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MANAGEMENT OF THE FALL ARMYWORM (*SPODOPTERA FRUGIPERDA*, J.E SMITH) IN ZAMBIA

January 2020

SDGs:	1 NO POVERTY · 2 ZERO HUNGER · 5 GENDER EQUALITY · 15 LIFE ON LAND
Countries:	Zambia
Project Codes:	TCP/ZAM/3603
FAO Contribution	USD 272 000
Duration:	17 November 2017 – 30 June 2019
Contact Info:	FAO Representation in Zambia
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Implementing Partners

Ministry of Agriculture (Department of Agriculture [DoA]) and Zambia Agriculture Research Institute (ZARI).

Beneficiaries

Small-scale and commercial farmers whose livelihood and income is likely to be affected by the presence of the fall armyworm (FAW).

Country Programming Framework (CPF) Outputs

Country Outcome 1: To sustain increased agricultural production, productivity and value addition of major crops, livestock, forest products and fisheries based on comparative advantage in different agro-ecological regions in the country.

Country Outcome 2: To create and enhance the sustainable management of the existing agricultural related resource base to be able to efficiently support vibrant and resilient agricultural production systems.

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Background

Agriculture is the main source of income and employment for over 60 percent of the population in Zambia, with the sector contributing between 8 and 10 percent of the country's Gross Domestic Product. Maize, the most important staple crop, is grown by 2.7 million farming households and accounts for 56 percent of the total area of annual food crops and from 30 to 70 percent of total caloric consumption. In the 2016/2017 growing season, the country's crop was affected by an unprecedented invasion of the fall armyworm, a pest native to Central and South America. FAW was reported in all ten provinces of the country, affecting over 279 843 farmers and damaging a total of 222 586 ha with an infestation rate of 90 percent.

The Government of Zambia spent over USD 3 000 000 on pesticides, personal protective equipment and seed for replanting, but all efforts made to control the pest using synthetic insecticides were unsatisfactory. The aim of the project was thus to address the negative impact of FAW on the production and international trade of maize by reducing the adverse effects of the pest on the productivity and food security of the majority of Zambians, who depend on the crop for their livelihood. Project activities would include: data collection for a better understanding of the biology of the insect, determination of the socio-economic and environmental impact of the FAW incursion, awareness creation, a strengthened early warning system, and the determination and implementation of appropriate management options.

Impact

Overall, the project has made a significant contribution to the management of FAW, with a marked decrease in maize crop yield losses, attributable to the FAW management methods and awareness messages generated by the project. Effective control of the pest in the future will lead to improved food security and increased household income generation, helping to alleviate poverty among the rural population of Zambia.

ACHIEVEMENT OF RESULTS

The project collected and analysed the socio-economic data needed to propose measures to combat FAW, provided training to extension officers and subject matter specialists in FAW biology, management and control, and designed and developed an FAW Monitoring and Early Warning System (FAMEWS), providing equipment and training in its use. Training was also provided in the biology, identification, management and control of FAW to around 187 000 farmer beneficiaries. In addition, public awareness of FAW was increased, principally though the production of radio and television programmes, which reached an estimated 500 000 farmers.

The short time span of the project impeded the full achievement of the project outcome, that of strengthening FAW monitoring and management capacities at all levels, and of significantly reducing FAW infestations and spread. Despite this, sustainable pest management options to protect both farmers' lives and the environment were successfully introduced and proven to be effective in the management of FAW. Although natural setbacks such as drought during the last cropping season affected crop and pesticide performance in two areas of the maize trials, these problems were resolved through irrigation and, in some cases, a reduction in the frequency of pesticide applications.

IMPLEMENTATION OF WORK PLAN

Letters of Agreement (LoAs) with ZARI and the University of Zambia (UNZA) were delayed because of misunderstandings with the implementing partners. Despite this, the risk of failure to successfully implement activities under the LoAs was effectively mitigated as all activities were implemented within the stipulated schedule and original budget. With regard to environmental risks associated with the use of pesticides, the project ensured that all recommended guidelines on the use of chemicals were respected.

FOLLOW-UP FOR GOVERNMENT ATTENTION

Information, Education and Communication (IEC) materials were developed through LoAs with the University of Zambia (UNZA) and ZARI. It is recommended that funds be found for their dissemination to farmers and rural communities.

SUSTAINABILITY

1. Capacity development

The Government has put in place the Plant Diseases Act, which adequately addresses plant disease management. The project was well integrated into those structures that deal with plant health and pest management, such as DoA and ZARI, and with the use of pesticides and chemicals, such as Zambia Environmental Management Agency. Alliances were forged through the creation of the FAW national taskforce , which incorporated all key stakeholders.

2. Gender equality

The selection of project beneficiaries was reasonably well balanced as 40 percent of beneficiaries were women.

3. Environmental sustainability

Environmental sustainability was mainstreamed through capacity-building activities and the dissemination of information on good agricultural practices (GAPs) for FAW management, including the promotion of climate-friendly practices that reduce reliance on synthetic chemicals.

4. Technological sustainability

Most of the technology introduced was simple and easy to use. Capacity-building and the use of local knowledge helped farmers and staff to improve their understanding of the new technologies.

Most government staff are always complaining of funding.

5. Economic sustainability

Very little central government funding has been allocated to fight FAW as a result of scarce resources. Most of the local knowledge generated will nonetheless continue to be used by farmers for many years to come.

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Documents and outreach products

❑ FAO/FAW Kasama back-to-office report. November 2018. 7 pp.

❑ Differences between maize stalk borer and the fall armyworm. Brochure. November 2018. 2 pp.

❑ FAO/ZARI/DoA training report. December 2018. 7 pp.

❑ FAO FAW brochure. December 2018. 6 pp.

❑ How to identify and manage the fall armyworm. January 2019. 4 pp.

❑ Evaluation of commercial pheromone lures for monitoring fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) on maize in Zambia. Journal of the Entomological Society Of Southern Africa (Under review). K. Zimba, P.H. Sohati, M.N. Moonga and P.O.Y. Nkunika.

❑ Machine learning algorithms for automated image capture and identification of fall armyworm (FAW) moths. Zambia Information Communication Technology (ICT) Journal. S. H. Chiwamba, J. Phiri, P.O.Y. Nkunika, M. Nyirenda, M. M. Kabemba and P. H. Sohati. Vol. 3 1ssue 1, 2019, 1-4 pp.

❑ Developing an automated identification and early warning and monitoring web-based system of FAW based on machine learning in developing countriesZambia Information Communication Technology (ICT) Journal. F. Chulu, J. Phiri, M. Nyirenda, M. Kabemba, P.O.Y Nkunika and S. Chiwamba. Vol. 3 1ssue 1, 2019, 13-20 pp.

❑ On-farm integrated pest management (part I). The Zambian farmer magazine. P.O.Y. Nkunika (2019). February. Vol. 30, No. 22, 26-28 pp. Lusaka.

❑ On-farm integrated pest management (part II). The Zambian farmer magazine. P.O.Y. Nkunika (2019). March. Vol. 30, No. 23, 34-36 pp. Lusaka.

❑ On-farm integrated pest management of the fall armyworm (part III). The Zambian farmer magazine. P.O.Y. Nkunika (2019). April, Vol. 30, No. 24, 34-36 pp. Lusaka.

❑ Fall armyworm and dry spell effects on maize production: lessons learnt. The Zambian farmer magazine. P.O.Y. Nkunika (2019). May. Vol. 30, No. 25, 34-36 pp. Lusaka.

❑ Fall armyworm and dry spell effects on maize production: lessons learnt. The Zambian farmer magazine. P.O.Y. Nkunika (2019). May. Vol. 30, No. 25, 34-36 pp. Lusaka.

❑ The use of information technology in the management of the fall armyworm (*Spodoptera frugiperda*). Submitted to The Zambian farmer magazine. P.O.Y. Nkunika (2019).

❑ The use of information technology in the management of the fall armyworm (*Spodoptera frugiperda*). Submitted to The Zambian farmer magazine. P.O.Y. Nkunika (2019).

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ACHIEVEMENT OF RESULTS - LOGICAL FRAMEWORK

Expected Impact	**To contribute to the improvement of food security and broaden household income generation to enhance poverty alleviation for the rural population of Zambia**	
Outcome	FAW monitoring and management capacities at all levels strengthened, FAW infestations and spread significantly reduced	
	Indicator	Innovative practices for sustainable crops, livestock, fisheries, and wildlife and forestry production are identified, assessed and disseminated, and their adoption by stockholders is facilitated.
	Baseline	About 50 000 farmers received FAW information.
	End Target	About 200 000 farmers received FAW information.
	Comments and follow-up action to be taken	The project trained extension officers, who, in turn, trained and raised awareness among farmers. To that effect, a reasonable number of smallholder farmers (187 000) received FAW awareness-raising in all ten provinces and several districts through the trained provincial and district subject matter specialists (extension officers). As funds were insufficient to reach all farmers, most were reached through integration with other activities, such as information dissemination during the Farmer Input Support Programme (FISPO), as well as during the distribution of other chemicals.
	Indicator	Improved capacities of government and stakeholders to plan for and conduct data collection, analyses, application and dissemination in the agriculture and forestry sectors.
	Baseline	No surveys conducted.
	End Target	Three surveys conducted; three data sets analysed; three reports written and published.
	Comments and follow-up action to be taken	As the amount of money required to conduct a survey exceeded the project budget, this activity was not conducted. However, information was extracted from the Computer Assisted Personal Interview (CAPI) system used by the Central Statistical Office to estimate the loss and damage attributable to FAW. This provided 100% in terms of provincial coverage, but only about 50% in terms of district coverage of the extension officers trained.
	Indicator	Strengthened human resources and organizational capacities in the food security and nutrition domain.
	Baseline	Ten provincial and 30 camp extension officers were trained in identification of FAW, trap-setting, trap-servicing and data collection.
	End Target	Thirty provincial and district staff members trained in FAW; 200 camp extension officers trained in identification of FAW, trap-setting, trap-servicing and data collection.
	Comments and follow-up action to be taken	A total of 220 provincial and 425 district officers and 150 camp extension officers received training in identification of FAW, trap setting, trap servicing and data collection.
	Indicator	Proportion of area contained by FAW management interventions as a percentage of the total area infested (both physical and chemically).
	Baseline	Only about 34% of the FAW-affected area was contained.
	End Target	85% of the affected area contained.
	Comments and follow-up action to be taken	70%. Through the various messages sent to farmers by trained camp extension officers, a good number of farmers managed to reduce the damage and losses incurred as a result of FAW.
	Indicator	Extent of coverage of established community-based FAW monitoring and forecasting system of FAW prone areas.
	Baseline	No communities reached.
	End Target	One hundred communities established community-based FAW monitoring and forecasting system of FAW.
	Comments and follow-up action to be taken	Around 70% of the target area was reached by robust and functional community-based FAW monitoring and forecasting system of FAW. This was enhanced by introduction of the FAMEWS application. However, most farmers do not own smart phones, leaving most FAW monitoring to the camp extension officers who own smart phones.
	Indicator	Percentage of crop loss caused by FAW infestation (disaggregated by crop type)
	Baseline	16% average yield loss to maize.
	End Target	5% average yield loss to maize after intervention.
	Comments and follow-up	There was a marked decrease in maize crop yield losses caused by FAW. This is attributable to the various management methods and awareness messages.

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	Indicator	Number of farmers reached with public awareness efforts on FAW.	
	Baseline	No farmers.	
	End Target	265 000 farmers access FAW information.	
	Comments and follow-up action to be taken	Approximately 500 000 farmers were reached through various public awareness channels, such as television documentaries, community radio programmes and brochures.	

	Socio-economic and environmental impact of FAW on farmers established		
Output 1	Indicators	Target	Achieved
	One national survey to collect socio-economic data and the environmental impact of FAW on farmers	One	Partially
Baseline	0		
Comments	As the cost of a national survey would have exceeded the project budget, data were compiled from the CAPI system, collected during the annual national crop forecast survey.		
Activity 1.1	Undertake a survey to collect socio-economic data and the environmental effect of FAW on farmers		
	Achieved	Yes	
	Comments	Activity not undertaken as initially planned as the cost of a national survey would have exceeded the project budget. A less costly alternative was chosen, i.e. to compile data from the CAPI system, collected during the annual national crop forecast survey.	
Activity 1.2	Undertake and analyse the socio-economic data collected to understand the findings of the survey and propose remedial measures		
	Achieved	Yes	
	Comments	Data were analysed and key variables extracted, including elements/variables on statistics on damage estimated to have been caused by FAW. Management options of chemicals procured by farmers were proposed.	
Activity 1.3	Make a publication		
	Achieved	Partially	
	Comments	The data were not publicized nationally, but were presented at a widely attended stakeholders' meeting held in Twangale Park, Lusaka, on 18 September 2018.	

Output 2	Community-based FAW early warning system strengthened		
	Indicators	Target	Achieved
	Community-based FAW early warning system established	One	Yes
Baseline	0		
Comments	At least one national system on community-based FAW early warning system was established. Training was conducted to build capacity of provincial and district subject matter specialists in use of FAMEWS. This was then rolled out so that FAMEWS data collection can be done by the community.		
Activity 2.1	Develop surveillance technology and early warning system		
	Achieved	Yes	
	Comments	The project designed and developed a web and mobile application integrated with Geographic Information System (GIS) for automatic data gathering and reporting and dissemination to small-scale farmers. This was achieved by automating the identification and capture of FAW moths in the field using a branch of artificial intelligence called machine learning. The system integrates GPRS and 3G/4G connectivity to allow automatic FAW data collection without field visits, while GPS provides location and position data. Furthermore, the FAMEWS app was instrumental in helping to establish the monitoring and early warning system.	
Activity 2.2	Procure and distribute surveillance materials and equipment		
	Achieved	Yes	
	Comments	A total of 2 200 pheromone traps and lures was procured and distributed to camp extension officers to be used in the FAW monitoring process. However, these were not enough to make a significant impact.	
Activity 2.3	Conduct pilot study to evaluate efficacy of pheromones and traps for effective management of FAW		
	Achieved	Yes	
	Comments	Four lure formulations: Standard (ST), North American (NA), Costa Rican (CR) and Brazilian (BR) were field evaluated. Significant differences were observed among formulations tested. The ST formulation attracted the highest number of male FAW moths.	
Activity 2.4	Design and develop a coordinated system for FAW data collection		
	Achieved	Partially	
	Comments	A system for data collection was established by training a good number of district extension officers in the use of the FAMEWS app; these subsequently trained selected camp extension officers. However, resources were insufficient to reach out to all camps.	
Activity 2.5	Training of research and extension officers		
	Achieved	Yes	
	Comments	A total of 445 provincial and district subject matter specialists was trained in FAW biology, identification, the management and control of FAW, and FAMEWS.	
Activity 2.6	Training of camp extension staff		
	Achieved	Partially	
	Comments	Only 150 camp extension officers were trained. Because of the limited resources, the approach was modified to focus on subject matter specialists, who would in turn train camp extension officers.	
Activity 2.7	Conduct a survey to delineate areas of low and high FAW prevalence		
	Achieved	Partially	
	Comments	This was not done as an independent activity but through the collection and analysis of data from the FAMEWS system. This reveals areas of low or high concentration of the pest.	

Output 3	Public awareness established			
	Indicators		Target	Achieved
	− IEC materials developed. − IEC materials printed. − Television documentaries and radio programmes on FAW.		− One. − 3 000. − Two.	− Yes. − Partially. − Yes.
Baseline	0			
Comments	Two television documentaries were developed (one by FAO and DoA, and the other by ZARI) and aired on national television.			
Activity 3.1	Development of IECs			
	Achieved	Yes		
	Comments	IEC materials were developed both through LoAs with UNZA and ZARI, but few were printed owing to a lack of funds.		
Activity 3.2	Print IEC materials			
	Achieved	Partially		
	Comments	Few brochures were printed as most available funds were used on the documentary.		
Activity 3.3	Produce television documentaries and radio programmes on FAW			
	Achieved	Yes		
	Comments	Two television documentary and radio programmes were produced and aired on national television and radio.		
Activity 3.4	Disseminate IEC materials			
	Achieved	Partially		
	Comments	The IEC materials printed were disseminated during training events and FISPO. The largest awareness-raising component was the airing of the television and radio programmes.		
Activity 3.5	Hold FAW management plant health rallies			
	Achieved	No		
	Comments	The project was constrained by insufficient resources and most funds were allocated to the capacity-building of subject matter specialists.		
Activity 3.6	Conduct meetings with policy-makers			
	Achieved	Partially		
	Comments	One meeting was conducted for the national FAW taskforce		

Output 4	Technical capacity on impact management options for FAW built		
	Indicators	Target	Achieved
	− Study the biology and behaviour of FAW − Asses management options to control FAW − Integrated Pest Management (IPM) for FAW − Procurement of laboratory equipment and reagents		Yes
Baseline	0		
Comments	A study was begun of the biology and life tables of FAW. The assessment of management options to control FAW was conducted and insect growth chamber procured.		
Activity 4.1	Study the biology and behaviour of FAW		
	Achieved	Yes	
	Comments	A study was conducted to determine the life tables of FAW on selected maize varieties. The FAW larvae are being reared and success will be determined by the rearing of more than three generations.	
Activity 4.2	Assess management options to control FAW		
	Achieved	Yes	
	Comments	Farmers were made aware that the presence of the FAW pest will continue and that they should be ready to observe its presence in their fields just after germination of their maize crop. They were also informed of traditional or indigenous methods to kill FAW tested by other farmers, especially then use of sand, ash and 'boom' detergent soap, still under evaluation at ZARI, as well as of new bio-pesticides recommended for FAW management, instead of relying on synthetic pesticides as a first line of defence. Botanical extracts such as Tephrosia, Neem-based pesticides (Nimbecidine) and Moringa were also highlighted, along with how to prepare them where and when available. They were also informed that chemical-based pesticides (synthetics) are to be used as a last resort after all the above methods and other GAPs have failed because chemicals are in most cases misapplied and harm both the environment and their users under normal conditions of use. Farmers were encouraged to contact their local agricultural office for assistance and information related to the FAW pest in their communities. Farmers are expected to share information and effective FAW control measures with their community.	
Activity 4.3	IPM for FAW		
	Achieved	Yes	
	Comments	Pheromone traps were deployed to camps so that trap catches could be captured and recorded for early warning systems and for FAW population dynamics studies. The efficiency and effectiveness of the sustainable methods was demonstrated through field trials and demonstration plots in selected places in all three agro-ecological regions of the country. Some of the sustainable methods demonstrated include the use of sand/soil, fertilizer, ashes, scouting and crashing of egg masses and larvae. Other methods include crop rotation, early planting, push and pull method and the use of botanicals such as neem-based chemicals. Demonstrations were also conducted through field visits and the sharing of knowledge on how to scout and manage the FAW pest.	
Activity 4.4	Procurement of laboratory equipment and reagents		
	Achieved	Yes	
	Comments	Essential equipment (insect growth chamber) was purchased and shipped from India under the UNZA LoA.	