S.Afr. Tydskr. Landbouvoorl./S. Afr. J. Agric. Ext., Kotey, Assefa, Obi
Vol. 44, No. 1, 2016: 59 – 74 & van den Berg.
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DISSEMINATING GENETICALLY MODIFIED (GM) MAIZE TECHNOLOGY TO SMALLHOLDER FARMERS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA: EXTENSION PERSONNEL'S AWARENESS OF STEWARDSHIP REQUIREMENTS AND DISSEMINATION PRACTICES

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ABSTRACT

Advice and technical information from extension services are critical in promoting new technologies and their adoption by farmers. This study determined extension personnel's awareness of GM maize technology and the associated extension services they provide to smallholder GM maize farmers in the Eastern Cape province of South Africa. Face-to-face interviews were conducted with extension staff of the Department of Rural Development and Agrarian Reform (DRDAR) in the province. Results indicated that inadequate training of extension personnel on GM maize technology influenced their perceptions of GM maize technology and awareness of its stewardship requirements. Generally, personnel had a low level of awareness of GM maize technology as a pest control strategy. Awareness of GM maize stewardship requirements amongst extension personnel was also low. These extension personnel disseminated GM maize technology, which they generally perceived as a high-yield technology, to smallholder farmers using non-participatory approaches and media sourced from GM seed companies. The findings of this study suggest that ensuring safe and sustainable adoption of GM maize technology on smallholder farms will require a more participatory extension approach that emphasizes smallholder farmers' access to information as well as the training of extension personnel on the stewardship requirements and dissemination practices associated with GM maize cultivation.

Keywords: Dissemination, extension, GM maize technology, smallholders, stewardship

1. DEFINITION OF PROBLEM

Smallholder agriculture is the mainstay of agricultural production in sub-Saharan Africa and plays a critical role in improving livelihoods and reducing the susceptibility of poor rural and urban households to food insecurity (Baiphethi & Jacobs, 2009:459; Yengoh, Armah & Svensson, 2009:112; Obi and Tebogo, 2011:28). In view of this, the Provincial Growth and Development Plan (PGDP) of the Eastern Cape government have placed particular emphasis on subsistence agriculture in its efforts to combat food insecurity and poverty (PGDP, 2004:8; Ndhleve & Obi, 2013:264). To this effect the PGDP has formulated a number of initiatives aimed at supporting smallholder farmers in the province. The current initiative being implemented under the PGDP is referred to as the 'cropping programme' (Eastern

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Cape Rural Development Agency, 2013:12). The cropping programme seeks to increase smallholder food production and access to production support services such as inputs, mechanisation and advisory services (Department of Rural Development and Agrarian Reform, 2014:8). Similar to the Massive Food Production Programme (MFPP), which was the first programme implemented under the PGDP (PGDP, 2004:10), the cropping programme focuses on increasing maize yields through the use of GM maize (Tregurtha, 2009:2; Jacobson, 2013:22).

GM maize has enhanced genetic traits that are patent-protected by the Plant Breeders' Rights Act, 1976 (Act No. 15 of 1976) and also regulated by the Genetically Modified Organisms Act (Act 15 of 1997). End-users purchasing GM seed [*Bacillus thuringiensis* (Bt) maize, herbicide tolerant maize and stacked gene trait (BR maize), which combines Bt and herbicide tolerance in one hybrid] are therefore required to sign technology licensing agreements with permit holders where they agree to comply with permit conditions (Iversen, Grønsberg, Van den Berg, Fischer, Aheto & Bøhn, 2014:2). Amongst others, these regulations prohibit the saving or recycling and sharing of GM seeds and also requires the spatial isolation of GM and non-GM maize plantings as a stewardship measure. To delay resistance evolution by target pests, farmers who plant Bt seed are required to plant refuge areas of non-Bt maize adjacent to Bt maize fields. Assefa & Van den Berg (2010:222) has stated that these regulations are better suited to the conditions and practices of commercial farming. This is borne out of the fact that in contrast to commercial farmers, inputs used by smallholder farmers are self-generated, being obtained directly from previous harvests or locally-sourced through exchange with friends, neighbours and relatives (Sperling, Remington & Haugen, 2006:(6):1). Additionally, the agricultural structure in smallholder systems typically consists of a high density of small fields which makes the maintenance of stipulated legal separation distances impossible (Aheto, Bøhn, Breckling, Van den Berg, Ching & Wikmark, 2013:95). Cultivation of GM maize by smallholder farmers therefore necessitates adoption of new management practices and changes in farmer behaviour, both for the sake of ensuring optimal use (Jacobson, 2013:30) and compliance with these regulations.

Extension and advisory support plays a key role in engendering attitudinal change and promoting the adoption of new technologies and good agricultural practices by smallholder farmers (Ozowa, 1997:12; Mafabia & Obi, 2011:224; Taye, 2013:3). The relevance of information transferred by extension services to smallholder farmers is an important determinant of its utilization (Opara 2010:1). Extension personnel may therefore not be able to successfully facilitate the adoption of new management practices by smallholder GM maize farmers unless they are aware of GM maize stewardship requirements and package these requirements in a manner that farmers perceive to be meaningful and appropriate for ensuring the long-term sustainability of GM maize technology. Studies conducted in localized areas of the Eastern Cape and KwaZulu-Natal provinces has indicated that successful and safe introduction of GM maize to smallholders was hindered by lack of transfer of information (Assefa and Van den Berg, 2010:221; Jacobson & Myrh 2012:120). This study therefore determined extension personnel’s awareness of GM maize technology stewardship requirements and the associated extension services they provide to smallholder GM maize farmers in the Eastern Cape Province.

2. PROCEDURE

2.1 Survey methodology

Surveys were conducted in five of the six District Municipalities of the Eastern Cape where dry land maize cultivation is undertaken by smallholder farmers. A total of 81 extension personnel from 16 service centres of DRDAR (Figure 1) were interviewed between September 2014 and May 2015. Respondents were selected on the basis of the presence of GM maize projects in their areas of operation. Extension personnel in each service centre were interviewed individually using a structured questionnaire. Topics covered in interviews included: insect pest constraints to maize cultivation, the strategies adopted for managing stalk borer infestation in maize, the level of awareness of GM maize stewardship requirements as well as the perceptions of extension personnel regarding GM crops with insect resistance and herbicide tolerance traits.

Frequency counts and percentages were used to describe the demographic and educational characteristics and the level of awareness of GM maize technology and its stewardship requirements. For all questions asked during interviews, percentages were calculated using the total number of extension personnel who responded to a particular question. In cases where respondents did not answer a particular question, they were excluded from the calculation of percentage values for that question.

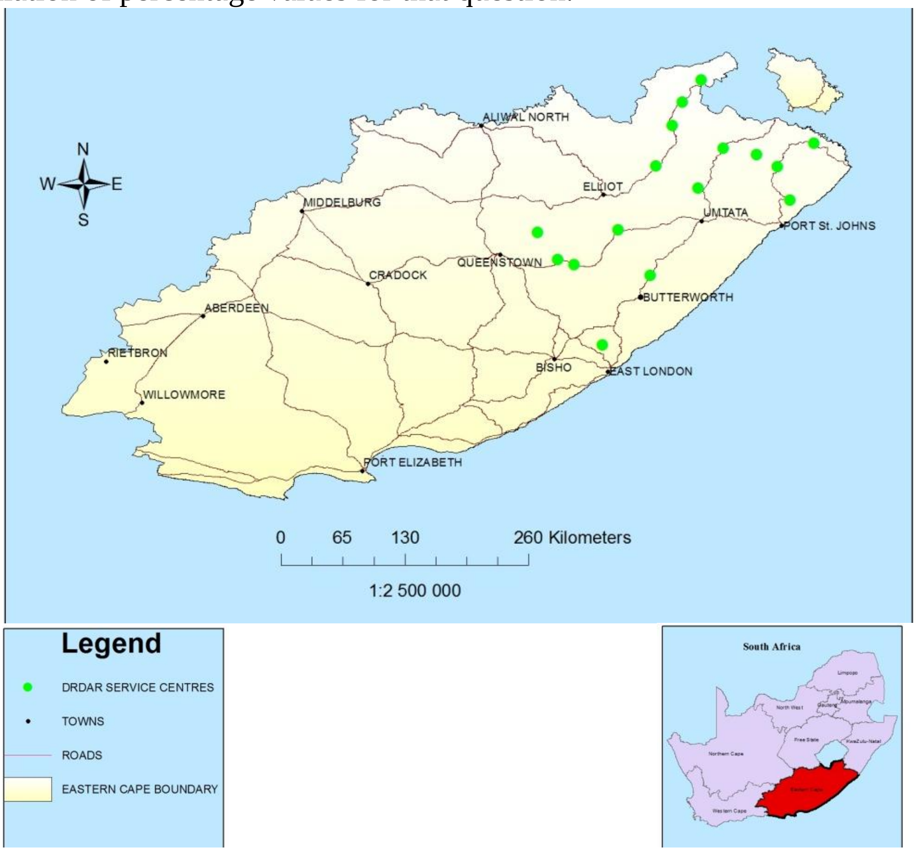

Figure 1: Map of the Eastern Cape showing localities at which respondents were interviewed

3. FINDINGS.

3.1 Demographic and professional characteristics of extension personnel.

The overall ratio of extension personnel to GM maize farmers was 1:101. Results indicate that the majority of extension personnel (64%) who render extension and advisory services to smallholder GM maize farmers are male. This is number is similar to the findings of the

Department of Agriculture Forestry and Fisheries (DAFF, 2009:3) which reported that the extension services in seven of the nine provinces of South Africa are dominated by male personnel. The ratio of both male and female extension agents to GM maize farmers were well above the target of one agent to 400 subsistence and household farmers for the country (Department of Agriculture, 2005:11). However, increasing the number of qualified female extension personnel may translate into better service provision (Hart & Aliber, 2012:7) and also boost food security in female-headed households. It has been observed that better information transfer to female farmers is achieved through female-to-female extension as opposed to male-to-female extension (SDC, 1995 cited in Manfre, Rubin, Allen, Summerfield, Colverson & Akeredolu, 2013:17). This is particularly important since female farmers constitute more than two-thirds of people involved in smallholder agriculture in South Africa (Hart & Aliber, 2012:2).

According Figure 2 below, a significant proportion (77%) of the extension personnel that participated in the survey was below the age of 50 years and only 14% of respondents were above the age of 55. Most of the respondents had a diploma qualification (35%) in agricultural extension (51%) and 38% had between 5-10 years of experience as extensionists. According to the Department of Agriculture (2005:9), on average, extension personnel in the Government service in South Africa possess a three-year post-matriculation agricultural diploma qualification which does not adequately equip them with the skills and expertise for the attainment of desired outputs. The knowledge and capacity of personnel to effectively perform tasks in a certain field of expertise generally increases with increasing number of years served in that particular field (Mathabatha, 2005:26). Thus, although the findings of this study reflect a similar situation, the high number of relatively young extension officers in the region provides an opportunity for capacity development related to the new technology such as GM crops that will be an important component of the farming system of the region in future.

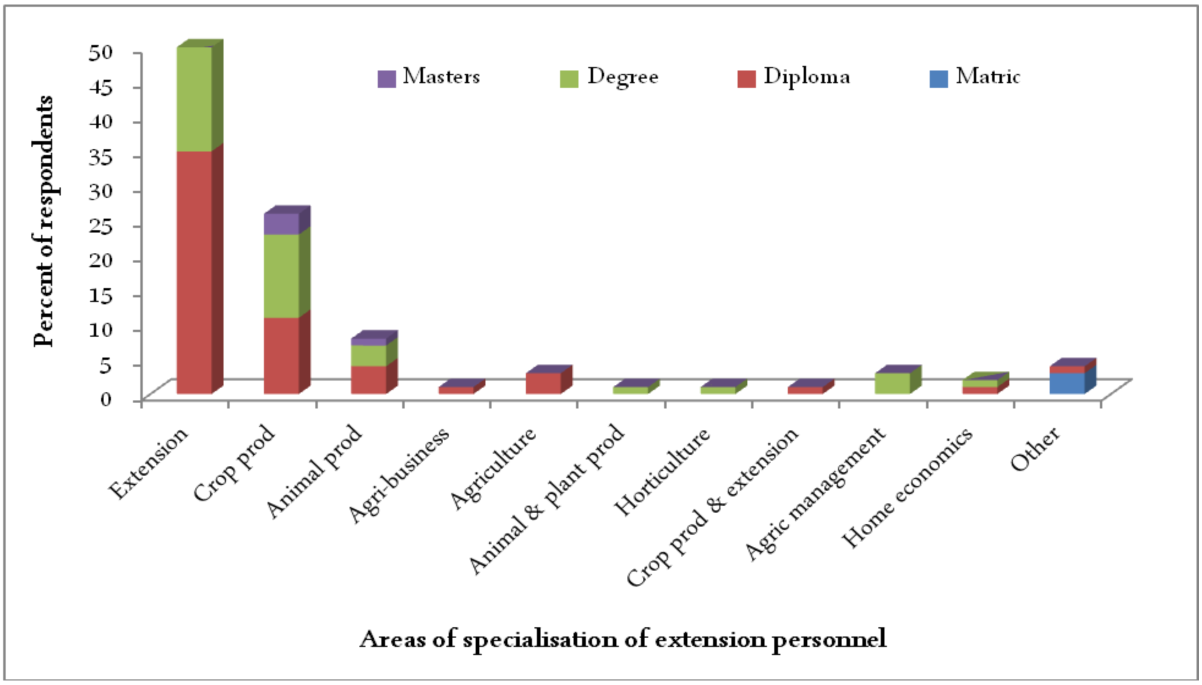

Figure 2: Educational and professional profile of extension personnel who render extension and advisory services to smallholder farmers in the Eastern Cape Province

3.2 Extension personnel's awareness about GM maize technology and stewardship.

A key aim of this paper is to establish the current status of the extension personnel's awareness about GM maize technology and stewardship and identify gaps that justify remedial intervention. The results are presented in Table 1 which shows the extension personnel's level of participation in GM maize technology training and their awareness regarding regulatory and stewardship aspects of GM maize seed use.

Table 1. Extension personnel's participation in GM maize technology training programmes and awareness about regulatory and stewardship aspects of GM maize seed use.

Training in GM maize technology	**Frequency**	**Percentage**
Yes	32	40
No	49	60
Total	81	100
Awareness of regulations governing GM seed use	**Frequency**	**Percentage**
Yes	19	27
No	52	73
Total	71	100
Specific details of regulations	**Frequency**	**Percentage**
Application of herbicides	1	5.6
Use of co-operatives for GM cultivation	1	5.6
No mixed cropping, re-use of GM seeds	9	50.0
No sharing of GM maize seeds	1	5.6
Don't Know	6	33.3
Awareness of refuge area planting	**Frequency**	**Percentage**
Yes	4	8
No	47	92
Total	51	100
Bt maize cultivation on smallholder farms poses no potential negative effects for local maize varieties	**Frequency**	**Percentage**
Agree	26	57
Disagree	12	26
Don't know	8	17
Total	46	100

The results indicate that the majority (60%) of respondents did not receive any training on GM maize technology before becoming involved in the dissemination of the technology to smallholder farmers (Table 1). The awareness of respondents regarding regulatory aspects and stewardship around GM seed use was generally low. The number of respondents that were aware of stewardship requirements regarding GM maize was low with 50% listing mono-cropping of GM maize (no inter-cropping of GM maize with other plant species) and no re-use of GM seeds as stewardship requirements (Table 1). Their lack of knowledge regarding this issue was further illustrated by answers referring to application of herbicides to Bt maize (5.6%), use of cooperatives for GM cultivation (5.6%) and no sharing of GM maize seeds (5.6%). Additionally, only 8% of respondents in whose area Bt maize was cultivated during the 2013/2014 season said they were aware of the fact that refugia needed to be planted adjacent to Bt maize fields. All respondents also indicated that neither they nor the farmers in their areas signed any technology agreements before being provided with seeds for cultivation. The level of awareness about the potential effects, through outcrossing of Bt maize on local maize varieties was also low with 57% of respondents indicating that Bt maize cultivation adjacent locally recycled maize seeds or varieties could have no adverse effect. A few (17%) respondents also did not know if Bt maize cultivation could adversely affect local maize varieties or not.

In accordance with the provisions of the GMO Act, Act 15 of 1997, the GMO Amendment Act (Act 26 of 2006), the Plant improvement Act, Act 53 of 1976, and the plant breeders rights Act, Act 15 of 1976, GM maize may only be cultivated by a farmer who has signed an agreement with the patent holder (Monsanto, 2012:1). Consequently, it is illegal to cultivate GM maize without a signed licence agreement or to ignore the conditions set forth in the licence (Monsanto, 2012:1). All extension personnel interviewed however revealed that because beneficiary farmers received their seeds for planting from DRDAR they were not required to sign technology agreements. This situation is however not unique to the cropping programme. Jacobson & Myhr (2012:115) observed that under the MFPP, smallholder farmers did not sign agreements with Monsanto, the permit holder. Results of interviews however indicated that extension personnel may not be aware that planting GM maize without the signing of technical agreements is an infringement of the law. This is particularly so because the specific regulations that respondents said they were aware of did not include the requirement for the signing of agreements (Table 1). The awareness of the regulation of mono cropping of GM maize and no re-use of GM seeds may be attributed to the fact that during the workshops that first introduced GM maize to smallholders in the province, farmers were advised not to inter-crop GM maize with other crops species or recycle GM seeds from harvests (Jacobson & Myhr 2012:114). In most areas of the Eastern Cape, farmers wishing to join the cropping programme in an area are required to form a group and elect a committee. The perception that only farmers' cooperatives can be used for GM maize cultivation may therefore be attributable to this.

The implementation of an insect resistance management (IRM) program is specified by technical agreements. The main IRM strategy used to delay resistance development by Bt maize target pests is the high dose/refuge strategy (Van den Berg, Hillbeck & Bøhn, 2013:155). This strategy involves the planting of hybrids expressing a high dose of insecticidal proteins and a refuge planting containing hybrids not expressing insecticidal proteins. The target pest is therefore not under selection pressure for resistance evolution in the refuge block and the refuge therefore produces a large number of susceptible insects (Burkness & Hutchison, 2012:1773). The role of GM crops in enhancing environmental sustainability in agriculture is compromised once GM maize target pests develop resistance to the technology (Jacobson & Myhr, 2012:118). As such, the planting of a refuge area adjacent to Bt maize is a vital component of Bt maize production that ensures long term sustainability of the technology. Awareness of the requirement for the planting of a refuge area next to Bt maize amongst extension personnel was however very limited. Refuge areas were also absent in all Bt fields inspected during field visits (data not shown).

Several authors have observed that the implementation of biosafety regulations including refuge plantings will be problematic on smallholder farms (Assefa & Van den Berg, 2010:221; Kruger, Van Rensburg & Van den Berg, 2012:49). Reasons assigned for this includes the structure (Aheto *et al.,* 2013:95) and conditions (Assefa & Van den Berg, 2010:222) of smallholder agriculture. The current structure of GM cultivation by smallholder farmers under the cropping programme mostly consists of several small fields organized into large units to facilitate mechanisation. The consolidation of small farm units into large ones therefore presents an opportunity for the planting of refuge areas adjacent Bt maize on such fields. Mannion & Morse (2013:17) have stated that the implementation of refugia in smallholder settings depends on increased awareness creation. However, although increasing the awareness of extension personnel in the province may facilitate the implementation of refugia, the implementation strategy of the cropping programme as well as short comings of key stakeholders like DAFF/DRDAR and GM seed companies in fulfilling duties stipulated in the GMO Act will have to be addressed. For example, inputs supplied by the District Municipality offices of DRDAR to service centres are usually matched to the area of land to be cultivated in each sub-district. Field visits indicated that seeds of non-GM iso-hybrids for the planting of refuge areas are not supplied along with these inputs. Therefore even if extension personnel at the sub-district level were aware of the requirement for the planting of a refuge area next to Bt maize, they will be constrained to ensure compliance. The practice of supplying GM seed without a conventional near iso-line is contrary to the practice that pertained when Bt maize was first introduced to smallholder farmers in the province. During the initial introduction of Bt maize to smallholder farmers, bags of Bt maize seed and its non-GM iso hybrid were provided to farmers for the planting of refuge areas (Gouse, 2012:164).

Under the GMO Act, inspectors within the DAFF are required to monitor for compliance to permit conditions including measuring the effectiveness of risk management strategies and the detection of possible adverse impacts. Similarly, representatives of the GM seed companies from whom farmers obtain their seeds are supposed to advise famers (in this case DRDAR) to ensure on-farm compliance with refuge planting requirements. It, therefore; follows that if these institutions insisted on compliance it would have heightened the awareness of extension personnel at the sub-district level and facilitated some level of compliance.

Local crop varieties cultivated by smallholders are adapted to different (and often changing) growing conditions and farmer preferences and therefore constitute co-evolving socio-biological systems that conserve genetic diversity under evolution (Tripp & Van der Heide, 1996:2; Bellon, Gotor & Caracciolo, 2015:171). The genetic diversity of these crops is vital to minimizing the susceptibility of crops to unexpected changes in climate, and to the emergence of new pests and diseases (Esquinas-Alcázar, 2005:947). Maize is a cross-pollinating crop, as such, unless deliberate measures are undertaken to separate GM and non-GM maize plantings, GM maize transgenes can lead to the erosion of the genetic diversity inherent in local maize varieties. This is particularly important given the fact that GM maize transgenes have recently been reported in non-GM maize in parts of the province (Iversen, *et al.,* 2014:17). Apart from the effects on the diversity of locally recycled seeds, the presence of transgenes in seed that are perceived to be non-GM may have an effect on pest resistance evolution in the long run. It has been reported by Van den Berg *et al.* (2013:158) and Iversen *et al.* (2014:18) that reduced Bt protein expression in open pollinated maize varieties that have Bt gene, may lead to resistance evolution. Increasing the awareness of extension personnel regarding these adverse effects will therefore facilitate the adoption of good GM maize stewardship programs by farmers which will in turn limit the proliferation of GM maize transgenes in locally recycled seeds.

3.3 Extension personnel's awareness on the relative importance of maize pests and GM maize as a pest management technology.

The study sought information from the extension personnel as to the insect pests that are important constraints to maize cultivation in their areas as well as the strategies adopted for managing these pests. The results are presented in Figures 3 and 4. Further, Table 2 shows extension personnel's perception of the benefits of cultivating GM maize in their areas of operation.

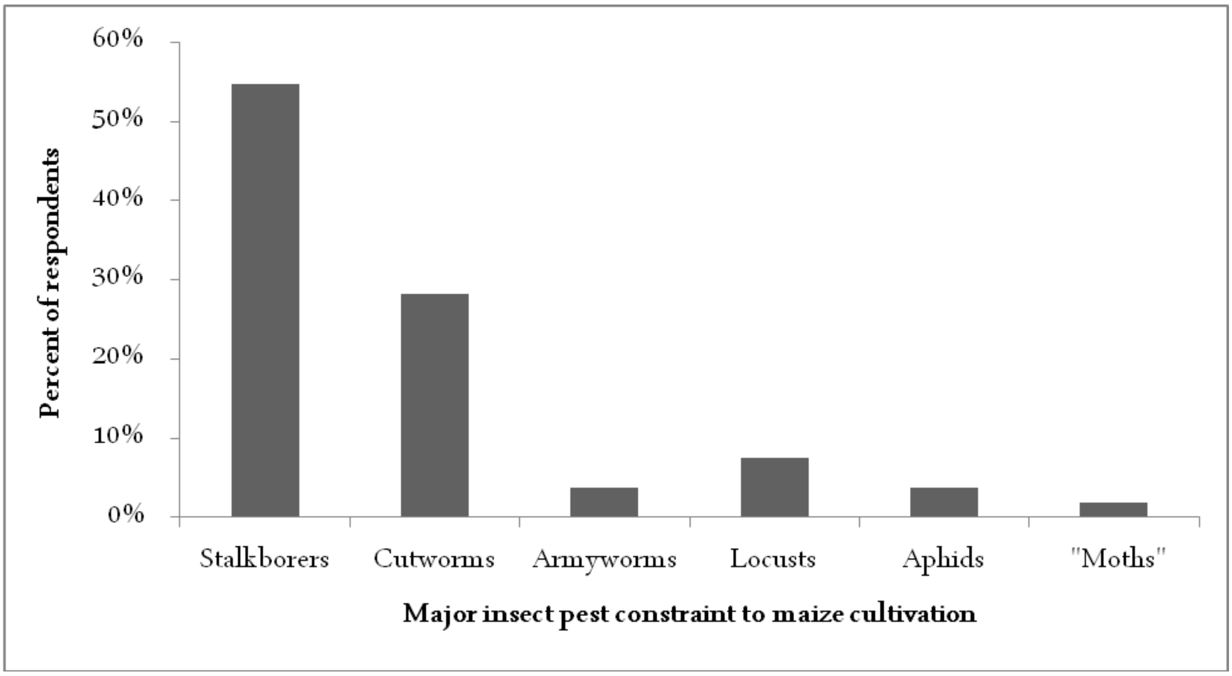

Figure 3: Insect pests of maize indicated by extension personnel to be important in the Eastern Cape Province

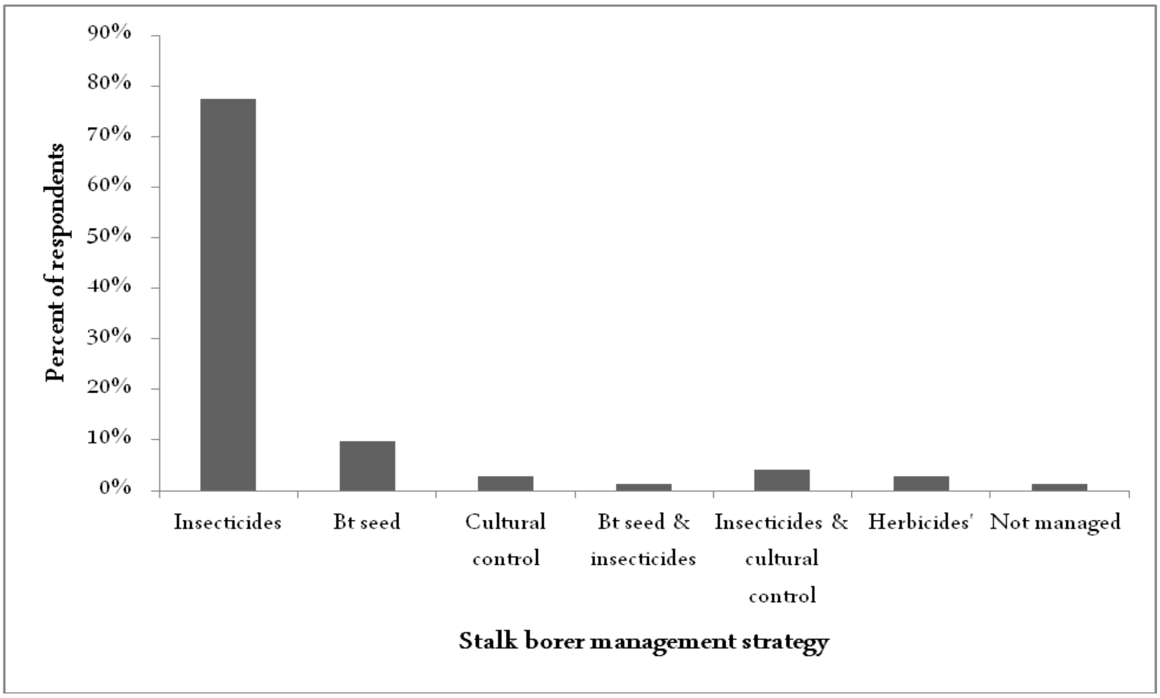

Figure 4: Strategies used for the management of stalk borers on maize farms of beneficiaries of the Eastern Cape Province's maize cropping programme.

Stalk borers were indicated to be the major insect pests of maize (Figure 3) and insecticide application was the most common method of control (Figure 4). About 28% of respondents also listed cutworms and locusts as major insect pest constraints to maize cultivation in their areas. The proportion of respondents that recognised the use of Bt maize seed as a stalk borer control tactic was generally low. Use of stalk borer resistant Bt maize as a sole tactic and in conjunction with insecticide sprays were respectively listed by only 10% and 1% of respondents. A combination of insecticide sprays and adoption of cultural control methods were used in 4% of operational areas. About 3% of respondents mentioned use of herbicides as the stalk borer control strategy. Twenty-nine percent of personnel perceived higher yields as the benefit farmers obtain from cultivating GM maize. Lower labour input was cited by 18% of respondents whilst 15% of respondents said farmers in their areas of operation obtained high yields and had a low labour input when they planted Bt maize (Table 2).

Table 2: Benefits indicated by extension personnel to be associated with planting of Bt maize.

Advantage derived from planting GM maize	Frequency	Percentage
Higher yield	23	29
Lower labour input	14	18
Drought tolerance	3	4
Higher yield, income	1	1
Higher yield and lower labour input	12	15
Lower labour input, resistance to pests	5	6
Seed adaptability, higher yield, resistance	4	5
Higher yield, drought tolerance, food safety	1	1
Higher yield, resistance to pests, diseases	5	6
Higher yield, drought tolerance, lower labour input	1	1
Don't know	11	14
Total	80	100

The listing of stalk borers and cutworms as the major insect pest constraints are consistent with the findings of Schimmelpfennig, Rosen & Pray (2013:39) regarding insect pest constraints on smallholder farms in South Africa. Although the predominant GM seed type (60% of operational areas) used in the operational areas of respondents during the 2013/2014 farming season was BR maize (combination of Bt and herbicide tolerance traits in one seed), stalk borer infestation on maize in these areas was mostly managed through insecticide application. Very few personnel demonstrated awareness of either the fact that Bt maize was a stalk borer management tactic, or that it provided advantages to smallholder farmers. The limited awareness of Bt maize as a stalk borer control tactic may be attributable to the low prevalence of personnel with a background in crop protection as well as a lack of on the job training on GM maize technology.

The current model of GM maize dissemination could also be a contributory factor. Interactions with personnel indicated that there was little participation in the selection of GM maize varieties by personnel at the sub-district level. Their role was mostly limited to ascertaining the seed colour desired by farmers in their areas. Inputs are also purchased and supplied as a package (fertilizer, herbicides, insecticides and seeds) for a pre-determined area (hectares) to be cultivated. This implied that Bt cultivars were supplied together with insecticides for stalk borer control which were subsequently sprayed onto fields including Bt fields. These could have limited the awareness of the personnel about the fact that Bt maize is stalk borer resistant. Kruger *et al.* (2012:48) also observed preventative application of insecticides on Bt maize on commercial maize farms in the country the practice goes contrary to the fact that one of the main advantages of insect pest resistant GM technology is the reduction of insecticide applications (Qaim, 2003:2125; Gouse, Pray, Kirsten, & Schimmelpfennig, 2005:93; Morse & Mannion, 2013:4). Additionally although the practice may contribute to delaying of resistance evolution by target pests it is far removed from good integrated pest management (IPM) (Van den Berg, Hillbeck & Bøhn, 2013:158). Hellmich, Albajes, Bergvinson, Prasifka, Wang, & Weiss (2008:147) have stated that GM crops expressing insecticidal proteins are an essential component of maize IPM strategies. This is however feasible only if Bt-crops replace the use of broad-spectrum insecticides and not if insecticide sprays are applied without the guidelines of economic thresholds and to GM Bt maize that may not require it. A few personnel indicated that stalk borer infestation on maize in their areas was managed with herbicides. As part of the mechanisation of farm operations, herbicides and insecticides are applied simultaneously using boom sprayers. It is therefore likely that these respondents could not distinguish between the two. Damgard-Hansen cited in Tregurtha (2009:12) previously reported that extension personnel have a limited awareness of agricultural chemicals.

3.4 Provision of extension and advisory services and GM maize technology information dissemination to smallholder farmers

Table 3 shows the level of extension contact and the strategies adopted by extension personnel for disseminating GM maize technology to smallholder farmers in their areas of operation.

Table 3: Extension contact and strategies used to disseminate GM maize technology to smallholder farmers in the Eastern Cape Province.

Periodicity of contact with GM maize farmers (percentage of personnel's annual extension activities)	**Frequency**	**Percentage of time schedule**
5-10 %	16	20
10-20 %	8	10
20-30 %	11	14
30-40 %	14	18
40-50 %	11	14
>50 %	19	24
Total	79	100
Strategies used for GM maize technology dissemination	**Frequency**	**Percentage**
Information (info) days	7	9.2
Info) days + flyers	1	1.3
Info days + video presentations	14	18.4
Info days + demonstration trials	3	3.9
Info days + flyers + video and training sessions	6	7.9
Workshops & training sessions	6	7.9
Info days + video and demonstration trials	2	2.6
Info days + flyers + video	20	26.3
Info days + flyers + video + Farmer Field Fora	6	7.9
Info days + flyers + video and demonstration trials	7	9.2
None	4	5.3
Total	76	100
Source(s) of media used to disseminate GM maize technology to smallholder farmers	**Frequency**	**Percentage**
DRDAR	7	10.6
GM seed companies	17	25.8
Non-governmental organisations	7	10.6
Dohne Agricultural Development Institute	1	1.5
DRDAR, Non-governmental organisations (NGOs)	3	4.5
GM seed companies and NGOs	11	16.7
DRDAR, GM seed companies	7	10.6
DRDAR, GM seed companies, NGOs	13	19.7
Total	66	100

Twenty four percent of respondents dedicated more than 50% of their annual extension schedules (from commencement of pre-planting operations in October to harvesting in June) to GM maize related activities whilst 20% dedicated between 5-10 % of their extension schedule to GM maize related activities. Only 10% of respondents dedicated between 10-20% of their extension schedule to GM maize related activities (Table 3). Generally, GM maize technology was disseminated to smallholder farmers through information days (Table 3). About 26% of respondents used flyers and video presentations to disseminate GM technology during such days whilst 18% of respondents used only video presentations during information days. Generally, less than 10% of respondents disseminated GM maize technology through workshops, training sessions or through participatory approaches such as farmer field fora and demonstration trials (Table 3). The primary source of media used to disseminate information was from GM seed companies (about 26% of respondents) that provided materials for this purpose. Although a sizeable proportion of respondents used media from a range of sources (DRDAR, GM Seed Company and NGOs) only 2% indicated that they used media from the Dohne Agriculture Development Institute in the Eastern Cape Province (Table 3).

Mpofu, Gurney, Fuzani, Seoka & Hanekom (2012:7) define extension services as a service of information, knowledge and skills development to enhance the adoption of improved agricultural technologies and facilitation of linkages with other institutional support services (input supply, output marketing and credit). In addition to rendering extension services to farmers, extension personnel in the Eastern Cape act as coordinators of rural development initiatives in their operational areas (DRDAR, 2014:28). Services rendered by personnel prior to maize planting include compilation of the lists of farmers who wish to participate in the cropping programme during the season. Personnel also assist farmers who cannot afford to pay the R1,800.00 contribution to obtain credit in order to participate in the program. Other pre-planting services rendered includes soil sampling and testing and plot demarcation. Procurement of production inputs are however undertaken by contractors/service providers appointed by the Eastern Cape Rural Development Agency, the implementing agency of the cropping programme. During the actual cultivation season, services provided by extension personnel are limited to supervision of the implementation (ploughing, planting, insecticide and herbicide application) of the programme by service providers and the writing of progress reports on the level of implementation of these services.

Interaction with extension controllers indicated that extension service provision is demand-driven and as such when farmers have problems they notify their extension personnel who diagnose the problem and if they have the solution to the problem they address it. Otherwise they link farmers with the relevant experts for redress. The current standard of service by extension staff in the province is the provision of appropriate technical advice to farmers on request within a stipulated number of working days (DRDAR, 2014:28). The current approach to GM maize cultivation, whereby all farming operations are undertaken by contractors, does not build the capacity of farmers in the business of farming or encourage ownership of their fields. Indeed, many extension personnel complained about the apathy of some farmers in their areas. According to personnel, after paying the R 1,800.00 contribution and identifying their fields for ploughing, these farmers will normally only visit fields again during harvesting. Personnel also revealed that in cases when the delivery and application of herbicides are delayed, these farmers leave their fields overgrown with weeds. It is therefore debatable how farmers who do not visit their fields or actively participate in decision making and management of their fields can identify problems and seek solutions from extension personnel. According to Roling (1995) cited in Ssemakula & Mutimba (2011:34) good farmers produce good extension personnel. An extension approach which empowers farmers is therefore likely to sustain a good and effective extension system. A more participatory approach that builds the capacity of farmers in maize cultivation and encourages ownership will therefore be needed if the goals of the cropping programme and in particular the cultivation of GM maize are to be attained.

Provision of information about an agricultural technology to farmers is an essential condition for its subsequent adoption (International Maize and Wheat Improvement Centre, CIMMYT, 1993:40). Radio, demonstration trials, village meetings, newspapers, newsletters, magazines, journals, posters, television, video and loud-speakers mounted on cars are important sources from which farmers may receive information about agricultural technologies (Rivera and Qamar, 2003:27). However, farmers' learning and ability to make good decisions and successfully use agricultural technologies is enhanced if they experiment with a technology prior to adopting it (Abadi Ghadim & Parnell, 1999:149). Smallholder farmers in the Eastern Cape province are mostly illiterate and have a low level of awareness of technical matters (Assefa & Van den Berg, 2010:221; Eastern Cape Department of Agriculture, 2008:18). Participatory technology dissemination may therefore be better suited to their circumstances than the use of print media (Obi & Pote, 2012:108) derived from GM seed companies whose primary clientele are literate commercial farmers. According to Ozowa (1997:12) the content of such information packages are generally technical, not well understood by farmers and consequently fail to motivate or elicit desired changes in their attitudes.

4. CONCLUSIONS AND RECOMMENDATIONS

This study revealed that although smallholder GM maize farmers in the Eastern Cape are relatively well provisioned with extension personnel, most of these personnel lack adequate training to effectively disseminate GM maize technology to smallholder farmers. The awareness of personnel about GM maize technology, its use and stewardship requirements was limited. Inappropriate farm management practices, including the continued application of insecticides on Bt maize varieties were also prevalent in the operational areas of personnel. Additionally, strategies used for disseminating GM maize technology was not participatory and relied mostly on the use of print media from GM seed companies whose primary clientele are literate commercial farmers. Inappropriate GM maize cultivation practices facilitate resistance development by target pests and weeds which ultimately reduces the long term sustainability of GM maize technology. To forestall these undesirable consequences, it is recommended that extension personnel be trained in IPM and aspects of good GM maize technology stewardship and consequences of non-compliance to stewardship programmes. The DRDAR should also facilitate access to the inputs (non-Bt hybrids) necessary for ensuring compliance to GM maize bio safety regulations. Participatory technology dissemination approaches that are better suited to the level of education and understanding of smallholder farmers should be explored and adopted to facilitate attitudinal change of target farmers.

5. ACKNOWLEDGEMENTS

Special thanks to the Agricultural Research Council (ARC) Collaboration Centre for Smallholder Farmer Development at the University of Fort Hare (UFH), the National Research Foundation (NRF) (Grant no. TP14082593855) of South Africa, the Genøk-Centre for Bio safety, Norway, Norad project GLO-3450 and the Govan Mbeki Research and Development Centre (GMRDC), University of Fort Hare, for their generous financial support. Our gratitude also goes to the Department of Zoology and Entomology, University of Fort Hare for transport assistance.

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