POSSIBLE PREDICTORS DETERMINING THE ADOPTION OF POTATOES (*Solanum tuberosum*) INTO THE WHEAT (*Triticum aestivum*) BASED CROPPING SYSTEM IN MOKHOTLONG, LESOTHO

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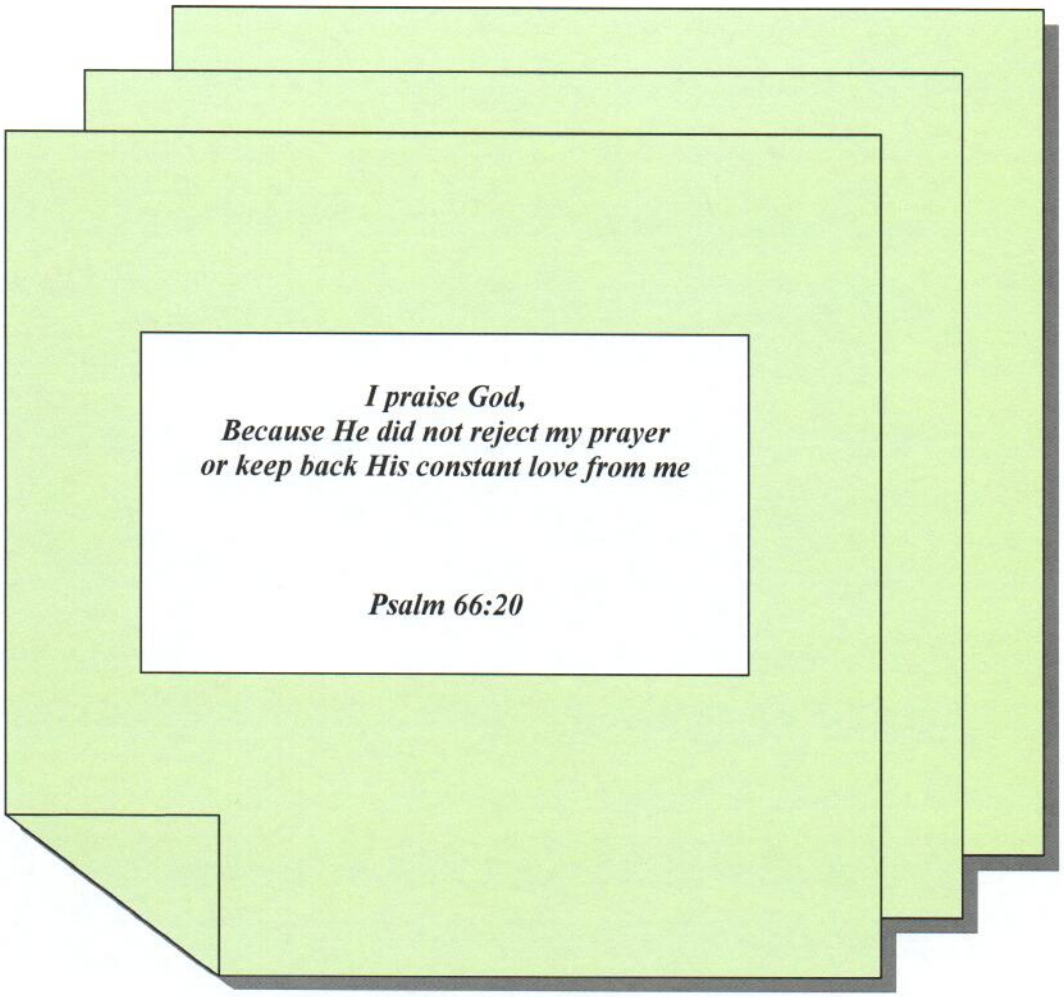
I praise God,
Because He did not reject my prayer
or keep back His constant love from me
Psalm 66:20

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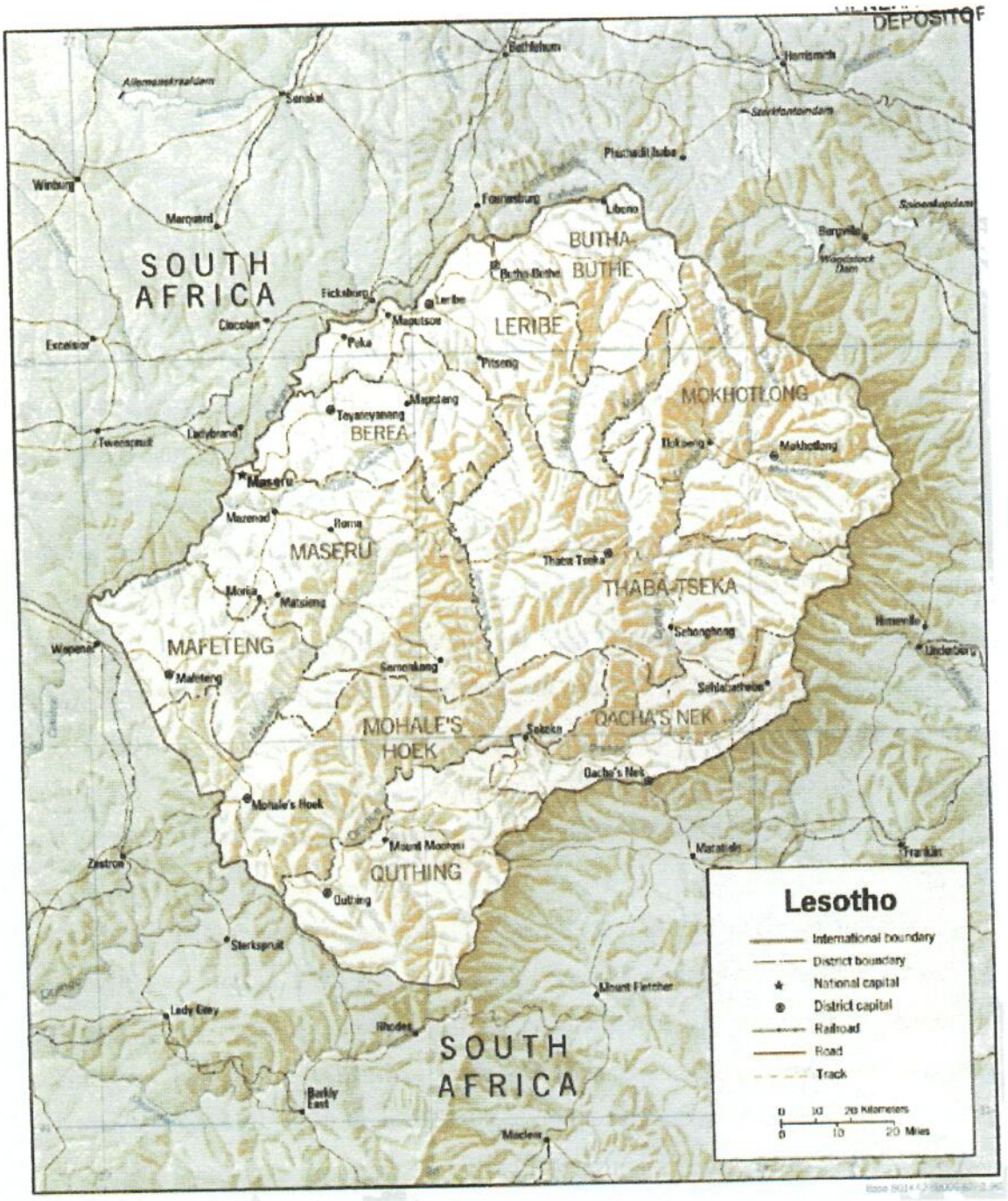


Source: Map of Lesotho, 1990 (201k)

Orientation map of Lesotho

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Studies of diffusion and adoption of innovations conducted since 1950's have established that the great majority of farmers get new ideas from family members, neighbours and friends (Francis,1995). It is true around the world (Norton & Alwang, 1993; Reijntjies, Haverkort & Waters-Beyer, 1992; Sims & Leonard, 1990) that sharing new ideas strengthens relationships and promotes the perpetuation of the structure of agriculture in place. This is true for family, subsistence agriculture. Family agriculture is a valuable structure that evaluates, adopts and modifies agricultural innovations to improve methods of production and the well-being of the farm family as well as the population in general. For family farms to adopt a new technology it must be preceded by technology diffusion. Technology diffusion is a link between research and development (R&D), and adoption (Arnon, 1989).

To understand farmers and their likely response to a whole range of interventions, whether they emanate from the agricultural researcher, extension worker or policy maker, it is important to have a clear understanding of the nature of the complex interactions between a variety of factors influencing a crop production system. Economic, political/law, ecological, technological and socio-economic factors in the environment influence farmers' choice and adoption of crop production systems. New technologies can only be successfully adopted and sustained when they accommodate the bio-physical factors, and when they are of benefit to the target farm. As any of these factors are marginal to the target farm, the range of beneficial innovations and possibilities for their widespread adoption narrows. The main influences of farm decision making were found by Bryden (1994) to be, among others:

- Promotion of income from different sources
- The size of the farm

- The number of economically active persons in the household
- The age of the farmer
- The background of the farmer, spouse and children
- The implementation of agricultural and rural policy at national and local levels.

Gladwin and Murtaugh (1980) emphasise the importance of studying the agricultural decision making process by subsistence farmers. Raikes (1994) explained the conditions of food security in Africa and the effects of policy on agricultural innovations that are intended to improve food security. According to Raikes (1994) a large number of people in Africa suffer from hunger and malnutrition because of lack of food security. Interventions to improve cropping technologies on marginal farms require a clear understanding of the adoption process and among other considerations, a precise picture of the farmers' knowledge, productive assets, local economy, and government policies (Gladwin, 1980). By developing such a comprehensive picture of the marginal farms, agricultural development workers can increase their capacities to design efficient and beneficial interventions (Erbaugh, Donnermeyer, Kyamanywa & Ekwamu, 1998; Lawas, 1998).

This is particularly important in marginal farm operations such as those in Lesotho, where research and extension resources are scarce and the natural resources are deteriorating. According to Carvalho (1990), agriculture forms a considerable part of domestic production in Lesotho. The agricultural production is however declining. Droughts, hail and frosts (early and late) are the factors that have led to the decline in crop production. Households in Mokhotlong are experiencing low crop yields and food insecurity worsened by scarcity of research and extension resources in Lesotho. These households are forced to seek better production technologies and crops of higher cash value than grain crops. Grain production is a common enterprise in Mokhotlong, where more than 75% of the cropland is devoted to maize (*Zea mays*) and wheat (*Triticum aestivum*) production. Less than 20% of the farming households are self-sufficient in cereals (Rosenblum, 1999). The growing of potatoes (*Solanum tuberosum*) was introduced to the Mokhotlong farmers in 1983 and 1984. Potatoes were infected by late blight (*Alternaria solania*) in this area (Mokhotlong) and yield was lower than other areas of potato production in Lesotho (Lesotho Farming System

Research Project, 1986). The late blight probably discouraged many farmers in Mokhotlong to grow potatoes at that time. The organisation, GROW[1] is in the process of introducing new crops and new technologies into the traditional wheat and maize cropping system. Potatoes were one of the new crops re-introduced since 1996. Beside the quest for seeking crops of higher cash value, the inclusion of potatoes in the farming system is in line with a call by Co-operative International Centre of Agronomic Research for Development (CIRAD) to encourage the so called 'two dynamic thrusts of the life phase' of the soil (Bosc & Freud, 1995). Research should give attention to selection of crop that improve the root mass, use crop combinations that have complementary root systems like shallow rooted - deep rooted crops.

According to the theory of choice presented by Gladwin (1980) the farmers' choice of crops is influenced, among others, by demand, soils, knowledge, labour availability, land size and credit availability. This is particularly true when farmers are faced with options to select new crops or varieties. The influential factors of farmers' choice will be listed and analysed in this study as parameters to determine the choice of either a wheat or a wheat-potato cropping system in Mokhotlong, Lesotho.

1.2 PROBLEM SETTING

Certain groups of farm households (recommendation domains) in Mokhotlong can benefit from either of the two crop production systems (wheat or wheat-potato) and a recommendation package can be focused on such groups. No typology was ever conducted in this area to determine which types of farm households can benefit by adopting, or are likely to adopt a wheat–potato production system. Farmers do not have identical circumstances and therefore identical needs. A tentative delineation of recommendation domains is necessary in identifying possible technologies for adoption.

Information about wheat production in Mokgotlong is needed for the purpose of planning and establishment of improvemed wheat research trials in this area. A problem-oriented approach to agricultural research begins by diagnosing the

[1] GROW is a registered non-governmental organisation (NGO) in Lesotho. It deals with agricultural technology development and transfer as well as other health and education related projects.

conditions, practices, and problems of a particular group of farmers. Once the problems are identified, a research program can be designed to address them (Tripp & Woolley, 1989). Livelihood and food security of households in Mokhotlong and other households under similar conditions, both in Lesotho and South Africa, can not be improved if policymakers are not informed of the factors contributing to decisions made in such households. In view of the above mentioned problems, it is perceived that this research will help policymakers, researchers and extension agents, and farmers to improve food security as well as quality of life of people in Mokhotlong.

1.3 MAIN STUDY OBJECTIVE

The main research objective is to identify the possible predictors of decision making by Mokgotlong farmers on adoption of a cropping system that includes potatoes into the traditional wheat based cropping system, which includes other crops other than potatoes. It is not the objective of this particular study to research on a wheat-potato rotation system.

1.3.1 Sub-objectives of the study

1.3.1.1 To investigate the significant factors that possibly influence the farmers to choose between cropping system which either include potatoes or not include potatoes.

1.3.1.2 To determine the major impacts of potato production on farming households.

1.3.1.3 To assess the impact of GROW's potato technology intervention on the farmers.

1.3.1.4 To supply policymakers with information for making effective policies, extension and research programs for an improved standard of living for the majority of the rural population in Lesotho.

1.4 OUTLINE OF THE STUDY

This study is concerned with the identification of the possible predictors of decision making by Mokgotlong farmers on the adoption of potatoes or any other crop into a traditional wheat based cropping system. **Chapter 2** contains a literature review of studies on farmers' decision making and technology adoption. The impact of policy on technology adoption is also discussed. In the same chapter the methods and models used by other researchers on technology adoption and variables considered in technology adoption studies are discussed. **Chapter 3** describes the background of the study area. A description is given of land tenure, climate, wheat and potato production, agricultural input supply and infrastructure. In **Chapter 4** a description of methods used in this study as well as specific dependent and explanatory variables selected for this study is given. In **Chapter 5** a description is given of the surveyed data. The analysis of the possible predictors of adoption of a wheat-potato production system is discussed in **Chapter 6**. The last chapter (**Chapter 7**) contains a summary of the explanatory variables included as possible predictors of decision making, important findings, and recommendations.

CHAPTER 2

REVIEW OF LITERATURE

2.1 INTRODUCTION

This chapter intends to give a brief outline of literature on technology adoption in small-scale agriculture. The chapter starts by reviewing the studies on farmers' decision making and technology adoption. It goes on to review the impact of economic policy on technology diffusion and adoption. The methods and models used by other researchers on technology adoption studies will be discussed. Lastly the chapter reviews the variables considered in technology adoption studies.

2.2 FARMERS' DECISION MAKING AND TECHNOLOGY ADOPTION

2.2.1 Farmers' decision making

The need to recognise the small farmer as a key factor in the transformation of traditional agriculture, by means of adoption of new technologies, is emphasised by many researchers (Chambers, 1983; Chambers, Pacey & Athrupp, 1989; Masora, 1986; Reijnties *et al.,* 1992 & Sarch, 1993). Gladwin (1980) reports some of the work done on decision making by farmers and points out, among other factors, how the market forces and ecological variation influence the farmers' decision to plant grain crops and vegetables. Anthony, Johnston, Jones and Uchendu (1979) found that the characteristics of a new technology in a small-scale farming system are that, the technology must be compatible with the farming system, scale neutral, reduce risks and be socially acceptable. It should also be affordable and able to function with locally available inputs.

2.2.2 Farmers' technology adoption

Willock, Deary, Jones, Gibson, McGregor, Sutherland, Dent, Morgan and Grieve (1999) conducted research on the role of attitudes and objectives in farmers' adoption of production practices. For example, if a farmer attaches a value to farming, regards

farming as a way of life, that farmer may develop a positive attitude towards adopting conservation methods to sustain the land for the succeeding family generations. The opposite may be the case if the farmer regards farming only as a business. That farmer develops an attitude to adopt technologies that maximise production and profit without a thought of sustainability. Willock *et al.* (1999) also found that attitudes influence behaviour and in some way it relates to adoption of new technologies.

Impressive success stories of new technology development, diffusion and adoption in Sub-Saharan Africa were reported by Sanders, Shapiro and Ramaswamy (1996). The success of cotton production in Bukina Faso and Mali in 1986-1987 was due to increased adoption of inorganic fertilizer, pesticide use, regular introduction of new cultivars, as well as the introduction of animal traction. The maize success in Ghana, Mali and Bukina Faso in 1989-1992 was due to the introduction of new cultivars and associated technologies for maize. This also led to an increase in annual income growth rate from 4.8 to 6.7 percent in Ghana, Mali and Bukina Faso in the 1980's. Sanders *et al.* (1996) also explained more about the risk consideration on adoption of new technologies. The degree of risk aversion is frequently hypothesised to be an important negative factor discouraging the adoption of technologies. However, (Sanders *et al.,* 1996) reported that there was little impact of risk aversion on farmers' technology choices in three of the four regions studied (South Central Niger, Western Niger, East Central Sudan - Cadaref vertisols and East Central Niger – Sim Sim vertisols). Sanders *et al.* (1996) found that diversification, networking and migration were important factors in farm households' reduction of their exposure to production risk.

The technology adoption by farmers is assumed to be taking place in stages as Tripp and Woolley (1989, page 6) stated "…. *most farmers are very cautious and tend to adopt one or a few new inputs or techniques at a time. The stepwise adoption behaviour has important implications* ...." Fujisaka (1998) suggested that research should embark on analysing where and under what conditions (and scales) adoption of technology is likely to take place. This type of analysis will increase efforts to develop ways by which the NARS (National Agricultural Research Systems) can work with farmers to facilitate their stepwise adoption of technologies.

2.3 THE IMPACT OF POLICY ON TECHNOLOGY ADOPTION BY FARMERS

Shucksmith (1993) found that structural factors such as relative price changes, policy incentives etc. have been seen to be important in explaining trends and variations in farmers' behaviour. Burton, Rigby and Young (1999) state that, if adoption of agricultural techniques is seen as an important aspect of a movement towards a more sustainable agriculture, an understanding of factors that lead farmers to adopt is a key component in policy design. While national and international policy discussions acknowledge the existence of various constraints of African food production (capital, land and labour) policymakers still have too little understanding of how various constraints affect household decision making (Henn, 1988). The family unit with a farm business gives rise to distinctive behaviors which agricultural researchers, extension workers and policy makers need to understand. According to Perkin and Rehman (1994), governments in developing areas often provide distorted economic incentives and their agricultural policies constitute a major reason for low levels of food production.

Norton and Alwang (1993) and Pretty (1995) have examined in detail how economic policies influence the development of sustainable agriculture in developing countries. Pretty (1995) argues that government policies have not been used with a view to directing agricultural practices towards adoption of greater sustainability. Government wishing to support diffusion of sustainable agriculture must facilitate the process with an appropriate range of policy measures like: decentralisation of administration to reach the local people; reform land tenure and give the local people the right to manage their local resources; develop an economic policy framework that would encourage a more efficient use of resources; and encourage a new institutional framework that would be more sensitive to the needs of the local people (Pretty, 1995).

Policy research can have a strong effect on the design, production, and diffusion of new technologies. This could also help researchers justify their work. The Consultative Group for International Agricultural Research (CGIAR) has taken a strong interest in food and agricultural policy, particularly as the policies interfere

with the generation and diffusion of farm technology (Anderson, Herdt & Scobie, 1988). Since extension plays a major role in technology diffusion and adoption, it is important to consider amicable extension policies in all technology adoption strategies (Botha, 1996; Inderjit & Strauss, 1998 & QDIPI, 1990).

2.4 METHODS AND MODELS USED IN TECHNOLOGY ADOPTION STUDIES

2.4.1 Methods used in technology adoption studies

Barlett (1980) and Willock *et al.* (1999) shows a move to more analytical methods using techniques developed by psychologists and sociologists for farmers' attitude enlightening and measurement. This has enabled researchers to gain valuable insight into the working of agricultural systems and identify relationships between a system's characteristics and the farmers' objectives. The focus on the work of Barlett (1980) is on studies done on the farmers' decision process itself. She also found that methods from traditional anthropological research may prove to be useful in measuring choices and determinants of choices. In studies of this kind it was shown that personal, family and farm business objectives depend on each other, and they need to be considered together (Perkin & Rehman, 1994). It was also shown that the highest ranked objective reflects a combination of life style and economic goals.

Perkin and Rehman (1994) described different methods of data collection on farmers' objectives and the techniques of subsequent analysis (Table 2.1). Using these methods and techniques they found that decision makers seem to find it difficult to rank any objective to be more important than another. They found that there is no clear hierarchy of objectives when all the farmers are treated as one group.

Table 2.1: Methods of data collection and their corresponding methods of analysis

Methods of data collection	Methods of analysis
Numerical rating	- Ranking - Principal components analysis
Pared comparison	- Thrustone Scaling - Multidimensional Scaling
Magnitude estimation	- Ranking

Source: Perkin and Rehman, 1994.

Barlett (1980) provides more information on the farming system of traditional agriculture. Barlett (1980) assembled the work of different authors (Chibnik, 1980; Dewalt & Dewalt, 1980; Gladwin, 1980; Gladwin & Murtaugh, 1980) who have studied agricultural production, focusing on the decision making process of the subsistence farmers.

2.4.2 Models used in technology adoption studies

Literature on technology adoption models includes work presented by Adesina and Zinnah (1993); Akinola and Young (1985); Feder, Just and Zinnah (1985) cited in Nichola and Sanders (1996). Furthermore, models on technology adoption studies are presented by Anim (1999); Burton *et al.,* (1999); Nell, (1998); Nkonya, Schroeder and Norman (1997). An explicit model of technology adoption is presented by Feder and Slade (1984). In this model, Feder and Slade indicate that adoption patterns over time are differentiated by farm size. Large farmers allocate more resources to information gathering in the early stages of the diffusion process. Where the farm size is small, no resources will be devoted to information gathering. The implication being that, larger farmers reach the critical level of information faster and they adopt earlier than smaller farmers. Furthermore, farmers with better access to information have higher levels of cumulative information and will therefore adopt earlier than other farmers (Norton & Alwang, 1993). Most of the models reviewed in this literature review measured adoption of new technology practices by counting users and non-users of the new practices. At least Nell (1998) and Nichola and Sanders (1996) gave a broader definition of technology adoption by counting those who are willing to use new technologies, the potential adopters of technologies.

According to Rogers' model of diffusion of innovations (Arnon, 1989), the technology is first adopted by a very small number of people. This group constitutes of sufficiently educated people who can realise the profit of the innovation, who are rich enough to invest in the inputs required and can afford to take the risk involved. After the innovation has proved successful, the next to adopt are those who are less prone to risk and can afford the expenditure involved in applying the innovation. The new technology will spread at an increasing rate and the bulk of farmers will follow. The last to adopt are the most conservative and the most averse to take risk.

All the reviewed literature with expanded theories, models and criteria of farmer decision making, do not clearly show how a small-scale farmer with subsistence objectives takes decisions. This is probably a confirmation that the criteria for farmer decision making with subsistence objectives presents problems to research. Rahm and Huffman (1984) and Smith (1989) stated that the decision making by small-scale farmers is based on income minimisation and utility maximisation as an objective. Otherwise a two-stage theory of choice presented by Gladwin (1980) is a simplistic model of procedures small-scale farmers use in making decisions. According to this theory, in the first stage of the choice process farmers eliminate all alternatives containing some aspects they do not want. In the second stage they eliminate irrelevant aspects and take the desicion.

2.5 VARIABLES CONSIDERED IN TECHNOLOGY ADOPTION STUDIES

2.5.1 Land ownership

Farmers who own land are more likely to invest in farming and to adopt new innovations (Matlosa, 1993). Bosc and Freud (1995) stated that in the African region as a whole, it appears that questions relating to the adoption of technologies can not be viewed in isolation with land tenure conditions. A wide array of land tenure systems exist, these systems reflect differences in many areas such as stage of development, culture, political system and others. According to Norton and Alwang (1993), a share lease type of land tenancy may have less incentive to a tenant to adopt some technologies unless the landlord also shares the cost of that particular

technology. Pretty (1995) supports the latter opinion by stating that land tenure is crucial for sustainable agriculture. Lack of land ownership increases the risk of resource degradation. If there is no security of ownership, farmers are less likely to invest in adoption of certain production practices. Land reform has had a substantial impact on agricultural growth and poverty alleviation in Iran, Taiwan, Kenya and Kerala in India (Pretty, 1995).

Lesotho Farming System Research Project (1986) and Matlosa (1993) indicated that no one has title deed to land ownership in Lesotho. Lesotho's land tenure system is predominantly governed by the customary law, Basutholand Native Laws of Lerotholi, according to which land belonging to the Basotho nation is held in trust by the king as head of state. This means land is communally owned. This type of land holding has the following weaknesses as described by Matlosa (1993): (a) land is taken as a free good, there is little or no incentive for farmers to consistently invest in agriculture, (b) customary land tenure does not provide security of tenure for the farmers, (c) land can not be used as collateral for bank credit, (d) customary land holding encourages scattered and unplanned villages and other settlements, bad land utilization and range management, and (e) the system discourages land consolidation for the establishment of economically viable farm units.

2.5.2 Land size

The variation in size of land holding affects incentives to produce and invest (Norton & Alwang, 1993). Gibbons, De Konick and Hasan (1980) found that in the Malaysian region the farm size cultivated appears extremely relevant to the operation of a successful farm, including the income it provides to the family. In both Malaysian and Aceh regions, larger farms achieve greater technical progress than small farms. It was evident in Bangladesh (Hossain, Khaleque & Kashem, 1998) that the changing of farming systems by farmers were more frequent among the landless and small farms than in medium and large farms without maintaining any specific trend. In Mokhotlong the average land holding size per household was 1.5 ha, with an average of two fields per household during the middle of 1980's (Lesotho Farming System Research Project, 1986). According to GROW (1998) the average land holding size in Mokhotlong was less than 1.5 ha per household during 1997.

2.5.3 Soil type

The choice of crops is influenced, to a certain extent, by soil type (Burton *et al.*, 1999). Chard (1957) describes the soil requirements of potatoes and how it influences the farmer's choice of a potato crop. A sandy loam soil which is of good depth, good fertility and well drained is best suited for potatoes. Heavy soils (i.e. clayey soils) are not suitable. These soils harden, making it difficult to cultivate and harvest the potatoes. Hard packing soils also inhibit growth of tubers. The soil is the second important resource after rainfall in regard to crop selection. Aspects of importance are clay percentage, effective depth, water-holding capacity, stones and soil structure in the profile (Quass, 1997). Certain crops are recommended for a specific clay percentage because crops with finer roots, for example, most grain crops have the ability to penetrate the smaller soil pores while tuber/root crops do better on sandy soils. According to Quass (1997) crops with a short growing season can be established on shallower soils. Crops with a long growing season should however be established on deeper soils.

2.5.4 Soil fertility

Bornman, Ranwell, Venter and Vosloo (1989) described soil fertility as the ability of a soil to make plant nutrients available to the growing plant. Soil fertility is exhaustible through poor practices such as over cropping, constant cultivation without fertilization and the breaking down of the soil structure (Bornman *et al.*, 1989). Low soil fertility is recognised as one of the major biophysical constraints affecting African agriculture (Brady, 1990; Sanchez, Shepherd, Soule, Place, Buresh, Izac, Mokwunye, Kwesiga, Ndiritu & Woomer, 1997). Sanchez *et al.* (1997) mentioned that based on Smaling's nutrient balance studies and their observations across Africa, soil fertility replenishment should be considered and be seen as an investment in natural resource capital. One of the many practices of replenishing depleted soil fertility is by crop rotation, especially with crops of different rooting systems (e.g. grain crops and tuber crops). Soil fertility trials that were conducted in Mokhotlong in 1961/1962 showed significant response to phosphorus and potash but no significant response to nitrogen (Weinmann, 1966). According to Carvalho (1990), crop production in Lesotho is declining due to increasing soil erosion and deterioration of

soil fertility. This is supported by Bosc and Freud (1995) with the statement that, in Africa as a whole, questions relating to the adoption of technologies should not isolate soil fertility maintenance.

2.5.5 Training

Training and visit (T&V) system of extension was seen as having the potential to become a powerful communication tool. It enabled vast numbers of farmers to be reached and trained quickly (Benor, Harrison & Baxter, 1984; Sims & Leonard, 1990). According to Nell (1998), training and visit extension system has not been a success in some areas. However, extension officers reported that training and visit system practiced by veterinary surgeon, animal health officers and extension officers played an important role in the training of small ruminant farmers in Qwa-Qwa (Nell, 1998). According to GROW (1998), field officers directly reached approximately three hundred households through workshops and follow-up visits in Mokhotlong. As an essential source, training is required for not only technical staff but also for farmers who adopt, carry out and modify the production technologies. Training in all cases involves both formal and informal methods and must be a continuous activity (Dlamini, Simelane & Khumalo, 1993).

2.5.6 Number of able bodied family members

Gibbons *et al.,* (1980) found that the number of adult household members employed on the household farm increases with the size of operation. In the Malaysian region where the average large farm is more than three times larger than the small farm, the larger farms employ only 61 percent more adults household members. Anthony *et al.* (1979) mentioned that most of the agricultural capital throughout history was produced by farmers and farm labour (including that of members of the family) working with simple hand tools as it happened with Pyrethrum farmers in Kenya and Cocoa farmers in Ghana and Nigeria. Table 2.2 shows the number of family members in rural households of Mokhotlong.

Table 2.2: Number of persons per household, number of rural households and amount of arable land (ha) per rural household in 1980

	Persons/ Household	No. of rural households	Arable land(ha)/ Household
Lesotho	5	277, 586	3.85
Mokhotlong	5	14, 708	3.39

Source: Lesotho Agricultural Situation Report, 1990.

2.5.7 Gender

Mkandawire (1993) indicated that in small scale farming, women are the primary work force in Africa. In certain societies, the wife has an important influence in the decision making process on the farm. According to Gladwin *et al.* (1997) and Mkandawire (1993) the fact that women have, for a long period been, neglected by the extension service led to the formulation of technologies that are inappropriate for women and therefore less adoption of new technologies among women occured. Kumar (1987) shares the same sentiments and states that development programs can produce drastic changes within households by altering the perceived value of the woman's contribution and the traditional structure of authority and resource allocation. Evans (1988) indicated that researchers and policymakers must link new technology and extension advice more directly to women producers in particular. In the context of crop farming in Africa, certain crop management activities are associated with gender (Anim, 1999; Burton *et al.,* 1999). Lesotho is no exception with regard to the relationship between gender and technological change in farming. Holland (1983) stated that certain agricultural work in Lesotho is strongly linked to gender (for example, ploughing and planting are renown to be work for the male members of the population) and it is likely that female headed households may lack labour for such work. The exclusive lack of labour for such tasks may occur in cases where the woman is young and the household size is small. Young people living in the rural areas have also received little attention from the extension service. Yet they have the potential to contribute towards the adoption of new technology (Arnon, 1989). In view of this literature, gender is taken as a holistic view of family composition, allocation of responsibilities to certain crops according to age and sex as they affect decision making.

2.5.8 Age and farming experience

More internal variables that will probably be included in this study are: farmer's age and farming experience as previous research (Anim, 1999; Burton *et al.*, 1999; Harath, 1998; Nell, 1998 & Nkonya *et al.*, 1997) indicated their contribution to farmers' decision making and adoption of technologies. Anim (1999) found that age and duration of participation in soil conservation scheme are not significant determinants of farmers' adoption of soil conservation measures in the Northern Province of South Africa. Nkonya *et al.* (1997) also reported that age does not significantly determine the adoption of improved maize seed in the Northern Tanzania. Burton *et al.* (1999) found that, in UK the probability of adoption of organic horticulture is reduced if the farmer is older, while farming experience did not significantly determine adoption. Harath (1998) also found that younger farmers are more likely to adopt farm conservation practices on large portions of their farms in the Central Highlands of Sri Lanka. Age is significantly determining the adoption of livestock medication technologies (external and internal parasite remedies) in Qwa-Qwa area, South Africa, while years of farming experience with livestock is not a significant determinant (Nell, 1998). According to Feder & Slade (1984), as a farmer accumulates knowledge of, and experience with the new technology, that farmer can be expected to produce more output with given input

2.6 CONCLUSION

It is evident from the literature review that there is a lack of research on crop technologies suitable to different recommendation domains in the study area. In South Africa too, such research is lacking and it requires a great deal of attention.

The adoption of technologies is influenced by many factors such as land ownership, land size, soil type and fertility, training, household composition and size, gender, age and farming experience. The situation in Mokhotlong is similar to the situation as cited in the rest of Africa and thus adoption could be affected similarly by these factors. Understanding these factors as they influence adoption could contribute to provision of adequate technologies, policies and stimulate effective research and extension in Lesotho.

CHAPTER 3

DESCRIPTION OF STUDY AREA

3.1 INTRODUCTION

This chapter gives an overview of the study area. Very limited literature is available on the selected study area. General information on Lesotho, especially the mountain areas, will be used in this chapter to describe the conditions pertaining to Mokhotlong. Pederson (2000) recommended that Molumong village can be used in this study as a reference to the study area because it is in the Mokhotlong district and some documented information is available. This is in agreement with Holland (1983) and Lesotho Farming System Research Project (1986) which indicated that, in surveys and other types of research the geographical area of Molumong village is representative of Lesotho's mountain areas such as Mokhotlong. The chapter describes the historical background, land tenure, climate, crops, availability of agricultural inputs, institutions and the infrastructure.

3.2 HISTORICAL BACKGROUND

Agricultural development in Lesotho is known to be influenced by the culture and traditions of the Basotho as well as Lesotho's relationship with South Africa. The nation of Lesotho grew out of stand–off in the conflict between the Basotho and the Boers (Lesotho Farming System Research Project, 1986 & Matlosa, 1993). The boundaries of Lesotho include mainly mountainous regions lacking high quality farmland, which means there is a relatively small amount of good cropland in Lesotho. Lesotho is mainly divided into three regions, namely: Northern Region (Butha-Buthe, Leribe, Berea and Maseru districts), Southern Region (Mafeteng, Mohale's Hoek and Quthing districts) and Mountain Region (Qasha's Nek, Mokhotlong and Thaba-Tseka districts), (Lesotho Agricultural Situation Report, 1990). According to the 1981 baseline survey, off-farm work in Lesotho was a more important source of cash income than the sale of farm produce (Holland, 1983). Despite the occurrence of snow and frost during summer in Mokhotlong, maize and

sorghum were fair crops while good harvests of wheat, peas, and potatoes were obtained. Due to the difficulties and costs associated with transport to isolated areas, no fertilizer and insecticides were supplied to Mokhotlong (Basutoland Annual Report, 1961). Mokhotlong district comprises of two valleys, Makoabating and Molikaliko valley. Each valley is made up of several villages (ten villages in Makoabating valley). Crop farming in these villages is mainly for subsistence, with a small amount of cash crops sold within the neighbourhood.

3.3 LAND TENURE

In Lesotho no one has title deed to land. Lesotho's land tenure system is predominantly governed by customary law, Basutholand Native Laws of Lerotholi, according to which all land belonging to Basotho nation is held in trust by the king, as the head of state. This means land is communally owned (Matlosa, 1993).

3.4 CLIMATE

3.4.1 Rainfall and temperature

Average annual rainfall ranges from less than 500 mm in the Senqu Valley (near Mokhotlong) to more than 900 mm in the mountains. Nearly 80% of the rainfall is received between October and March, during summer. In Lesotho, summer is quite warm with an average maximum temperature of approximately 29^0C. Winter is cool in the lowlands occasionally getting to below 0^0C at night, there are incidences of snow and early morning frost. Winter is colder along the foothills where crops are grown and much colder in the mountain areas than in the lowlands (Lesotho Farming System Research Project, 1986).

3.5 AGRICULTURE

3.5.1 Crops

Crop farming in Lesotho is characterised mainly by small subsistence farms where very little of the crop produce is sold. Agricultural productivity (both labour and land) is low (Lesotho Farming System Research Project, 1986). In Mokhotlong the main crops are maize, wheat, beans and peas. GROW (1998) reported that crop diversity is

low on Mokhotlonng farms. Maize and wheat together occupied 78.5% of the observed land. Pulses (peas, beans and lentils) together occupied 16% and potatoes only 1% of the observed cropland. Lesotho Farming System Research Project (1986) indicated that studies done at Siloe, Nyakosoba and Molumong reveal that the rich farmers tended to plant more of their land to grains compared to the poorer farmers. The poorer farmers allocated more of their land to legumes and left more of the land fallow. Nevertheless, Ralitsoele (2000) mentioned that they see Mokhotlong as a suitable area for deciduous fruit production as well as small stock production. Table 3.1 shows the production of major crops in Mokgotlong relative to the rest of the country.

Table 3.1: Crop production in metric tons

	1985/86		**1986/87**		**1987/88**		**1988/89**	
	Wheat	**Maize**	**Wheat**	**Maize**	**Wheat**	**Maize**	**Wheat**	**Maize**
Lesotho	11,009	5,097	18,547	4,790	19,237	6,414	29,698	7,568
Mokhotlong	3,627	3,188	2,606	2,305	3,581	5,159	5,820	3,887

Source: Lesotho Agricultural Situation Report, 1990.

3.5.1.1 Wheat

The lowland wheat crop is confined to the Southern districts of Lesotho. Wheat is planted during April, May and June while the harvest takes place during December and January. The area on which wheat is grown is smaller in the lowland compared to the mountains. The mountain wheat crop is grown at higher altitudes (Makoabating 2408 meters above sea level) and the wheat is planted in October, when the risk of frost is over, and harvested during March and April (Basutoland Annual Report, 1953). Nearly 10% of Lesotho's cultivated land is devoted to wheat. The average yield per hectare is very low (about 0.8 tons/ha) and it fluctuates widely between years. Lesotho farmers produced an estimated 18 000 tons of wheat in 1993/94 and 9 700 tons in 1994/95 (van Schalkwyk, van Zyl & Doyer, 1996). Wild oats (*Avena futua L.*) is a serious problem in the higher altitudes. It became very clear that there is a need to have an alternative crop planted in rows on a wheat based rotation system to help control wild oats in the mountains. Peas would be best suited for this because the pea can withstand cool weather and can be planted in rows for cultivation. A wheat-

pea-potato rotation system was seen as the best possible choice in mountains and cooler sub-regions (Holland, 1983).

3.5.1.2 Potatoes

Potatoes were introduced into the crop rotation system to Mokhotlong farmers during 1983 and 1984. The potatoes in the Mokhotlong area were infected by late blight and the yield was lower compared to other potato producing areas in Lesotho (Lesotho Farming System Research Project, 1986). The late blight probably discouraged many farmers in Mokhotlong to adopt the technology of rotating with potatoes. An Irish potato variety is being researched to determine the best varieties with high yield and adaptability to various climatic conditions. The results show that BP1 gave the highest yield in three agro-ecological zones, Maseru, Siloe and Nyakosoba. KP90114.5 yielded very low in all agro-ecological zones except in Nyakosoba (Agricultural Research Division, 1997).

According to Mosenene (2000), the Machobane Farming System (MFS) played a significant role in the production of potatoes in the low lands during middle of the 20th century. The system did not enjoy political support and was deterred. After a retrial of the system in 1991, small farmers made a considerable success out of potato production. An innovated system was then called Machobane Agricultural Development Foundation (MADF). It is however reported that small farmers who produce potatoes do fall in and out of production possibly due to high labour involved in the system. Mosenene feels that GROW has made a popular intervention in Mokhotlong since 1996, among all the villages in the highlands, in as far as the spread of potato production technology is concerned.

Chard (1957) reported that potatoes are produced in valleys because of their susceptibility to frost. In the mountain areas potatoes do well if planting is delayed just to avoid frost. According to Chard (1957) potatoes are planted after September, after the onset of spring rains and planting can progress to the middle of January.

3.6 AVAILABILITY OF AGRICULTURAL INPUTS AND INSTITUTIONS

3.6.1 Agricultural inputs

According to Holland (1983), many households in Molumong do not own oxen. Only 17% of the households own a minimum span of oxen (four oxen). The problem with those who own oxen is that their oxen are in a poor condition at the time of ploughing because of inadequate grazing during the dry winter period. Most households own yokes and ploughs while most of the other tillage equipment such as harrows, planters, cultivators and carts are owned by just a few households. None of the surveyed farmers owned a tractor. Holland (1983) went on to explain that those farmers who purchase farm inputs in the lowlands experienced less difficulty than those farmers in the mountains. Given the geographical conditions of Mokhotlong it is likely that the greater travel time, lack of access to stores and certainly lack of cash in the mountains areas are the major factors affecting the purchasing of farm inputs. These problems are encountered with fertilizers, spare parts and ox-drawn ploughs. Seed distribution is not equitable in Lesotho (Moima & Ranthamane, 2000; Mosenene, 2000) and farmers have to collect their seed orders from the city (Maseru). Because of long distances and poor road conditions, the majority of farmers can not afford the cost of transport.

3.6.2 Agricultural institutions

Ministry of Agriculture and GROW are the two institutions that provide agricultural support service in Mokhotlong (Rosenblum, 1999).

3.7 INFRASTRUCTURE

Most of Lesotho's agriculture is remote and far from the market centers. The agricultural areas have very poor roads. Many places are not accessible by road and have no telephone (Lesotho Farming System Research Project, 1986). This describes exactly what the case is with the villages surveyed in this study, Patiseng, Nazareth, Sekokong, Manganeng and Mateanong. Patiseng and Sekokong are not accessible by vehicle. A horse or a donkey is needed to access such places.

3.8 CONCLUSION

It is clear that infrastructure in Mokhotlong does not permit total access to agricultural inputs. Unavailability of seed tubers and the late blight may have had a negative impact on adoption of potatoes by farmers despite all the efforts of promoting the technology of growing potatoes. Wild oats seems to be a threat to sustainable wheat production in Mokhotlong.

CHAPTER 4

DESCRIPTION OF VARIABLES AND METHODOLOGY

4.1. INTRODUCTION

This chapter describes the method and procedures followed in this study. In the first section of this chapter the variables selected for this study are discussed and justified. The second section discusses the survey procedure, choice of study area, sampling and development of the questionnaire. The last section gives a description of statistical analyses performed.

4.2 DESCRIPTION OF VARIABLES

Most of the variables considered for analysis in this study were selected from the reviewed literature in chapter 2, while some variables were identified by a panel of individuals from GROW, Agricultural Research Council - Small Grain Institute and the University of the Free State. The following explanatory variables were used to determine possible predictors contributing to adoption of a cropping system considered in this study (wheat + potatoes): sex, age, training, land ownership, soil type, household size, number of family members below six years of age, number of family members between 16 –18 years of age and farming experience.

4.2.1 Dependant variables

4.2.1.1 Crops planted. In this study, crops planted/adopted by the farmers refers to wheat or wheat + potatoes.

4.2.1.2 Farm households' knowledge on soil fertility, cultivars, pests, diseases of wheat and potatoes. It is assumed in this study that the farmer households' knowledge on the listed aspects is related to the explanatory variables sex, age and training, to be discussed later. During the analysis only soil fertility will be considered as a dependent variable while the other aspects will be considered for descriptive analysis.

4.2.2 Explanatory variables

Explanatory variables can be classified into **categorical** and **continuous** variables depending on how a variable is measured.

4.2.2.1 Categorical variables

1) Sex is included as one of the categorical variables where 1=male and 0=female (Nell, 1998).

2) Age of the farmer is a variable used in this study as identified in the literature review. Four selected age categories (20-39, 40-49, 50-59, >60) were used to determine farmers' age.

3) A farmer is considered trained in this study when he/she has received formal or informal **training** by extension officers, or by fellow farmers. Farmers' training by extension officers is a way to assess the impact of GROW since all extension service in the study area is provided by GROW.

4) Land ownership is measured in this study as dummy variables where 1 = Own land, and 0 = Not own land. Hence no one holds title deed to land in Lesotho (chapter 3), in this study own land means the respondent has customary ownership of land. Not owning land means the respondent is renting, share cropping and/or offered permission to use the land by either a friend, relative or neighbour.

5) Soil type on which farmers grow their crops (wheat and potatoes), where 1= selected soil type and 0 = the rest of the soil types on the list (Appendix A).

4.2.2.2 Continuous variables

1) Household size. It is assumed that the household size is influential to the farming operation were subsistence production is the main objective. Household size is the total of all people living permanently within the household.

2) Number of family members below six years of age. In this study it is assumed that children below the age of six years (< 6 years) require labour for care, and they are not seen as part of the family labour. It is also assumed that children below the age of six years need a specific type of diet. This may influence the farmers' choice of crops.

3) Number of family members between 6 – 18 years. It is assumed in this study that all active members in the farm family form part of the farm labour hence less people in Mokgotlong have off-farm employment (Bryden 1994).

4) Farming experience by the number of years the farmer has been farming with that particular crop serves as a proxy (Nell, 1998). As a farmer accumulates knowledge and experience with the new technology, that farmer can reasonably be expected to generate more output with a given input (Feder & Slade, 1984). Years of wheat farming are justified to be years of farming (farming experience) in this study because every farmer in Mokhotlong grow wheat and the majority have grown wheat since adulthood.

Land size was difficult to obtain because the farmers did no know their farm sizes, they were only estimating the sizes. This problem occurs where there is no proper farm records. Therefore this variable (land size) and the corresponding **yield** were not used for analysis.

All the open-ended questions (Appendix A) were grouped and their cumulative frequencies together with other parts of the data are presented in chapter 5.

4.3 METHODOLOGY

4.3.1 Choice of study area

Mokhotlong was chosen for this study because its agricultural system resembles that of subsistence agriculture. A system in which decision making and adoption of technologies are influenced by the predetermined factors. As seen in chapter 3, Mokhotlong is divided into two valleys, of which Makoabating valley was chosen for this study because there were more wheat farmers than in the other valley (Molikaliko valley). The presence of more wheat farmers in Makoabating suggests that the climate in Makoabating valley is best suited for wheat production, therefore more information about wheat production in Mokhotlong could be obtained from this area.

4.3.2 Sampling for the survey

Out of the ten villages of Makoabating valley, five were randomly selected for this study. Each chosen village was visited and a list of wheat farmers and the potato farmers was drawn up with the assistance of local people. A stratified sample of thirty wheat growing farmers and thirty wheat + potatoes growing farmers was chosen using a table of random numbers (Leedy, 1997).

Wheat farmers in this study are farmers who grow wheat, other grain crops and legume crops but do not grow potatoes.

Wheat + potato farmers in this study are farmers who grow wheat, other grain crops, legume crops and potatoes.

4.3.3 Development of the questionnaire

The questionnaire was developed to obtain primary information on farmers and household characteristics, influential factors on decision making and the impact of training on adoption of potatoes (Appendix A). Examples of other questionnaires were used (Derek & Collinson, 1980; Marasas, Anandajayasekeram, Tolmay, Martella, Purchase & Prinsloo, 1997; Nell, 1998) to develop the questionnaire. Field workers from GROW and individuals from the Small Grain Institute and the University of the Free State were involved in discussions to develop the questionnaire (Appendix A). The questionnaire was pre-tested on five farmers in four of the villages in Mokhotlong before it was used in the survey. Secondary information was obtained from literature, scientists from GROW in Mokhotlong, Agricultural research division and Helvetas[2] in Maseru.

4.4 STATISTICAL ANALYSIS

The SAS statistical program was used to perform the following statistical analyses:

1. **Cross tabulations** were performed to determine the frequencies that will be used in the description of the surveyed data in chapter 5.

[2] Helvetas Lesotho, Swiss Association for International Cooperation.

2. **Chi-square test** was performed in the analysis of categorical explanatory variables with larger frequencies (observations).

3. **Fisher's exact probability test** was used in the analysis of categorical explanatory variables with smaller frequencies (observations) or where the data had a low expected score, counts or values.

4. A **t-Test** was done on continuous variables such as household size, children below the age of six years (members < 6), members aged between 6-18 years and farming experience to test whether there is significant difference between wheat and wheat + potato farmers where the data is nominally distributed.

5. **Pearson Correlation** was conducted to test whether there is a relationship between farming experience and household knowledge on soil fertility.

CHAPTER 5

DESCRIPTION OF SURVEYED DATA

5.1 INTRODUCTION

To understand farmers and their technology adoption behavior, it is important to have a clear understanding of the interactions between factors influencing their cropping system. To understand the environment in which technologies must be exploited in Mokhotlong, this chapter analyses the demographic information of the farmers; determines the sources of training; the level of farming experience and knowledge; analyses what influences farmers' choice and what crop management practices they consider important. Gender analysis is also included. The chapter concludes by highlighting a few important findings.

5.2 DEMOGRAPHIC INFORMATION OF THE SAMPLE FARMERS

As shown in Table 5.1 the different age groups indicate that 57% of the farmers are over 50 years. The fact that 38,33 are above 60 years shows that there is no retirement in subsistence farming. The people tend to farm for as long as they are able to. To some extent they are forced to farm even if age does not allow because they have to provide for their children and grand children.

Table 5.1: Age of farmers

Age **(n=60)**	**Percentage**
20 – 39	18,33
40 – 49	25,0
50 – 59	18,33
> 60	38,33

While the emphasis is on household size, it is important to determine the household composition because the composition may influence household decision making process. The mean household size and composition are shown in Table 5.2. The mean

household size is 5,7 and varies from 1 to 15 per household with a standard deviation of 2,7. Household size shows an increase from 1980 as reported in Lesotho Agricultural Situation Report (1990). Only one person per household is less than six years and varying between 0 and 4 with standard deviation of 1,2. The mean number of family members aged between 6 and 18 years is 2 per household and varies between 0 and 5 with standard deviation of 1,6.

Table 5.2: Mean household size and composition

	Mean n=60	**Std dev**
Household size	5,7	2,7
Number of family members < 6 years	1,0	1,2
Number of family members between 6 – 18 years	2,0	1,6

5.3 TRAINING, FARMING EXPERIENCE AND HOUSEHOLD KNOWLEDGE

5.3.1 Training

Sixty three percent of the 60 farmers indicated that they use extension officers as the source of training (see Table 5.3). Twenty two percent do not have any source of training and 10% receive training from both extension officers and neighbour farmers. Five percent receive training from their neighbour farmers only. These results indicate that only 27% of the farmers use their own or their neighbour's knowledge for their training needs which according to Nell (1998) is dangerous. About a third of the farmers receive training from extension officers on production of wheat and potatoes which is an indication that GROW's impact on spread of potato adoption is remarkable. This agrees with Mosenene (2000)'s expression that GROW's intervention in Mokhotlong is popular as far as potato production technology is concerned.

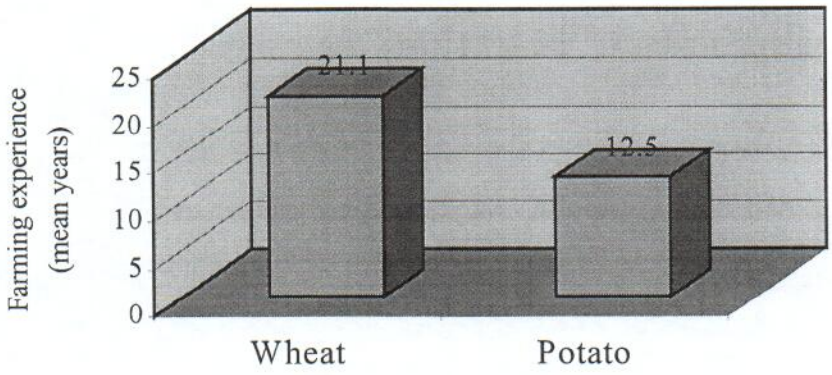
Table 5.3: Training sources used by sample farmers

Training sources	Percentage
Extension officers	63
Fellow farmers	5
Both	10
None	22

5.3.2 Farming experience

Farming experience with wheat and with potato varies from 1 to 56 years. The mean years of farming experience with wheat and with potato are 21,1 and 12,5 years respectively with standard deviations of 15,33 and 14,12 respectively (see Figure 5.1). This is an indication that potato farming is a younger practice than wheat farming in Mokhotlong.

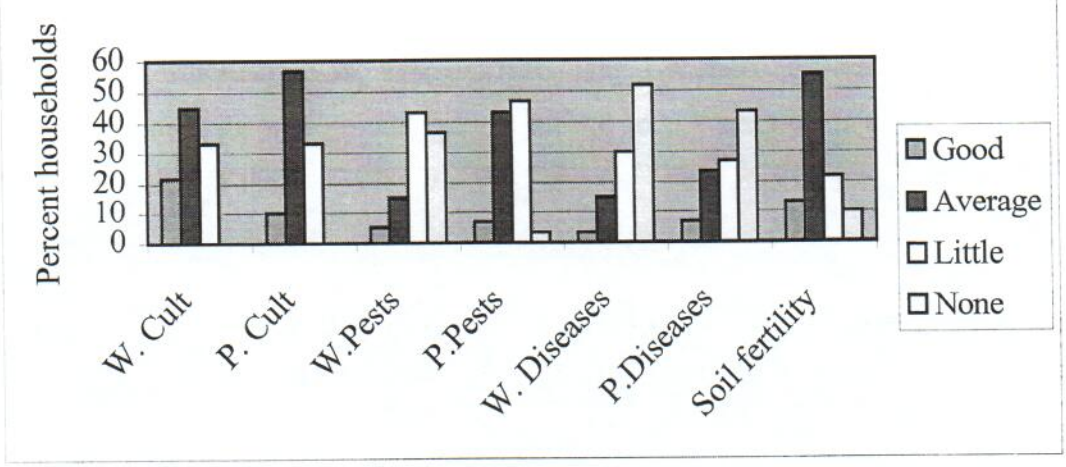
Figure 5.1: Farming experience of respondents



5.3.3 Farm household knowledge

The level of household knowledge about different cultivars, pests and diseases of wheat and potatoes, and knowledge of soil fertility are presented in Figure 5.2 below.

Figure 5.2: Farm household knowledge



Cultivars: Figure 5.2 shows that only 22% of farm households have good knowledge on wheat cultivars, while 45% and 33% have average and little knowledge respectively. A similar pattern is observed with potato cultivars where only 10% have good knowledge on potato cultivars while 57% and 33% have average and little knowledge respectively.

Pests: There is an indication that little knowledge about pests (43% wheat pests and 47% potato pests) exists within the households. A notably high percent (37%) of households in Mokhotlong have no knowledge about wheat pests. Only five percent of the households have good knowledge, while 15% have average knowledge about pests of wheat. Only seven percent of the households have good knowledge about potato pests and 43% of the households have average knowledge on potato pests.

Diseases: Level of household knowledge about diseases of these two crops (wheat and potatoes) is similar though not equal. Many households in Mokhotlong have no knowledge about diseases of the two crops (52% wheat and 43% potatoes) while very few have good knowledge (7% potatoes and 3% wheat).

Soil fertility: Fifty five percent of the households in Mokhotlong have an average knowledge on soil fertility. Very few (13%) have good knowledge.

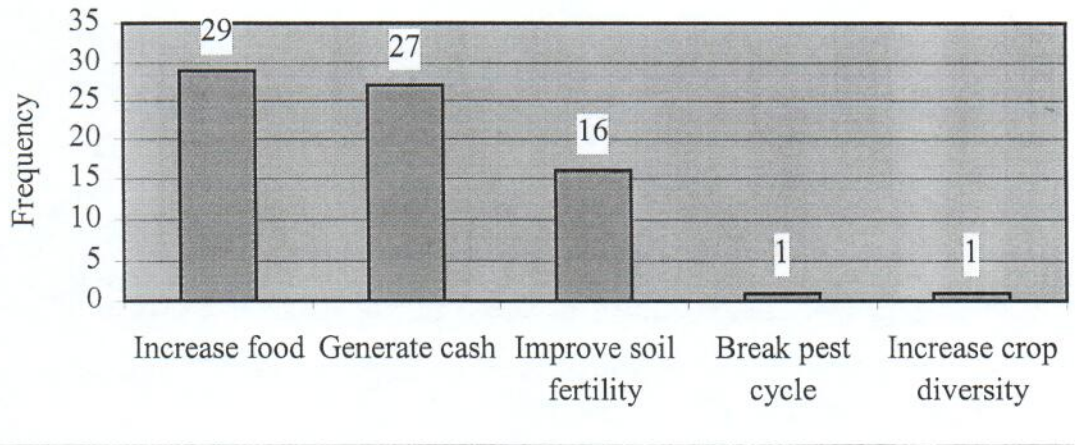
The observation made from Figure 5.2 is that the level of knowledge in Mokhotlong about the indicated aspects is relatively low. It is not the interest of this study to look at different diseases and pests prevalent in Mokhotlong but it is evident that there is a need for more advice to farmers on the different diseases and pests. The results suggest that increasing the farmers' knowledge about new wheat cultivars and increasing the availability of such cultivars can possibly change wheat production of the Mokhotlong farmers. The results are in line with what was found by Sanders *et al.* (1996), that introduction of new cultivars and associated technologies of maize increased annual income growth rates from 4,8 to 6,7 percent in Ghana, Mali and Bukina Faso in the 1980's.

5.4 CHOICE AND MANAGEMENT OF CROPS

5.4.1 Farmers' choice of potato crop

Farmers have different aims and reasons for adoption of practices. To explore some of these reasons in Mokhotlong, farmers were asked to indicate which of the following are their reasons for adopting potatoes. Farmers were allowed to mention more than one reason. The reasons for including potatoes and their frequencies are shown in Figure 5.3.

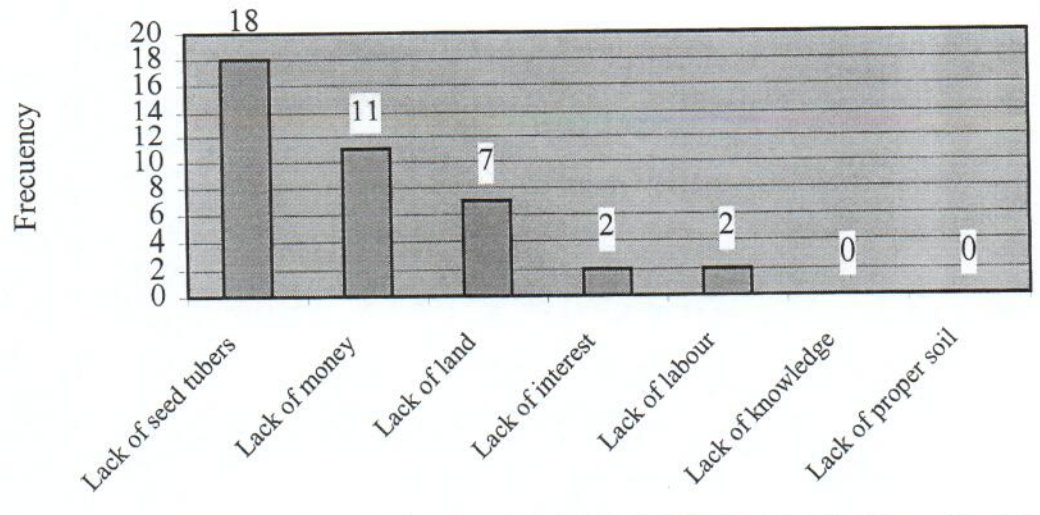
Figure 5.3: Reasons for including Potatoes in the system



It can be seen from Figure 5.3 that farmers in Mokhotlong are concerned with household food security. Hence growing of wheat is a usual practice to these farmers, they feel that they can supplement this by growing potatoes. The next reason, after food increment, is to sell the potatoes and acquire cash for other household needs. The third reason for including potatoes is to improve soil fertility. Farmers have an idea that rotation of tubers and cereals exploit the different soil depths and improves soil structure. The survey shows that 83% rotate potatoes every two seasons while 17% do not rotate. Sixty four percent of the farmers rotate wheat every two seasons, 21% do not rotate and 15% rotate every three seasons and more. The crops included in the rotation are mainly (not in order) maize and peas. Very few farmers (1,6%) consider diversification of crops as a reason for choosing potatoes. It was confirmed during verification of data that Mokhotlong farmers do not know that crop diversification helps break pests cycle. That is probably because knowledge about pests is low as seen earlier in Figure 5.2.

As adoption of practices is done for some reasons and non-adoption may be due to other reasons. Such reasons can be exploited through appropriately structured studies. Those farmers who do no plant potatoes mentioned the reasons shown in Figure 5.4 as their reasons for not including potatoes in the cropping system.

Figure 5.4: Reasons for not including Potatoes in the system

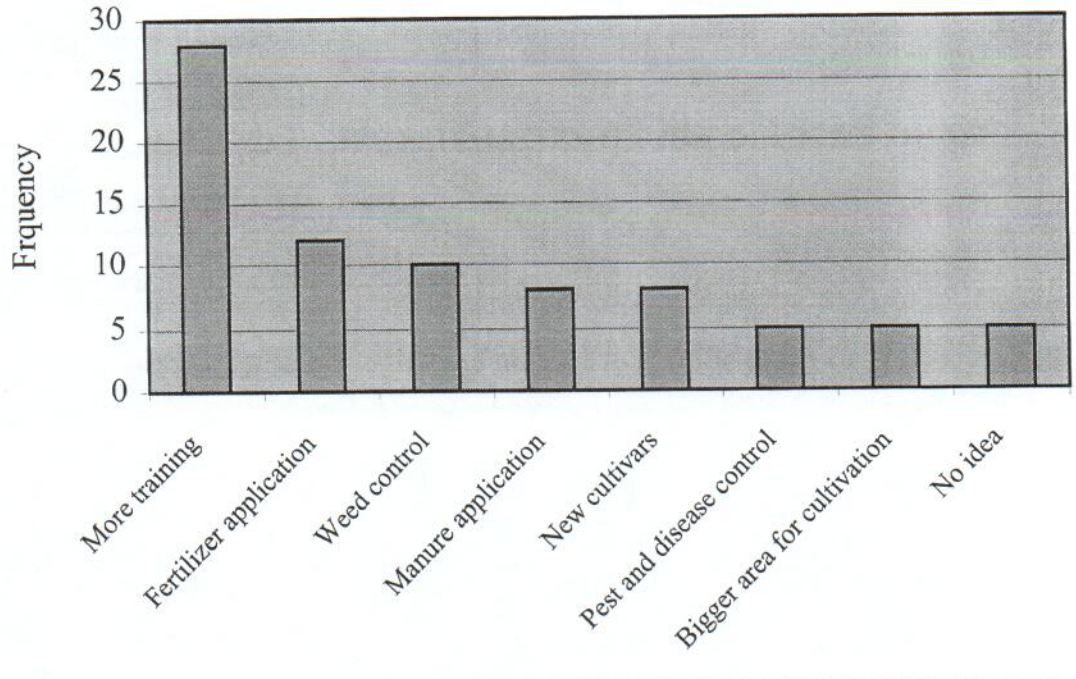


It is evident from Figure 5.4 that lack of seed tubers, lack of money and lack of land are the major reasons that prevent the adoption of potatoes by farmers. Lack of seed tubers is the main problem but the farmers indicated that if they could have money to buy seed they would not experience this problem. The farmers say they can buy seed from wherever it is available in the country. It was observed earlier in Figure 5.2 that the farmers' level of knowledge is relatively low. However lack of knowledge is not the reason for farmers not planting/growing potatoes.

5.4.2 Farmers' crop management options

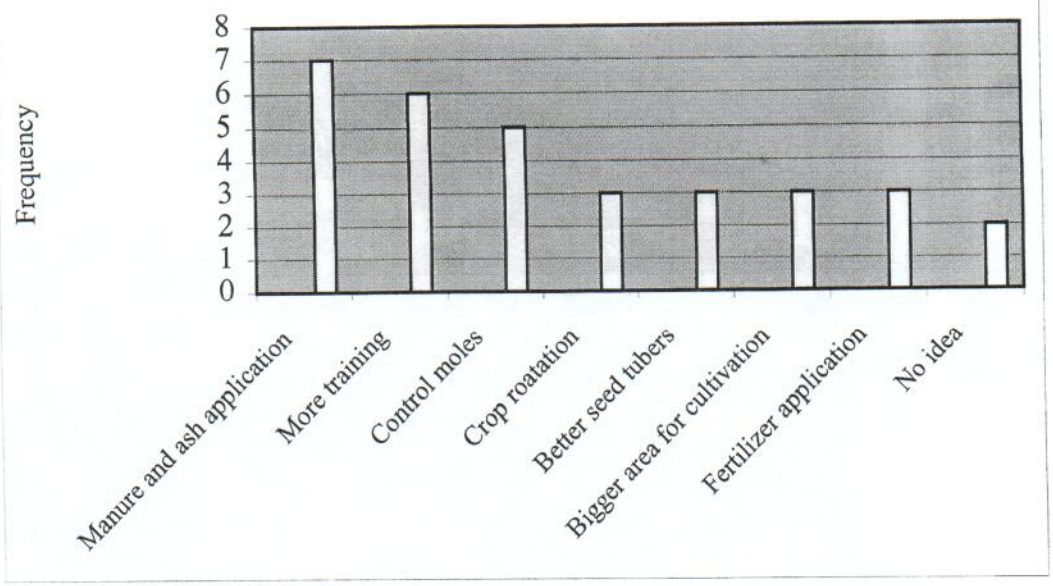
Farmers' perceptions on how wheat and potato production can improve in Mokhotlong are presented in Figures 5.5 and 5.6 respectively. In figure 5.5, 45% of the 60 wheat farmers expressed their need for more training. Despite the lack of knowledge in the area, it is interesting to find some farmers who realise that application of fertilizer, weed, pests and disease control, and use of new cultivars (improved cultivars) can possibly improve their wheat production.

Figure 5.5: Aspects needed to improve wheat production



Fertilizer application is mentioned, though there is no supply of fertilizer in Mokhotlong as discussed in chapter 3. Even though the use of kraal manure is a cheaper option, it might not be enough in households that use it as fuel. It was not the aim of this study to determine the prevailing weeds, however wild oats is a threat to the future of wheat production in Mokhtlong. Figure 5.6 shows that management options similar to those of wheat are needed for potatoes. A better way of controlling moles can increase adoption of potatoes in Mokhotlong.

Figure 5.6: Aspects needed to improve potato production

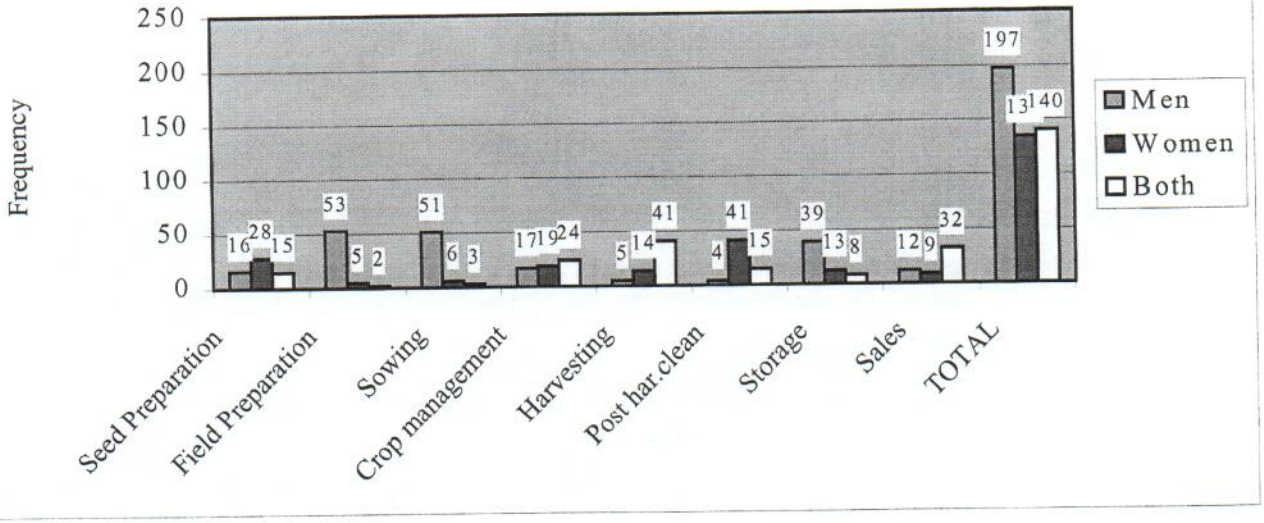


5.5 GENDER AND RESPONSIBILITIES ON PRODUCTION OF WHEAT AND POTATOES

It is important to know who has control of what, within the household. Gender analysis helps to target technologies and projects to specific categories of people with potentials of adoption of technologies. It was a coincident to have an equal proportion of male and female farmers of 50% each in the sample. The fact that both men and women are equally represented indicates that farming is a full time activity for both sexes in Mokhotlong. It is not like other regions of subsistence farming were mostly women are farming while men are employed elsewhere. For example, in South Africa a study and survey of this kind would probably sample more women than men. If it is assumed that farming is shared equally among men and women in Mokhotlong, it

must also be assumed that certain farm activities/operations are gender related. It is therefore interesting to look at each operation to find out what each member of the household is responsible for. Being responsible for an activity does not mean one is doing it, however in this study it is found that ones' responsibility happens to be ones' job. Figure 5.7 shows how men and women are responsible for certain activities of wheat production.

Figure 5.7: Gender and responsibilities on Wheat production



As it is shown in Figure 5.7 women are mostly responsible for seed preparation and getting it ready for planting and are responsible for post harvest cleaning. Post harvest cleaning is mainly threshing and winnowing. Men are mostly responsible for field preparation, sowing and storage. Crop management, harvesting and sales are the responsibilities of both men and women. The total indicates that men are more responsible for most activities than women and at least both (men and women) are doing more activities together. The results agree with Holland (1993) that ploughing and planting are known to be males' work in Lesotho.

Figure 5.8: Gender and responsibilities on Potato production

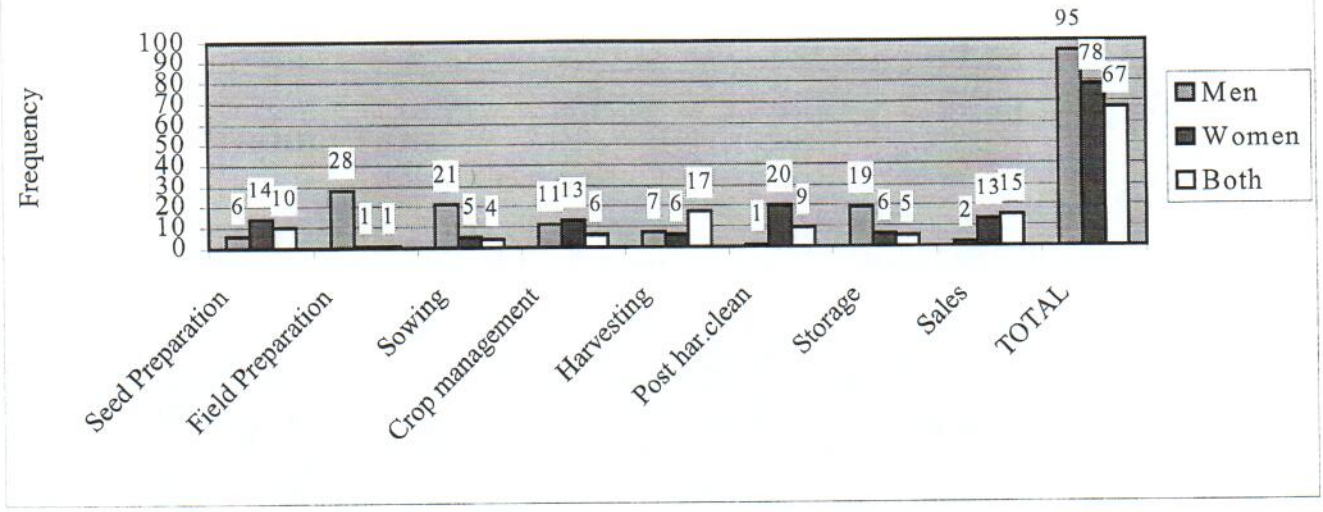


Figure 5.8 shows how men and women are responsible for certain activities of potato production. It can be seen from Figure 5.8 that men are more responsible for field preparation, sowing and for storage of the potatoes. Women are predominantly responsible for taking care of seed tubers and getting them ready for planting and cleaning the potatoes after harvest. At least harvesting is a responsibility of both women and men. The total indicates that men are more responsible than women as far as potato production is concerned.

From the results in Figures 5.7 and 5.8 it is suggested that farm decision makers and adopters of technologies (related to the operations indicated) are those people (sex) with most responsibilities on a particular operation.

5.6 CONCLUSION

This chapter has shown that twenty seven percent of the sample farmers had never received training from extension officers. This agrees with the finding that level of knowledge is relatively low in Mokhotlong households and the fact that more training comes on top of the aspects needed to improve the production of wheat and potatoes. Mokhotlong farmers are shown to increasingly grow potatoes with the little knowledge available. Increasing household food supply and generating more cash are major reasons for adoption of potatoes.

CHAPTER 6

ADOPTION OF A WHEAT + POTATO PRODUCTION SYSTEM

6.1 INTRODUCTION

The results on the possible predictors of adoption of potato into the wheat based cropping system are presented and discussed in this chapter. There are two major dependant variables that are tested. *Crops adopted by farmers* is the first dependent variable. Crops referred to here is actually a cropping system: a wheat + potato system and a wheat system which does not include potatoes. The results are presented in Tables 6.1 and 6.2. *Household knowledge on soil fertility* is the second dependent variable. The results are presented in Table 6.3 and Figure 6.1. The chapter concludes by summarising the important findings.

6.2 CROPS ADOPTED BY FARMERS

Crops adopted by farmers referred to in this study is a cropping system. The analysis determined whether the adoption of wheat or a wheat + potato cropping system is dependent on the following farmer's characteristics, namely: sex, age, training, land ownership, the farm's soil type, household size, number of household members below six (< 6) years of age, number of household members between 6-18 years of age and farming experience. The first five characteristics are categorical independent variables and are presented in Table 6.1, while the last four are continuous independent variables and presented in Table 6.2. They were all tested as possible predictors of adoption of different crops in question ($p \leq 0,15$).

Table 6.1: Characteristics of farmers categorised on the basis of observed adoption of wheat and wheat + potato production system. Their significant levels as possible predictors ($p \leq 0,15$) distinguishing between the adoption of the two production systems

Explanatory variables	**Wheat + Potato n = 30**	**Wheat n = 30**	**$p \leq 0,15$**
Categorical variables			
Sex			1,0[1]
Males	15	15	
Females	15	15	
Age			0,57[1]
20-39	5	6	
30-49	7	8	
50-59	4	7	
>60	14	9	
Training			**0,11[2]**
Fellow farmers	3	3	
Extension officers	24	17	
None	3	10	
Land ownership			**0,09[1]**
Own	27	22	
Not own	3	8	
Soil type			0,57[2]
Dark shallow	3	5	
Dark deep	24	21	
Red shallow	1	3	
Red deep	2	1	

1. Chi-square Test 2. Fisher's Exact Test

Training is a significant possible predictor that distinguishes between the adoption and non-adoption of potatoes in Mokhotlong (see Table 6.1). Mokhotlong farmers receive training mainly from extension service provided by GROW. The results indicate that many farmers (80%) who receive training from extension officers are adopters of potatoes compared to the few non-adopters of potatoes (57%). Nell (1998) found similar results where training sources are significant possible predictors of adoption of antibiotics in Qwa-Qwa.

Land ownership is also a significant possible predictor that distinguishes between the adoption and non-adoption of potatoes. Farmers who own land or have security of tenure tend to be possible adopters of potatoes. This is suggested by the finding that 90% potato adopters own land compared to 73% non-adopters of potatoes. It seems like the few farmers who do not own land (described in chapter 4) devote all the land resource to the production of the main crop. It is no exception for these farmers not to adopt potatoes because it is well known from literature (Norton & Alwang, 1993; Pretty, 1995) that farmers who do not own land have less incentive and are less likely to adopt certain production practices.

Table 6.2: Characteristics of farmers categorised on the basis of observed adoption of wheat and wheat + potato production system. Their significant levels as possible predictors (p = ≤ 0,15) distinguishing between the adoption of the two production systems

Explanatory variables	**Wheat + Potato n = 30**	**Wheat n = 30**	**t-Test p ≤ 0,15**
Continuous variables	**Mean**		
Household size	6,43	5,47	0,19
Members < 6 years	1,03	0,83	0,51
Members 6-18 years	2,17	1,90	0,52
Farming experience	26,30	16,93	**0,02**

t-Test

Table 6.2 shows that farming experience is the only continuous explanatory variable that comes out as a possible variable that significantly distinguishes between the

adoption and non-adoption of the wheat + potato production system. The results indicate that potato adopters tend to have more years of farming experience (26,3 average years) than non-adopters of potatoes (16,9 average years). Since farming is the source of life for every household in Mokhotlong the survey shows that the majority of people have been farming since their adulthood. One can therefore say it is possible that many farmers can adopt potato into their current wheat based system as their years of farming experience increase. It is not within the scope of this study to determine the specific number of farming years at which farmers can possibly start adopting potatoes. This finding is in agreement with Rahm and Huffman (1984) who found that experience tends to increase adoption efficiency of Iowa farm operators in America. However this finding is uncommon in the literature on adoption of technologies, experience rarely came out as a significant predictor in the literature reviewed (Anim, 1999; Burton *et al.*, 1999; Nell, 1998; Nichola & Sanders, 1996). The number of family members below six years is not significant despite the indication by some farmers that, they like potato because is a reliable relish for the children. Farmers are growing potatoes irrespective of their household sizes and number of children aged 6 to 18 years. This probably indicates that potatoes do not require additional labour to what is required by the wheat crop.

6.3 THE FARM HOUSEHOLD KNOWLEDGE

The following analysis suggests a number of hypotheses regarding the extent of households' knowledge. Farm households' knowledge is presumed to have an impact on the farmers' decision and it relates to adoption of new farming technologies. The households' knowledge on *soil fertility* is hypothetically influenced by the internal household characteristics: sex, age, training and farming experience. These farmer characteristics are categorical explanatory variables (except farming experience) and are shown in Table 6.3, together with their significant levels as possible predictors.

Table 6.3: Characteristics of farmers categorised on the basis of their households knowledge on soil fertility. Their significant levels as possible predictors ($p \leq 0,15$) distinguishing between good and little knowledge on soil fertility

Explanatory variables	**Good**	**Little**	**$p \leq 0,15$**
Categorical variables	**n = 60**		
Sex			**0,01**[1]
Male	25	5	
Female	16	14	
Age			0,19[2]
20-39	9	2	
30-49	7	8	
50-59	9	2	
> 60	16	7	
Training			0,49[2]
Fellow farmers	3	0	
Extension officers	25	13	
Both	3	3	
None	10	3	

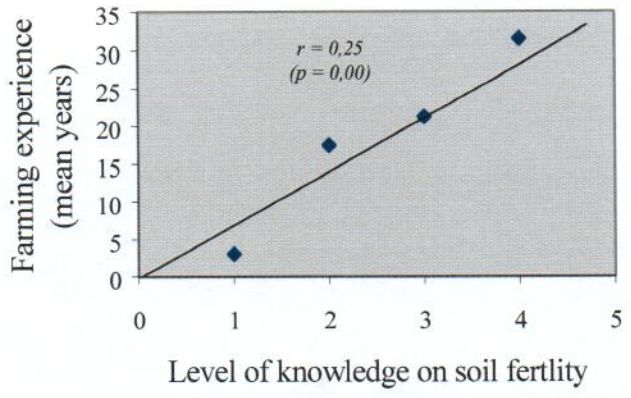
1. Chi-square Test. 2. Fisher's Exact Test.

The results in Table 6.3 show that sex is significantly distinguishing between good and little knowledge on soil fertility. The results indicate that more male farmers (42%) have good knowledge on soil fertility compared to female farmers (27%). In this case where the interviewed farmer is taken as the representative of his/her household the impression is that, households that are male dominated are more likely to have knowledge on soil fertility. Such households will probably adopt soil fertility-related technologies such as alternating shallow rooted crops, like wheat, with heavy rooted crops like potatoes. The female dominated households are less likely to consider crop alteration with potatoes to improve soil nutrient supply because of the lesser knowledge on soil fertility. Improving soil fertility is one of the reasons why farmers tend to adopt potatoes in Mokhotlong (chapter 5). These results indicate that it is mostly male farmers who mentioned improving soil fertility as one of the reasons

for adoption of potatoes. However in the literature reviewed, Burton *et al.* (1999) found opposite results where a female farmer' probability of adoption was 17 times that of her male counterpart in the UK. Training women on soil fertility and crop rotation aspects can possibly increase adoption of potatoes in Mokhotlong. Kumar (1987) has the same perspective and mentioned that changing the perceived value of women's contribution can produce drastic changes within households.

Training is not significantly predicting the household knowledge about soil fertility. This brings the suggestion that those farmers who have knowledge of soil fertility have it through intuition. However if this aspect (soil fertility) can be included in training programs it can bring about improvements in the soil fertility and subsequent crop yields.

Figure 6.1: Correlation between farming experience and knowledge on soil fertility



1.None 2. Little 3.Average 4. Good

Figure 6.1 shows that there is a highly significant (p = 0,00) correlation between household knowledge on soil fertility and farming experience. Although the correlation is very weak (r = 0,25), the general trend of the relationship is acceptably clear. The farmers have no knowledge when they have fewer years (average 3) of farming experience and good knowledge when they have more years (average 31,5) of farming experience. The households with good knowledge about soil fertility are seen as potential adopters of potatoes because they may need to rotate crops in order to improve soil fertility. The correlation agrees with the effect of farming experience on choice of crops explained earlier in this chapter (Table 6.2).

6.4 CONCLUSION

Possible adopters of potatoes are farmers who receive training from extension officers, farmers who own land, and farmers with many years of farming experience. Fewer women than men have good knowledge on soil fertility. Women may not practice crop rotation and that decreases women's chances of including potatoes in the cropping system. Farmers with more average years of farming experience have good knowledge on soil fertility. These are the farmers expected to practice crop rotation that may include potatoes as one of the crops.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

7.1 SUMMARY

The main objective of the study as stated in chapter 1, was to identify possible predictors of adoption of potatoes into the wheat based cropping system. In this study nine explanatory variables were tested against two dependent variables ($p \leq 0,15$). They were **categorical variables** sex, age, training, land ownership and soil type, **continuous variables** household size, number of household members below the age of six (< 6) years, number of household members between 6-18 years of age and the farming experience. The dependent variables tested were: *crops adopted by farmers* and *household knowledge on soil fertility*. Of all the nine explanatory variables tested against *crops adopted*, only two categorical variables **training** ($p = 0,11$) and **land ownership** ($p = 0,09$), and one continuous variable, **farming experience** ($p = 0,02$) were significant possible predictors. Of all the three variables (sex, age and training) tested against *household knowledge on soil fertility,* only **sex** emerged as a significant possible predictor ($p = 0,01$). There was a highly significant correlation ($p = 0,00$) between farmers' *years of farming experience* and *level of knowledge on soil fertility*. However the correlation is very weak ($r = 0,25$).

From the descriptive analysis it was noted that only 27% of the farmers used their own or their neighbour's knowledge for their training needs. About a third of the farmers received training from extension officers on production of wheat and potatoes. The impact of GROW on potato adoption was evident through training.

Farmers have more years of experience with wheat than with potatoes. The growing of potatoes was introduced to Mokhotlong in 1983-84 but the survey shown that some of Mokhotlong farmers started growing potatoes in the early 1960's.

The level of households' knowledge about cultivars, pests, diseases of wheat and potatoes as well as soil fertility was low. Twenty one percent of the farmers do not

rotate wheat and 15% rotate wheat every three and more years. This practice may worsen the existing problem of wild oats (a major problem) on wheat production. Lack of seed tubers, lack of land and crop damage by moles were identified as the major problems of potato production in Mokhotlong.

Men have most responsibility in both crops (wheat and potato). That suggests that men are mostly the decision makers in the production of wheat and potatoes. However it is necessary to consider specific operation to which men or women are responsible in cases where one needs to determine the decision makers on various farm operations.

7.2 RECOMMENDATIONS

Policy

- For the development of agriculture, diffusion and adoption of technologies, the functioning of input markets, especially for seed and fertilizer is increasingly important.
- Increased investment in roads and other infrastructure including communication will accelerate the entrance of private firms into input marketing and should ideally result in affordable prices. More development agencies with research and training objectives will also be attracted.
- Poverty alleviation and enhancement of technology adoption should be supported by efficient land distribution and allocation. Government should sort out amicable means of helping households without arable land.

Research

- Great emphasis in Mokhotlong needs to be placed on wheat agronomic innovations to respond to the constraints of the declining soil fertility, late maturing cultivars, frost damage and wild oats.

- There is a great need to study in detail the existing pests and diseases of wheat and potatoes in Mokhotlong in order to develop appropriate control measures with farmers' evaluation.
- Because of the difference of the type of work which men and women perform, research and training must target men if the technology is going to affect men and women if it is going to affect women. The extension services' preference for targeting male over female farmers had negatively affected the productivity of female farmers. Agricultural projects should focus on individual farmers (men and women) within households rather than the household as a whole.

Appendix A

Questionnaire

POSSIBLE PREDICTORS OF ADOPTION OF POTATO INTO THE WHEAT BASED CROPPING SYSTEM IN MOKHOTLONG, LESOTHO

Questionnaire to farmers.
All information will be treated confidential.

Sources: Derek Byrlee, Michael Collinson, *et al.* and Nell W. T

1. GENERAL INFORMATION

1.1 Date of interview _____
1.2 Name of enumerator _____
1.3 Questionnaire number _____
1.4 Farmer's name _____
1.5 Village name _____
1.6 Which of the following crops are you planting?

1.Wheat **2.** Wheat and Potatoes

1.7 Crop enterprises **(area and average yield of wheat and potatoes only)**

Crop	**Number of cultivars**	**Cropland area Allocated (m^2)**	**Average annual production (bags)**
Wheat			
Potatoes			
Other crops			
Maize			
Pea			
Barley			
Oats			
Pumpkin			
Lentil			
Bean			

1.8 Tenure Arrangements (Mark with X):

	Wheat Ha	**Potato Ha**
Own		
Rental		
Sharecrop		
Offer		

1.9 Soil Type
1.9.1 **Wheat**

1 Dark		2 Red	
11 Shallow	12 Deep	21 Shallow	22 Deep

1.9.2 **Potato**

1 Dark		2 Red	
11 Shallow	12 Deep	21 Shallow	22 Deep

2. RESPONDENT CHARACTERISTICS

2.1 Sex **1.**Male **2.** Female

2.2 Family composition and size

Total number of family members	
Number of family members between 6 – 18 years	
Number of family members below six years	

2.3 Age of the farmer in years

1. 20-39	**2.** 40-49	**3.** 50-59	**4.** >60

3. FARMING KNOWLEDGE

3.1 How long have you been farming with?

1. Wheat	Years
2. Potatoes	Years

3.2 How do you rate the knowledge of your household on the following?

1. None **2.** Little **3.** Average **4.** Good

1. Wheat cultivars	
2. Wheat diseases	
3. Wheat pests	
4. Potato cultivars	
5. Potato diseases	
6. Potato pests	
7. Soil fertility	

3.3 Did any household member ever receive informal training by……(Mark with X)

1. Other Farmers	**2.** Extension Officers	**3.** Both	**4.** None

3.4 Which aspect/s of crop production do you think your household is lacking knowledge of, to improve your production?

3.5 What is needed (according to you) for your wheat production to improve?

3.6 What is needed (according to you) for your potato production to improve?

3.7 Why do you include potato production in your crops? **(Potato farmers only)**

1	Cash
2	Food
3	To break pest cycle
4	To improve soil fertility
5	To increase diversity
6	Other

3.8 What prevents you from planting potatoes? **(Only farmers without Potato)**

1	Lack of seed tubers
2	Lack of interest
3	Lack of land
4	Lack of knowledge
5	Lack of labour
6	Your soil type
7	Is not your preferred food
8	Lack of money
9	Other

3.9 Does adoption of potato production have impact on wheat production?

1. Positive	**2.** Negative	**3.** No impact	**5.** Don't know

3.9.1 Please explain how adoption of potato production impacts on wheat production.

4. FINANCIAL MANAGEMENT

4.1 **(Wheat crop)** How do you manage to finance the supply of the following inputs / operations?

Inputs/Operations	**1. Cash**	**2. In kind**	**3. Self reliant**
Seeds			
Ploughing			
Planting			
Weeding			
Harvesting			
Transport			

4.2 **(Potato crop)** How do you manage to finance the supply of the following inputs / operations?

Inputs/Operations	**1. Cash**	**2. In kind**	**3. Self reliant**
Seed tubers			
Ploughing			
Planting			
Weeding			
Ridging			
Harvesting			
Transport			

5. CROP MANAGEMENT

5.1 How often do you rotate your crops?

	1. None	**2.** Every year	**3.** Every two years	**4.** More
Wheat				
Potato				

5.2 **(Wheat)** What do you consider to be the most important constraints of wheat production in this area? Please rank them in order of frequency.

5.3 **(Potato)** What do you consider to be the most important constraints of potato production in this area? Please rank them in order of frequency.

6. DECISION MAKING

6.1 When making decision on which crop to plant, which of the following aspects play an important role in guiding your decision? (in order of priority)

Food for the household	
Highest income	
Easy to produce/manage	
There is market for product	
Other	

6.2 Each responsibility is marked 1, and the total of the marks reflects sex in association with responsibilities for each operation on crop production.

Wheat

Parameter	1. Man	2. Woman	3. Both
Who is responsible for seeds			
Who is responsible for Field preparations			
Who is responsible for Sowing			
Who is responsible for Crop management			
Who is responsible for Harvesting			
Who is responsible for Post-harvest cleaning			
Who is responsible for Storage			
Who is responsible for Sales.(If any)			
Totals			

6.3 Each responsibility is marked 1, and the total of the marks reflects sex in association with responsibilities for each operation on crop production.

Potato

Parameter	1. Man	2. Woman	3. Both
Who is responsible for seeds			
Who is responsible for Field preparations			
Who is responsible for Sowing			
Who is responsible for Crop management			
Who is responsible for Harvesting			
Who is responsible for Post-harvest cleaning			
Who is responsible for Storage			
Who is responsible for Sales. (If any)			
Totals			

Thank you so much for your time, co-operation and patience.

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