International Journal of Agricultural Extension and Rural Development Studies
Vol.5, No.3, pp.13-23, August 2018
Published by European Centre for Research Training and Development UK (www.eajournals.org)

ASSESSMENT OF CULTIVATION PRACTICES OF WHEAT AND KNOWLEDGE OF RUSSIAN WHEAT APHID (*DIURAPHIS NOXIA),* IN MOKHOTLONG AND THABA TSEKA DISTRICTS OF LESOTHO

Pitso Masupha[1], Astrid Jankielsohn[2] and Lintle Mohase[3]

[1]Department of Crop Science, National University of Lesotho, Roma, Lesotho,
[2]Crop Protection, ARC-Small Grains, South Africa.
[3]Department of Plant Sciences, University of Free State, Bloemfontein, South Africa

ABSTRACT: *Mokhotlong and Thaba Tseka districts are major wheat producing areas in Lesotho. However, wheat yield has been declining over the past years. The purpose of this study was to investigate farmers' cultivation practices, knowledge and management of Russian wheat aphid as possible factors for the low yields of wheat, and the capacity of extension staff in assisting the farmers in wheat production in Mokhotlong and Thaba Tseka districts, Lesotho. Three focus group discussions organized with the help of local chiefs and extension staff members were conducted to collect qualitative data which was used to formulate structured questionnaires for the interview schedule. A total of 60 farmers and 31 extension staff were interviewed. Three factors were found to be the major determinants of low yields; farmers' continued use of traditional cultivation methods, the use of recycled seed from a variety (Bolane) that was introduced in the early 60s in Lesotho and farmers and extension staff ignorance on the existence and impact of Russian wheat aphid in Mokhotlong and Thaba Tseka. The study recommend that research on Russian wheat aphid distribution, impact and resistance status of Bolane must be undertaken and the Ministry of Agriculture should capacitate extension staff and farmers though training and resource allocation to adopt improved cultivation practices.*

KEYWORDS: Extension Staff, Farmers, Russian Wheat Aphid, Mokhotlong, Thaba Tseka, Bolane

INTRODUCTION

The economy of Lesotho is mostly dependent on agriculture with a small industrial sector. The type of agriculture practiced is mainly subsistence with a minimal portion of commercial farming. Lesotho has four agro-ecological zones; Lowlands, Foothills, Mountains and Senqu River Valley (SRV). The lowlands (1,388 – 1,800 m above sea level) form a narrow belt (20 – 50 km wide) along the western border of the country and account for 80% of the productive arable land. The SRV, at similar elevation, is a major grassland area supporting livestock in mixed farming systems. The Foothills rise from 1,800 to 2,000 m above sea level and form a narrow strip running from the north-east to south-west of the country, adjacent to the lower mountain range. This region makes up eight percent of the country. The Mountains (2,000 - 3,482 m above sea level) account for 61% of the land area and are primarily used for summer grazing (Chakela 1999 and Matete and Mokitimi 2007). Lesotho has a temperate climate, with the average rainfall over the entire country ranging from 300 mm to 1,300 mm. The highest rainfall is recorded in the northern part of the highlands while in lowlands mean annual rainfall ranges between 650 mm to 850 mm (Lesotho Meteorology Services 2001). Temperatures are highly variable, on diurnal, monthly and annual time scales. Normal

Print ISSN: 2058-9093, Online ISSN: 2058-9107

monthly winter minimum temperatures range from -6.3 °C in the highlands to 5.1 °C in the lowlands. However, extremes of monthly mean winter minimum temperatures of -10.7 °C can be reached, and daily winter minimum temperatures can drop as low as -21°C at few places like Malefiloane and Semonkong in the highlands. Subzero daily minimum temperatures can be reached even in summer both in the lowlands and in the highlands (Lesotho Meteorology Services 2000).

Grain production is a common enterprise in 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 cereal production (Serage et al. 2002), especially wheat. Wheat is amongst the most adapted crops in Lesotho and the third most important food source of the country. There are two wheat planting seasons, winter and spring, and the wheat is planted under dryland conditions on residual moisture of autumn rainfall and winter precipitation (snow), respectively (Moremoholo and Purchase 1998). Summer wheat grown in the highlands of Lesotho provides food, roofing material, fuel and seed to subsistence farming households (Tolmay et al. 1999). Reports by Lesotho Bureau of Statistics (2014 and 2015) indicate that, in the ten districts of Lesotho, Mokhotlong had the highest area planted to wheat over two consecutive years (2012-13/ 2013-14), followed by Thaba-Tseka. The average yield per ha for wheat in the country from 2009 - 2014 has been higher than that of the other five major crops grown in the country, and Mokhotlong and Thaba Tseka have been leading districts in terms of wheat production. The average yield for the country is 1.1 tha^{-1} (Lesotho Bureau of Statistics 2015). Mokhotlong and Thaba-Tseka had average yield of 1.66tha^{-1} and 1.05 tha^{-1} respectively in 2012 - 2013 (Lesotho Bureau of Statistics 2014) which is far below that of the neighboring province Free State in South Africa with 2.90 tha^{-1} in the same year (SAGL 2013). The study hypothesized that the major cause of differences in wheat yield between South Africa and Lesotho could be the cultivation practices and use of, at least, Russian wheat aphid susceptible cultivars. The Lesotho government recommends and subsidises cereal seed to the farmers. Wheat varieties recommended have varying degrees of tolerance to different biotypes of RWA. It is, however, not known whether the recommendations are made based on the yield potential, RWA tolerance or both. Therefore, the study was conducted to investigate farmers' cultivation practices and knowledge and management of RWA as possible factors for the low yields of wheat. The capacity of extension staff in assisting the farmers in wheat production was also evaluated.

METHODOLOGY

Study Area

Mokhotlong (29°20´S 29°00´E) is entirely in the Mountain region and has the highest terrain in the Maluti range. It is the source of the Senqu river, Lesotho's primary watershed and has population of approximately 97,713 with an area of 4,075 km² (Lesotho Bureau of Statistics 2006). The study areas in Mokhotlong; Malefiloane and Libibing, were selected with the advice of the Ministry of Agriculture and Food Security in Mokhotlong. The areas have clinics, schools, shopping areas and the mill. The two villages are the major wheat producing areas and communities from around come to these places for services.

Print ISSN: 2058-9093, Online ISSN: 2058-9107

Thaba-Tseka is found on 29°30´S 28°40´E with an area of 4,270 km² and population of approximately 129,880 (Thobei, Sutarno, and Komariah 2014). The study site Mants'onyane Ha Paraffin, was also selected with the advice of the Area Extension Officer responsible for Crop Production, on the basis that farmers also grow wheat in addition to maize, which does not grow well under existing cold conditions.

Data Collection

The study was conducted from September 2015 to October 2016. The target groups were farmers and agricultural extension staff. A combination of qualitative and quantitative techniques was used for data collection. Qualitative data were obtained through the use of focus group discussions (FGDs) organized with the assistance of the village chief and agricultural extension staff. Three FGDs were conducted with participants ranging from eight to twelve. The discussions targeted elderly people who were assumed to have knowledge on the cultivation practices in the village. Quantitative data were collected using structured questionnaires. Two different interview schedules were used, one for the farmers and another for extension staff. Farmers were randomly chosen and interviewed at their homes, business areas like shops and mills, and some were found at community gathering places (*Khotla*). A total of 60 farmers and 31 extension staff were interviewed.

Data Analysis

Qualitative data were content-analysed, grouped thematically, and then used to develop the structured questionnaire used to collect quantitative data. The parameters analysed for the farmers were location, gender, education, land ownership, farming practices, RWA knowledge, and management of wheat production. Information analysed from the extension staff included, factors influencing the choice of wheat varieties grown, fertiliser use, knowledge of RWA, training and access to updated agricultural information from South Africa, availability of farmers' field acreage database, and knowledge of farmers on the acreage of their fields. Descriptive statistics were used to present the findings and data were analysed using SPSS statistical package version 19.

RESULTS AND DISCUSSION

Twelve farmers were interviewed in Thaba-Tseka with more females (67%) than males (33%). Respondents were visited at their homes. It is common in developing countries (Lower middle incomes) for women to be on the forefront in household maintenance; they fetch water and firewood, prepare food, and engage in agricultural activities. In Lesotho, this role and the associated burden imposed on women, is particularly acute given the large number of female headed households (Maile 2001). In Mokhotlong 48 farmers were interviewed with more males (67%) than females (33%). Interviews were conducted at the community gathering places, mills and shopping centers. These are the places that are frequently visited by men. The majority of the respondents in both districts had only completed secondary level of education and the largest percentage (40%) dropped out at primary level. This may have an impact on the understanding of the dynamics of RWA and its impact on wheat yield. All the people interviewed had some fields and the majority had one (38%) or two (40%), as shown in Table 1. Serage et al. (2002) found that 82% of the people engaged in wheat and potato production in Mokhotlong own land. Traditionally, in

Print ISSN: 2058-9093, Online ISSN: 2058-9107

Lesotho the chief of the village allocates ownership; powers of land distribution are vested in the chief and land is given as a "free good". Therefore, there is no limit on the number of fields one could own because of indiscriminate allocation of land (Daemane 2012). Farmers did not know the sizes of their fields. However, as shown in Table 3, there is a database for all the fields in the districts. Extension staff reported that farmers are not aware of the acreage of their fields mainly because they never hire machinery for field operations, which are usually paid for, based on the acreage of the field. They use their own cattle.

Table 1. Demographic data of the farmers

	Mokhotlong (48)	**Thaba Tseka (12)**
Gender		
Male	32	4
Female	16	8
Education		
Primary	19	5
Secondary	11	4
High school	11	1
Tertiary	4	0
Never attended School	3	2
Number of fields owned		
1	16	7
2	19	5
3	10	0
4	2	0
5	0	0
6	1	0

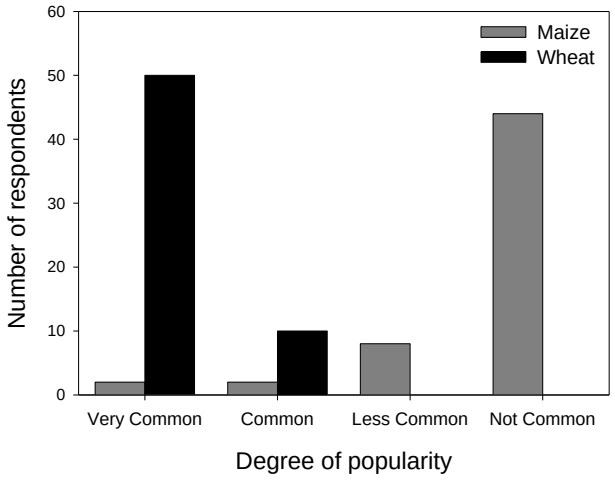

Figure1. The most popular crop between maize and wheat.

Print ISSN: 2058-9093, Online ISSN: 2058-9107

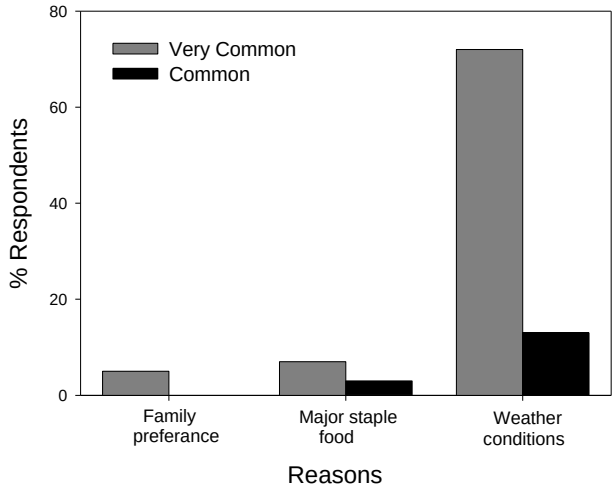

Figure 2. Farmers reasons for growing wheat.

The results of the survey as shown in Figure 1 indicate that wheat is the most common crop grown in the sampled areas of Mokhotlong and Thaba-Tseka. Farmers explained that the short growing season characterised by early and late frost (Weather conditions, Figure. 2) does not allow maize and sorghum to thrive in these areas. This was in corroboration with Moeletsi and Walker (2013), who mapped Thaba-Tseka and Mokhotlong as largely unsuitable for maize production. This is based on the the heat units (>1,500 GDD), frost-free season, slope, seasonal rainfall >500 mm and 15-day dry spell indices.

Cultivation Practices

Table 2: Farmers' cropping practices

Practices	Responses	Percentage
Land Preparation		
Ox-drawn plough	57	95
Tractor	3	5
Seed Source		
Selected from previous harvest	31	51.7
Agro shops	2	3.3
Donors	1	1.7
Government	1	1.7
Other famers	25	41.7
Seeding		
Broadcast by hand	58	96.7
Animal drawn planter	2	3.3
Fertiliser Application		
Yes	1	1.7
No	59	98.3
Cropping Challenges		

Print ISSN: 2058-9093, Online ISSN: 2058-9107

Diseases	4	6.7
Insects	1	1.7
Weather	50	83.3
Market	1	1.7
Weeds	1	1.7

Table 3: Extension staff response on farming systems

Practices	Responses	Percentages
Fertiliser use		
Yes	10	32.3
No	13	41.9
Some farmers	8	25.8
Reasons for not fertilising soil		
Expensive	10	50
Inaccessible	4	20
Destroys the soil	6	30
Common wheat pests/pathogens/weeds		
Smut	21	67.7
Wild oat	10	32.3
Availability of farmers' fields acreage database		
Yes	30	96.8
No	1	3.2
Farmers knowledge on the acreage of their fields		
Yes	14	45.2
No	7	22.6
Not all	10	32.3
Reasons for not knowing		
They normally use their own traditional ways of measuring their fields.	6	35.3
They use their own cattle for operations. Never hire machinery.	11	64.7

Farmers rely heavily (95%) on ox-plough for land preparation. The use of animals is less costly and the equipment is easy to maintain. However, the animals are often in poor health conditions at the start of cropping season when main traditional tillage operations are required, leading to slow and poor tillage. This way of land preparation is a long-standing tradition and Mofoka (1985) has also shown that farmers use ox-drawn cultivators to prepare land for wheat cultivation. Because Thobei, Sutarno, and Komariah (2014) found that climatic parameters (rainfall, maximum and minimum temperature) did not strongly affect crop production in Mokhotlong and Thaba-tseka, the choice of seed and use of ox-drawn plough were hypothesised as the major factors affecting crop production in these districts. This is in agreement with Costa, Crovetto, and Bocchi (2013), who indicated that, in Tanzania, the major constraint facing the agricultural sector is the falling land productivity

Print ISSN: 2058-9093, Online ISSN: 2058-9107

due to the application of poor technology as well as dependence on unreliable and irregular weather conditions. In their report, they showed that about 70% of crop area is cultivated by hand hoe, 20% by ox-plough and 10% by tractor. Melesse *et al.*, (2001) further stated that ploughing with *Maresha* (ox-drawn plough) results in low soil moisture and, since soil moisture is a limiting factor under dry land farming, crop productivity is very low in traditional cultivation systems. The high amount of time spent on tillage also delays planting and hence, farmers in dryland areas cannot use the full growing period of the already short growing season. As a result, crop productivity is reduced and sometimes farmers face total crop failure when the rain stops earlier than the average, leading to famine. Mofoka (1985) described lack of moisture as a limiting factor to wheat production in Lesotho. Consequently, lack of good cultivation practices, untimely and improper land preparation comprise some of the key factors constraining wheat production in Lesotho.

The majority (97%) of farmers broadcast seed for planting. Farmers usually prepare the land in winter (June and July) taking advantage of snow moisture. Farmers start planting in October by broadcasting the seed and ploughing it under while some plough first and use ox-drawn harrow to incorporate it into the soil. Seeds germinate but some never emerge to the soil surface, leading to more seed being used in broadcasting than drilling. Other seed may be placed very shallow or on the soil surface. These seeds often do not survive due to dry soil. The uneven stands from broadcasting compared to drilling, often result in lower yields.

The traditional cultivation practice may explain why almost all the farmers (Table 2) did not use fertiliser, even though extension staff (Table 3) argue that the majority of farmers do not use fertiliser because of the cost (50%). Some farmers are of the opinion that fertilisers have bad effects on soil as they only get good yield once and, in subsequent years, yield declines drastically when they do not use fertiliser. This clearly indicates lack of knowledge on plant nutrition and the importance of nutritional status of the soil in wheat production. Lesotho is characterised by heavily eroded soils with poor fertility and this contributes to the declining yields of field crops (Kaliba and Rabele 2004). Farmers perceive weather (83%) in particular hail and storm followed by diseases (rust, 7%) as primary constraints to wheat production.

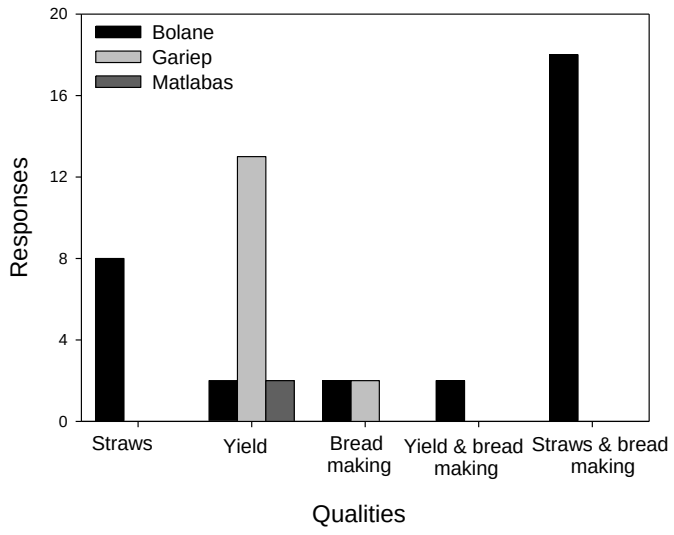

Figure 3. Extension staff perception on Common wheat varieties and their preferred characteristics

Print ISSN: 2058-9093, Online ISSN: 2058-9107

The seed used by the farmers is mostly from the previous harvest (Table 2). More than 90% of the seed used is either farmer's own saving or it is obtained from other farmers. Modern high yielding varieties rarely outperform farmers' traditional varieties (Tolmay et al. 2000) and this has been the case with Mokhotlong as modern varieties released in the past had not significantly increased yields. It was established during the survey that *Bolane* is the most widely used variety both in Thaba Tseka and Mokhotlong. Its whiter colour results in bread with lighter colour and the larger straw length, which is preferred for roofing, are the reasons for being the favored variety by the farmers as shown in figure 3. Its low yield does not encourage farmersto choose high yielding varieties like Gariep. *Bolane* is adapted to the highlands of Lesotho. It is a tall variety with low tillering capacity, prominent awns and long spikes. Gariep named *Phallelo*, which means donation, (donated by the government and the NGOs), is one of the varieties grown by the farmers, according to extension staff (Figure 3), because of its good yield. The majority of farmers, however, still prefer *Bolane* above Gariep. Farmers criticise Gariep for its slender and short stems that cannot be used for roofing, therefore farmers rarely plant it. Other varieties used at very low scale include *Mapompei*, 410, and *T'soloha*. Weinmann (1966) stated that *Bolane, Mant'sa Tlala* (driving out hunger) and *Mohohlotsane* were the most commonly grown varieties by the farmers. *Mant'sa Tlala* was released in South Africa in 1985 as Tugela and it was later promoted in Lesotho as *Mant'sa Tlala*. *Mohohlotsane* is an awnless variety of medium canopy and its origin is unknown.

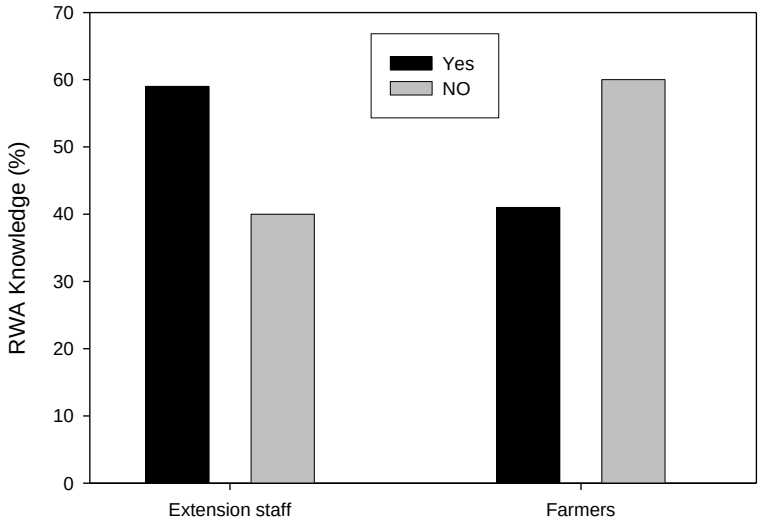

Figure 4. Knowledge of Russian wheat aphid by extension staff and farmers

The percentage of farmers (70%) and extension staff (41%) without knowledge of Russian wheat aphid, (RWA) is surprisingly high given the number of years it has emerged as a pest of wheat in Lesotho, (Purchase, Roux, and Hatting 1993 and Tolmay et al. 2000), the biotypes that have been recorded and efforts to manage the pest in Lesotho (Makhale, Moremoholo, and Mohammed 1999 and Moremoholo and Purchase 1999). Extension staff (Table 3) believe wild oat and smut are the major pests/diseases/weeds of wheat in the two

Print ISSN: 2058-9093, Online ISSN: 2058-9107

districts. Smut is mainly promoted by recycling of the seed without any treatment for pathogens. Among those who were aware of RWA existence, only 44% were conscious of infestation in their field. Makhale, Moremoholo, and Mohammed (1999) stated that RWA is seen as one of the constraints in wheat production in Lesotho, where yields have decreased from 1.8 ton ha^{-1} to f 0.8 ton ha^{-1} in the mid-seventies. It was established that farmers never monitor their growing wheat fields after planting. They only work on the fields when the crop is ready for harvesting and this maybe the reason why they never notice RWA in their fields. A small number (32%) of extension staff showed that they had training in wheat husbandry and the majority of them are those with knowledge of RWA. It was also established that only 58% of staff had access to South African Agricultural information, which was mainly through internet (61%).

The first RWA-resistant wheat cultivar in the world, known as Tugela-DN was bred and released by Agricultural Research Council-Small Grain Institute (ARC-SGI) in 1993 (Marasas *et al.*, 2005). In 1993, ARC-SGI donated Tugela-DN to the Lesotho Ministry of Agriculture. Farmers rapidly adopted the new cultivar, aptly re-naming this cultivar "*Puseletso"* which means "the regaining of that which was lost to us" (Moremoholo & Purchase, 1998). The success of host plant resistance strategy however, is challenged by the occurrence of resistance-breaking insect biotypes (Van der Arend 2003). Since the introduction of RWA in South Africa in 1978 four biotypes have been recorded (Jankielsohn 2014) and three of them (RWASA 1, 2 and 3) have been mapped in Lesotho (Jankielsohn 2011). It is highly possible that the fourth biotype is also present in Lesotho as no survey on the distribution and diversity of RWA has been conducted in Lesotho since 2011. No new cultivars, with resistance against the new biotypes, have been introduced into Lesotho.

Implication to Research and Practice

Cultivation practices, choice of seed and RWA prevalence affect wheat yield in the mountain districts of Mokhotlong and Thaba Tseka. Extension staff either lack extension skills or are not well resourced to guide the farmers. The Ministry of Agriculture, research institutes and academia should initiate research and capacity building programmes aimed at improving wheat production in these districts. Such programmes should start with extension staff capacity building and research should focus on socio-economic status of the farmers, tillage, soil fertility, planting methods and pest surveillance models with emphasis to RWA. The importance of *Bolane* to the farmers in these districts cannot be overlooked, therefore understanding its agronomic properties as well as its interactions pests, particularly RWA, should form a key component of research programmes. Russian wheat aphid resistant germplasm should be incorporated into breeding programs where *Bolane* can be used as crossing parent.

CONCLUSION AND RECOMMENDATIONS

The study was conducted to investigate the farmers' cultivation practices and the knowledge and management of RWA as possible factors causing the low yields of wheat, as well as the capacity of extension staff to assist farmers in wheat production. The mixed-methods approach that incorporated both the farmers and the extension staff enabled us to gain insight into the factors that affect wheat production in Mokhotlong and Thaba Tseka.

Print ISSN: 2058-9093, Online ISSN: 2058-9107

The following were the major findings from the study:

i) Farmers still use traditional farming methods like ox-drawn plough, planting without fertilisers, broadcasting the seed and recycling the seed.

ii) *Bolane*, a variety that was introduced in Lesotho in the early 1960s, is preferred over the modern varieties because of its additional benefits like roofing, livestock feeding and fuel.

iii) Both the farmers and extension staff have no knowledge of Russian wheat aphid despite its well documented impact and distribution in Lesotho (Moremoholo & Purchase 1998; Makhale, Moremoholo, and Mohammed 1999 and Jankielsohn 2011).

REFERENCES

Chakela, Q.K. (1999) State of Environment in Lesotho 1997. National Environment Secretariat (NES), Ministry of Environment, Gender and Youth Affairs, Government of Lesotho.

Costa, S. Crovetto, G. M. and Bocchi, S. (2013) Family farming in Africa: Overview of good agricultural practices in Sub Saharan Africa. *Faculty of Agricultural and Food Sciences, Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy . 48.*

Daemane, M. (2012) Problems of land tenure system in Lesotho since post-independence: challenging perspectives for sustainable development in land administration and management. *Journal of Sustainable Development in Africa* 14 (8):164 - 178
development due to plant host resistance: a literature study. *Eucarpia Leafy Vegetables 2003. Pp 75*

Jankielsohn, A. (2011) Distribution and diversity of Russian wheat aphid (hemiptera:aphididae) biotypes in South Africa and Lesotho. *Journal of economic entomology, 104 (5): 1736 – 1741.*

Jankielsohn, A. (2014) The Russian wheat aphid. Farmer Weekly. 17: 22–23.
Kaliba A.R., and Rabele, T. (2004) Impact of Adopting Soil Conservation Practices on Wheat Yield in Lesotho. *Managing nutrient cycles to sustain soil fertility in Sub-Saharan Afric,*. Edited by André Bationo 42: 593 – 608, Nairobi Kenya.

Lesotho Bureau of Statistics. (2009) 2006 Lesotho Population Census. *Analytical report*, volume IIIA. Maseru, Lesotho.

Lesotho Bureau of Statistics. (2014) Agricultural production survey crops 2012/2013. *Statistical Report*, No: 2 of 2014, Lesotho

Lesotho Bureau of Statistics. (2015) Agricultural production survey crops 2013/2014. *Statistical Report* No: 6 of 2015, Lesotho.

Lesotho Meteorology Services. (2000) Lesotho National Report on Climate Change. 23-25.

Lesotho Meteorology Services. (2001) Climate Change in Lesotho. *A hand book for practitioners*. Maseru, Lesotho

Makhale, G.L., L. Moremoholo, L. and Mohammed, J. (1999) Country Profile: *Maize and Wheat in Lesotho*. WMIRNET News 1(2): 2-3.

Marasas, C.N., Anandajayasekeram, Millard, S. and C.J. van Rooyen. (2005) Farm-Level adoption and impact of agricultural technology: the case of Russian wheat aphid

Print ISSN: 2058-9093, Online ISSN: 2058-9107

resistant cultivars in South Africa. *South African Journal of Agricultural Extension*. 34 (2): 318-333.

Matete, M., and Mokitimi, M. (2007) Economic analysis of maize production in the Maseru district, Lesotho: The case of Masianokeng Resource Center. *Lesotho journal of agricultural sciences*, 1 (1): 77 - 94

Melesse, T., Kidane, G. Shilima, G. and Hirut, A. (2001) Development and evaluation of tillage implements for maize production in the dryland areas of Ethiopia. *Seventh Eastern and Southern Africa Regional Maize Conference*, 308-312.

Moeletsi, E. M., and Walker S. (2013) Agroclimatological suitability mapping for dryland maize production in Lesotho. *Theoretical and Applied Climatology*, DOI 10.1007/s00704-012-0829-1

Mofoka, E.M. (1985) Cropping systems in small scale wheat cultivation. *Regional Wheat Workshop for Eastern Central and Southern Africa and Indian ocean*, 236 - 239. Njoro Kenya.

Moremoholo. L., and Purchase J.L (1998) The release of Puseletso, a Russian wheat aphid (*Diuraphis noxia*) resistant cultivar, in Lesotho. *The tenth regional wheat workshop for Eastern, Central and Southern Africa*, 426 – 429. Stellenbosch, South Africa.

Purchase, J. L., Roux, L and Hatting H. (1993) Progress of the Southern African Regional wheat evaluation and improvement nursery (SARWEIN) from 1974 to 1993.

SAGL. (2013) Production figures for main production areas over seasons. *Wheat Report 2012/2013*

Serage, K.L., Nell, W.T. Makula, M. and Tolmay, J.P.C. (2002) Possible predictors determining the adoption of potatoes (*Solanum tuberosum*) into a wheat (*triticum aestivum*) based cropping system in Mokhotlong, Lesotho. *13th International Farm Management Congress,Wageningen, The Netherlands, July 7-12, 2002*

Thobei, Sutarno, and Komariah (2014) Effects of climate change on crop production in Thaba-Tseka and Mokhotlong districts Lesotho Highlands. *Journal of Agriculture and Veterinary Science Volume 7 (1): 37-44*

Tolmay, J., Rosenblum, M. Moletsane, M. Makula, M. and Pederson (2000) The introduction of disease and pest resistant wheat cultivars to small-scale farming systems in the highlands of Lesotho. *The eleventh regional wheat workshop for Eastern, Central and Southern Africa*, 190 – 194. Addis Ababa, Ethiopia.

Van Der Arend, J. M. (2003) The possibility of *Nasonovia ribisnigri* resistance breaking biotype

Weinmann, H. (1966) Report on Crop Research in Lesotho 1960 – 1965. *Ministry of Agriculture Co-operatives and Marketing, Lesotho. Maseru, Lesotho*

Print ISSN: 2058-9093, Online ISSN: 2058-9107