Journal of Medicinal Plants for Economic Development
ISSN: (Print) 2519-559X

A survey of plants used by rural small-scale farmers to control pests of cabbage in the Eastern Cape Province, South Africa

Authors:
Nolitha L. Skenjana[1]
Maxwell A. Poswal[1]

Affiliations:
[1]Dohne Agricultural Development Institute, South Africa

Corresponding author:
Nolitha Skenjana,
leo_mlanj@yahoo.com

Dates:
Received: 28 Feb. 2018
Accepted: 11 Apr. 2018
Published: 30 July 2018

How to cite this article:
Skenjana, N.L. & Poswal, M.A., 2018, 'A survey of plants used by rural small-scale farmers to control pests of cabbage in the Eastern Cape Province, South Africa', *Journal of Medicinal Plants for Economic Development* 2(1), a57. https://doi.org/10.4102/jomped.v2i1.57

Background: Resource-poor small-scale farmers often cannot afford the high prices of chemical insecticides to control pests on crops; as a result, some use botanical insecticides.

Aim: The aim of the study was to document ethnobotanical pest control methods used by rural small-scale farmers to control pests of cabbage in the Eastern Cape Province of South Africa.

Setting: 217 rural small-scale crop-producing farmers from 14 towns in the Amathole, Joe Gqabi, Alfred Nzo, Chris Hani and OR Tambo Districts participated in the study.

Methods: Questionnaires were administered to consenting farmers between July and November in 2012, using the convenience and stratified purposive sampling techniques. Data collected were subjected to descriptive statistical analysis.

Results: The majority of farmers using botanical insecticides were females above the age of 60 years. The farmers identified 23 plants, which they use in their pest control strategies against seven pests of cabbage. The annual herb *Tagetes minuta* L. (Asteraceae) was cited as the most commonly used herb by 47% of the respondents, followed by *Chenopodium ambrosioides* L. (Chenopodiceae), *Aloe ferox* Mills. (Asphodelaceae) and *Nicotiana tabacum* L. (Solanaceae). Various plant parts were used in combinations or alone in the preparation of formulations mainly against aphids, cutworms and the diamondback moth.

Conclusion: The plants, plant parts, combinations and formulations used by farmers in their cabbage pest control strategies need to be scientifically authenticated for efficacy.

Introduction

Cabbage (*Brassica oleracea* var *capitata* L.) is the most cultivated brassica crop in South Africa (Mandiriza-Mukwirimba, Kritzinga & Aveling 2016:35–44). It is widely used throughout the country in making salads, soup, ink, cabbage atchar, canned as prickled cabbage and at times frozen for later use (Department of Agriculture, Fisheries and Forestry [DAFF] 2010).

Studies indicate that cabbage contains a high content of vitamin K, antioxidants, dietary fibre, folate and several carotenoids and glucosinolates that are not found in other foods (Mithril et al. 2012:777–785). The use of the crop has been shown to reduce the risk of some cancers, especially those in the colorectal group (Ibrahim & Yusuf 2015:248–251). Other medicinal benefits of cabbage include the treatment of gout, stomach problems such as peptic ulcers and constipation, deafness, eye problems, headache, skin problems, asthma, morning sickness and hangovers (Stephen & Suresh 2015:546–561).

In the Eastern Cape Province, cabbage is one of the most cultivated vegetables (Kiribige 2014) and the crop is regarded as one of the staple foods (Mkize 2003). It is an inexpensive source of vitamins and minerals in a maize-based diet. Insect pests are some of the most significant constraints to cabbage production in the province and are often controlled with chemical insecticides (Kiribige 2014; Mlanjeni 2014; Weeks 2007). Some farmers, particularly those not participating in the government programmes, tend not to control at all although they have pest problems because of the high costs of chemical insecticides. Others use alternative methods, with a few practising indigenous pest control methods such as botanical insecticides (Mlanjeni 2014). In the province, knowledge on indigenous pest control methods is available but is being eroded because of the lack of documentation (Odeyemi, Masika & Afolayan 2006:174–176). The aim of the study was to identify and document plants, plant parts, combinations used in botanical insecticides prepared by rural small-scale farmers in the control of insect pests of cabbage.

Materials and methods

Study sites

A survey involving 217 farmers was conducted in five of the six district municipalities (Figure 1) of the Eastern Cape Province covering 14 towns, that is Amathole (Butterworth, Centane, Stutterheim, Keiskamahoek), Alfred Nzo (Mount Ayliff, Mount Frere), Joe Gqabi (Mount Fletcher, Sterkspruit), Chris Hani (Cala, Cofimvaba, Engcobo) and OR Tambo Districts (Tsolo, Libode and Port St John's).

Survey methodology

The survey was carried out between July and November 2012 using the convenience and stratified purposive sampling techniques. The proposal for the study met the ethical requirements set by the Döhne Agricultural Development Ethical Committee, and a certificate on ethical compliance was issued prior to the commencement of data collection. Every participating farmer gave a verbal consent prior to the administration of questionnaires. The farmers were interviewed individually using detailed semi-structured questionnaires.

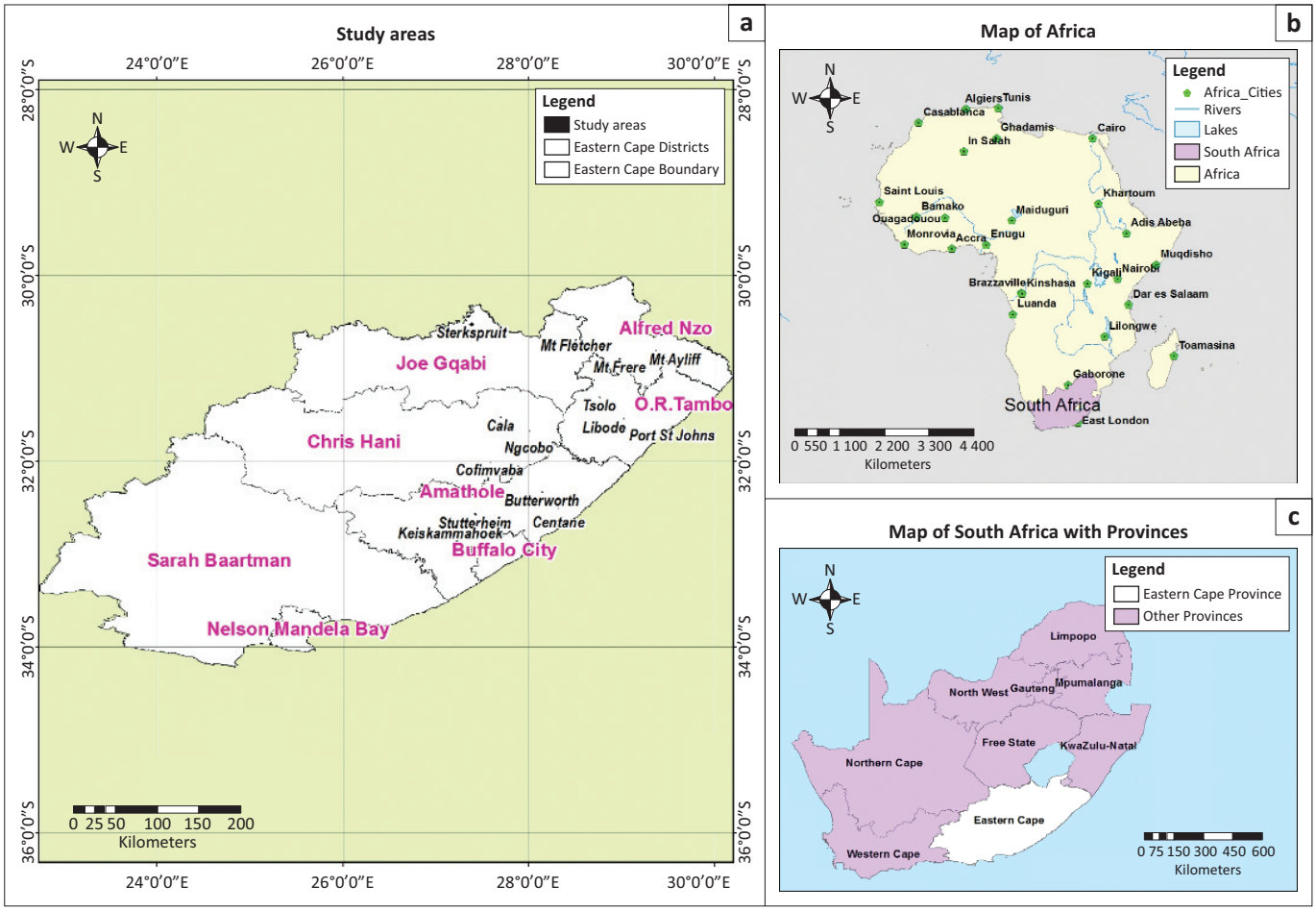
Data collection and analysis

Data were collected on plants and plant parts used in insect pest management, preparation methods, including formulations and their combinations, and their target pests, and farmer demography. Plants used by respondents in pest control strategies were collected and identified at the Döhne Agricultural Development Institute Herbarium in Stutterheim, where voucher specimens are kept. The valid plant names were confirmed using specialised literature such as Dold and Cocks (1999:267–292), van Wyk, van Oudtshoorn and Gericke (1997) and Bromilow (1995). Pictures, live and voucher specimens were used for identification of insect pests. Where there was uncertainty, confirmation was obtained from the Albany Museum at Rhodes University in Grahamstown, South Africa. Mkize (2003) was used to verify local names of insects.

Data were analysed using descriptive statistics, whereas percentages were calculated using Microsoft Excel (2010).

To calculate the frequency of citation percentage of plants used in pest control, equation 1 was used:

$$\%\ \text{Frequency of citation:}\ \frac{\text{Total number of citations per plant}}{\text{Total number of farmers using plant-based methods}} \times 100. \quad \text{[Eqn.1]}$$



Source: Eastern Cape Department of Rural Development and Agrarian Reform GIS Unit

FIGURE 1: Geographical map of the study sites.

Results and discussion

Demography of farmers

The majority of farmers in the study area were females with a male farmer to female farmer ratio of 9:16 (Table 1). Overall, farmers were aware of insects affecting cabbages in their cultivation areas. This could be attributed to their level of education, because only 8% of the farmers had never attended school. The experience with farming in those cultivation areas as majority were old and therefore they could have in-depth understanding of pests in their cultivation areas.

The knowledge and use of botanical insecticides differed from district to district. Older farmers from Alfred Nzo and Chris Hani districts with the mean age of 65 and 78 years, respectively, were more knowledgeable than the rest. This confirms an assertion by Odeyemi et al. (2006) that the indigenous knowledge in the province resides with older farmers.

Plants used in the control of cabbage pests

Farmers identified 23 plants used in their cabbage pest control strategies (Table 2). The majority of the plants belonged to the Solanaceae (22%) and Asteraceae (22%) families and were mainly collected from the wild (65%). The most cited and used plants were *Tagetes minuta* L. (Asteraceae), *Chenopodium ambrosioides* L. (Chenopodiceae), *Aloe ferox* Mills. (Asphodelaceae) and *Nicotiana tabacum* L. (Solanaceae), with citation frequencies of 47%, 32%, 30% and 30% respectively. The citing of these plants by the farmers is consistent with the findings of Mlanjeni (2014) in the same cultivation zones, which reported their use in the control of maize stalk borers. In addition, Odeyemi et al. (2006:174–176) reported the use of *T. minuta*, *A. ferox* and *N. tabacum* by farmers to control insect pests of various crops in Mthatha, Lady Frere, Queenstown, Alice, King William's Town, Whittlesea, Bhaziya and Engcobo. Inclination towards the wide use of these plants in the province could be because of their relative effectiveness in insect pest management, ease of access compared to other plants and their multi-purpose characteristics as some are also used medicinally and in

TABLE 1: Demographic information of respondents.

Data	Alfred Nzo (%)	O.R. Tambo (%)	Amathole (%)	Joe Gqabi (%)	Chris Hani (%)	Total (%)
Total no. of farmers	35 (16.1)	50 (23)	47 (21.7)	32 (14.8)	53 (24.4)	217
Plant users	8 (2)	3 (6)	3 (6.4)	3 (9)	8 (15.1)	25 (12)
Mean age of plant users	65	58	63	64	78	66
Male:female ratio of plant users	3 (1):5 (2)	0:3 (12)	0:3 (12)	1 (4):2 (8)	5 (20):3 (12)	9 (36):16 (64)
Education level of plant users	**None**	**Primary school**	**High school**	**Tertiary education**	-	-
	2 (8)	11 (44)	11 (44)	1 (4)	-	-
Occupation of plant users	**Pensioner**	**Unemployed**	**Employed**	**Self-employed**	-	-
	16 (64)	8 (32)	0	1 (4)	-	-

TABLE 2: Plants identified and used by farmers for pest control in cabbage.

Scientific names	Local names	Habitat	Plant type	Use value %
Solanum umtuma Voronts. & S. Knapp.	Umthuma	Wild	Shrub	4
Solanum giganteum Jacq.	Icuba lasendle	Wild	Shrub	8
Nicotiana tabacum L.	Icuba lesiXhosa	Wild or Cultivated	Perennial Herb	30
Nicotiana glauca Graham.	Icuba lesixhosa elide	Wild	Shrub	4
Capiscum annuum L.	Upele-pele or Itshilisi	Cultivated	Perennial Herb	8
Artemisia afra Jacq.	Umhlonyane	Wild or Cultivated	Herbaceous Shrub	8
Tagetes minuta L.	Untsangu-ntsangu or Unukayo	Cultivated Ground	Annual Herb	47
Bidens pilosa L.	Umhlabangubo	Cultivated Ground	Annual Herb	8
Eriocephalus punculutus DC.	Isirhalarhala	Wild	Shrub	24
Sonchus oleraceus L.	Ihlaba	Wild or Cultivated	Annual Herb	4
Tulbhagia violacea Harv.	Isivumba mpunzi or Utswelana	Wild or Cultivated	Perennial Herb	4
Allium savitum L.	Igaliki	Cultivated	Perennial Herb	8
Allium cepa L.	Itswele	Cultivated	Perennial Herb	8
Leonitis ocymfolia (Burm. f.) Iwarsson.	Isihlungu	Wild or Cultivated	Perennial Herb	8
Alepidea amatymbica Eckl & Zeyh.	Iqwili	Wild	Perennial Herb	16
Pittosporum viridiflorum Sims.	Umkhwenkwe	Wild	Tree	12
Aloe ferox Mills.	Ikhala	Wild or Cultivated	Tree	30
Aloe maculata All.	Unomaweni or Ingcelwane	Wild or Cultivated	Tree	4
Urtica lobulata E. Mey	Umbabazane or Irhawu	Wild or Cultivated Ground	Annual Herb	8
Chenopodium ambrosiodes L.	Unukani or Imbikicane or Unukayo obomvu	Wild	Perennial Herb	32
INP***	Umakoti uny' edwaleni	-	-	4
INP***	Qolwane	-	-	4
INP***	Umyathaza	-	-	4

INP*** denotes information not provided, only the local name, preparation method and target pest of the plant were given. No specimens were collected because farmers indicated that the plants were collected in mountains.

TABLE 3: Preparation methods, plant parts, formulations and combinations used and their corresponding target pest.

Extraction method	Plant part(s) and formulations used	Target pest
Boiling	*Solanum umtuma* and *Bidens pilosa whole plants* are boiled in water and allowed to cool. The mixture is applied on the whole plant and soil around it on 3-day intervals.	Aphids or Cutworms
	Leaves of *Eriocephalus punculutus* and *Aloe ferox* are boiled in water with copper sulphide and allowed to cool. They are applied around the plants bi-weekly.	Cutworms
Boiling and soaking	*Leaves* of *Chenopodium ambrosiodes* are boiled in 20 L of water and soaked overnight and applied on the whole plant and around it once.	Aphids or Cutworms
Soaking	*Solanum giganteum* and *Artemisia afra whole plants* are soaked in water for 3 days and applied on the whole plant twice weekly.	Aphids or DBM
	One handful of *Nicotiana tabacum leaves* is soaked in 20 L of water for few hours and applied on the whole plant on intervals of 3 or 5 days.	Spiders or Aphids or Ants
	Tagetes minuta and *Allium cepa whole plants* are soaked in 20 L of water for 3 days and applied on the whole plant weekly or bi-weekly.	Aphids or Cutworms or DBM
	Tagetes minuta leaves and *stalk* are soaked in water for 7 days and applied on the whole plant twice weekly.	Aphids or DBM
	Tagetes minuta and *Tulbaghia violacia leaves* are soaked in 20 L of water for few hours and applied daily or twice weekly on the whole plant.	Aphids or Bagrada bugs or Locusts
	Crushed *Urtica lobulata leaves* and crushed *T. minuta* plants are soaked in water for few days and applied on whole plants weekly.	Aphids or DBM
	Eriocephalus punculutus leaves and *stalk* are soaked in 20 L of water for 5 days and applied on leaves avoiding the growth point or the head of the cabbage plant or on whole plants on weekly or bi-weekly intervals.	Aphids or Locusts or DBM
	Eriocephalus punculutus leaves mixed with rock hyrax urine is soaked in water overnight and applied on the soil around plants bi-weekly.	Cutworms
	Leaves of *C. ambrosiodes* are soaked in water mixed with kraal manure for few days. The mixture is applied on the whole plant on 3 or 5 day intervals.	Aphids or DBM or Locust
	Crushed *leaves* of Umakoti uny' edwaleni are soaked in water for 7 days and applied on the whole plant daily.	Aphids
	Qolwane *leaves* and *whole plant* of *A. afra* are soaked together in 20 L of water for 7 days. The mixture is applied on the whole plant twice weekly.	Aphids or DBM
	Dried and crushed *leaves* and *bark* of Umyathaza are soaked in water for few hours. The mixture is applied on the whole plant and soil around it weekly.	Aphids or Cutworms
Mixing	Crushed *C. ambrosiodes whole plants* are mixed with 5 L of water and applied weekly on cabbage leaves including the head weekly.	Aphids
	Nicotiana tabacum leaves are crushed and mixed with 5 L of water. The mixture is applied on the soil around plants bi-weekly.	Cutworm
	Nicotiana tabacum, *Sonchus aleraceus* and *Nicotiana glauca whole plants* are crushed and mixed with water. The mixture is then applied on the whole plant.	Aphids or DBM
	C. annum pods cut into small pieces, crushed *Allium savitum cloves* and one table spoon of sunlight dishwashing liquid are mixed together with 2 L of water and applied weekly on leaves.	Aphids
	Allium cepa leaves and *bulbs* are cut into small pieces, mixed with hot water and Madubula and applied on the whole plant and around it twice weekly.	Aphids or cutworms
	Dried and crushed *leaves* and *stalk* of *Alepidea amatymbica*, *leaves* and *bark* of *Leonotis ocymifolia* and *Pittosporum viridiflorum* are mixed together and applied on the whole plant daily. Dried and crushed *leaves* and *stalk* of *A. amatymbica*, *leaves* and *bark* of *L. ocymifolia* are mixed with on the whole plant and around it daily.	Aphids Aphids or cutworms
	Dried and crushed *leaves* and *stalk* of *A. amatymbica*, *leaves* and *bark* of *P. viridiflorum* are mixed together and applied on the whole plant daily. Dried and crushed *leaves* and *stalk* of *A. amatymbica*, *leaves* and *bark* of *P. viridiflorum* are mixed together in water and applied daily on the whole plant and around it daily.	Aphids Aphids or cutworms
	Crushed *A. ferox leaves* are mixed with water and applied daily on the whole plant. Crushed *A. ferox leaves* are mixed with Bulalazonke and water and applied on the whole plant and round it three to four times a week.	Aphids Aphids or cutworms
	Crushed *Aloe maculata leaves* are mixed with water and applied on the whole plant daily.	Aphids

DBM, diamondback moth.

Words in italics indicate plant parts used in formulations.

ethno-veterinary formulations and their combinations (Dold & Cocks 1999; 2000; 2002).

Pest control preparation methods, formulations and combinations and their target pests

To prepare plant materials, farmers made and used different formulations and combinations (Table 3). The use of formulations and combinations by farmers in these study areas for insect pest management is consistent with small-scale farmers from other parts of South Africa and Africa. Researchers such as Sibiya et al. (2013:1790–1798), Kamanula et al. (2011:41–49), Lwoga (2009), Deng et al. (2009:231–235) and Agea et al. (2008:419–420) have alluded to similar activities of products from these plants on a variety of crops by small-scale farmers in KwaZulu-Natal, Zambia and Malawi, Tanzania, Kenya and Uganda, respectively.

The 27 pest control preparation methods, identified by famers, were categorised using four extraction techniques, namely boiling, mixing, soaking and a combination of boiling and soaking. Mixing and soaking techniques were the most prevalent (44.4%). The prevalent use of these two extraction techniques could be associated with the fact they are inexpensive compared to boiling, and perhaps do not take as much time as when a combination of mixing and boiling is employed.

Farmers in this study worked with a variety of plant parts in the preparation of insecticides. Similar to a number of studies conducted on indigenous insect pest method, including that of Mugisha-Kamatenisi et al. (2008:342–348) in Kenya, they used leaves alone, leaves and bark, leaves and bulb, whole plants, leaves and stalks, cloves and pods. Leaves were the most used plant parts. Seemingly, leaves are easier to pick

TABLE 4: Arthropod pests of cabbage in the study areas.

Local name	English name, Order, Family	Joe Gqabi	Amathole	Alfred Nzo	OR Tambo	Chris Hani	Total
		(*N* = 32)	(*N* = 47)	(*N* = 35)	(*N* = 50)	(*N* = 53)	(*N* = 217)
Umbundane	Cutworms, Lepidoptera, Noctuidae	21 (65.6%)	22 (46.8%)	21 (60%)	23 (46%)	24 (45.3%)	111 (51.2%)
Iintwala zekhaphetshu	Aphids, Hemiptera, Aphididae	17 (53.1%)	22 (46.8%)	21(60%)	24(48%)	32 (60.4%)	116 (53.5%)
Ubhomoyi, Ikritsi	Cricket, Orthoptera, Stenopelmatidae	4 (12.5%)	1 (2.1%)	0	0	6 (11.3%)	11 (5.2%)
Iimbovane	Ants, Hymenoptera, Formicidae	5 (15.6%)	4 (8.5%)	13 (37.1%)	8 (16%)	7 (13.2%)	37 (17.1%)
Intethe	Locusts, Orthoptera, Acrididae	1 (3.1%)	0	0	0	4 (7.5%)	5 (2.3%)
Ivivingane or Ibhabhathane lekhaphetsu	Diamondback moth, Lepidoptera, Plutellidae	6 (18.8%)	26 (55.3%)	15(42.9%)	9 (18%)	7 (13.2%)	63 (29%)
Izigcawu	Spiders, Arachnida, Aranae	0	5 (10.6%)	17 (48.6%)	16 (32%)	21 (39.6%)	59 (27.2%)

and to work with compared to other plant parts, and possibly were a convenient choice for older farmers who were the majority users of botanical insecticides in this study. Leaves also contain more secondary plant metabolites, thereby observed to be most active.

Formulations and their combinations were applied either on the whole cabbage plant, leaves including the head or avoiding the head, the whole plant and around it or just around the plant. This seemed to vary per insect pest.

Regarding quantities of ingredients or plant parts, farmers were unable to provide quantities of each ingredient used in formulations or combinations because they depended on plant availability, as the majority were not cultivated. As a result, preparation methods were not standardised. Farmers, however, did indicate intervals of insecticide application.

Arthropod pests of cabbage in the cultivation areas

Farmers identified six insect pests and one arachnid (spider) as pests of cabbage (Table 4). Of the six insects, only a cricket (Orthoptera: Stenopelmatidae) was not controlled by using plant insecticides. The most cited arthropod pests were aphids (Hemiptera: Aphididae), cutworms (Lepidoptera: Noctuidae) and the diamondback moth (DBM) (Lepidoptera: Plutellidae) with a citation frequency of 53.4%, 51.2% and 29% respectively. Aphids, the DBM and cutworms are confirmed as the most prevalent pests of cabbage in South Africa (DAFF 2010; Mkize 2003; Weeks 2007). The prevalence of each pest differed per district. Only 40% of formulations or combinations were prepared against cutworms, whereas 89% were for the control of aphids. This could mean that aphids were viewed as the most problematic pests in the study areas. Although spiders were perceived as pests, they are generally predators of insect pests and their presence in gardens is regarded rather as that of a friend than a foe (Sunderland 1999: 308–316).

Conclusion

These findings, based on farmers' observations and practices, will need to be tested under greenhouse and field conditions. A continuous documentation, assessment and validation of indigenous pest control methods is needed so that the information does not get eroded or lost. Furthermore, research on these methods may lead to the development and deployment of local technologies for pest management.

Acknowledgements

The authors would like to acknowledge the farmers who willingly participated in this study and the Eastern Cape Department of Rural Development and Agrarian Reform for funding this project.

Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

N.L.S. was the project leader and was responsible for all conceptual contributions and the writing of the manuscript. M.A.P. provided consistent comments during the analysis and write-up of the manuscript, and thoroughly reviewed it. All authors read and approved the final version of the article.

References

Agea, G.J., Katongole, B., Waiswa, D. & Nabanoga, G.N., 2008, 'Market survey of *Mondia whytei* (mulondo) roots in Kampala City, Uganda', *African Journal of Traditional, Complementary and Alternative Medicine* 5(4), 419–420.

Bromilow, C., 1995, *Problem plants and alien weeds of South Africa*, Briza Publication, Pretoria.

Deng, A.L., Ogendo, J.O., Owuor, G., Bett, P.K., Omolo, O.E., Mugisha-Kamatenesi, M. & Mihale, J.M., 2009, 'Factors determining the use of botanical insect pest control methods by small holder farmers in the Lake Victoria basin, Kenya', *African Journal of Environmental Sciences and Technologies* 30, 231–235.

Department of Agriculture, Forestry and Fisheries (DAFF), 2010, 'Cabbage', Department of Agriculture Forestry and Fisheries, Pretoria.

Dold, A.P. & Cocks, M.L., 1999, 'Preliminary list of Xhosa plant names from the Eastern Cape, South Africa', *Bothalia* 29(2), 267–292. https://doi.org/10.4102/abc.v29i2.601

Dold, A.P. & Cocks, M.L., 2000, 'The medical use of some weeds, problem and alien plants in the Graham'stown and Peddie district of Eastern Cape, South Africa', *South African Journal of Science* 96, 467–473.

Dold, A.P. & Cocks, M.L., 2002, 'The trade in medicinal plants in the Eastern Cape Province, South Africa', *South African Journal of Science* 98, 589–597.

Ibrahim, I.A.A. & Yusuf, A.J., 2015, 'Assessment of folic acid and iron in cabbage consumed in Bauchi state', *Journal of Chemical Pharmaceutical Research* 7(7), 248–251.

Kamanula, J., Sileshi, G.W., Belmain, S.R., Sola, P., Mvumi, B.M., Nyirenda, G.K.C. et al., 2011, 'Farmers' insect pest management practices and pesticidal plant use for protection of stored maize and beans in Southern Africa', *International Journal of Pest Management* 57, 41–49. https://doi.org/10.1080/09670874.2010.522264

Kiribige, D., 2014, 'A comparison of estimated maize and cabbage enterprise budgets of ideal small-scale commercial and subsistence farms in the Eastern Cape Province of South Africa', *International Journal of Economics Commerce & Management* 12(2), 1–14.

Lwoga, E.T., 2009, 'Application of knowledge management approaches and information and communication technologies to manage indigenous knowledge in the agricultural sector in selected districts of Tanzania', Ph.D. thesis, School of Sociology and Social Studies, University of KwaZulu-Natal.

Mandiriza-Mukwirimba, G., Kritzinger, Q. & Aveling, T., 2016, 'A survey of brassica vegetable smallholder farmers in the Gauteng and Limpopo provinces of South Africa', *Journal of Agriculture and Rural Development in the Tropics and Subtropics* 117(1), 35–44.

Mithril, C., Dragsted, L.O., Inge Tetens C.M., Biltoft-Jensen, A. & Astrup, A., 2012, 'Dietary composition and nutrient content of the New Nordic Diet', *Public Health Nutrition* 16(5), 777-785. https://doi.org/10.1017/S1368980012004521

Mkize, N., 2003, 'A contribution to cabbage pest management by subsistence and small-scale farmers in the Eastern Cape, South Africa', MSc thesis, Dept. of Zoology & Entomology, Rhodes University.

Mlanjeni, N.L., 2014, 'Identification and documentation of ethnobiological methods used by rural farmers to control stalk borers of maize in the Eastern Cape Province of South Africa', MSc thesis, Dept. of Botany, University of Fort Hare.

Mugisha-Kamatenesi, M., Deng, A., Ogendo, J., Omolo, E., Mihale, M., Otim, M. et al., 2008, 'Indigenous knowledge of field insect pests and their management around Lake Victoria basin in Uganda', *African Journal of Environmental Science and Technology* 2, 342–348.

Odeyemi, O.O., Masika, P. & Afolayan, A.J., 2006,'"Farmers" knowledge and experience of indigenous insect pest control in the Eastern Cape Province of South Africa', *Indilinga-African Journal of Indigenous Knowledge Systems* 5(2), 174–176.

Sibiya, J., Tongoona, P., Derera, J. & Makanda, I., 2013, 'Smallholder farmers' perceptions on maize diseases, pests and other production constraints, their implications for maize breeding and evaluation of local maize cultivars in KwaZulu-Natal, South Africa', *African Journal of Agricultural Research* 8(17), 1790–1798. https://doi.org/10.5897/AJAR12.1906

Stephen, A. & Suresh, R., 2015, 'Nutritive and therapeutic values of vegetables from the markets of Chennai, Tamil Nadu, India', *Journal of Academia and Industrial Research* 11(3), 546–561.

Sunderland, K., 1999, 'Mechanisms underlying the effects of spiders on pest populations', *Journal of Arachnology* 27(1), 308–316.

Van Wyk, B.E., van Oudtshoorn, B. & Gericke, N., 1997, *Medicinal plants of South Africa*, Briza Publication, Pretoria.

Weeks, W.J., 2007, 'The effect of a cabbage-carrot intercropping on the incidence of cabbage pests', MSc thesis, Department of Environmental Science, North-West University.