer to wait for better prices. This means that round potato farms have to be closer to the road network. Therefore, improving road networks in rural areas is very important if we are to truly improve production practices.

Results of this study showed that farmers who were exposed to extension services were more than 3 times more likely to select modern crop varieties than those who were not exposed to it. This calls for the government to continue to improve the extension services in remote areas. Surprisingly, however, results also showed that even in places where extension officers were available, only a very few farmers had contacted them. Again, this calls for further investigation as to what might be wrong with current practices.

5.0 CONCLUSION

Round potato production in the study area was found to be highly profitable as indicated by the gross margin analyses. However, farmers' decisions regarding round potato production were guided by factors other than profitability. For example, farmers allocated more acreage to staples for home food security than round potatoes. Acreage decisions among farmers were guided by food security and cost of production. Although different varieties differed in profitability, but profitability itself was not a significant factor in variety selection. However, location of respondents and exposure to extension services were very significant factors in variety selections. Farmers in higher potential areas such as Njombe and Mbeya were more likely to choose modern varieties and purchase agricultural inputs than those from Nkasi. Also, farmers who were exposed to extensions services were more than three times more likely to select modern varieties than those who were not exposed to it. Interestingly, however, even in villages where extension officers were available only a very few farmers had contacted them. Results further showed that variety selections depended on availability of seed tubers. Since the majority of farmers stored own seed tubers, the issue of selection was practically not present. Even those who purchased seed tubers from the neighbourhoods

were forced to buy whatever was available and many times in small quantities. Finally, the study concludes that round potato farmers in the study area were not optimisers of profit.

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