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

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ABSTRACT

*The main objective of the study was to identify possible predictors of adoption of potatoes into a wheat-based cropping system. In this study nine explanatory variables were tested against two dependent variables (p ≤ 0,15). The explanatory variables were gender, age, training, land ownership, soil type, household size, number of household members below the age of six (< 6) years, number of household members between 6 and 18 years of age and 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, namely **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 (gender, age and training) tested against household knowledge on soil fertility, only **gender** emerged as a significant possible predictor (p=0,01). Farmers' years of experience and level of knowledge on soil fertility indicated a significant relationship (p=0,00) with a correlation coefficient of 0,25.*

INTRODUCTION

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. For family farms to adopt a new technology it must be preceded by technology diffusion (Arnon, 1989). While 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. The main factors influencing farm decision-making were found by Bryden (1994) to be, amongst 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, and the implementation of agricultural and rural policy at national and local levels.

Carvalho (1990) has indicated that agriculture forms a considerable part of domestic production in Lesotho. Droughts, hail and frosts (early and late) are, however, the factors that have led to the decline in crop production. Households in Mokhotlong are experiencing low crop yields. These households are forced to seek better production technologies and crops with a higher cash value than grain crops. Grain production is a common enterprise in the Mokhotlong district, 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 first introduced to the Mokhotlong farmers in 1983/84. Potatoes were infected by late blight (*Alternaria solania*) in this area (Mokhotlong) and the yields were lower than in other areas of potato production in Lesotho (Lesotho Farming Systems Research Project, 1986). The production of potatoes as an additional crop was not well adopted by farmers in this area. GROW (a non-governmental organisation in Lesotho) 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.

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). 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.

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 cropping system. The main objective of this paper is to present the possible predictors of decision-making by Mokgotlong farmers on adoption of a wheat-based cropping system that includes potatoes.

MATERIALS AND METHODS

The study area

Mokhotlong is situated 29° latitude and 29° gratitude in the North-Eastern part of Lesotho. Mokhotlong borders KwaZulu-Natal (a province of South Africa). The road between Butha-Buthe, the nearest large town, and Mokhotlong is about 170 km and is well tarred. The road runs through mountainous terrain and takes three hours to drive. The dirt (gravel) road from Mokhotlong to the surveyed area (Makoabating) is very poor where only a four-wheel drive vehicle can be used. The 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 in the summer between October and March. In Lesotho, summer is quite warm with an average maximum temperature of approximately 29 ^{o}C. Winter is cold in Mokhotlong, normally getting to below 0 ^{o}C at night with frost and incidences of snow every year. Crop farming in Lesotho is characterised by small subsistence farms where very little of the crop produce is sold. In Mokhotlong the main crops are maize, wheat, beans and peas. In the mountain areas of Lesotho crops are grown at higher altitudes (Makoabating, the surveyed area, is 2 408 meters above sea level).

Sampling and statistical analysis

Makoabating, one of the two Mokhotlong valleys, was chosen for this study. Out of the ten villages of Makoabating valley, five were randomly selected. Each of the villages chosen was visited and a list of wheat farmers and the wheat-potato farmers was drawn up with the assistance of local (GROW) field officers. A stratified sample of thirty wheat growing farmers and thirty wheat-potato growing farmers was chosen using a table of random numbers (Leedy, 1997). A pre-tested questionnaire was used to collect data and the data was analysed using the SAS statistical program (Stokes, Devis & Kock, 1995).

Dependent and explanatory variables

The first dependent variable was *crops adopted by farmers (wheat-potato adopters and non-adopters)*. **Wheat-potato adopters** in this study are farmers who grow wheat and potatoes every year. **Non-adopters** in this study are farmers who grow wheat, other grain crops and legume crops every year, but do not grow potatoes. The second dependent variable was *the level of household knowledge on soil fertility* The level of household knowledge on soil fertility was rated **good** or **little** by the interviewees and it was tested to be predicted by the determined explanatory variables.

The explanatory variables of adoption of a wheat-potato cropping system were divided into two sections, namely categorical and continuous explanatory variables. Two tests were used to determine the difference between wheat-potato adopters and non-adopters. In the case of categorical variables a chi-square test was used and a t-Test was used in the case of continuous variables. The chi-square test was used to test the explanatory variables determining the level of household knowledge (good or little) on soil fertility.

RESULTS AND DISCUSSION

The analysis determined whether the adoption of wheat-potato or wheat cropping system is dependent on the following farmers' characteristics, namely gender, age, training, land ownership, the soil type of the farm, household size, number of household members below six years (<6) of age, number of household members between 6 and 18 years of age and farming experience. The results of the first five characteristics (categorical independent variables) are presented in Table 1, while the results of the last four characteristics (continuous independent variables) are presented in Table 2.

Crops adopted by the farmers

The characteristics of farmers (categorical independent variables) categorised on the basis of observed adoption of a wheat-potato or wheat cropping system and their significant levels as possible predictors ($p \leq 0,15$) distinguishing between the adoption of the two cropping systems, are presented in Table 1.

Table 1. Characteristics of farmers categorised on the basis of observed adoption of a wheat-potato or wheat cropping system and their significant levels as possible predictors (p ≤0,15) distinguishing between the adoption of the two cropping systems

Explanatory variables	Wheat + Potato n = 30	Wheat n = 30	p ≤ 0,15
Categorical variables			
Gender			$1,0^1$
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			$\mathbf{0,11^2}$
Fellow farmers	3	3	
Extension officers	24	17	
None	3	10	
Land ownership			$\mathbf{0,09^1}$
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 the first significant possible predictor that distinguishes between the adoption and non-adoption of a wheat-potato cropping system in Mokhotlong. Mokhotlong farmers receive training mainly from extension services provided by GROW. The results indicate that many farmers (80%) who receive training from extension officers are adopters of a wheat-potato cropping system, 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 QwaQwa.

The results in Table 1 show that land ownership is also a significant possible predictor that distinguishes between the adoption and non-adoption of a wheat-potato cropping system. Farmers who own land or have security of tenure tend to be possible adopters of wheat-potato. This is suggested by the finding that 90% wheat-potato adopters own land, compared to 73% of the non-adopters. It seems like the few farmers who do not own land (Serage, 2000) 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.

Gender, age and soil type did not significantly come out as possible predictors of adoption and non-adoption of a wheat-potato cropping system. It was found that 38% of the farmers are above 60 years of age. These people have to farm even if they are very old because they have to provide for their children and grand-children. It was observed during the survey that the difference in soil types on Makoabating farms is minimal, dark deep soils are common.

The characteristics of farmers (continuous independent variables) categorised on the basis of observed adoption of a wheat-potato or wheat cropping system and their significant levels as possible predictors (p ≤ 0,15) distinguishing between the adoption of the two cropping systems, are presented in Table 2.

Table 2. Characteristics of farmers categorised on the basis of observed adoption of a wheat-potato or wheat cropping system and their significant levels as possible predictors (p ≤0,15) distinguishing between the adoption of the two cropping 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[1]
Members < 6 years	1,03	0,83	0,51[1]
Members 6-18 years	2,17	1,90	0,52[1]
Farming experience	26,30	16,93	**0,02**[1]

1. t-Test

Farming experience is the only continuous explanatory variable that emerges as a possible predictor that significantly distinguishes between the adoption and non-adoption of a wheat-potato cropping system. The results indicate that wheat-potato adopters tend to have more years of farming experience (26,3 average years) than non-adopters (16,9 average years). Since farming is important for the livelihood of 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 potatoes into their current wheat-based system as their years of farming experience increase. It was 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 that of 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, Rigby & Young, 1999; Nell, 1998; Nichola & Sanders, 1996). The number of family members younger than six years is not significant despite the indication by some farmers that they like potatoes because is a reliable food source 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 potato production does not require additional labour, comparing to what is required by the wheat crop.

The farm household knowledge

The farmers' knowledge on soil fertility would lead to adoption of soil fertility-related practices such as crop rotation. It is assumed that farmers in Mokhotlong who have good knowledge about soil fertility, are rotating their crops, and potatoes are likely to be included in their rotation system. To determine which groups of households have good knowledge on soil fertility (and are likely to adopt a wheat-potato cropping system), gender, age and training were tested as possible predictors. The characteristics of farmers categorised on the basis of their household knowledge on soil fertility and their significant levels as possible predictors ($p \leq 0,15$) distinguishing between good and little knowledge on soil fertility, are presented in Table 3.

Table 3. Characteristics of farmers categorised on the basis of their household 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 ≤ 0,15
Categorical variables		N = 60	
Gender			**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 show that gender significantly distinguishes between good and little knowledge on soil fertility. The results indicate that significantly more male farmers (42%) have good knowledge on soil fertility, compared to female farmers (27%). In this case where the interviewed farmer was taken as the representative of his/her household, the impression was that male dominated households are more likely to have better knowledge on soil fertility. Such households will probably adopt soil fertility-related technologies such as alternating shallow rooted crops, such as wheat, with heavy rooted crops such as potatoes. The female dominated households are less likely to consider crop rotation with potatoes to improve soil nutrient supply because of the lack of knowledge on soil fertility. Improving soil fertility is one of the reasons why farmers tend to adopt potatoes in Mokhotlong (Serage, 2000). However, Burton *et al*. (1999) found opposite results where a female farmer's probability of adoption of horticultural techniques was 17 times that of their male counterparts in the United Kingdom. Training women on soil fertility and crop rotation aspects can possibly increase adoption of potatoes in Mokhotlong. Changing the perceived value of women's contribution can produce positive changes within households in Mokhotlong.

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. Extension training concerning soil fertility is not efficient in Mokhotlong. Nell (1998) also found that extension training was not efficient in QwaQwa. However, if this aspect (soil fertility) can be included in training programmes, it can bring about improvements in the soil fertility and subsequent crop yields in Mokhotlong.

A valuable positive relationship was found between the level of knowledge on soil fertility and farming experience with p=0,00 and a correlation coefficient significantly greater than zero (r=0,25). The households with good knowledge about soil fertility are seen as potential adopters of a wheat-potato cropping system 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 as seen in Table 2.

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, which suggests that women may not practice crop rotation and that this decreases their chances of including potatoes in the cropping system. Farmers with more average years of farming experience are adopters of a wheat-potato cropping system. The extension workers can plan their training in either of two ways, namely to add more effort on the adopters of a wheat-potato cropping system so that their crop production can improve, or to place more effort on the non-adopters to increase/widen the adoption of a wheat-potato cropping system. However, it must be borne in mind that success with extension will lead to an increased production of potatoes and may have market implications hence potatoes are grown as cash crops.

This study was not aimed at studying the effect crop rotation in Mokhotlong, and further research on crop rotation in order to develop appropriate rotation programmes that can best suit the farmers and solve their food security problems, is therefore necessary. A sustainable crop rotation programme would be the one that caters for the declining soil fertility and ever increasing soil erosion in Mokhotlong.

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