RIU

Village forecasts combat armyworm plagues in eastern and southern Africa

Validated RNRRS Output.

Villages in eastern and southern Africa now make their own forecasts of armyworm outbreaks. The low-cost system—using a single trap to catch armyworm moths and a rain gauge—means that farmers no longer depend on warnings from central pest offices. Warnings from central offices were often too late and too general to be useful. Villages now organise the forecasts themselves. They decide who will be trained to use the equipment and work out the forecast from the moth catch and rainfall data, and who will warn everyone. The self-contained forecasts, proven to be accurate four times out of five in Tanzania, Ethiopia and Kenya, help farmers prepare for outbreaks and prevent damage to their crops.

Project Ref: **CPP42:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP42

A. Description of the research output(s)

Research into Use
NR International
Park House
Bradbourne Lane
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ME20 6SN
UK

Geographical regions included:

Botswana, Ethiopia, Kenya, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zimbabwe,

Target Audiences for this content:

Crop farmers,

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Community-based armyworm forecasting (CBAF) in east and southern Africa

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Crop Protection Programme; USAID; ICART CRARF SADC

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

Projects:

R8407/R7966/R6762 (CPP).

GCP/INT/720/USA (USAID) Community Based Forecasting of the African Armyworm. The purpose of this project was to determine the feasibility and practicality of implementing CBAF in a second district in Tanzania where socioeconomic and agro-ecological conditions were rather different from the original pilot villages. The project value was US$105,000 and duration, 1 year.

ICART CRARF SADC Region (EU) Community based forecasting for improved cereal productivity and profitability in Malawi, Tanzania and Zimbabwe. Project approved for funding, Sept 06, due to commence July 07.

Partners:

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Mr Gaspar Malaya, National Armyworm Coordinator, Pest Control Services (PCS), Ministry of Agriculture, P O Box 15040, Arusha, Tanzania armyworm.2004@satconet.net

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Mr Francis Musavi, Coordinator, Migrant Pests, Plant Protection Services Branch (PPSB), Ministry of Agriculture and Rural Development, P O Box 14733, Nairobi, Kenya (Ms Jacinta Ngwiri has now been appointed to this post)

Mr Wilfred Mushobozi, Eco Agri Consultancy Services Ltd P.O.Box 15040, Arusha, Tanzania. info@ecoagriconsult.com

[1]USAID and SADC project leader; [2]CPP projects leader; [3]USAID project only but CPP funding provided (under R8407) to bring Ethiopian representatives to CBAF workshop.

4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? ***(max. 400 words)****. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

African armyworm, Spodoptera exempta (Walk.) (Lepidoptera: Noctuidae), is a serious outbreak pest of cereal crops and grasslands in Eastern and Southern Africa, threatening food security by devastating small scale subsistence farms and commercial production alike (Rose et al., 2000). In Tanzania, the area infested over the last 10 years has ranged from 50 to over 500,000 ha per year. In affected areas total crop loss can occur, depending on the age of crop attacked and whether replanting is feasible. In a recent socioeconomic survey in Tanzania (Njuki et al., 2003), farmers estimated average losses in poor growing seasons to be 70% when replanting was necessary. In good growing seasons, and when replanting was not necessary, average yield loss from an armyworm outbreak was estimated at 23%.

The problem with armyworms is that they are migratory. This means that outbreaks can appear very suddenly at very high density, catching farmers unawares and unprepared. The causes of outbreaks are now reasonably well understood and the technical part of the output is a method that has been developed whereby using a single moth trap and rain gauge in a village, the occurrence of an armyworm outbreak can be forecast for that village with an accuracy of about 80%.

While central co-ordination is still necessary, the old approach of centralised forecasting has been found to be unworkable at the village level (Njuki et al., 2003). In common with decision making in agriculture and other sectors, there is growing recognition that districts and communities can usefully play a much greater role.

In response, community-based armyworm forecasting (CBAF) has been developed. The implementation package includes:

- community engagement, monitoring and evaluation using participatory methods,
- invitation to the community to take control of aspects of the decision-making such as who will be trained to be the village forecasters and how the forecast will be disseminated within the village,
- armyworm moth trapping and rainfall monitoring equipment,
- training on how to operate the pheromone trap, rain gauge, how to arrive at a forecast from the moth catch and rainfall information collected.

To maintain operations in subsequent years requires provision of lures for the pheromone trap and occasion replacement of any breakages to equipment. With this small on-going external input, evidence indicates that communities will continue to operate CBAF otherwise unaided.

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
	X		**X**	**X**	

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

Crops most frequently reported as affected are maize, sorghum, millet, wheat and rice, and to a lesser extent teff, barley and sugarcane (Haggis, 1984). Indirect losses to livestock due to armyworm outbreaks in pasture are at times severe and cattle deaths can occur when recently infested pastures are grazed, as some species of grass are cyanogenic when attacked by armyworm (Giorgiadis & McNaughton 1988); in one famous incident up to 100 cattle were killed (Rose et al., 2000).

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
X							

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

A possible 'migrant pest' cluster might include CBAF with novel control (R8408), Quelea (R8426, R7967, R6823, R8314), brown locust (R7779), ICOSAMP (R8315, R7890), and armoured bush cricket (R8253, R7428). Although the latter is not migratory in the normal sense its control is often organised by the same organisations.

From the perspective of armyworm forecasting, the most important link has previously been in relation to the national forecasting service where useful economies were obtained by sharing satellite derived data with the quelea project.

Community-based (as opposed to national) forecasting of armyworm is deliberately designed to be self contained with the village. No direct value would be added to the output by clustering CBAF with other outputs except that ICOSAMP could provide a useful dissemination role to encourage further uptake and reporting on CBF activities (ICOSAMP is a partner in the SADC project mentioned under Question 3).

There is possibly more potential for value to be added by clustering with other research outputs that operate using participatory methods, at the same village level, and in the same countries/districts that armyworm occurs. Potential candidates from the profile list that may meet at least some of these criteria are listed below but the potential for mutual benefit has not yet been explored further:

- bean ICPM (R8414…) E Minja;
- integrated maize crop management (R8219...) P Seward;
- pest and soil management, maize (R8452…) A M Mbwaga;
- communication, semi-arid systems (R8428…) A Sutherland;
- pest and soil fertility management (R8449…) Z R Khan;
- access to markets (R8275) A Dowrd; (R8274…) A Agona;
- grain store mud based silos (R6658...) R Hodges;
- pest management (R6311…) R Hodges;
- uptake promotion (R8381) N Hatibu;
- goat production (R7634) C Ahuya.

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*

*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

Technical evaluation of CBAF was carried out by assessing the accuracy of the forecast based on the records of rainfall and moth catch recorded by the village forecaster and reports of outbreaks by other farmers and the extension officer. In the pilot villages (see 11. below) forecasting accuracy achieved an impressive 80% with an armyworm outbreak being approximately four times more likely if the forecast was positive than if it was negative

(Holt et al., 2006) Cost benefit analysis was used to evaluate the viability of the CBAF package, including the training costs. The largest costs for CBAF are incurred during start-up. Running costs in contrast are extremely low, again contributing to potential sustainability. Even including start-up costs, the yield saved through forecasting need only be (at the most) 1.6 – 4.3% for CBAF to be economically worthwhile. In terms of penetration of the technology, this corresponds to less than 6.5% of farmers. A far greater proportion than that received and responded to the village forecasts. On economic grounds therefore, it is not at all surprising that the uptake of CBAF has been so strong.

The uptake of CBAF was also thought to be successful because it fulfils a real need using an appropriate technology. The armyworm problem is important and widespread and farmers are aware of it and want to do something about it. The CBAF approach uses village level technology and farmers have seen that it does work. The way in which CBAF has been introduced and implemented has been highly participatory, providing empowerment and ownership, engagement of the community and the village authorities and offering aspects of the decision making to the villagers themselves. Participatory methods extended to all aspects of the process and farmers were facilitated to evaluate the outputs themselves. Ownership is evidenced by the fact that pilot villages have continued to run CBAF with little external intervention. In addition, local initiatives have arisen associated with CBAF, e.g. a sprayer rental scheme and a contract sprayer group. As a sign of institutional investment, in some cases village, district and national programme authorities have allocated some funding to allow CBAF to continue.

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

Following the initial community-based forecasting pilot carried out in 5 villages in Kilosa district during the 2001/2002 armyworm season, there are now 20 villages in 4 Districts of Tanzania implementing CBF of armyworm. In addition, 5 villages (in one district) in Kenya and 10 villages (in two districts) in Ethiopia started CBF last year (in March 2005). Activities at the two locations in Ethiopia (Konso Woreda, Fedis Woreda) were largely supported by the Ethiopian national programme plus a small amount of funding connected to the USAID project. Monitoring and evaluation was carried out in all these villages and in all cases the farmers were facilitated to carry out the monitoring and evaluation themselves. The participatory nature of the monitoring and evaluation was a key part of the technology validation because the farmers could see for themselves that it worked.

Validation was also carried out a technical level using appropriate statistical methods; the list of villages from which data for technical validation were obtained is listed below:

Holt J, Mushobozi W, Musave F, Musebe R, Kimani M, Day, R K. 2005. Extent of dataset of armyworm moth trap catches, rain gauge readings, community forecasts made and outbreak occurrence, in CBF pilot villages in Tanzania (Tz) and Kenya (K). ü indicate coverage of validation data set.

District (Country)	Village (Tz)	Sub-location (K)	Year 01/02	02/03	03/04	04/05

Kilosa (Tz)	Madudu	ü	ü	ü	ü
	Magore	ü	ü	ü	ü
	Dumila	ü	ü	ü	ü
	Mvuni	ü		ü	ü
	Ilonga	ü	ü	ü	
Moshi (Tz)	Uchira			ü	
	Yam Makaa			ü	
	Mabogini			ü	
Hai (Tz)	Mungushi			ü	
Machakos (K)	Kibau				ü
	Mithanga				ü
	Mithini				ü
	Kyamutwii				ü
	Wetaa				ü

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

35 Villages (20 in Tanzania, 10 in Ethiopia and 5 in Kenya) have implemented and continue to implement CBAF. The number of farmers in a village is highly variable but is usually several hundred. Evaluations have shown that the different stakeholders have all acknowledged benefits in a variety of ways. For example, the Tanzania Government provided resources for the approach to be extended to Hai and Moshi Districts. A further 5 villages in a third district in Ethiopia were trained this year using national programme funds. All the stakeholders with whom discussions were held continue to see CBAF as beneficial. At the village level (farmers, extensionists, village government) benefits include:

- Earlier control of armyworm, through monitoring and preparation for control.
- Increased potential for slower-acting alternatives to conventional pesticides such as NPV.
- Reduced crop damage.
- Empowerment of the community, through a sense of ownership and improved understanding of the armyworm problem.
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At the district level benefits include:

- Improved links between District Agricultural Office staff and village governments and extension officers.
- More time to respond to requests for assistance in control.
- Use of rainfall data for other purposes.

The primary stakeholders were the farmers and participation was in general reasonably balanced between men and women, usually with similar numbers of women and men at the village meetings and participatory evaluations.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

The 14 villages listed in the table (under Question 11) plus six other villages in Tanzania (including Kilemapofo, Msasani Oria) and five sub-locations in Mwala division, Kenya (Wetaa, Mithini, Kibau, Mithanga, Kyamutwii). In Kenya, the farmer forecasters maintained telephone contact with Mr Musavi in the year following set-up. It was his intention to set up further CBAF operations in Taita / Taveta but a major reorganisation of the ministry prevented this. The new incumbent to Mr Musavi's post, Ms Jacinta Ngwiri, has expressed strong interest in continuing the CBAF initiative in Kenya. In Ethiopia, 10 villages were introduced to CBAF during the last year of the CPP project using national programme funds, and a further five further pilot villages (in another district) have been added since the CPP project ended.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

To assess sustainability a re-evaluation was carried out in 04/05 of the villages originally trained in 01/02. Forecasting was still being undertaken in all five villages by the original forecasters. Forecasts had been issued reliably and the equipment maintained well, and there was every indication that they were performing their role as effectively as in the first season when they were trained.

In Ethiopia, the national programme has plans to introduce CBAF to another ten villages (five in each of two new districts) next year.

Usage is spreading within the pilot villages but not necessarily as originally envisaged. Villages agreed that the forecasters would inform the village government and then extension officer who would communicate to other farmers. The forecasters were however reported to be the primary source of information and this was still the case in the re-evaluation. Other farmers were the 2nd most frequent source of forecast information, but the role of the extension officer had declined. Overall 52% of farmers who experienced an outbreak in 2003/2004 received a warning, so information is flowing, but there remains scope for improved penetration.

Wider demand for the approach. No systematic attempt has been made to assess demand for implementing CBAF on a wider scale, but there are strong indications that the demand is there. At national level CBAF has been included within the migrant pest control budget, and the Kilosa District authority has expressed support for scaling up. There are also cases of enquiries from NGOs who wish to implement the approach in the agricultural communities with whom they are working.

*15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? **(max 350 words).***

A number of structures have assisted with promotion and adoption:

- Involvement of regional organisations (CABI and DLCO) has been important in providing continuity of approach and methodology, providing a forum for multi-country dialogue and meetings, and facilitating inter-country information sharing and exchange / training visits.

- The existence of national structures / programmes (PCS, Tanzania and PPSB, Kenya) with a specific mandate which includes armyworm has been vital in allowing staff and other resources to be directed towards the initiative. During the project this mandate was explicitly broadened to include CBAF and national organisations provided additional funding to allow for example pilots to be carried out in a new location and to make sprayers available for farmers to rent in some participating villages.

- In the national programmes there has been a policy shift towards decentralisation and community empowerment. It has traditionally been the responsibility of government ministries and international organisations to forecast and control migrant pests but there has been an active shift in policy to transfer responsibility to the farmer whose crops are affected. Community empowerment and capacity building is becoming increasing recognised as the way forward by international donors. CBAF is fully aligned with these policy shifts.

A workshop carried out under the last CPP project identified key facts of success under two broad issues:

- The technology has a sound scientific basis which is regionally applicable and demand driven, and offers a major improvement over existing approaches

- Implementation of the technology is by a process of participation which has fostered empowerment and community ownership and it has fitted within existing structures and institutions

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Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

More effective use of pesticides is achieved. Previously, pesticides have very often been applied indiscriminately without the proper crop monitoring that has been shown to have improved as a result of CBAF. Where pesticides have been necessary, they have frequently applied too late to be of benefit. CBAF has resulted in more timely (earlier applications which kill the larvae before serious damage occurs. Increased awareness of armyworms and armyworm control is likely to improve pesticide safety. The greater lead time offered by forecasting means that that slower-acting alternatives to conventional pesticides such as NPV become a more feasible option.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

There is a possibility of increased pesticide use as more farmers gain the knowledge and skills to control armyworm effectively.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Climate change has caused increased climatic variability and will continue to do so, in turn making crop yields more uncertain. The previously unpredictable arrival of armyworm (from the farmers' perspective) offered yet another source of uncertainty in the production of a viable crop. CBAF greatly alleviates this source of uncertainty and so helping to offset that caused by climate change.

There is some possibility that migrant pest outbreaks in general and armyworm outbreaks in particular will become more frequent with climate change. For example, locust outbreaks have been associated with the El Nino effect, a phenomenon which has become more frequent in recent years and causing climatic disruption particularly to sub-Saharan Africa.

Annex

References

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HOLT, J., MUSHOBOZI, W., DAY, R.K., KNIGHT, J.D., KIMANI, M., NJUKI, J., MUSEBE, R. 2006. A simple Bayesian network to interpret the accuracy of armyworm outbreak forecasts. Annals of Applied Biology 148, 141-147.

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