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Use of indigenous knowledge to control potato pests in Umzimkhulu Local Municipality

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Background: In South Africa, Umzimkhulu Local Municipality (ULM) is one of the areas where many households engage in subsistence agricultural activities for survival. However, there are several pests reported and studies have identified as constraints in potato production.

Objectives: The current study was conducted to evaluate the indigenous approaches used in managing pests of potatoes by smallholder farmers in ULM.

Method: Semi-structured questionnaire was used to gather information and data were analyzed using the Statistica Software Package, Version 2010 (StatSoft Inc., Tulsa, OK, USA).

Results: The study revealed that majority of farmers with their limited knowledge, rely on indigenous knowledge (IK) practices to control potato pests; athough both indigenous knowledge method and inorganic pesticides are effective in pest management.

Conclusion: Information on IK that is carried by elders in the rural communities is at risk of being lost due to death of these information holders; therefore, documentation of this information is recommended. External support to develop the skills and knowledge of farmers by identifying existing knowledge that is relevant to their circumstances is crucial.

Contribution: Through a deeper understanding of IK and the documentation of these techniques for those who want to increase potato production in these communities, the study aims to have a sustainable effect on pest and disease management in rural communities. Enhancing research projects with rural communities, where this knowledge is frequently the only asset they control and undoubtedly one they are acquainted with, can be especially successful by building innovations on IK.

Keywords: indigenous knowledge; pest and diseases; yield; potatoes; potato farmers.

Introduction

Pests are significant and potential threats to global food economy and security (Bebber et al. 2014; Fones et al. 2020). The International Plant Protection Convention (IPPC) defined pest as 'any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products' (Food and Agriculture Organization [FAO] 2022). It further defined quarantine pests as 'a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled'. Pests, which are frequently found on the leaves, flowers and stems of crop plants, harm crops directly (by eating their leaves, fruits or vegetables, and frequently also by destroying the crops before they ripen), and indirectly (by spreading bacterial, viral and fungal infections) (Osei et al. 2021). Economic damage is the amount of crop damage an insect causes that supports the use of artificial control measures when valued.

In South Africa, there are several pests of economic importance that have been identified in the previous studies as constraint in potato production. Of the 60 pest species known to attack potatoes in South Africa, four were classified as problematic in most production regions and these include potato leaf miner (*Liriomyza huidobrensis*), potato tuber moth (*Phthorimaea operculella*), cyst nematodes (*Globodera rostochiensis*) and aphids (*Myzus persicae*) (Denner, Venter & Niederwieser 2012; Potatoes SA 2017a,b; Visser et al. 2003). Fungal diseases of importance are early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*) (Denner, Theron & Millard 2003). The most problematic bacterial diseases in South Africa are bacterial wilt (*Ralstonia solanacearum*) and common scab (*Streptomyces scabies*) (Gouws, Mienie & Theron 2003). Soil and tubers are primary pathways of most economically important diseases. The most serious viruses in terms of crop losses in South Africa, which are monitored by the Potato Certification Scheme,

are potato leaf roll virus, potato virus Y and tomato spotted wilt virus (Black 2008).

Knowledge of the pests' behaviour, biology and population ecology is critical to determine the correct method (Biedermann et al. 2019; Phyllis 2013). The goal is to manage the crop as a whole system, keeping pests at acceptable levels by utilising several harmonising strategies (Johnson 2008). Numerous studies have established that indigenous farmers have vast knowledge of controlling pests. While pests are a major constraint in vegetable production in many parts of Southern Africa, little is known about farmers' knowledge and management practices (Nyirenda et al. 2011). A growing body of literature suggests that many farming communities possess traditional knowledge of pests that affect their crops and alternative approaches to their control (Sileshi et al. 2008). In recent years, there is a resurgence of interest in reviving the age-old farming system through scientific approach which is known by modern humans as organic farming, because of hazardous effect of excessive chemicals in agricultural systems, environment and human health (Chhetry & Belbahri 2009).

It is necessary to re-popularise the indigenous methods of insect control given that they are mostly safer and cheaper than synthetic insecticides (Afolayan, Masika & Odeyemi 2006; Kuyu & Bereka 2020; Yigezu & Wakgari 2020). Smallholder farmers revert to indigenous ways of pest management as pesticides are not readily available and financially accessible (Mihale et al. 2009). A number of indigenous knowledge practices (IKPs) in pest management have been recorded and studies have recommended the use of indigenous pest management strategies as viable and ecologically friendly options (Zijlstra et al. 2011).

In KwaZulu-Natal, Umzumkhulu Local Municipality (ULM) is one of the areas where many households engage in subsistence agricultural activities for survival. According to KwaZulu-Natal Department of Co-operative Governance and Traditional Affairs (2015), the agricultural sector is one of the dominant sectors in ULM. Pests are a major constraint in crop production; they reduce yield and threaten food security in rural areas, including ULM. The majority of smallholder farmers in Umzimkhulu rely on indigenous knowledge (IK) pesticides to manage the challenge of pests. Understanding farmers' knowledge of existing pest and diseases, including their current management practices is important for planning of suitable interventions and successful management strategies.

The Department of Agriculture, Land Reform and Rural Development (DALRRD) is charged with promoting comprehensive rural development as well as developing agricultural value chains, supplying agricultural inputs, and monitoring output and consumption in the agricultural sector. In South Africa, *Fertilizers, Farm Feeds, Agricultural Remedies, and Stock Remedies Act* of 1947 (Act No. 36 of 1947) regulates the production, distribution, importation, sale, use and advertisement of pesticides as well as the operation of sterilising plants and pest control operators. *Agricultural Pests Act 36* of 1983 (Act No. 36 of 1983) provides for measures by which agricultural pests may be prevented and combated and for matters connected therewith. South Africa is obliged to align its phytosanitary legislation, regulations and measures with the relevant international obligations and standards, such as World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (WTO- SPS Agreement) and IPPC, to prevent the entry, establishment and spread of regulated pests (FAO 2013; WTO 1995). It is essential to evaluate the strength of IK pesticides to ensure that it responds effectively to the challenges faced by farmers in Umzimkhulu who currently rely only on IK pesticides. Thus, this study is intended to examine the indigenous approaches used in managing pests of potato among smallholder farmers in ULM.

Materials and methods

The study was conducted in three randomly selected wards (2, 15 and 21) under ULM (30.2595° S, 29 6963° E), Harry Gwala District in the KwaZulu-Natal province, South Africa. The study targeted a specific group of potato farmers in Ward 2, 15 and 21 randomly selected under ULM. A purposive sampling was adopted for the study. A purposive sampling technique is typically used when a particular group of individuals with comparable traits are to be interviewed, as well as when the researcher wants to assess the viability of a potential study and in a case study that aims to comprehend a particular bounded context (Tongco 2007). Many households in ULM engage in subsistence agricultural activities for survival. Potato is one of the major agronomic crops produced in ULM (ULM 2012). Some of the identified challenges facing agriculture in Umzimkhulu include cost of agricultural inputs which limits entry into farming in traditional areas and limitations on local skills to farm on both a small and a large-scale basis (ULM 2012). Participants were identified with the help of key informants. The key informants consisted of traditional leaders and agricultural extension officers in the communities; they were selected according to their experience in farming in the area and the knowledge of pests, preferably more than 5 years of experience. Data were collected using questionnaire from 90 smallholder potato farmers to gather information about demographics, practices, experiences and effectiveness of practices used to manage pests in potato production.

Data were subjected to Statistica Software Package, Version 2010 (StatSoft Inc., Tulsa, OK, USA) for statistical analysis to determine the demographic characteristics of the potato farmers in the study area, identify various indigenous management methods of pests, and investigate the effectiveness of the indigenous management approaches. Spearman's correlation ranks were used to determine the relationships between demographic characteristics and farming practices. The one-way ANOVA was used to compare means of yields in kilograms per acre across participant's household characteristic.

Ethical considerations

Ethical clearance to conduct this study was obtained from the CAES Health Research Ethics Committee of the University of South Africa (no. 2018/CAES/151).

Results and discussion

Demographic characteristics of participants

The demographic information provided background details on participants including age, gender, educational level, household size, source of income and farming experience (Table 1). These details are common denominators in determining factors influencing IK system in crop production. Demographic factors such as age, experience, wealth, household circumstances, production priorities and gender have an impact on the individual's access and ability to use indigenous knowledge practices (Okoroba, Okodudu & Joab-Peterside 2019; Falk, Kumar & Srigiri 2019).

In the current study, the majority of farmers (68%) were above 61 years and 1% were below 30 years of age. Age is one of the key parameters in IKPs utilisation and preservation (Deng & Nina 2020; Kuyu & Bereka 2020). This shows that older people were more involved in IK-based potato farming than younger people. The probable reason for such trends might be that, young aged farmers might have engaged in non-agricultural activities, less interested in agriculture sector and were moving away to other commercial enterprises (Pearce 2001). A wealth of IK is generally found from older people (Lwoga, Ngulube & Stilwell 2020; McGinnis, Harvey & Young 2020). Correlation analysis indicated that there was a positive association between the age and years of potato farming experience by the participants, although the correlation was not so strong ($r^2 = 0.3220$; $p = 008$) (Table 2). The findings of the current study are in line with the study conducted by Rigg et al. (2020) who found that the farmers who are generally more aged will have more experience in farming and thus have favourable attitude towards IK. Hence, age was found positively significant. There was also a positive association between the ages of participants and their primary sources of income apart from potato farming ($r^2 = 0.3906$; $p = 0.001$) (Table 2). Other variables did not make significant correlation with the age of potato farmers.

TABLE 1: Demographic characteristics of participants.

Demographic characteristics	Mean	Standard deviation	Frequency (%)
Age (years)	101.5	7.5	-
Above 60	-	-	68
51–60	-	-	20
41–50	-	-	8
31–40	-	-	3
Less than 30	-	-	1
Gender	101.2	0.4	-
Female	-	-	76
Male	-	-	24
Marital status	101.3	0.8	-
Single	-	-	9
Married	-	-	85
Separated	-	-	3
Widowed	-	-	3
Education	101.9	0.6	-
No formal education	-	-	20
Primary	-	-	70
Secondary	-	-	8
Tertiary	-	-	2
Household size	101.6	0.8	-
More than 8 members	-	-	57
5–8 members	-	-	23
1–4 members	-	-	20
Primary income	101.8	1.2	-
Grant	-	-	66
Farming	-	-	7
Other businesses	-	-	13
Employment	-	-	14
Farming experience (years)	101.2	0.7	-
16 and above	-	-	89
11–15	-	-	6
5–10	-	-	2
Less than 5	-	-	3

In terms of gender, more females participated (76%) than males (24%). Verma (2001) and Jose and Shanmugaratnam (1993) reported that the majority of smallholder farmers are women who produce food crops using traditional farming methods. Kuye et al. (2006) echoed that the harvesting processes are labour-intensive and for the majority of traditional farmers such activities are carried out by women. Proper understanding of the role of gender as well as of the intrinsic value of IK is crucial to the solution of situation-specific problems in our quest towards the construction of models for sustainable development (Hill 1993).

The current study also revealed that 85% of participants were married while 9% were single, 3% were widowed and 3% were separated. There was a positive correlation between family size and marital status of producers ($r^2 = 0.3338$; $p = 0.006$) (Table 2).

The results showed that the majority of participants (70%) had obtained a primary school education, 8% had obtained a secondary education, 2% had obtained a tertiary education and 20% of the participants had no formal education. This shows that the younger participants (less than 40 years) were more literate than older participants (above 60 years). Indigenous knowledge is very significant for farmers with limited formal education (Mogomotsi, Sekelemani & Mogomotsi 2020; Notsi 2012).

The current study indicated that, of the households, 57% contained 5–8 family members, 23% had 9 members, and 20% had 1–4 members. Chimbidzani (2006) indicated that members of the household engaged in various farming activities simply because the majority of smallholder farmers cannot afford hired labour. Smallholder agriculture is labour-intensive and requires a large labour supply; households with more members can share labour. This is in agreement with the recent studies conducted by Igwe and Ijhe (2020) and Belachew, Mekuria and Nachimuthu (2020) that the household size may determine labour availability for implementing indigenous practices.

TABLE 2: Pearson's correlations to examine the relationships among study variables.

Variables	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
A	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	−0.24	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	0.00	0.26*	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	0.19	0.17	0.25*	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	0.02	−0.07	0.33**	0.09	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	0.39**	−0.04	−0.05	0.32**	0.17	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
G	0.32**	0.32**	0.24*	0.48**	0.13	0.20	1.00	-	-	-	-	-	-	-	-	-	-	-	-
H	0.18	0.18	−0.08	−0.15	0.20	0.28**	0.17	1.00	-	-	-	-	-	-	-	-	-	-	-
I	0.20	0.20	−0.06	−0.16	0.17	0.28**	0.20	0.99**	1.00	-	-	-	-	-	-	-	-	-	-
J	0.14	−0.04	−0.07	0.08	0.09	0.03	0.20	0.19	0.15	1.00	-	-	-	-	-	-	-	-	-
K	0.09	0.09	−0.00	−0.00	0.07	−0.08	0.15	0.05	0.05	0.26*	1.00	-	-	-	-	-	-	-	-
L	0.09	0.46	−0.00	−0.00	0.07	−0.08	0.15	0.05	0.05	0.26*	1.00	1.00	-	-	-	-	-	-	-
M	0.04	0.04	−0.07	−0.17	0.09	0.05	0.09	0.62**	0.64**	0.04	0.09	0.09	1.00	-	-	-	-	-	-
N	0.04	0.04	−0.07	−0.17	0.09	0.05	0.09	0.62**	0.64**	0.04	0.09	0.09	1.00	1.00	-	-	-	-	-
O	0.05	0.05	0.21	0.11	0.07	−0.08	0.17	0.16	0.16	0.14	0.06	0.06	0.15	0.15	1.00	-	-	-	-
P	−0.03	−0.03	0.07	0.18	0.15	0.12	0.05	0.09	0.09	−0.22	−0.25*	−0.25*	0.15	0.15	0.00	1.00	-	-	-
Q	0.21	0.21	−0.04	−0.05	−0.08	−0.07	−0.03	0.26*	0.26*	0.12	0.48**	0.48**	0.17	0.17	0.17	0.02	1.00	-	-
R	0.05	0.05	−0.02	0.01	−0.08	−0.00	−0.06	−0.13	−0.13	−0.09	−0.006	−0.006	−0.17	−0.17	−0.01	0.05	−0.03	1.00	-
S	0.16	0.16	0.01	0.14	0.11	0.08	0.01	−0.01	−0.02	0.02	0.01	0.01	−0.07	−0.07	0.05	0.25**	0.00	−0.03	1.00

NB: Correlations were highly significant (**) at $p \leq 0.01$ and significant (*) at $p \leq 0.0$; were: A, Age; B, Gender; C, Marital status; D, Educational qualification; E, Family size; F, Income source; G, Number of years in farming; H, Plot size; I, Yield; J, Cultivar choice; K, Usage of certified seeds; L, Usage of GMO; M, Intention to sell potato; N, Intention to sell to local fresh produce markets; O, Knowledge of common pests; P, Pest control stage of plant; Q, Effectiveness of pest control strategy; R, Source of pest control information; S, Pest control challenges.

There were various primary sources of income in the communities, ranging from a grant, farming, employment and other businesses. Farmers depend mostly on grant (66%), employment (14%), other businesses (13%) and farming (7%). This reflects that grant contributed towards the improvement in the farming activities because the income can be used to buy inputs.

Sources of income

Farmers who relied on social grant produced significantly lower yield as compared to full-time farmers (Table 3). The same applies to those with other businesses and other employments. Majority of farmers were old and depended on grant as an income. In addition, the primary source of income had positive correlations with the age of farmers ($r^2 = 0.3338$; $p = 0.001$), educational background of the farmers ($r^2 = 0.3272$; $p = 0.007$), size of the plot for potato production ($r^2 = 0.2873$; $p = 0.018$) and yield ($r^2 = 0.2878$; $p = 0.018$) (Table 2).

Farming experience

Most farmers (89%) had 16 years and above of farming experience and the rest of participants had less than 15 years. In terms of IK for potato production by small-scale farmers at ULM, older farmers had more farming experience using IK system. Farming experience has a positive link with the improvement in potato production, because rich production experience can educate the farmers to improve the practices of their gardens and farms. Pearson correlation analysis indicated that there were positive associations between farmers' experience with age of the producer ($r^2 = 0.3220$; $p = 0.008$), marital status of producers ($r^2 = 0.2496$; $p = 0.042$) and producers' educational background ($r^2 = 0.4891$; $p = 0.000$) (Table 2).

TABLE 3: Yield differences based on potato farmers' sources of income.

Source of income	Mean ± SE
Grant	6.93220 ± 1.024650[a]
Farming	28.83333 ± 3.213112[b]
Other business	5.33333 ± 2.272013[a]
Other employment	5.00000 ± 2.182880[a]
F statistics	99.76554***

Values (M ± SE) with different letters in a column differ significantly (***) at $p < 0.0001$.

There was significant difference between farmers with less than 5 years of experience as compared to the farmers with 11–15 years of experience in potato production using indigenous knowledge at ULM (Table 4). Farmers with 11–15 years of experience produced significantly greater yield as compared with those with lesser years of experience. However, there was non-significant difference of the yield produced by farmers with less than 5 years and those with more than 10 years of experience. This might have been caused by the fact that IK was shared among potato producers at ULM. Therefore, it is perceived that older people had accumulated indigenous knowledge and experience over time, as compared to younger farmers. The farming experience grows along with the age; the farmers will know the worth of the Indigenous Technical Knowledge (ITK), thus giving rise to positively significant relationship (Coppola et al. 2020).

Farmers' intention

In terms of yield, there is significant difference between the yield produced by farmers who intend to sell their produce to local markets and those who produce for home consumption (Table 5 and Table 6).

This suggests that farmers with bigger plots get higher yields and farmers with the higher yield sell the produce and have the market. There was positive association

TABLE 4: Yield differences based on potato farmers' years of experience in potato production using indigenous knowledge.

Farming experience (years)	Mean ± SE
Less than 5	15.66667 ± 5.374580[b]
5–10	3.00000 ± 6.582489[a]
11–15	17.60000 ± 4.163132[b]
16 and above	7.12500 ± 1.040783[ab]
F statistics	20.77494***

Values (M ± SE) with different letters in a column differ significantly (***) at $p < 0.0001$.

TABLE 5: Yield differences based on potato farmers' intention to sell their produce.

Intention to sell potato	Mean ± SE
Intention to sell	17.13793 ± 1.335067[b]
No intention to sell	3.50820 ± 0.920528[a]
F statistics	162.0908***

Values (M ± SE) with different letters in a column differ significantly (***) at $p < 0.0001$.

TABLE 6: Yield differences based on potato sold to the local markets.

Distance to market	Mean ± SE
Selling to local markets	16.63333 ± 1.343883[b]
Not selling at all	3.53333 ± 0.950269[a]
F statistics	150.1253***

Values (M ± SE) with different letters in a column differ significantly (***) at $p < 0.0001$.

between the yield and producers' sources of income ($r^2 = 0.2878$; $p = 0.018$) (Table 2).

Farmers who had prior intention to sell their produce at the local market produced significantly higher yield as compared to the farmers who did not intend to sell their potatoes. The same applied to the producers who did not sell their potatoes to the local markets. Both the plot size and intention of farmers to sell their potatoes to markets had a significant and positive correlation with producers' intention to sell their produce to the local markets ($r^2 = 0.6228$; $p = 0.000$) (Table 2).

Potato cultivars grown by farmers in Umzumkhulu Local Municipality

Smallholder farmers engage in crop production as one of the strategies to enhance their household livelihoods in the study area. Majority of the farmers planted Mondial cultivar (85.5%), followed by Mnandi (6.7%) and then BP1 (2.2%). However, 5.6% of farmers were not sure of the cultivar that they planted (Figure 1). Tripp (1997) indicated that farmers chose seed varieties based on their needs. The choice of cultivar only made a positive correlation with usage of certified seeds ($r^2 = 0.2619$; $p = 0.032$) and usage of Genetically Modified Organism (GMO) varieties ($r^2 = 0.2619$; $p = 0.032$) (Table 2). Other variables did not make a significant correlation with the choice of cultivar by potato farmers at ULM. The main cultivars on the FPMs (Fresh Produce Markets) 2016 calendar year, listed by Potatoes SA (2017a,b) are Mondial (55%), Sifra (23%), Valor (6%), Lamorna (4%), Up-to-date (2%), Savana (2%), BP1 (2%), Avalanche (2%), Electra (1%) and other (5%) (Potato SA 2017a, b).

Farmers planted both their own saved potato seeds and seeds (certified) accessed through DALRRD and Lima Rural Development Foundation (LIMA). Farmers stored the seeds

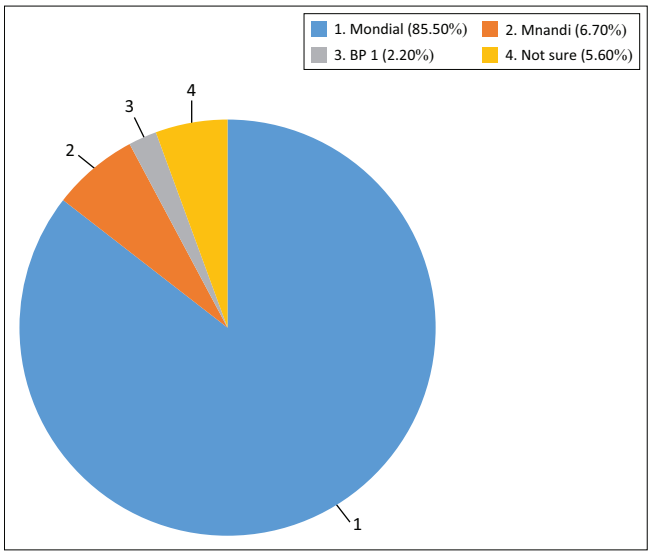

FIGURE 1: Potato cultivars grown by farmers in Umzumkhulu Local Municipality.

in plastics or containers. In many traditional farming systems, it is a common practice that farmers produce their own seeds or ask from neighbours or other farmers and relatives (Abdisa et al. 2001; Chirwa & Aggarwal 2000). Akullo et al. (2007) and Corbeels, Shiferaw, A. and Haile (2000) echoed that traditional farming systems are characterised by dependence on local seed varieties saved from the previous season.

All the participants produced the potatoes in homestead gardens in a very small piece of land ranging from 100 m² –2500 m² per household. According to Ali (2005), landholding is the primary disadvantage in smallholder farming because the majority of farmers have limited land size (Abraham & Pingali 2020; Mahmood & Zubair 2020). Potatoes were planted in spring every year, under dryland while harvesting commenced in summer. Potatoes are harvested using hand hoes and fork spades and buckets or sacks to collect. The harvested potatoes are stored inside the house; a farmer would identify a cool room.

Problematic pests

Pests are a major challenge for potato farmers in ULM. The majority of farmers have more than 16 years of farming experience (89%) and have been encountering the same potato pests in their gardens. Identified pests known to attack potatoes were mentioned by farmers in local language (*isiBhaca*). The description of local names of insect pests is expected to help entomologists, extension workers and others who work with rural communities to better understand pest occurrence and appreciate local knowledge (Midega et al. 2012). The identified pests were cutworm '*Umbundane*', locust – '*Ntothoviyane*', millipede '*Shongololo*' and mole 'Mvukuzane'. Mole was perceived as the most problematic pest species in the study area. In a study conducted by Allemann et al. (2003), it was found that moles and late blight are major pest problems encountered in KwaZulu-Natal and the Eastern Cape. Pests are most prevalent during the summer months.

Farmers perceived that the potato would come out with small fresh holes, damaged by insects. In some cases, there would be green patches on the potato tubers. Others had rough skin with uneven sizes although farmers used the same seed and planted at the same time. Some look fine on the outside but when they cut there would be a brown ring inside.

Traditional farmers are in the position to see only those pests that are observable (Abate, Van Hius & Amopofo 2000; Gognsha & Hiruy 2020). From the description of the pests encountered by farmers in the current study, it was evident that their fields are infested by different pests and the infestation has an impact on the quality of their potato produce. The level of damage to potato crops described by farmers varied from one household to another. Each time farmer realised that there was a pest or disease affecting potato crop and reducing yield, appropriate pest management would be applied using IK or pesticides. According to Potatoes SA (2018), during the 2017 production year, there was lots of damaged tuber observed during packing of potatoes, showing mechanical damage, rot, wilting and skinning. In collaboration with the Agricultural Research Council (ARC), the Potatoes SA developed methodologies to identify causes of tuber damage.

The direct impact of pests on potato production in the study area is the yield and quality reduction. The reduction causes significant economic losses to farmers. As mentioned earlier, for 7% of participants, farming is the primary source of income. The livelihood of such farmers is fully dependent on potato production, and the losses threaten food security.

Potato pest management strategies

The smallholder farmers in ULM use both indigenous knowledge practices and pesticides to control pests. It was found that 74% of participants used IK and 26% relied on pesticides (Figure 2).

Participants indicated that IK still played an important role in their communities. The farmers in ULM still have a high regard for IK. Participants mentioned that Umzimkhulu local communities have a variety of local knowledge practices that can contribute to pest and disease reduction initiatives. During an interview with the key informants (Extension Officers from the Provincial Department of Agriculture), the common view that emerged was that in order for IK to contribute to pest and disease management, there is a need to ensure that the local knowledge and practices used in pest management initiatives are recorded, and promoted for future use in the communities. It is generally recognised that indigenous farmers' knowledge is crucially important for developing sustainable agriculture because this way of farming needs to adjust to local situations, which the farmer usually knows more about than the researcher or the extension farmer (Van de Ban & Hawkins 1996; Löw 2020).

Even though the majority of potato producers relied on IK, there were non-significant differences in the yield produced by farmers who applied chemicals and IK to control potato pests. Indigenous pest management strategies were identified from the communities in ULM.

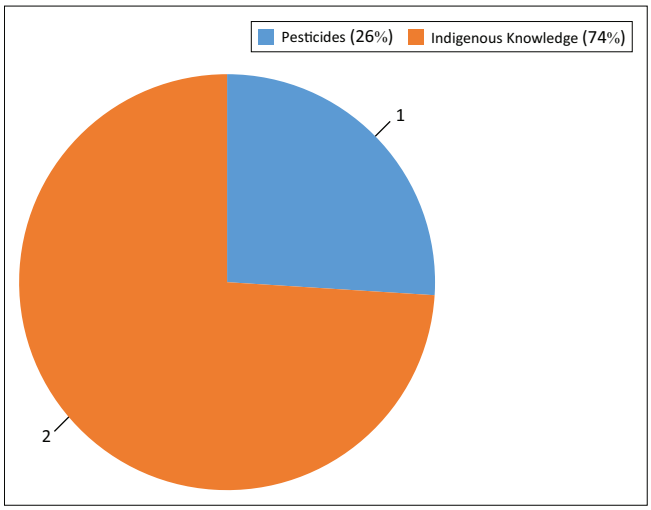

FIGURE 2: Pest management methods in the study area.

In the current study, the perceptions by farmers on the IKPs were:

- Hand picking is easy and serves as an emergency control method.
- The strong odour of plants serves as insect repellent.
- Scarecrows scare the pests and chase them away.
- Cats hunt and eat some pests.
- Ash is available in households using firewood for cooking; it chases away any type of pest.
- The practices are cost-effective and sometimes there are no costs involved.

Participants presented a clear understanding of IK and the practices used to manage pests. They were able to stipulate how each practice is applied and how it works. Fenta (2006) mentioned the use of natural plant materials, using ash on crops, hot pepper mixed with ash and spraying animal urine that are found to provide effective substitutes for agrochemicals. Vorster (2007) also found ash to be one of the main pest repellents for gardens and field crops in smallholder farming. According to Abate et al. (2000), these indigenous knowledge pest management strategies are based on:

> [*B*]uilt-in features in cropping systems, such as farm plot location, crop rotation, and intercropping, or on specific responsive actions to reduce pest attack, such as timing of weeding, use of plants with repellent or insecticide action, traps, scarecrows, smoke, and digging up grasshopper egg masses. (p. 642)

These IKPs in pest management have also been identified by Gressel (2010). A number of IKPs in pest management have been recorded, and studies have recommended the use of indigenous pest management strategies as viable and ecologically friendly options (Abate et al. 2000; Elango et al. 2020; Verma et al. 2020).

Farmers indicated that all the pests identified were difficult to control. Ninety-nine percent of the participants responded that their methods were effective. They mentioned that the effectiveness of pest management method depended on the type of pests controlled. Farmers explained that the effectiveness of IK methods was sometimes dependent on the interest with which the farmer pursue these methods.

Farmers described the method as an easy to learn and pass on method, less time-consuming, easily applied, cost-effective, locally and easily available, no skills required and it is a compatible method of pest management. Indigenous pest control methods are environmentally friendly. In line with the study conducted by Abdulsalam-Saghir and Banmeke (2015), indigenous methods of controlling pests are considered cost-effective, easy to use or handle and they do not require formal education. Indigenous Technical Knowledge products are cheap and, in most cases, cost-free in monetary terms and it is easy to grasp the concepts and practices because knowledge can be passed on orally using the local language (Akullo et al. 2007; Van Wyk & Thurnet 2020).

The major limiting factor to the use of IK in pest management in the community is the lack of documentation. Indigenous knowledge is transferred by word of mouth, it is not scientifically documented and therefore, difficult to access. It is susceptible to being ignored and neglected. There is also a threat of IK in pest management being lost when old people pass on. Farmers also indicated that exposure to modern training has influenced people's attitudes towards using IK.

Management and preservation of IK are key issues related to methodology, access, intellectual property rights and the media and formats in which to preserve it (Chigwada & Chiparausha 2020; Lwoga et al. 2020; Keats 2020). According to Greniere (1998), there are other specific limitations regarding the application of IK.

Even though the majority of potato producers relied on IK, there were non-significant differences in the yield produced by farmers who experienced no challenges as compared to those who experienced labour intensiveness and expensiveness of pest control using indigenous knowledge at ULM. Pest control challenges positively correlated with the control stage ($r^2 = 0.2527$; $p = 0.039$).

The extension officers identified the mole as the most problematic in potato production in the study areas. Extension officers provide potato farmers with certified seeds, fertilisers, and chemical pesticides and advise them in order to assist with improving their production. Some of the IKPs were taught to them by the farmers. The extension officers perceive the IK approach to pest management as effective. Indigenous knowledge is popular in the rural areas. Most farmers produce in small fields for consumption and IK is practised. The method does kill the pests but it is slow. It works in small plots but it would become a challenge in bigger fields because it requires more labour, for instance 'hand picking'. Extension officers advise farmers to complement the indigenous knowledge with chemicals in order to acquire the benefits of both. In a study conducted by Abdulsalam-Saghir and Banmeke (2015), it was stated that some methods are time-consuming, most botanical crops and/or herbs used are going into extinction and most methods are less effective for large scale. The key informants mentioned that there was a need to ensure that the local knowledge and practices used in pest management initiatives are recorded and promoted for future use in the communities.

Conclusion and recommendations

The study revealed that pests were regarded as the main constraint to potato production in the study area. This could be linked to the lack of appropriate pest control management practices. Intervention is required to address a series of issues beyond just providing technological answers to the immediate production and pest management problems. The majority of farmers in ULM live in rural areas where IK is considered to be important because of the general lack of resources. Knowledge within the surveyed communities is mainly passed on by elders or members of the community to the new generation. Community holders of IK are encouraged to share the knowledge to the younger generation and other farmers to promote its usage and continued passage of it from generation to generation. This will also give access to the knowledge to some farmers who are not aware of it so that they may learn of effective IKPs, passed on from generation to generation. The study indicated that there was a lack of proper documentation of IK for future generations. The lack of documentation of this knowledge makes it difficult to preserve and transfer the information.

Documentation of this information is highly recommended. It is recommended that external support is provided to potato farmers in the study area, addressing and assisting with the production challenges. The provision of extension through extension workers is important to develop the skills and knowledge of farmers by identifying existing knowledge that is relevant to their circumstances. This will assist the farmers to improve their practices to meet their needs in farming.

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Authors' contributions

A.M.N. conceptualised and collected the data; P.P.T. supervised the study and assisted in its conceptualisation. F.N.M. validated the research.

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Data availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Disclaimer

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