Research Into Use sharing lessons to enable innovation in agriculture

Putting research into use: community based armyworm forecasting in Kenya

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Abstract

African Armyworm (*Spodoptera exempta*) is a serious, sporadic outbreak pest in Kenya, as well as other countries of Eastern and Southern Africa. It attacks all graminaceous crops, so is a significant concern for smallholder farmers as well as for governments wishing to achieve food security. Since the late 1960s, a key component of the management strategy has been outbreak forecasting, run by national forecasting units. In recent years a new, community based approach to forecasting has been developed and tested in several countries, and in Kenya the approach is now being scaled up. This paper focuses on the approach to scaling up that is being used, rather than details and impact of the technique itself. Five components are presented: addressing registration issues; establishing the equipment supply chain; building implementation capacity; stimulating demand; generating policy support.

Introduction

The African Armyworm, *Spodoptera exempta* (Walker) Zimmerman 1958 (Lepidoptera: Noctuidae) is a devastating pest. Large 'armies' of voracious black caterpillars appear suddenly, catching farmers unawares and unprepared. This is due to the unusual migratory behaviour of the adult moths, which arrive *en masse* and lay billions of eggs in a few days. The resulting armies devour any crops in the grass family, including maize, sorghum, millet, rice and wheat, as well as pasture grasses. Uncontrolled outbreaks can cause total crop loss, with millions of hectares affected in bad years. Indirect losses to livestock due to armyworm outbreaks in pastures are sometimes severe, due to a combination of starvation and poisoning (Rose *et al*., 2000). The worst affected countries in Africa are Tanzania and Kenya (Haggis, 1984).

In the 1960s, studies on armyworm outbreaks led to an understanding of their migratory behaviour, allowing the development of national and regional forecasting services (Betts and Odiyo, 1968), which continued over a number of years (Odiyo 1979, 1990). Data on light trap moth catches, incidence of previous outbreaks, and meteorological charts, allowed broad predictions to be made of where outbreaks might occur in the coming one to two weeks. The first such service was set up by the East

African Agriculture and Forestry Research Organization (EAFFRO), based at Muguga, serving the East Africa region (Betts *et al*., 1970). National services continue to operate in Tanzania and Kenya.

In the 1970s the chemical identity of the *S. exempta* sex pheromone was determined (Beevor *et al*., 1975), and a synthetic version of the pheromone was developed for use as a lure in moth traps. Work was undertaken to test different trap designs, pheromone components and pheromone dispensers, and the use of pheromone traps thus replaced light traps, being much cheaper and easier to operate. In Kenya there are now over 400 pheromone traps operated by extension agents, who are expected to send their trap catch data to the Plant Protection Services migrant pest unit each week during the cropping season.

Although useful, particularly for national level decision making, national level forecasts have some drawbacks from the point of view of an individual farmer. A forecast usually covers a District, but because outbreaks are patchily distributed, even when there is a high probability of an outbreak somewhere in a District, the probability of an outbreak on any particular farm is still low. Thus the information is of limited value to individual small scale farmers. In addition, delays can occur in the communication of trap data to the central forecaster, and in communicating forecasts or outbreak warnings to farmers, further devaluing the forecast at farm level.

Day and Knight (1995) suggested the development of different types of forecasts for different decision makers, but it was not until a workshop in 2001 in Tanzania that the idea of community based armyworm was crystallized (Knight, 2001). Studies were undertaken to determine communities' views on how local forecasting might work. (Njuki *et al*., 2003), and the approach was successfully piloted in Kilosa District, Tanzania

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(Mushobozi *et al*., 2005). Since then the approach has been extended to several hundred villages in Tanzania, Malawi and Zimbabwe.

Kenya is now adopting the approach with the aim of laying the basis for wide scale implementation among communities in all the worst affected areas. This paper describes the approach that is being adopted, and the early results.

Approaches to scaling up

The following approaches are being used to scale up Community Based Armyworm Forecasting (CBAF) in Kenya.

Addressing registration issues: For products to be made commercially available they need to satisfy the prevailing regulatory requirements. In Kenya, pest control products are regulated by the Pest Control Products Board (PCPB), and the synthetic pheromone used in the pheromone trap for outbreak forecasting has never been submitted for registration.

Establishing the equipment supply chain: If the community based forecasting approach is to be used on a wide scale, a mechanism is required to enable communities to access the equipment readily. Options for achieving this are being investigated through both public and private sector entities.

Building implementation capacity: Armyworm control is a concern of the Ministry of Agriculture. There is therefore a need for capacity to implement the approach within the ministry. This does not mean that it is envisaged the approach will always be a public sector activity, but ensuring that the ministry can at least backstop the approach is essential at this stage.

Stimulating demand: Demand driven technologies may be the most successful, but if potential users have no knowledge of a technology, they are unlikely to demand it. Thus the aim is to catalyse demand for CBAF at community level.

Promoting policy support: Decisions about how resources are deployed to manage migrant pests including armyworm are made at various levels. National and district level decision makers are among the most important, and if they are to support the approach, they need to be aware of what CBAF entails, what it costs, and what the benefits are.

Progress with scaling up

Addressing registration issues: To apply for registration of a biochemical pest control product in Kenya, the Pest Control Products Board's (PCPB) Form A3 (version dated August 2005) is used. The form states it is "for any proposed use of the chemical products (growth regulators, pheromones, botanical products, etc) of naturally occurring organisms (bacteria, protozoa, fungi, viruses, plants, animals, etc) for the control of invertebrate pests and pathogens of crops and livestock, the control of weeds, public health and environment. The use of biochemical pest control products for the control of vertebrate pests is not contemplated." Thus registration of a pheromone falls under this requirement, but no pheromones of any sort have ever been registered in Kenya.

One reason for this may be that Form A3 covers a broad range of chemicals, and the data requirements may not be appropriate for all the products it covers. For example, pheromones and other semiochemicals (organic compounds that carry messages between individuals of a species or between individuals of different species) that are used for modifying pest behaviour rather than killing them, are likely to be much safer than biocidal products. Thus in a number of countries, semiochemicals have specific registration requirements which take into account key differences between these products and conventional chemical pesticides. The Organisation for Economic Cooperation and Development (OECD, 2002) presents a rationale for reduced data requirements for semiochemicals, summarized as follows:

- Application rate is generally low, and often comparable to natural emissions
- Volatility and rapid environmental transformation minimize residues and non-target exposure
- Straight chain lepidopteran pheromones (the commonest types of registered semiochemicals) have low mammalian toxicity. Acute oral toxicity and acute dermal toxicity place them in the US Environmental Protection Agency's category IV, non-toxic. There is no evidence of mutagenicity.

According to OECD (2002), the data thus justify substantial reductions in health and environment data requirements for the registration of semiochemicals. PCPB has therefore drafted new requirements specifically for registration of semiochemicals. The draft requirements must be presented for public scrutiny and consultation, before the PCPB can consider implementing them.

Establishing the equipment supply chain: The chemical identity of *S. exempta* pheromone has been known for many years (Beevor *et al*., 1975; Campion *et al*., 1976) and commercially available synthetic *S. exempta* pheromone is a blend of Z9-14Ac, Z9E12-14Ac and Z11-16Ac. The pheromone and the trap are available from several suppliers in Europe and USA, but for registration purposes, there must be a local agent. Work is going on to set up supply chains that would enable commercial sale. However, it must be noted that the market for *S. exempta* pheromones and traps for use in CBAF will always be small, even if all susceptible villages use CBAF (a maximum of a few thousand per year) so the possibility of public sector purchase and distribution has not been ruled out. Nevertheless, with a data registration requirement that is less stringent, there are likely to be other markets for pheromones in Kenya, and thus *S. exempta* pheromone might be one of a range supplied by manufacturers and distributors.

Three possible supply scenarios are envisaged. The Ministry of Agriculture may purchase and distribute the equipment through the extension system. At present it is often received through the Desert Locust Control Organisation for Eastern Africa (DLCO-EA) and/or the International Red Locust Control Organisation for Central and Southern Africa (IRLCO-CSA). Second, private companies could import for the Ministry through the normal tender processes. Third, private companies could import and distribute through their normal distribution networks.

Building implementation capacity: The key process in implementing CBAF is the mobilisation and training of communities. In pilot trials this can be done by the central migrant pest unit, but for large scale implementation this would not be adequate. Initially a training of trainers (ToT) approach is being adopted, in which District level agricultural extension officers are trained in CBAF, and how to introduce it to communities. This is supported by experience from Tanzania, where different approaches to upscaling have been tested.

Early in 2010 a ToT for 16 agricultural extension officers was conducted. These officers were then responsible for implementing CBAF in 40 sub-locations (see next section). In late 2010 two more ToTs will be conducted, so creating capacity to initiate CBAF in at least 120 new communities every year. If several thousand sublocations need CBAF, this is clearly still inadequate, though further ToT courses would increase this capacity further.

In addition, opportunities for building implementation capacity in other organizations are being investigated. NGOs, for example, work with communities, and the Ministry could run ToTs for them. Private sector organisations might also be interested in learning how to implement CBAF.

Stimulating demand: In early 2010, CBAF was introduced to 40 sub-locations in eight districts (Table 1). From each sub-location 2 farmers, 1 extension officer and the Assistant Chief were trained.

Table 1: Sites of CBAF implementation in first half of 2010

District	Division	Sub-location
Makindu	Ngumo	Muuni
		Kaungini
	Makindu	Syumile
	Kavete	Nyakaa
	Kiboko	Kasuvi
Yatta	Yatta	Kwandolo

		Kalutani
		Kavingoni
	Katangi	Mekilingi
	Ikombe	Mathingani
Matungulu	Matungulu	Mukengesya
	Central	Kwale

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		Kalandini
	Kyanzavi	Kyeleni
Kitui Central	Central	Munganga
		Mbitini
		Kyangunga
		Utooni
	Katulani	Maliku
Nzauni	Nguu	Mitumoni
		Mweini
	Kalamba	Kalamba
	Mbitini	Masue
	Matiliku	Kathathu
Machakos	Central	Lower Kiandani
		Kimutwa
		Mikuyu
Mukaa	Kalama	Muumandu
		Kiitini
	Malili	Mathithye
		Ngaamba
		Itumbwe
	Kiou	Kwale
	Kasikeu	Kasikeu
Makueni	Wote	Unoa
		Kikumeni
	Kaiti	Makongo
		Kaumo
	Kee	Matulan

Later in 2010 training will be given to representatives from a further 40 sub-locations, including Districts in Coast Province where some of the earlier outbreaks in a season often occur. Thus by the end of 2010 CBAF will be being implemented in 80 sub-locations. By starting CBAF in a good number of districts in the major outbreak areas, it is expected that these communities will stimulate further demand in neighbouring communities, and build awareness of the approach.

Generating policy support: While generating general awareness of CBAF, policy and decision makers are a key stakeholder group who should understand CBAF. A range of communication activities are being devised to target this group including:

- Open-days at sub-locations where CBAF is in operation, so that the decision makers can interact directly with the beneficiaries
- Use of the mass media
- Use of private sector advertising channels
- Preparation of targeted information, such as policy briefs including economic justification of CBAF
- Promotion of CBAF through regional organisations

Discussion and Conclusions

In countries where CBAF has been more extensively tested than in Kenya (particularly Tanzania and Malawi), the approach has been enthusiastically received by farmers, district administrations and by central migrant pest units (Mushobozi *et al*., 2005; Negussie *et al*., 2010). However, the fact that a technology or process is beneficial and in demand does not mean that its scale-up or widespread adoption can be taken for granted. The initiative reported here is a planned attempt to think about the entire "innovation system", and to apply some of the approaches that such thinking entails (Day and Romney, 2010). As it is still in progress, it is not yet possible to say how successful the initiative will be, but some observations and reflections are presented.

Registration is sometimes seen as a constraint to upscaling, and can entail additional investment. However, the view has been taken that registration is a necessary part of commercialisation and upscaling, and that in the long run it promotes sustainable and widespread adoption of safe and effective pest management methods. Thus the work being done in relation to registration procedures will encourage up-scaling not only of CBAF, but also of other applications of semiochemicals in pest management, none of which has ever been registered in Kenya.

Establishing the equipment supply chain is linked to pheromone registration, but because the market for the equipment is relatively small, it is not yet clear to what extent the private sector will become involved. Upscaling often benefits from the involvement of the private sector, but only if the returns are adequate will their involvement be sustained. Thus different options are being kept open, including possible public-private partnerships.

To get CBAF beyond the pilot scale requires a significant increase in implementation capacity. Initially capacity is being developed within the Ministry, but in the future it is possible that multiple approaches might be used. If the private sector takes up distribution and marketing of the equipment, it is possible that the equipment could be sold with an instruction manual. The onus would then be on the purchaser to seek assistance in implementation, if deemed necessary.

Experience in Tanzania and Malawi suggests that once introduced, other communities express demand (Negussie *et al*., 2010). Thus in this initiative the aim is to "seed" the demand, through implementing it in a significant number of communities. However, it is also recognised that such diffusion cannot alone achieve the level of upscaling required. Engaging key decision makers through a variety of methods can lead to simultaneous top-down supply push as well as bottom-up demand pull.

While this initiative is a project insofar as it is externally funded for a specific period of time (18 months), implementation is different from many research projects in several ways. First the funders are more actively engaged in the process than they might be for a more traditional research project. For example, they have already made videos to support awareness creation especially at decision maker level. In parallel with implementation, they are also undertaking lesson-learning activities to guide scaling-up initiatives elsewhere. Second, a more “entrepreneurial” approach is being adopted (Hall *et al*., 2010). The initiative does not have a logical framework, but instead a business case was developed and presented to justify the external support. And third, the researchers involved in the initiative are realising that their role is more facilitative than directive.

However, it is anticipated that any feeling of discomfort this might cause is more than compensated for by the expectation that the results of years of research really can be put into use, to the benefit of the millions of smallholder farmers who need it.

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References

Beevor, P.S., Hall, D.R., Lester, R., Poppi, R.G., Read, J.S. and Nesbitt, B.F. (1975). Sex pheromones of the armyworm moth Spodoptera exempta. Experientia, 31, 22-23.

Betts, E. and Odiyo, P.O. (1968). A preliminary note on the use of light trap data for forecasting outbreaks. pp.111-112 in Record of Research Annual Report 1967. Muguga, East African Agriculture and Forestry Research Organisation.

Betts, E., Rainey, R.C., Brown, E.S., Mohamed, A.K.A. and Odiyo, P.O. (1970). Inauguration of an experimental armyworm forecasting service in East Africa. pp. 110-112 in Record of Research Annual Report 1969. Muguga, East African Agriculture and Forestry Research Organisation.

Campion, D. G., Odiyo, P. O., Mushi, A. M., Hall, D. R., Lester, R., Nesbitt, B. F. (1976). Field tests with the synthetic sex pheromone of the African armyworm Spodoptera exempta (Wlk.). Miscellaneous Report, Centre for Overseas Pest Research, 1976 4pp.

Day, R.K. and Knight, J.D. (1995). Operational Aspects of Forecasting Migrant Pests. In: Drake, V.A. and Gatehouse, A.G. (Eds.), pp. 323-334. Insect Migration: Physical factors and physiological mechanism. Cambridge University Press, UK.

Day, R.K. and Romney, D. L. (2010). Putting innovation systems approaches into practice. In: The Dynamics of Rural Innovation: a primer for emerging professionals. Royal Tropical Institute, Netherlands. (In press).

Haggis, M.J. (1984). Distribution, frequency of attack and seasonal incidence of the African armyworm Spodoptera exempta (Walk.) (Lep.: Noctuidae), with particular reference to Africa and southwestern Arabia. Tropical Development and Research Institute, London. 116pp.

Hall, A., Clark, N. and Frost, A. (2010). Bottom-up, bottom line: Development-relevant enterprises in East Africa and their significance for agricultural innovation. Working Paper #2010-42, United Nations University, Maastricht, The Netherlands.

Knight, J.D. (2001). Planning workshop on the development and implementation of improved forecasting and novel control methods for armyworm in Tanzania. Report of a Workshop held at Eastern and Southern Africa Management Institute, Arusha, Tanzania. 9th - 11th October, 2001. Imperial College, London, UK.

Mushobozi, L., Grzywacz, D., Musebe, R., Kimani, M. and Wilson, K. (2005). New approaches improve the livelihoods of poor farmers and pastoralists in Tanzania through monitoring and control of African armyworm, Spodoptera exempta. Pathways out of Poverty. Aspects of Applied Biology 75:37-46.

Negussie, E., Musebe, R., Day, R., Romney, D., Kimani, M., Maulana, T. and Mallya, G. (2010). Integrating indigenous and exogenous communication channels and capabilities through community-based armyworm forecasting. African Crop Science Journal 18. (In press).

Njuki, J., Mushobozi, W. and Day, R. K. (2003). Improving armyworm forecasting and control in Tanzania. Report of a socioeconomic survey. CABI Africa, Nairobi.

Odiyo, P.O. (1979). Forecasting infestations of a migrant pest: the African armyworm, Spodoptera exempta (Walker). Philosophical Transaction of the Royal Society of London, Series B 287: 403 – 413.

Odiyo, P.O. (1990). Progress and developments in forecasting outbreaks of the African armyworm, a migrant moth. Philosophical Transaction of the Royal Society of London, Series B 328: 555 - 569. OECD. (2002). Guidance for Registration Requirements for Pheromones and Other Semiochemicals Used for Arthropod Pest Control. OECD Series on Pesticides Number 12.

Rose, D. J., Dewhurst, C. F. and Page, W. W. (2000). The African Armyworm Handbook: The Status, Biology, Ecology, Epidemiology and Management of Spodoptera exempta (Lepidoptera: Noctuidae). Second Edition. Chatham, UK: Natural Resources Institute.

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