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Determination of farmers' practices for on-farm conservation of locally adapted maize (*Zea mays* L.) cultivars in traditional-type agricultural systems in Lesotho

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Abstract

A study to identify and understand farmers' practices for conservation of locally adapted maize cultivars on-farm and traditional knowledge that guides these practices was carried out in two agroecological regions in Lesotho, with the aim of generating information that could be used to develop, support and promote on-farm conservation strategy in the country through relevant policy channels. This was achieved by a socioeconomic survey, based on semi-structured and in-depth, open-ended interviews with 141 smallholder farmers. Specifically, the study investigated on which locally adapted maize cultivars farmers maintain in traditional-type agricultural systems, the specific variables influencing farmers to maintain these cultivars, the contribution of local maize cultivars to farmer diversity-based livelihood strategies and the practices farmers use to maintain them. Nine locally adapted maize cultivars were recorded in the two areas. These cultivars are valued by farmers because of their adaptation to local environmental conditions, their agronomic performance, their storage quality and diverse end uses, including sale. Results of binary logistic regression analysis show that farmers who are likely to maintain local maize cultivar diversity on-farm are those who have a long history of maize cultivation and those who depend both on farming and off-farm activities for household income. The findings of this study also indicate that locally adapted maize cultivars have cultural, socioeconomic and ecological benefits to the farming communities. Farmers maintain the local maize cultivars by both local seed management and field management practices. A two-sample *t*-test shows that the two communities differ in terms of seed sourcing behaviour, time of seed selection and seed storage practices, but all have the same objective with seed selection.

Keywords: locally adapted maize cultivars, on-farm conservation, traditional knowledge, management practices, traditional-type agricultural systems, Lesotho

Contents

Introduction

In situ conservation of agrobiodiversity on-farm has received growing focus of attention by the international community, particularly after the signing of the Convention on Biological Diversity in 1992. It also forms a significant part of the Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture. While *ex situ* conservation efforts have been a significant contribution to the conservation of the available useful genetic resources, *in situ* conservation has been advocated as a complementary strategy to *ex situ* conservation (Long et al. 2000; Louette 2000). *In situ* conservation is defined by the Convention on Biological Diversity as the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties, (UNEP/CBD/Article 2 1992).

The key feature of *in situ* conservation of agrobiodiversity on-farm is the traditional knowledge and practical skills of the farmers; thus it is sometimes referred to as on-farm management (Engels and Wood 1999). It is increasingly recognized that farmer management of crop genetic diversity based on traditional cultivars continues to be of central importance in many production systems (UNEP/CBD/SBSTTA/7/1 2001). Farmers' management of diversity refers to the cultivation of more or less specialized crop populations (Bellon 1997). As Bellon (1997) says, diversity maintained by farmers is not just the set of varieties that they keep, but also the management processes these varieties are subject to and the knowledge that guides these processes. On-farm conservation is based on the recognition that, historically, farmers have developed and cultivated crop genetic diversity and that this process still continues among many farmers in spite of socioeconomic and technological changes (Bellon 1997). It emphasizes the role of farmers for two reasons: (1) crops are not only the result of natural factors, such as mutation and natural selection, but also and particularly, of human selection and management; and (2) in the last instance, farmers' decisions define whether these populations are maintained or disappear. However, this approach to conserving agricultural biodiversity remains unfamiliar, ambiguous and controversial to many people (Cromwell and van Oosterhout 2000).

A number of governments, research institutes, and non-governmental organizations are now engaged in research projects to better understand and improve the effectiveness of existing on-farm conservation, its management and improvement, and use of plant genetic resources for food and agriculture, in order to achieve a better balance between *ex situ* and *in situ* conservation strategies (FAO 1996). In any event, Lesotho as a party to the Convention on

Biological Diversity is trying by all means at its disposal and ability to adhere to the articles of the convention (UNDP 2001). However, the technique for encouraging or supporting on-farm conservation still remains less well understood, it is still in its initial stages/infancy in Lesotho. There has been no exploration of the cultural, socioeconomic, or environmental variables which influence farmers' attitudes towards maintaining crop diversity on-farm, and therefore no understanding of farmers' willingness to get involved in on-farm conservation; there is little knowledge of the mechanisms which have kept the traditional farming systems sustainable and productive for generations. With this in mind, it is not practical to assume that farmers will continue to maintain optimal crop diversity without any institutional and policy support. Hence intervention at technical and policy levels is required as a means of encouraging on-farm conservation of local crop diversity. This can only be achieved after there is a solid understanding of what farmers are doing, why they do it and how they do it. Sthapit and Friis-Hansen (2000) say it better, "Agrobiodiversity will not be saved unless it is used. If the continued use of local cultivars by farmers is to form part of a conservation strategy, it is important to understand why farmers grow landraces, when they grow them and how they maintain and use them". Without this knowledge it is difficult to identify farmers who are likely to maintain agrobiodiversity in the long run, what is important to them, what constraints they face in maintenance of agrobiodiversity and how they can be supported. This information is very important because as Smale et al. (2001) say, the survival ability of a traditional crop variety within a particular agroecological niche depends, to a great extent, on the decision of farmers to cultivate that variety. Also, according to Jarvis and Hodgkin (1998), in the process of planting, managing, selecting, harvesting and processing, farmers make decisions on their crops that affect the genetic diversity of the crop populations. Over time, a farmer may alter the genetic structure of a crop population by selecting plants with preferred agro-morphological or quality characteristics. Farmers' efforts therefore need to be recognized and supported so that they will continue to maintain optimal crop diversity in the farming systems.

Thus, in accordance with the Convention on Biological Diversity (CBD), the FAO Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (GPA), and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), a study to determine practices important for maintenance of locally adapted maize cultivars on-farm and traditional agricultural knowledge that guides these practices was carried out in two agroecological regions in Lesotho. For this study, locally adapted cultivars are defined as variable plant populations, adapted to local agroecological conditions, which are named, selected and maintained by farmers to meet their socioeconomic, cultural and agroecological needs. It was the overall aim of this study to generate information that could be used to develop, support and promote on-farm conservation strategy in the country through relevant policy channels. To achieve this, a socioeconomic survey was conducted with the following specific objectives:

(i) to identify the present status of locally adapted maize cultivars in the target area and their associated traits
(ii) to identify specific variables influencing farmers' willingness to maintain local maize cultivars on-farm
(iii) to determine the contribution of the local maize cultivars to farmer livelihood strategies
(iv) to determine practices used for maintenance of these cultivars by farmers

Materials and methods

This section gives an outline of the area in which the study was conducted, sources of data, and methods used to collect and analyze data. Data collection, processing and analysis took place during the fieldwork between July 2006 and March 2007. It included primary data collection and review of existing/secondary data. Secondary data was obtained from census reports, genebank databases, published literature, grey literature and personal communication with experts.

Background to the country

Lesotho comprises 30,588 km^2 of land surface that is entirely surrounded by the Republic of South Africa and lies entirely outside the tropics between latitudes 28°S and 31°S, and longitudes 27°E and 30°E. The country is bounded by the Republic of South Africa's provinces of the Free State in the west and north, Eastern Cape in the south, and Kwazulu-Natal in the east (Fig. 1). All the land surface in Lesotho is situated more than 1,000m above sea level. The lowest point in the country, where the Senqu River flows across the border, is 1,388m above sea level, while the highest part, Thabana Ntlenyana, is 3,482m above sea level (Chakela 1999).

The country is divided into four distinct agro-ecological zones based on the variation in geomorphology and topography (Fig. 1.2); the Lowlands have elevation ranges of 1,388m to 1,800m, the Foothills with elevations of 1,800m to 2,000m, the Senqu River Valley with elevations of 1,388m to 2,000m and the Highlands occurring at the elevation of 2,000m – 3,482m (Bureau of Statistics 1998; Lesotho Meteorological Services 1999). Apart from the limitations caused by the weather and climatic conditions, only around 15% of the country is arable and the rest is composed of rocky land as well as steep slopes. The mountain region of the country covers 70% of the total land surface.

Lesotho has a continental temperate climate that is marked by four clearly identifiable seasons, and normally receives 85% of its average annual rainfall of 700mm in the seven months from October to April, with higher averages of 1200mm recorded in the mountain region, and low averages of 500mm recorded in the Senqu River Valley which forms a rain shadow area (Lesotho Meteorological Services 2000). Precipitation has become increasingly erratic, resulting in periodic droughts and hazardous farming conditions. Rainfall is often marked by heavy torrents which are associated with severe soil erosion. Snowfall is a common occurrence in the mountain areas, the coldest region of the country (Lesotho Meteorological Services 2000).

The study area

The research on which this study is based was conducted in two out of four agroecological zones, representing 50% of the zones available to smallholder farming in Lesotho. Farming communities comprising Semonkong Agricultural Resource Centre at Semonkong in Maseru district and farming communities comprising Tale Agricultural Resource Centre in Leribe district were selected as the target area. Semonkong is situated in the central highlands and Leribe in the northern lowlands of the country (Fig. 2). The two sites were purposefully chosen on the basis of a significant variation which exists in local crop diversity, which is due to both local socioeconomic conditions (such as integration into input, product and labour markets) and agroecological conditions (such as fragmentation of land holdings, presence of diverse niche environments).

Farming conditions are harsh at Semonkong, at an altitude of 2300m or more above sea level. The growing season is short, winter temperatures are low and from May to September there is frost and often snow. On average there are only about 100 frost-free days during the cropping season – obviously a limiting factor for agriculture. Even during the short growing season, between mid September and mid April, natural hazards like frost, hail, droughts and severe downpours are by no means uncommon. Moreover, there is hardly any flat land for farming in the area. Gradients range from 10% to over 50%, (Semonkong Rural Development Project 1996). Cattle are used as draft animals for primary and secondary tillage, crops are sown and harvested manually, and chemical inputs such as pesticides are seldom used. Generally speaking, Leribe is more economically developed than Semonkong; this is due to presence of flat, arable land suitable for farming, access to farm machinery such as tractors and planters, good transport infrastructure and easier access to markets.

The regional map of Southern Africa

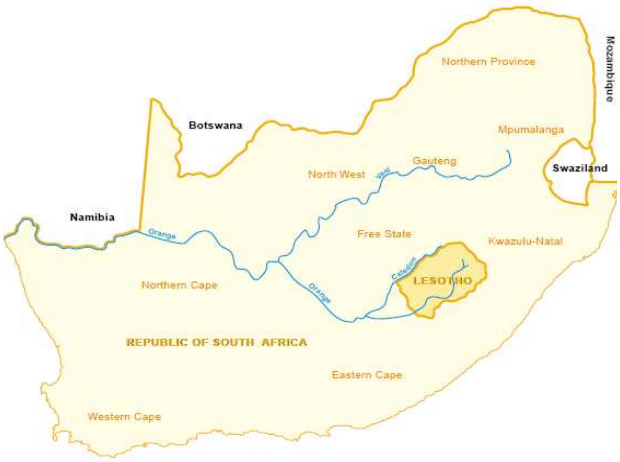

Fig. 1. Location of Lesotho in Southern Africa

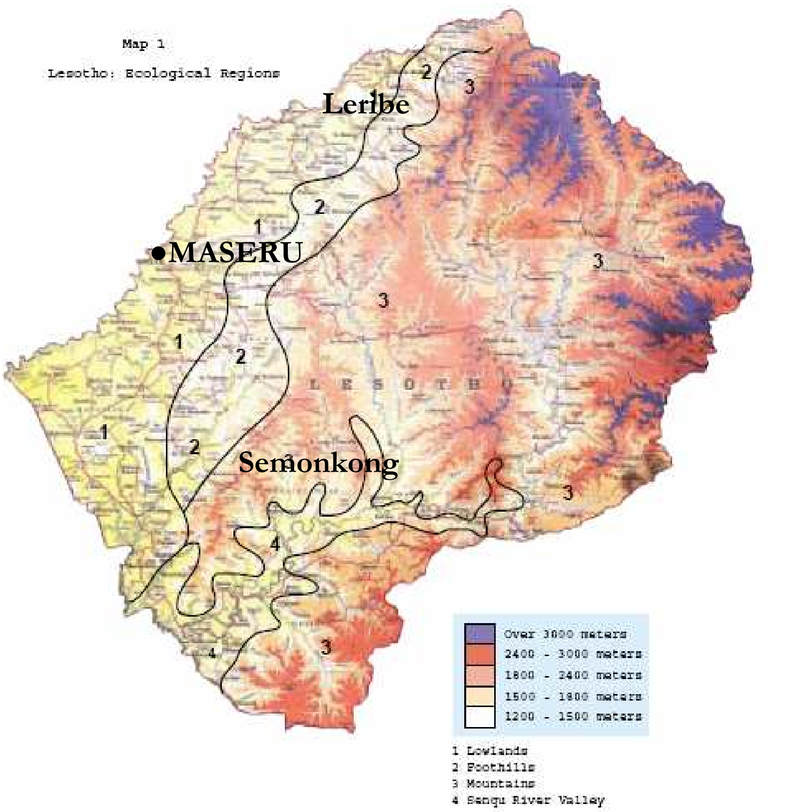

Fig. 2. Map of Lesotho showing the study sites

Choice of target crop species

In order to keep information collection and analysis manageable, the study focused on on-farm conservation of diversity in one crop species.

In Lesotho 85% of the households live in rural areas and derive all or part of their incomes from agriculture. The major crops grown in Lesotho in the order of importance are maize, sorghum, wheat, beans and peas. Other crops grown to a significant scale include potatoes and vegetables (Ministry of Agriculture 1995).

Maize, which was domesticated in central Mexico around 1500 BC, was brought to Africa around 1500 AD. Having spread to all corners of the continent within the relatively short period of 500 years, it is now Africa's most important cereal crop (McCann 2005). While in the modern economies of the United States, East Asia, and Europe maize is the industrial raw material, Africa's maize, however, has a different function altogether. Africa is distinctive among world regions in that 95% of its maize is consumed by humans rather than being used as livestock feed or industrial raw material (McCann 2005). In sub-Saharan Africa, maize is a staple food for over 50% of the population. It is mostly grown by subsistence farmers under dryland farming (International Institute of Tropical Africa 2002). Lesotho is among the world's top three countries with the highest percentage of maize consumed in national diets, with 46% of total calories, following Zambia and Malawi (McCann 2005).

It is in this regard that the focus of this study was on-farm conservation of locally adapted maize cultivars. Maize was selected as a target crop species for the study due to its importance for local livelihoods in Lesotho. It is the staple food for almost all of the country's population, constituting 40% of daily diet. Secondly, local maize cultivars are under severe threat in the country from the modern cash-based economy which promotes improved cultivars, the main emphasis being on yield.

The study targeted all locally adapted maize cultivars. Due to the absence of facilities for molecular characterization, and time constraint for agro-morphological characterization, local maize cultivars were only distinguished on the basis of local names used in the study areas[1].

[1] The name or description of a farmer's variety may be related to the original source of the material and the morphology of the plant (colour, shape, height, growth habit, etc.). A clear description of this is outlined by Jarvis et al. (2000).

Identification and selection of survey sample

Jarvis et al. (2000) give a guideline of the basic principles of choosing a representative sampling size. They point out that sampling size depends on the amount of variation among samples. A larger sample size will give more information on the variation between samples than will a smaller sample, thus, the more homogeneous the population, be it in terms of household characteristics, field soil types or variety populations, the less the need will be for larger sample sets.

Identification of the villages appropriate for the study was done in collaboration with the extension workers from each of the two resource centres, and lists of potential households were drawn with the help of village leaders as well as other local people from the study sites. A sample of 15 villages representing about 30% of the villages was drawn from 50 villages covering the selected agricultural resource centres. A stratified random sampling procedure was employed to ensure representation of all the sub-centres and 10% of smallholder maize farming households within each of the 15 villages was randomly selected for household survey, making a sample size of 141 respondents. Due to the time consuming nature of the study and limited resources, the number of farm families targeted in the study was 150.

Survey technique

Selected farmers were contacted in advance, usually directly but sometimes through a local intermediary, who was the area extension agent in most cases, in order to explain the purpose of the study, and to establish their willingness to participate. The methods used for data collection were both quantitative and qualitative in nature. The survey instrument used was a questionnaire, completed by personal interviews. The questionnaire was administered at household level and where possible, in the farmers' fields. This allowed direct observation of the farmers' practices used for maintenance of local maize cultivars in their fields and helped verify the information provided by the farmer. The household members interviewed were either men or women, depending on who was at home during the time of interview.

The survey questionnaire (Appendix 1) included both semi-structured (with a set of categorised alternatives to choose from) and in-depth, open-ended questions (not pre-categorised). Frankfort-Nachmias and Nachmias (1996) discuss the pros and cons of both types of interviews. Semi-structured questions included demographic and socioeconomic characteristics of farmers and their households. Most of the questions were open-ended and were framed to understand conditions in which farmers operate, the benefits they derive from local maize cultivars, the constraints they face in production, particularly from the farmers' own point of view and relative to their own knowledge systems. The interviews were realized with individuals, complemented by informal group discussions to deepen and validate data gathered by questionnaire survey.

The study was participatory in nature, as farmers were not just involved in an extractive information gathering process only, but also in a large part of the analytical process. In the words of King (2000), "the use of participatory research tools helps communities to better understand their situation and identify their own solutions". This kind of research also increased farmers' confidence in their own abilities as individuals as well as a community. Group discussions were openly recorded, allowing responses to be verified afterwards. On average, interviews lasted 15-30 minutes.

Data analysis

Background to data analysis

The present status of locally adapted maize cultivars in the two study areas was assessed by different local names representing local maize cultivars. While Morris and Heisey (1997) & Wood and Lenné (1997) argue that the number of different names representing the cultivars in a given field, farm or region is not usually a good indicator of diversity, Tripp (1996) states that the most common means of assessing the status of farm level crop diversity is by counting farmer-named varieties. Bajracharya et al. (2002) also mention that a farmer-named cultivar is the initial indicator of diversity on-farm.

In analyses of on-farm diversity, the dependent variable can be measured as a choice between two types of crop populations, a choice of how many varieties to grow, a choice of area allocation among varieties, or in other ways (Jarvis et al. 2000). Maxted et al (2002) suggest that concentration be made on farmers who are currently maintaining high levels of diversity. Therefore in this study determination of the specific variables influencing farmer's willingness to maintain local maize diversity on-farm (i.e., identifying people who are likely to maintain local maize diversity on-farm) was based on the assumption that there is a direct relationship between farmer's willingness to maintain local maize diversity on-farm and the number of maize cultivars grown on-farm, following the same procedure as that employed by Cromwell and van Oosterhout (2000). In other words, if farmers are cultivating more maize cultivars, it is assumed that this demonstrates their willingness to maintain these cultivars on-farm.

The contribution of local maize cultivars to farmer livelihood strategies was determined based on the local uses and benefits derived from maintenance of local maize cultivars.

To determine the practices used for maintenance of local maize cultivars on-farm, survey farmers were asked to provide information about local seed maintenance practices in terms of the way they select seed for the next cropping season, the way they store the seed, and the way they exchange seed within their own social networks. Farmers were also asked to provide information on the ownership of fields on which the cultivars are grown, land use and field management practices which they apply to maintain the listed maize cultivars on-farm, starting from land preparation to harvesting. In-depth description of the practices followed once they were mentioned; this involved a detailed description of how the practice is carried out, farmer's objective with the practice, decision-making practices at household level and gender involvement in the practice.

Since semi-structured and in-depth, open-ended interviews were employed in this study, most responses provided qualitative data. Therefore, to facilitate quantitative analysis of data, numeric codes were assigned to each category of observations. Data editing, cleaning and screening preceded statistical analyses.

Analytical tools

Demographic and socioeconomic characteristics of survey respondents were analysed by means of descriptive statistics.

The status of local maize diversity was analyzed based on average area (in acreages) allocated to each cultivar and number of households growing each cultivar for a total of four classifications (*Large area and many households*, *Large area and few households*, *Small area and many households*, *Small area and few households*).

Binary logistic regression analysis was carried out to assess the probability that a farmer chooses to maintain local maize cultivars on-farm. The dependent variable was coded as 1 if the farmer maintains more than one type of maize cultivars (favourable condition) and 0 if he/she maintains only one maize cultivar (unfavourable condition). According to the logistic model, the probability (P_i) that the *ith* farmer is willing to maintain local maize cultivars is given by:

$$P_i = \frac{1}{1 + e^{-z_i}} = \frac{e^{z_i}}{1 + e^{z_i}} \qquad (1)$$

or

$$Z_i = \log \left[\frac{P_i}{1 - P_i} \right] \qquad (2)$$

Where P_i is the probability that the *ith* farmer is willing to maintain local maize cultivars; Z_i is an index that is linearly related to an array of socioeconomic and sociocultural variables influencing farmers' willingness to maintain local maize cultivars on-farm. More specifically, the relationship between these variables and Z_i may be described as:

$$Z_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_n X_{in} \qquad (3)$$

Where *β's* are parameters of the logit model to be estimated, *X's* are the hypothesized explanatory variables influencing the farmers' willingness to maintain local maize diversity on-farm. These include: *sociodemographic variables:* age of the farmer (in years), gender, level of formal education, family size (number of family members), and number of years in maize cultivation; *socioeconomic variables:* herd size (number of farm animals owned), farm size (land area in acreages), and source of household income. The model was estimated using Enter Method. Categorical subcommand was selected in order to create dummy variables to be included in the model.

Practices used for maintenance of locally adapted maize cultivars on-farm were analysed by means of frequency distributions and descriptive statistics. A two-sample *t*-test procedure was employed to compare the means of observations in the two areas, assuming equal variance.

All statistical analyses were carried out using Microsoft Excel and Statistical Package for Social Sciences (SPSS) Version 11.5 software for Windows.

Ethical considerations

This study will serve as an important record of local indigenous knowledge associated with maintenance of locally adapted maize cultivar diversity and will therefore be documented and respected accordingly.

Finally, and perhaps most importantly, it is expected that this study will strengthen the capacity of the National Plant Genetic Resources Centre (NPGRC) to enhance the support of *in situ* conservation of agrobiodiversity on-farm.

Results

Characteristics of survey respondents

Characteristics of survey respondents according to demographic and socioeconomic variables are summarised in Table 1. A total of 141 respondents (66 at Semonkong and 75 at Leribe) were interviewed at household level. Across the two study areas, there are no significant differences among survey respondents in terms of gender, age groups, distribution of marital status, family size (measured by number of people in a household), and source of household income, $p>0.05$. A significant difference is observed in level of formal education and herd size between the two regions, $p<0.05$.

Most survey respondents had formal education, usually at the primary level (70.9%), majority of these are from Leribe (81.3%). A large percentage of the respondents owned less than 20 farm animals (67.4%). On average, Semonkong farmers owned a larger proportion of farm animals than farmers at Leribe (Mean 2.1 ± 1.8). Majority of farming households in both areas depended on both farming and off-farm employment as source of household income (51.1%).

Table 1. Demographic and Socioeconomic characteristics of survey respondents in two study areas

	Semonkong (n=66)			Leribe (n=75)		
	No. (%)	Mean	Std.	No. (%)	Mean	Std.
Gender		1.55	0.502		1.43	0.498
Male	30 (45.5)			43 (57.3)		
Female	36 (54.5)			32 (42.7)		
Age		3.08	0.865		3.29	0.712
<20	1 (1.5)			-		
20-40	17 (25.8)			10 (13.3)		
>40-60	26 (39.4)			34(45.3)		
>60-80	20 (30.3)			30(40.0)		
>80	2 (3.0)			1 (1.3)		
Marital status		2.26	0.590		2.21	0.527
Single	5 (7.6)			4 (5.3)		
Married	39 (59.1)			51 (68.0)		
Widowed	22(33.3)			20 (26.7)		
Level of formal education		0.92	0.640		1.16	0.494
No formal education	16 (24.29			2 (2.7)		
Primary school	39 (59.1)			61 (81.3)		
Secondary school	11			10 (13.3)		
High school	-			2 (2.7)		
Family size		1.68	0.559		1.55	0.576
<5	24 (36.4)			37 (49.3)		
5-10	39 (59.1)			35 (46.7)		
>10	3 (4.5)			3 (4.0)		
Herd size		2.06	1.839		1.09	0.440
0	9 (13.6)			1 (1.3)		
<20	27 (40.9)			68 (90.7)		
20-40	11 (16.7)			5 (6.7)		
>40-60	6 (9.1)			-		
>60-80	3 (4.5)			1 (1.3)		
>80-100	3 (4.5)			-		

>100	7 (10.6)			-		
Source of household income		1.56	0.500		1.47	0.502
Mainly dependent on farming	29 (43.3)			40 (53.3)		
Dependent on farming and off-farm activities	37 (56.1)			35 (46.7)		

Present status of locally adapted maize cultivars

Table 2 shows the frequency distribution of locally adapted maize cultivars reported in the two areas. Nine local maize cultivars were reported. Depending on the socioeconomic context and environmental circumstances, the individual households were found to maintain a range of one to four local maize cultivars, (mean = 1.3±0.5).

Since the cultivar names were just recorded as given by the farmers without modifying them, some maize cultivars were just called *'Poone'* which means maize in the local language, farmers did not have specific names for them, but they have been growing them for several years. Since the target farmers both at Semonkong and Leribe were those who were known to be growing local maize cultivars and due to the fact that the study was not dealing with modern cultivars, these cultivars are still considered as local cultivars in this study even though they may not be the same e.g., *Poone e khubelu* (yellow maize) and *Poone e ts'oeu* (white maize). At Semonkong only locally adapted maize cultivars are grown, therefore, it can be concluded that these are local cultivars even though the farmers did not have specific names for them.

Table 2. Frequency distribution of locally adapted maize cultivars reported in the two study areas

Reported local maize cultivars	Semonkong	Leribe
*Hlakaleboea le lepolanka	**59**	1
*Hlakaleboea le lehakoana	10	0
Lekutumane	3	0
Silverking	1	**49**
Torolane	0	19
'Matjolobane	3	0
Borotho	1	1
Natal 8 row	1	9
Palama	4	0
Poone e khubelu	6	22
Poone e ts'oeu	0	4

* Farmers distinguished the cultivar *Hlakaleboea* according to the grain shape, *Hlakaleboea le lepolanka* is a dent type while *Hlakaleboea le lehakoana* is a flint type. These cultivars also differ in agronomic performance as reported by the farmers, therefore, they are treated as different cultivars in this study.

Palama, *'Matjolobane, Lekutumane* and *Hlakaleboea le lehakoana* were not reported at Leribe while *Torolane* and *Poone e ts'oeu* were not reported at Semonkong. The average area allocated to maize cultivars was 2.4 acres at Semonkong and the number of households growing local maize cultivars was 8.55 or 9 on average; whereas at Leribe the average area allocated to maize cultivars was 2.9 acres and the average number of households growing local maize cultivars was 11. The two areas are not significantly different in terms of the proportion of farm area allocated to local maize cultivars, ($t = -0.611$, $df = 114$, $p>0.05$, $n=116$). It was also found that farmers at Leribe maintain high diversity of local maize cultivars than those at Semonkong (Fig. 3) though the means are not significantly different, ($t = -1.191$, $p>0.05$). Table 3 shows the amount and distribution of locally adapted maize cultivars at Semonkong and Leribe based on average area allocated to local maize cultivars and number of households growing maize cultivars.

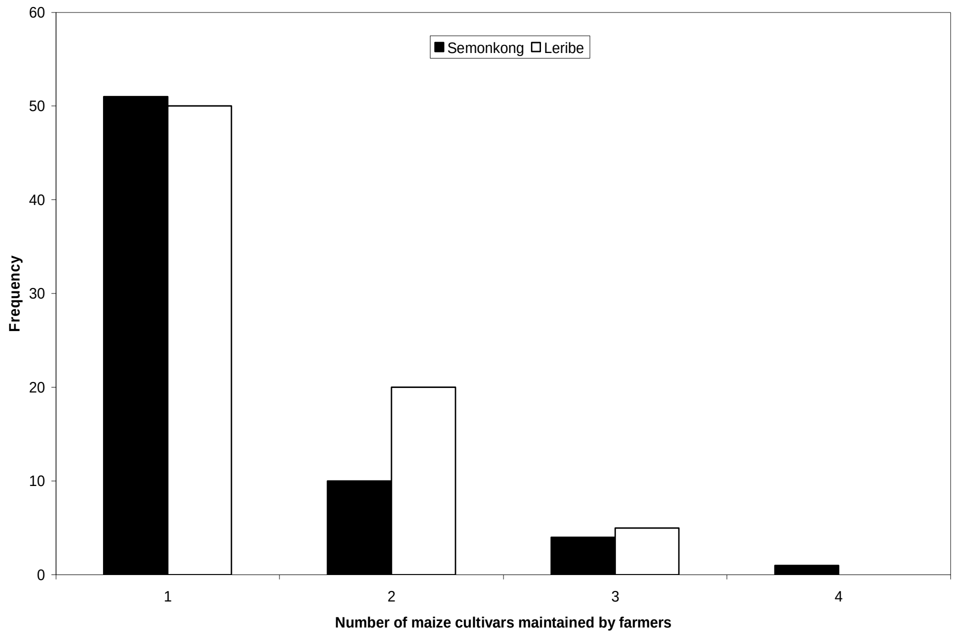

Fig. 3. Number of maize cultivars grown by farmers as observed in two study areas.

Table 3. Amount and distribution of locally adapted maize cultivars based on average area and number of households growing maize cultivars

Category	Semonkong	Leribe
Average area allocated to local maize cultivars (acres)	2.4	2.9
Average number households (HH*) growing maize cultivars	8.55	11.11

Cultivar classes:		
Large area and many HH	Hlakaleboea le lehakoana, Hlakaleboea le lepolanka	Silverking
Large area and few HH	-	Hlakaleboea le lepolanka, Natal 8 row
Small area and many HH	-	Torolane
Small area and few HH	Lekutumane, Silverking, 'Matjolobane, Borotho, Natal 8 row, Palama	Borotho

HH = Households

Specific variables influencing farmers' willingness to maintain local maize cultivars on-farm

Results of logistic regression analysis as summarised in Table 4 show that the number of local maize cultivars grown on-farm is highly correlated with two variables; (i) source of household income, and (ii) number of years in maize cultivation. Other independent variables: age of the farmer (in years), gender, level of formal education, family size (number of family members), herd size (number of farm animals owned), and farm size (land area in acreages) did not show any significant correlation with the farmers' decision to maintain local maize cultivars on-farm.

Table 4. Logistic regression results of independent variables influencing farmers' willingness to maintain local maize diversity for the two locations (n=141)

Independent Variable	B	S.E.	Wald	P	-2 Log Likelihood	Chi-square	R square
Farm size (<1 acre)	0.440	0.569	0.596	0.440	116.926	23.413	0.260
Age (<50 years)	-0.685	0.525	1.698	0.193			
Education (No formal education)	0.454	0.676	0.451	0.502			
Family size (<6)	-0.152	0.485	0.099	0.754			
Herd size (<20)	0.175	0.560	0.098	0.754			
Number of years in maize cultivation (<10)	-1.300	0.489	7.063	0.008*			
Source of household income (Dependent on farming only)	-1.510	0.491	9.469	0.002*			
Gender (Male)	0.351	0.471	0.557	0.456			

* Correlation is significant at $p<0.05$ level. B = logistic regression coefficient, SE = standard error, Wald= Wald statistic (which has a chi-square distribution), *P* = significance level, *R square* statistic (measures the proportion of the variation in the response that is explained by the model).

Contribution of the local maize cultivars to farmer livelihood strategies

In Lesotho local maize cultivars play a vital role for rural household food security and diversity-based livelihoods. The contribution of local maize cultivars to farmer diversity-based livelihood strategies is presented below:

Local use and cultural benefits of local maize cultivars

Maize is one cereal crop which can be used in as many ways as possible. Virtually every part of the plant - including the grain, leaves, cobs, stalks, and even roots—can be put to human use. Among the farmers surveyed in the two study areas, it was found that farmers maintain diverse maize cultivars to meet specific agronomic and end-use requirements. People eat maize at its green, milky stage—boiled or roasted on the cob. Also during this time, some maize cultivars produce sweet, juicy stalks which people chew. When the crop is physiologically mature, the ears are harvested and the kernels are ground into flour. Though the flour can be used for preparing other dishes, it is mainly used to cook the staple food, *papa*. Some local maize cultivars are good for making *papa* (in terms of taste and good cooking quality – less flour used) (Table 5); others are tasty when boiled or roasted on the cob at milky stage; while others are suitable as animal feed, especially for horses and poultry; the thick stalks and cobs make good cooking fuel; the stalks are also piled as fodder after harvest. The maize stalks are highly needed in winter and at the beginning of the planting season when there is no plant cover for animal grazing.

Economic benefits of local maize cultivars

Local maize cultivars are adapted to average to marginal environments where farmers have limited options. One of the reasons why farmers grow locally adapted maize cultivars is that improved cultivars need seed and other production inputs to be purchased every year, so most of resource poor farmers in agriculturally marginal areas are not able to meet this requirement, therefore they opt for locally adapted maize cultivars. Most of these cultivars produce hard grains that render them good storage quality, farmers do not have to buy chemicals to control for storage pests as long as the seeds are thoroughly dry, (as shown in the section of *seed storage practices*, only 1.4% of the farmers are controlling storage pests), this also has a good economic implication. Again, while small scale farmers mainly grow maize for household consumption, some maize cultivars are sold in the local market as grain or as seed for generation of household income (Figure 4). Local maize cultivars therefore provide services including livelihood support.

Table 5. Cultural and agronomic characteristics of locally adapted maize cultivars reported at Semonkong and Leribe

	Consumption-related attributes						Environmental and production-related attributes				
Reported local maize cultivars	Taste at milky stage	Quality for making *papa* (taste)	Cooking quality (less flour used for making *papa*)	Milling quality	Storability (Storage quality)	Fodder	Maturity level	Drought tolerance	Pest resistance	Frost resistance (Cold tolerant)	Yield
Hlakaleboea le lepolanka	Not tasty	Tasty	Poor	Good	Good		Fast	High	Low	High	High
Hlakaleboea le lehakoana	Tasty	Not tasty	Good	Good	Good		Fast	High	Low	High	High
Lekutumane	Tasty	Not tasty	Good	Good	Good	Good	Fast	Poor	Poor		Low
Silverking	Not tasty	Tasty	Poor	Poor	Good		Very fast				High
Torolane	Tasty	Tasty	Very good	Good	Good		Fast				High
'Matjolobane	Not tasty						Fast	High			
Borotho					Poor		Late				
Natal 8 row	Tasty	Not tasty				Good					High
Palama			Good				Fast			Poor	High

Ecological benefits of local maize cultivars

As a food plant, maize is grown either in the field or on a homegarden. Local maize cultivars are most commonly grown under natural conditions without external inputs e.g., farmers at Semonkong do not apply fertilizer in their fields; rather, the maize stubble is ploughed into the soil in winter immediately after harvest so as to improve the soil structure and the fertility status of the soil. Local maize cultivars which were recorded both at Semonkong and at Leribe are grown under very diverse environmental conditions in terms of topography, site feature, slope aspect, soil characteristics, etc. Along with the sociocultural reasons, locally adapted maize cultivars are the choice for a variety of niches and ecosystems, for example, *Hlakaleboea*, a cold tolerant local maize cultivar, is the most commonly cultivated cultivar at Semonkong, at an altitude of 2,300 meters or more above sea level, where there is extremely short growing season because of frost.. Because of the prevailing drought and frost conditions which general crop production is subject to in the country, farmers prefer local cultivars because of their adaptation to harsh conditions and early-maturing characteristic, they yield some harvest after all but the worst conditions. In this way, growing locally adapted maize cultivars minimizes production risks and increases the resilience of the farming system. Farmers at Leribe also reported that they prefer local maize cultivars because they are tasty compared to modern cultivars, which are produced with high external inputs. Landraces are therefore chosen because of their ecological advantages with multiple economic implications. Therefore, in one way or another, growing locally adapted maize cultivars enhances ecosystem health and human well-being.

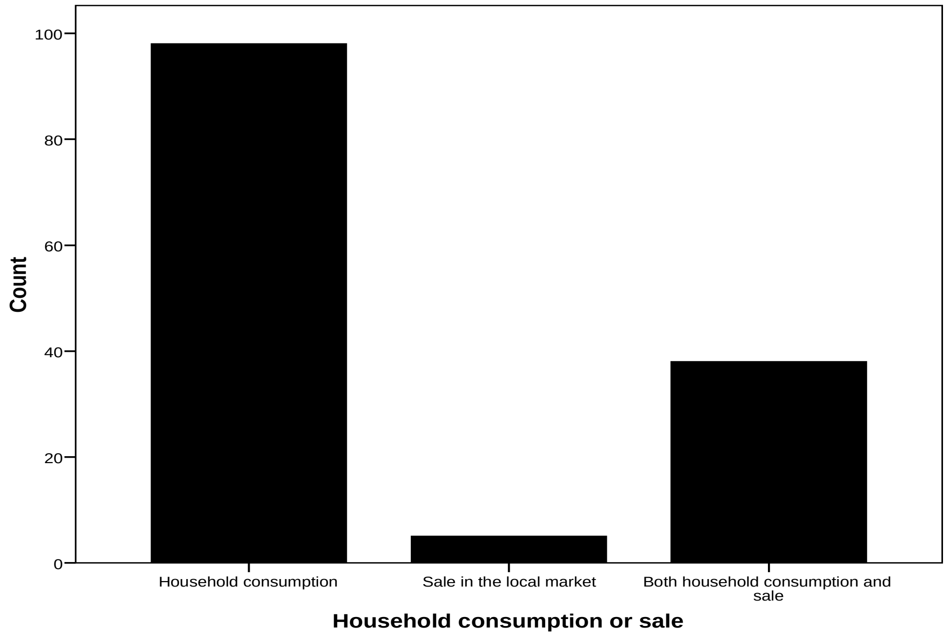

Fig. 4. Household consumption of local maize cultivars or their sale in the local market.

Last but not least, across the two study areas, 45% of the farmers perceive that the next generation will continue to grow locally adapted maize cultivars, while 27% do not think the next generation will continue to grow locally adapted maize cultivars and 28% have no idea. For those who think the next generation will continue to grow locally adapted maize cultivars, their reasons are (i) they are aware of their multiple benefits, 18% of respondents, (ii) they have shown interest in farming, 16% and (iii) they are shown how to maintain them, 11%. For those who think the next generation will not continue to grow locally adapted maize cultivars, their reasons are (i) they are no longer interested in farming, 15% and (ii) they will want to change, 12%.

Practices used for maintenance of local maize cultivars on-farm

The findings of this study indicate that farmers apply many regular processes to maintain local maize cultivars on their farms which include, among others, land preparation, planting, cultivation, harrowing, weeding, applying fertilizers, applying pesticides, harvesting, selecting, storing and exchanging local maize cultivars. Descriptions of field management practices and gender involvement in the practices are given in Appendix 2. Reported maize cultivars included those grown on farmers' own fields, freehold (77.3%), on rented fields (3.5%) and on fields in association with other farmers, sharecropping (19.1%).

Farmer decision-making practices

Decisions on which variety to grow, proportion of field area to allocate for maize varieties and which management practices to apply are either made by men, women or both men and women, but most commonly, decision-making at household level is done by both men and women (Figure 5).

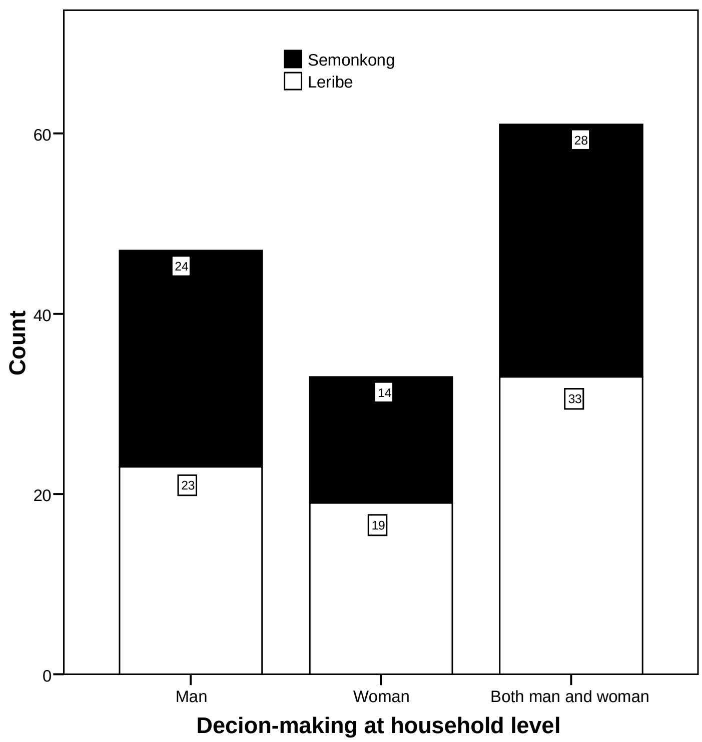

Fig. 5. Farmer decision-making at household level

Seed sourcing practices

The seed source was classified in three categories as shown in Figure 6 (i) "Own seed[2]" (seed selected by the farmer from his own harvest, (ii) Seed obtained from another farmer within village and (iii) Seed obtained from a neighbouring village. Data on seed sources illustrate the important role played by seed acquired from other farmers inside and outside the communities relative to seed that local farmers obtain from their own harvests. These findings, therefore, show the extent of farmer to farmer seed exchange in the two regions. If a farmer does not grow a particular variety for several successive seasons, it does not necessarily mean that the farmer has ceased cultivating it altogether, as long as the seed for that cultivar can still be obtained from other farmers. This is proved by the farmer responses to an open-ended question "what would you do if you lost all your seed?", they always mentioned that they would look for seed of the same cultivar from their relatives, from their neighbours or from the neighbouring villages. Results of the *t*-test indicate that there is a significant difference between the two regions in terms of seed sourcing behaviour, ($T=2.446$, $p<0.05$).

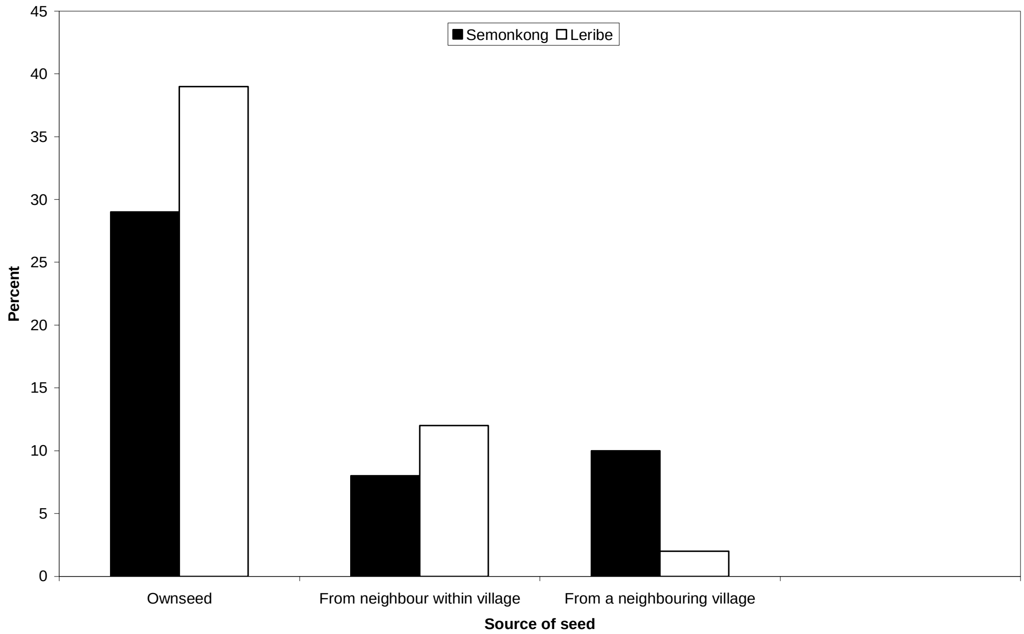

Fig. 6. Farmer seed sourcing practices as observed in two areas

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[2] A seedlot is considered "own seed" if the ears from which the kernels were selected were harvested by the farmer in his own field

Among the farmers who are outsourcing seeds off-farm, their reasons of using seed from other sources include. (a) to try seed of new varieties, (b) loss of harvested seed (poor harvest, stored seed lost due to pests or diseases, seed eaten or sold), (c) to replace diseased or physiologically deteriorated seed, (d) own seed not of good quality, (e) lack of seed choice because of sharecropping[3], and (f) difficulty of maintaining seed viability from harvest until planting.

Seed selection practices

Among the farmers surveyed in these two regions, majority of farmers select seed for the next cropping season, 37% at Semonkong and 48% at Leribe, while only 10% at Semonkong and 6% at Leribe respectively do not select seed. Those who do not select seed mentioned that, according to their experience, any healthy seed grows, so that there is no need to select seed whereas others do not have time to select the seed. For those who select seed, their reasons for selecting the seed are: to ensure good seed quality and good germination, and to maintain the purity or ideotype of the variety (Table 6). Across the two study areas, the purpose of seed selection is almost the same, no significant difference.

Looking at the level of seed selection, only one case was reported at Leribe of seed selection at the plant level, seed selection is most commonly done at ear level (95%) and only five cases were reported of seed selection at the grain level. Selection on ear characteristics alone seemed to be the most common practice for local maize in the two regions.

Table 6. Farmers' objective with seed selection

Purpose of seed selection	Semonkong N (%)	Leribe N (%)	Total N (%)
No seed selection	14 (15)	8 (9)	22 (24)
To ensure good seed quality and good germination	17 (19)	23 (25)	40 (44)
To maintain the purity or ideotype of the variety	15 (17)	14 (15)	29 (32)
Total	46 (51)	45 (49)	91 (100)

The criteria used by farmers in seed selection include well-developed ears without fungi or insect damage, well-filled and healthy kernels. Some also

[3] This is still an important practice in Lesotho whereby one farmer produces maize in association with another farmer because of socioeconomic or agroecological constraints. The field owner supplies inputs such as seed and draught animals, and the cropping partner supplies labor. Selection of which varieties to plant is normally done by the field owner.

consider ears with straight lines and the number of lines, depending on the variety type, as they say "seed ears should be typical or representative of the ideotype of the variety". In other words, the seed ear should resemble the variety the farmer wants to harvest. From the selected ears, kernels of the top of the ear and those of the base are not used as seed; rather, they are added to the grain for household consumption. These were observed both at Semonkong and Leribe.

The time of seed selection is presented in four categories as (i) in the field prior to harvest, (ii) at harvest time, (iii) after harvest during storage, (iv) in the farm store immediately before planting (Fig. 7A-B). Selection is not done from plants in the field during the cropping season considering the vegetative characters of the plant, but from a pile of harvested ears that constitutes the household's grain stocks. These stocks include ears from the entire population of maize plants in the farmers' fields - those in the centre and those on the borders of the field, which are more likely to be contaminated by adjacent maize fields. Farmers do not control pollen sources or consider the vegetative and agronomic characteristics of the plants that produce the selected ears. Sometimes farmers select their ears for seed immediately before planting, choosing them from the ears remaining after consumption of the previous season's harvest, the reason being the ability of the seeds to have survived storage pests and disease attack until the next cropping season. Farmers' time of seed selection is significantly different between the two regions ($t=-3.759$, $P<0.05$).

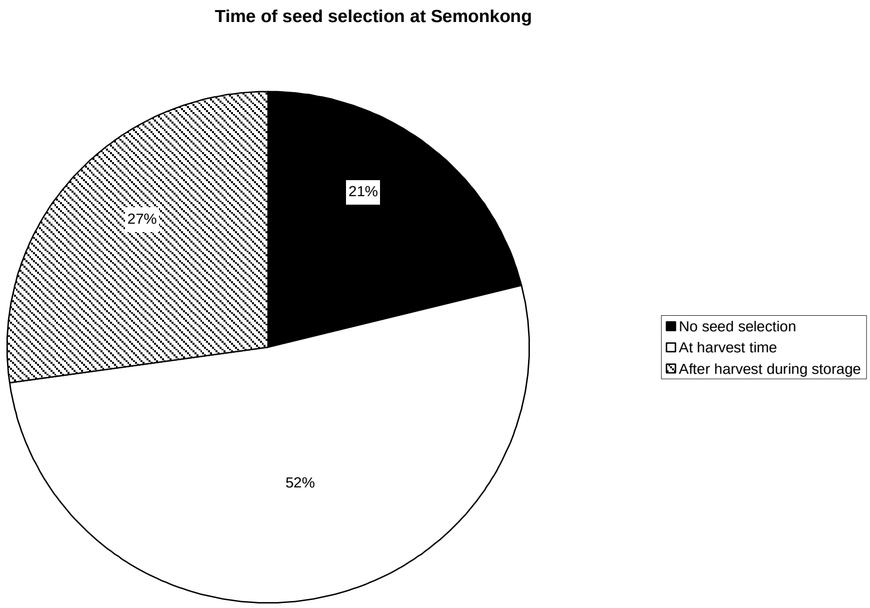

Fig. 7A. Farmers' time of seed selection at Semonkong

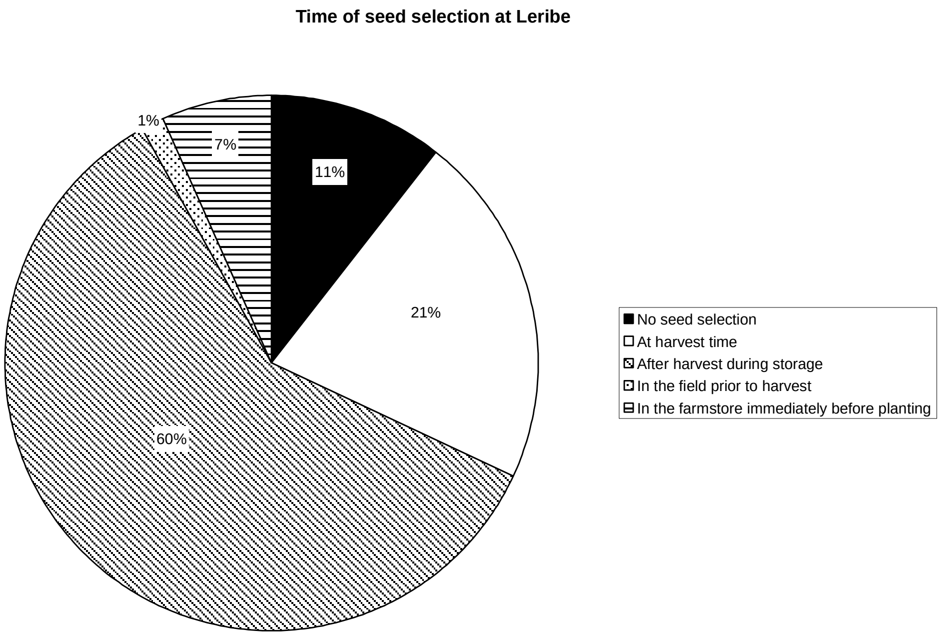

Fig. 7B. Farmers' time of seed selection at Leribe

Seed storage practices

The findings of this study indicate that farmers who select and save seed for the next cropping season are very careful to store seed in safe places to maintain high seed quality. This is because the methods of seed storage and storage devices used may determine the vulnerability of seed to pests, diseases and physiological deterioration, thereby affecting seed quantity and quality for the next planting season.

In most cases farmers keep seed in local containers and structures made with locally available materials. Seed storage by the farming communities in the two regions was presented in five categories as shown in Table 7; (0) No seed storage, whereby the farmer is not selecting the seed for the next cropping season, and therefore no seed to store, (1) Unthreshed seeds stored together with grain, (2) Threshed seeds stored in a separate container, (3) Unthreshed seeds stored in a separate container, (4) Seeds mixed with chemicals to control storage pests, and (5) Unthreshed seeds piled in a separate house (without a container). Independent samples t-test procedure revealed that the two regions differ significantly in terms of seed storage practices, $t = -2.453$, $P<0.05$.

Table 7. Farmer seed storage practices

Seed Storage practice	Semonkong N (%)	Leribe N (%)
No seed storage	14 (10)	8 (6)
Unthreshed seeds stored together with grain	8 (6)	16 (11)
Threshed seeds stored in a separate container	31 (22)	14 (10)
Unthreshed seeds stored in a separate container	11 (8)	30 (21)
Seeds mixed with chemicals to control storage pests	-	2 (1)
Unthreshed seeds piled in a separate house without container	2 (1)	5 (4)
Total	66 (49)	75 (53)

Constraints faced by farmers in maintenance of local maize cultivars on-farm

Table 8 summarizes the main practical constraints faced by farmers in maintenance of local maize cultivars and farmers' responses to these constraints as observed both at Semonkong and at Leribe. Animal draft power is the only alternative available to smallholder farmers in their remote areas. Draft animals have drastically decreased in numbers as a result of stock theft. Again, these animals depend on the communal rangelands for their survival, which in turn are also badly degraded as a result of over-grazing.

Table 8. The main practical constraints faced by smallholder farmers in maintenance of local maize cultivars at Semonkong and Leribe and farmers' responses to the constraints.

	Farmers' responses	
Constraints	Semonkong	Leribe
Frost	This is a major limiting factor to agriculture at Semonkong. Farmers store seed in large quantities, if frost occurs immediately after seed emergence, they reseed their fields.	Not a very big problem, but if it occurs, farmers opt for another crop.
Drought	Generally there is no solution except early planting.	No solution.
Pests	This is not considered as a major problem at Semonkong. Pesticide application is not a common practice; farmers may use traditional medicine to control pests.	Application of pesticides.

Low nutrient content Low yield	Low nutrient content is not considered a problem at Semonkong; farmers still consider their soils fertile. Very few farmers have started applying farm yard manure in their fields to increase yield.	Application of organic and inorganic fertilizers, intercropping with legumes, especially beans.
Lack of established markets Lack of seed	Farmers sell or exchange their produce and seed within their own social networks: with relatives, with neighbours within village or from neighbouring villages.	Farmers sell or exchange their produce or seed with relatives, with neighbours within village or from neighbouring villages. At Leribe farmers also have access to commercial markets.
Lack of draft animals	This is a very big problem at Semonkong. Farmers make arrangements to assist one another. Though this is still an important custom, it is associated with problems because those who have draft animals plough their own fields first and later assist their neighbours, sometimes when it is already late in the planting season so that the crops are not able to escape frost or drought.	Not a problem at Leribe since farmers have access to farm machinery such as tractors.

Discussion

Although the recording of local maize cultivars encompassed different maize types in terms of grain colour and shape, farmers actually planted only an average of 1.3 cultivars per household. They select for traits which they value most in local maize cultivars. The major concerns to which the prioritized characters refer include drought tolerance, yield, storage quality, taste, earliness and frost/cold tolerance. The specific traits which farmers valued most in a local maize cultivar, according to the findings of the present study were (i) their adaptation to local environmental conditions, (ii) their agronomic characteristics like drought tolerance, (iii) their storage quality, they resist damage by storage pests because of hard grains, (iv) tolerance to harsh climatic conditions, they yield some harvest after all but the worst conditions and (v) their quality for making the traditional porridge, though these vary considerably among farmers and between the two areas. Bellon and Brush (1994) found that farmers prefer maize cultivars because of their adaptation to specific soil conditions. When asked if they can grow local maize cultivars under different environmental conditions or if these cultivars need specific conditions, survey farmers mentioned that based on their agroecological knowledge and field experience, these cultivars can grow anywhere in the agroecosystem, though this is referring to the local conditions. Within region, local maize cultivars are grown under varying local environmental conditions in terms of topography, site feature, slope aspect, and soil characteristics. They have developed their distinctive properties within these local environmental conditions.

Nine local maize cultivars were recorded in the two study areas, excluding those which did not have specific local names. Two of them are the most commonly grown cultivars while others are not abundant in the areas where they are found. The main observation was that a number of local maize cultivars within farmers' fields gradually disappear or become rare due to their inability to compete with early maturing local cultivars or high yielding, improved cultivars in the farming system. The dominance of *Silverking* in Leribe and *Hlakaleboea* in Semonkong, both of which are early-maturing cultivars, is a clear indication of severe erosion which has occurred in local maize cultivars as demonstrated by reduced number of households growing late maturing cultivars and reduced proportion of farm area allocated to them. Persistent drought and frost conditions as well as marginality were found to be the major contributing factors to erosion in local maize cultivars; that is why farmers at Leribe maintain high diversity of local maize cultivars than those at Semonkong where there are harsh growing conditions, this was also reported by Chiwona (2000) in Malawi. Farmers at Leribe also grow modern cultivars, but this is not possible under the harsh conditions at Semonkong with its extremely short growing season.

In general, according to the findings of this study, more farmers maintain one type of maize cultivar, 71%, while those who maintain more than one type of maize cultivar constitute 29%. Results of logistic regression analysis show that tow independent variables are associated with farmers' willingness to maintain local maize cultivars on farm. These are number of years in maize cultivation and source of household income.

From the logistic regression analysis it is found that it is not one single set of variables, whether socioeconomic or sociodemographic, that determines on-farm crop diversity, but a combination of these sets of variables. This was also found by Cromwell and van Oosterhout (2000) using multiple regression analysis. These results imply that farming families who are likely to maintain high levels of local maize diversity on-farm could be identified from either regions but are (i) farmers who have a long history of maize cultivation (>10 years), due to their agroecological knowledge and field experience, and (ii) those who depend on both farming and have access to off-farm activities. The results suggest that farmers who depend on on-farm and off-farm employment for generation of household income are likely to maintain local maize diversity on-farm. It is those who have some form of community leadership (highest within the off-farm employment category). In most cases these are the village chiefs or headmen who normally have access to large fields other than other villagers. Even though age did not show any significant correlation, the findings of this study also suggest that it is older farmers who are likely to maintain local maize diversity, those who have been under maize cultivation for more than ten years. Cromwell and van Oosterhout (2000) also found that older farmers are likely to maintain diversity of small grains in Zimbabwe. Maxted et al. (2002) consider the importance of knowledge people have of diversity and its management and suggest that older people be specifically targeted for on-farm conservation activities. But Cromwell and van Oosterhout (2000) suggest that this may pose a threat to the longer term maintenance of on-farm crop diversity when the older generation dies and when economic pressures on younger families continue to increase. Maxted et al. (2002) are also aware of the question of sustainability, and suggest that it would certainly be advantageous if younger farmers were involved as well. This suggests awareness campaigns of the importance of cultivating local maize cultivars among younger farmers.

Analysis of the contribution of local maize cultivars to diversity-based farmer livelihood strategies shows that farmers are unlikely to maintain local maize cultivar diversity simply for the public benefit that this could provide; local maize cultivars have a variety of private values to the farming communities, which are sociocultural, economic and ecological. Farmers therefore make rational decision that suit to their local conditions. Local maize cultivars have provided important options to address diverse ecosystems and local needs particularly in areas that are diverse and resource poor. Rijal and Synnevåg (2005) also found that unlike the greater economic value for improved varieties, landraces are considered to have a variety of substance, symbolic and adaptive values. The complementary roles of crop landraces and knowledge becomes vital to livelihoods, particularly in areas that are diverse, complex, and which are isolated from a variety of services related to market and extension. While small scale farmers mainly grow maize for household consumption, in the present study it was also found that local maize cultivars are grown for both household consumption and for sale in the local market. Rana *et al.*, (2000) reported that most rice landraces are used for home consumption whereas the modern varieties are grown for market purposes. Brush and Taylor (1992) also found that Andean farmers grow traditional potato cultivars primarily for home consumption and improved cultivars for the market.

Farmer to farmer seed exchange, whether between farmers within the community or outside the community, is clearly very important for continued maintenance of local maize cultivars on-farm in the surveyed farming communities, especially at Semonkong where farmers do not have access to any other type of maize seed other than their local cultivars. These patterns of maize seed exchange or seed sourcing behaviour explain major differences among survey farmers as described by Cromwell *et al.* (1993), who discuss four main groups of farmers with regard to seed sourcing behaviour: (i) there are farmers who are seed secure, those who can fulfil their own seed needs, (ii) some farmers source seed off-farm from time to time out of choice, (iii) other farmers source seed off-farm from time to time out of necessity, and lastly (iv) some farmers are seed insecure and consistently need to source seed off-farm. Wright and Turner (1999) refer to these groups and discuss the implications for genetic diversity; for instance, that seed secure farmers will tend to maintain their own varieties, they may manage a wider range of varieties than other farmers, without being affected by invasion of new varieties, and seed-insecure farmers may use a wide range of varieties, but may not necessarily continue to use them from one year to the next. While small-scale farmers usually prefer to use their own seed, there are a variety of reasons why farmers may use seed from other sources: to try seed of new varieties, loss of harvested seed (poor harvest, stored seed lost due to pests or diseases, seed eaten or sold), to replace diseased or physiologically deteriorated seed, own seed not of good quality and lack of seed choice because of sharecropping. These reasons are also explained by Long et al. (2000) and Louette and Smale (1998) who also indicate that farmers may use seed from other sources because of specialization e.g. use of mechanized planters (requiring graded seed) or production for particular markets (requiring uniform, pure seed).

It was obvious during this study that traditional ethnobotanical knowledge held by the farming communities is a main source of understanding diverse local uses and traditional management practices of local crop diversity on-farm. Farmers have the skills and knowledge to select crop varieties on the basis of their phenotypic characteristics. Seed selection is considered by majority of farmers as an important practice in the maintenance process of maize cultivars. This ensures that high quality seeds are planted every season and that purity of the varieties is maintained. Farmers believe that kernels from the top of the ear will not germinate or will produce badly developed ears with small kernels since these kernels are usually small, and are often damaged by birds, insects, and fungi. Kernels at the base of the ear are normally bigger in size compared to those at the top of the ear, they are often not damaged by birds or insects, but still, farmers do not select them as seed. They only select those at the centre of the ear as seed. These findings are similar to what Bellon (1990); Louette and Smale (1998); & Louette (2000) observed for maize. Differences, however, were found in the time of seed selection at Semonkong and Leribe. Most farmers select seeds after harvest, during storage, except in a few exceptions where seed selection is done in the field prior to harvest, considering the vegetative characters. Seed selection is based exclusively on ear characteristics alone. The ears may be from the entire population of maize plants in the farmers' fields - those in the centre and those on the borders of the field, which are more likely to be contaminated by adjacent maize fields. Farmers do not control pollen sources or consider the vegetative and agronomic characteristics of the plants that produce the selected ears. With maize, however, unless humans carefully control the pollination process, the plants exchange genetic materials with neighbouring plants and fields. Thus, all the maize in a given field will differ from the previous generation, a trait that lends the plant an unreliable and unpredictable character (McCann 2005). Maxted et al. (2002) argue that since the farming system is not closed, genetic diversty which is likely to enter the system is likely to be relatively similar to the landrace as it is likely to come from local farms. Therefore, the immigration of alien genetic diversity is unlikely to eradicate locally adapted diversity due to farmer and local environmental selection pressures. They point out that on-farm conservation is a dynamic process and qualitative changes of genetic diversity should be expected. Sometimes farmers select their ears for seed immediately before planting, choosing them from the ears remaining after consumption of the previous season's harvest, the reason being the ability of the seeds to have survived storage pests and disease attack until the next cropping season; this was also found by Chiwona (2000).

Conclusions

To this end, according to the findings of this study, it can be concluded that over generations, farmers have developed practices that maintain diverse maize cultivars in the farming systems. Local maize cultivars are still maintained by the farming communities with their traditional knowledge, skills and techniques. Depending on their field experiences and diversity available to them, farmers know how different cultivars behave and how they can maintain and use them. They have continuously developed strategies to conserve this diversity through a number of community-based management practices.

The study also concludes that it is not one single set of variables, whether socioeconomic or sociocultural that determines on-farm crop diversity, but rather a complex combination of these sets of variables.

From the findings of the study it can also be concluded that locally adapted maize cultivars have a significant contribution to the farmer livelihood strategies. They are one of the few resources available to resource-poor farmers in agriculturally marginal areas to ensure sustainable production and diversity-based livelihoods. Farmers who grow local maize cultivars are interested and willing to do so. They dedicate their valuable resources to make cultivation of these cultivars possible. This is because of the multiple benefits these cultivars have to their own personal lives, on their own farms, within their own communities.

Contrary to the modern concept of variety, traditional cultivars are not genetically stable populations that can be well defined for conservation purposes; rather, local varieties constitute systems that are genetically open. Given the evidence provided by the findings of this study that farmers do not control pollen from adjacent maize fields which is likely to contaminate their maize crops which can be of same or different type, and considering the fact that during seed selection they focus on ear characteristics which are likely to be contaminated, it can also be concluded that farmers do not necessarily conserve maize diversity on-farm but maintain an active genepool. Farmers do not preserve a static range of crops and crop varieties on their farms, but rather discard diversity in a dynamic fashion, according to their needs.

Despite all the above measures, a farmer or community opting for on-farm conservation is contributing to the local/national cause to ensure the well-being of present and future generations. Their efforts, therefore, need to be appreciated and supported. Intervention is needed to address the constraints faced by the farmers if they are to continue in maintaining local maize diversity on-farm. A major challenge is to ensure that farmer management of this important agrobiodiversity continues as an on-going process. It deserves the support of mankind if there is interest in the needs of future generations. This could be through the following policy recommendations:

- Development of a national policy on on-farm conservation and management encompassing the provision of both monetary and non-monetary incentives to those opting for on-farm conservation.

- Development of curriculum and courses on agrobiodiversity conservation in schools, colleges, universities and extension training.

- Institutionalizing activities like diversity fairs in national agricultural extension programmes. These would bring farmers together, where they can exchange views and knowledge about the importance and uses of different crop cultivars, also, such tools can be used to locate the areas with rich diversity for several economically important crops and recognize them for on-farm conservation.

- Value addition in the products of local maize cultivars. This is an important aspect, which has not been given due attention.

- Strengthening and supporting the informal seed supply system which is important for farmers' household needs and diversity based livelihoods. This could serve to promote on-farm conservation of local maize cultivars and to satisfy a majority of farmer seed demands caused by poverty, seed quality and variety change.

- Conservation of rare and valuable genetic resources *ex situ* before they are lost from the farmers' fields.

- Establishment of molecular characterization facilities to measure and characterize genetic resources at the DNA marker level.

- Development of participatory methods to allow utilization of these resources by researchers and development agencies.

- Improvement of farmers' ability to select for desirable traits by transfer of knowledge of scientific methods of seed selection from plant breeders to farming communities, with active participation of the farming communities. This could provide general principles that farmers themselves could use, however, still incorporating their own knowledge systems.

- Improving both the qualitative and quantitative traits in local maize cultivars to enhance the market value of the crop could be a key strategy towards increasing cultivation of this crop and hence conservation of its genetic diversity.

Recommendations for further studies

- In this study, local maize diversity was only distinguished on the basis of local names of maize cultivars used in the study areas. The problem with this method, however, was the apparent use of different local names for the same cultivar as observed in the two study areas. Therefore in order to be certain whether the study dealt with different local maize cultivars, verification of the recorded cultivars is recommended.

- It is also recommended that similar studies be conducted on the same crop or on different crops and in different agroecological zones of the country so as to get a broader picture of the status of diversity in a particular crop species, also, in order to compare the results, since there is not so much variation observed within region..

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Appendix 1 Survey questionnaire

Questionnaire number ______

Date of interview________________
Location________________________
Interviewer_____________________
Respondent/Farmer's name_______

	No.	Questions	Responses
Information on farmer household	1.	Gender	▪ Male ▪ Female
	2.	Age of respondent	______________________
	3.	Marital status	▪ Single ▪ Married ▪ Widowed ▪ Separated ▪ Divorced
	4.	Level of formal education	▪ No formal education ▪ Primary School ▪ Secondary School ▪ High school ▪ University/college ▪ Others (specify) ____________________________
	5.	Number of household members	________________________________
	6.	Herd size and composition	Cattle______________________ Sheep______________________ Goats______________________ Horses_____________________ Donkeys____________________ Others (specify)_____________ Total________________________
	7.	Source of household income	________________________________ ________________________________ ________________________________
	8.	Off-farm activities	________________________________ ________________________________

Information on locally adapted maize cultivars and their associated traits	**9.**	Which maize varieties do you grow? (Mention by local names, one at a time)	__________ __________ __________ __________
	10.	What is the local meaning of this variety name?	__________ __________
	11.	For how long have you grown this variety? (no. of years in maize cultivation)	__________
	12.	Why do you grow this variety?	__________ __________ __________ __________ __________
	13.	What qualities do you like with this variety?	__________ __________ __________ __________
	14.	What don't you like with it?	__________ __________ __________ __________
	15.	What do you use it for?	__________ __________
	16.	Can you grow this variety for several purposes (services and products) or you can only grow it for specific purposes? Explain.	__________ __________
	17.	Do you grow it for household consumption or for sale?	▪ Household consumption ▪ Sale in the local market ▪ Sale in the commercial market ▪ Both household consumption and sale, etc.

Information on practices used for maintenance of local maize diversity	**18.**	Who decides on which variety to grow and proportion of field area to allocate for maize varieties in the household?	______________________ ______________________
	19.	How big is the field you allocate for this variety? (area in acres)	______________________ ______________________
	20.	Is it your own field?	▪ Yes ▪ No
	21.	If yes, how did you obtain it?	▪ Inherited from parents ▪ Bought, etc.
	22.	If not own field, explain.	▪ Sharecropping ▪ Rented, etc.
	23.	How can you describe this field in terms of topography, slope aspect, soil characteristics, drainage, etc?	Topography:______________ Site feature:______________ Slope aspect:______________ Soil texture:______________ Soil drainage:______________
	24.	Can you grow this variety under different environmental conditions or it needs specific conditions? Explain.	______________________ ______________________ ______________________ ______________________
	25.	Where did you get the seed?	▪ From farmstore (own seed) ▪ Fom neighbour (within village) ▪ From a neighbouring village ▪ Bought from the local market ▪ Others (specify) ________
	26.	Do you select/save the seed for the next cropping season?	▪ Yes ▪ No

	27.	If yes, why do you select the seed? (if no, go to no.32)	__________ __________ __________
	28.	When do you select the seed?	▪ In the field before harvest ▪ During harvest ▪ After harvest in the farmstore ▪ Immediately before planting, etc.
	29.	Who is doing the selection?	__________ __________
	30.	At what level do you select seed?	__________
	31.	What is the criterion used for seed selection and why?	__________ __________ __________
	32.	If no, why don't you select/save the seed?	__________ __________
	33.	How do you store the seed?	__________ __________
	34.	Other than seed selection and storage, which practices do you apply to manage the crop, in different stages of the cultivation cycle?	__________ __________ __________ __________ __________ __________ __________ __________
	35.	At which stage/when do you apply each practice?	__________ __________ __________
	36.	Why do you apply this practice?	__________ __________
	37.	How is it done?	__________
	38.	Is this work shared equally among household members? (household division of labour) Explain.	__________ __________ __________ __________ __________
	39.	Is the household labor enough to do this work? If not,	__________ __________

		explain how you solve this problem.	
	40.	Is any practice in the cultivation cycle more important than others? If so, mention which one and why it is important.	______
	41.	What would you do if you lost all your seed?	______
	42.	Do you encounter any problems in maintenance of this variety? Explain.	______
	43.	How do you solve your problems?	______
General comments	**44.**	Do you think the next generation will continue to grow this variety?	▪ Yes ▪ No ▪ No idea
	45.	If yes/no, why do you think so?	______
	46.	What is not included in this survey which you think is important to discuss?	______
	47.	What is your general opinion?	______

Thank the respondent and terminate interview.

Appendix 2 - Field management practices used to maintain local maize cultivars on-farm

Practice	Description of the practice	Gender involvement in the practice
Winter ploughing	This involves ploughing the field in winter after harvesting so that the maize stubble is incorporated into the soil to improve the soil structure, it is also done to preserve the soil moisture, and to expose weeds and insects. At Semonkong this is done by animal drawn plough whereas at Leribe this primary cultivation is done by tractors.	Only men are involved in this practice.
Sowing/Seeding	Sowing is done manually (by hand) at Semonkong, using the same plough which was used for primary tillage. At Leribe this is done by a planter, a farm implement which is non-existent at Semonkong, among farmers studied. In most cases the planter is drawn by cattle, but horses are currently getting attention in this operation as draft animals. Seeds are normally sown with both organic and inorganic fertilizers and with legumes in Leribe; use of inorganic fertilizer does not exist in Semonkong since the farmers still consider their soils fertile, very few farmers have started applying farm yard manure in their fields.	At Semonkong this is done by men, except in a few exceptions where women have to assist by sowing while men are holding the plough. At Leribe, women's role in sowing is to mix the fertilizers with seed, while men focus on the animals.
Harrowing	This involves breaking the soil clods with a harrow, either before seeding or immediately after seeding to ease germination, aeration and infiltration.	Only men are involved in this practice.
Fertilizer application	As discussed in sowing/seeding above.	
Cultivation	This is the act of cultivating the field after the maize seed has emerged from the soil, usually when it has 2-4 leaves. The purpose is to remove weeds which may compete with the plants using the cultivator or plough if the cultivator is not available. It also enables water infiltration into the soil as the cultivator produces furrows between	During the process of cultivation by men, women follow the cultivator to remove weeds manually, uplifting nearly broken

	lines, a great advantage when it is raining. It is done once or twice depending on the farmers' interests or constraints.	plants and thinning plants.
Earthing	This practice involves heaping the soil around the plants as they are growing so that the roots are not exposed, using the plough.	Only men are involved in this practice.
Weeding	This is removal of weeds using a hoe. It is still a normal practice at Leribe, done after the soil has been loosened by the cultivator whereas at Semonkong it no longer takes place; farmers only remove weeds with the cultivator as explained above. This is one practice which needs extra labour, in cases where household labour is not enough, casual labourers are hired and either paid by cash or by the produce after harvest, or a group of women make an arrangement to assist one another, or the villagers are asked to help (*matsema*).	Where it is still practised, this operation is normally done by women but sometimes men offer a helping hand.
Pesticide application	This implies application of chemicals in the fields to control pests. In most cases the reported maize pests are the stem borer and cutworm. There also exists use of traditional medicine to control these pests, mainly at Semonkong.	Only men are involved in this practice.
Harvesting	This involves removal of physiologically mature plants from the fields. It is done manually in both study areas.	Both men and women are involved.
Seed selection	In each season the farmer keeps a proportion of seed for resowing in the following year, in other words the farmer makes a conscious decision about which sample to retain for seed. It is considered the most important practice for ensuring that there will be harvest in the field, and that the farmers are still keeping the characters which they want.	Both men and women are involved in this practice.
Seed storage	This means keeping aside the selected seeds so that they do not mix with household grain or accidentally be eaten up. Farmers are very careful to store seed in a safe place in order to maintain high seed quality.	Both men and women are involved.