CROP PROTECTION PROGRAMME

Economic evaluation and international implementation of community-based forecasting of armyworm

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FINAL TECHNICAL REPORT

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Annex 7

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Annex 7

Workshop held at CABI Africa, Nairobi 5 – 7th September 2005

Economic evaluation and international implementation of community-based forecasting (CBF) of armyworm

Contents

Introduction

Following a three year Department for International Development Crop Protection Program (DFID CPP) -funded project in which Community-based forecasting (CBF) of armyworm was developed and implemented in Tanzania, a one year follow-on project moved CBF to a new country, Kenya with a pilot study taking place in Machakos district. The present workshop concerns this follow-on project. The project also assessed the technical performance of CBF and its sustainability from the pilot studies carried out so far in Tanzania. With a view to future scale up of CBF to reach more villages, a more general economic analysis was initiated and the key elements identified that have made CBF a success so far. In addition to DFID funding, USAID also funded a one year CBF project which funded a second pilot in Tanzania as well as involving DLCO-EA personnel from Ethiopia. Using these funds, DLCO-EA with the Ethiopian MoARD last year carried out their own CBF pilot. Enabling a valuable sharing of information between delegates from Tanzania, Kenya and Ethiopia, DFID funded the attendance of representatives from DLCO-EA and MoARD at this workshop.

1. An overview of the community-based armyworm forecasting initiative in Kenya

Francis Musavi – Plant Protection Officer/Migratory Pests

The pilot community based armyworm forecasting was implemented in Mwala Division of Machakos district. The district with an estimated 99,170 farm families has 159,500 Ha under Crop Production and 445,600 Ha is range land. Maize, Sorghum and millets which are vulnerable to armyworm attacks

are also the most commonly grown cereal crops in the district. The district is classified among the primary outbreak areas where the initial outbreaks of the season are normally recorded before spreading to other areas of the country if not controlled.

Mwala division was chosen for this pilot phase as it is among the most high risk armyworm out break areas in the district. Five sub-locations in the division were selected namely: (i) Wetaa, (ii) Mithini, (iii) Kibau, (iv) Mithanga, (v) Kyamutwii.

The activities undertaken are tabulated below:

Activity	**Timing**	**Remarks**
(a) Baseline survey	1st – 4th March 2005	• Individual interviews and group discussion approach were used.
(b) Sub-location meetings	7th – 11th March 2005	• A total of 236 participants from the 5 sub-locations attended the meetings. • Two farmer forecasters elected from each sub-location for further training. • Communication methods to communicate forecast warnings discussed and agreed on.
(c) Training workshop	14th – 15th March 2004	• Attended by 20 participants as follows: o Nine farmers elected during sub-location meetings. o Five assistant chiefs (one per sub-location). o Five locational extension officers. o One divisional extension officer. • At the end of the workshop each sub-location was issued with a forecasting pack. • The trap and rain gauge were installed on 18/3/05 and data collection started on 19/3/05. • The first forecast was issued on 25/3/05.
(d) Official Project Launching	29th April 2005	• Organized to publicize CBAF. • Officiated by Assistant Minister for Agriculture (representative). • Trainees were presented with certificates.
(e) Mid-season Evaluation	3rd – 7th May 2005	• Group discussion approach used. • Discussions with farmer forecasters.
(f) End-of-season evaluation	11th – 15th July 2005	• Individual interviews. • Group discussions. • *A detailed report presented elsewhere.*

For successful implementation of this project, the following partners were involved in the field activities but with different roles:

- Plant Protection Services Sub-division and CABI.
- District Agricultural Office – Machakos.
- Divisional Agricultural Extension Office – Mwala.
- Locational Agricultural Extension Offices.
- Sub-location administration office (Assistant Chiefs).
- Farmer forecasters
- Local community.

The Plant Protection Services played specific roles:

- Reporting progress of the project activities to Ministry of Agriculture Headquarters.
- Providing of traps and servicing materials.
- Preparation of the forecast pack
- Liaising with CABI in project implementation.
- Liaising with the district counter part - Machakos
- Providing stationery and other equipment for meetings and the training workshop
- Participating in sub-location meetings, monitoring and evaluation activities.
- Running the surveys and training workshop with CABI.

Observations made

- Community based armyworm forecasting is probably best suitable for high risk outbreak areas.
- There is a need to carry out thorough sensitization of the local community before initiating a community based project to enhance local ownership.
- Introduction of CBAF should be made with the aim of complementing central forecasting other than substituting it.
- More research should be directed to coming up with affordable control options. Severe armyworm outbreaks are more common in Semi-arid areas where farmer incomes are low.

Way Forward

- Expand the community based armyworm forecasting to cover other high risk districts to enhance accuracy of forecasts issued by the central forecasting service.
- Strengthen the central forecasting unit to obtain more accurate/reliable long-term forecasts for use by the government in advance planning for armyworm control logistics (Pesticides and Equipment).
- Establish a reliable supply of traps, and their accessories.

2. Details of the Machakos survey, monitoring and evaluation

Baseline survey

The specific objectives of the baseline survey were to assess farmer perceptions about armyworms, examine the farmer decision making behaviour in relation to armyworms and to determine the yield losses due to armyworms

Farmer perceptions about armyworms. Farmers aware of armyworms, but had divergent views about what causes armyworms or when they appear. 45% of the farmers did not know what causes armyworms. Some thought armyworms were associated with heavy rainfall and storms. Armyworms were regarded as the most serous pest because they could cause total crop loss.

Cause of armyworm	No. of farmers reporting it
Moths	24
Appearance of mist	10
Drought	3
Strong winds/ storm, rainfall	7
Does not know	45
Prolonged drought followed by heavy rainfall	11
Total	100

The farmer decision making behaviour in relation to armyworms. The main armyworm control method was use of pesticides but 41% of the farmers never controlled during the last outbreak. Reasons for failure to control were limited financial resources, lack of information, lack of access to pesticides and lack of sprayers (43%). Armyworms attacked mainly maize (83%). Government pesticides were supplied but they were limited in quantity and occasionally arrived late. Most farmers were not aware of the government forecasting service. Only 13% received a warning during the last outbreak (2004). Control methods used: Use of own pesticides (36%), Use of government pesticides (12%), Removal by hand (11%), No control at all (41%).

Yield losses due to armyworms ranges from 60-100% depending on whether it was a good or bad growing season. A good growing season was perceived to be one with adequate rainfall and no armyworms; A bad growing season was one with drought and/ or armyworms.

Mid-season monitoring

Performance of the forecasters. The forecasters described their forecasting activities correctly to the fellow farmers. The forecasters were recording correctly and making the forecasts correctly and was done every week starting 19/3/2005. Forecasters were maintaining the forecasting equipment correctly. Farmers reported that they saw forecasters performing forecasting duties and having been given forecast information.

Adherence to the forecast rules. Forecasters operated according to the forecast rules. Only negative forecasts were issued but
These were consistent with forecasting rules. Farmers reported that they trusted the forecasts.

Accuracy of the forecasting rules. All the forecasts were negative and no outbreaks were reported. Further evaluation is necessary under conditions were outbreaks occur.

Information flow among the stakeholders. Sources of information in the sub-locations (in no particular order were reported to be:
Schools, Churches, Assistant chiefs, Extension officers, Village elders, Market places, Forecasters, Special village groups (Myethia)

Farmers' response to forecasts and perceptions about community forecasting. Farmers have stated appreciating the importance of community forecasting. They now have an understanding of what armyworms are i.e. what they are and what causes them. Forecasting of armyworms before an outbreak was accepted as being possible and after a forecast warning farmers reported that they could take different actions in case of a positive forecast. This remains to be tested as no positive forecasts & no outbreaks were reported. Actions in case of a positive forecast would include: monitoring the fields, going to look for/ purchase pesticides, visiting the extension office for advice, controlling whenever there was an outbreak. These were the actions farmers reported they would take but did not because there were no outbreaks.

Suggest corrections and modifications of procedures: hold regular meetings to create awareness, increase the number of forecasters possibly for each sub-location, enhance information flow from the sub-location to the district level, provide information on appropriate pesticides and safe use of pesticides, improve access to pesticides and sprayers, hold farmer trainings in different areas, provide motivation the forecasters, and scale up CBF to other sub-locations.

<u>End-of-season Evaluation</u>

Objectives
1. Asses farmer perceptions and knowledge of community forecasting
2. Determine the performance of the forecasters
3. Assess the forecasting information flow among the stakeholders
4. Assess the role and participation of the different stakeholders
5. Examine the methods and effectiveness of control
6. Identify improvements that could be made during scale-up

Asses farmer perceptions and knowledge of community forecasting. Farmers were aware community forecasting of armyworms and had benefited from it in terms of: gaining knowledge about the causes and occurrence of armyworms, timely information on impending armyworm outbreaks, reduction in losses attributed to armyworm infestation. Farmers reported that they were now

aware that armyworms could be forecasted, 92% of the farmers as opposed to the initial 51% reporting that armyworms could be forecasted. Farmers reported the activities of community forecasting to include: trapping moths, forecasting of armyworms, outbreak announcement and monitoring traps.

Determine the performance of the forecasters. Forecasters were recording correctly and making the forecasts correctly. The forecasting was done every week and forecasters were maintaining the forecasting equipment correctly. The forecasters continued issuing the forecasts, adhered to the forecast rules but only negative forecast were given, in total 75 negative forecasts were issued. The forecasts were consistent with forecasting rules

Accuracy of the forecasting rules. Only negative forecasts issued and no outbreaks were reported, so forecasting was accurate as far as can be judged.

Forecasting information flow among the stakeholders

Sources of Information	Number of farmers
Assistant chiefs	35
Sub-location extension officer	34
Sub-location forecaster	51
Mosques	1
Churches	34
Schools	29

Views were given on improvements that could be made during scale-up: train more forecasters, provide transport and some honorarium to the forecasters, take forecasters for refresher courses and seminars, provide seminars to the other farmers regarding the role of forecasting, give the forecasters protective clothing, encourage community initiatives for collective control, provide sprayers for hire, and motivate the forecasters.

3a. Community-based forecasting of armyworm in Tanzania, from November 2002, overview & future

Following the initial community-based forecasting pilot 5 villages in Kilosa district during the 2001/2002 armyworm season, there are now 20 villages in 4 Districts implementing CBF of armyworm. Evaluations have shown that the different stakeholders have all acknowledged the benefits in a variety of ways. For example, the Tanzania Government and/or donors have provided resources for the scaling up which has been carried out in Tanzania as well initiating pilots in new countries – Kenya and Ethiopia.

A number of specific achievements have been identified during the monitoring and evaluation:

- Farmers predicted armyworms outbreaks sufficiently early to be of use
- More farmers monitored their fields for armyworm and took timely (early) control

- Armyworm damage was reduced and this translated into higher yields
- Quick responses for intervention from district officials were facilitated

The District officials themselves reported benefits:

- Districts felt supported through capacity building
- Rainfall data from CBF of armyworm was benefiting other projects.
- Districts were getting information about high moth catches when they occurred rather than, as typically used to happen, information about outbreaks when it is largely too late to respond
- The links between community forecaster, village Government, extension staff & district office have been strengthened

Benefits as reported by Village Governments and farmers:

- They expressed a sense of ownership of the CBF activity and a willingness both to continue it and to support it
- Farmers reported getting warnings in advance of impending A/W outbreaks
- As a result more farmers also reported monitoring their crops for armyworm and taking early control.
- African armyworm is now better understood in the villages implementing CBF

Lesson learned

- Community-based forecasting has proved to an effective method for supporting poor farmers to control armyworm outbreaks, at least in those districts with a high risk of armyworm attack, were it has been piloted.
- CBF implementation in the villages as promoted a better partnership between scientists and farmers through a shared concern to solve the problem.

Challenges

- A high demand for CBF has been expressed by groups and individuals from non-CBF villages and districts. The need for scaling up is therefore very apparent.
- As more results become available from the pilot studies, on-going research and development is needed to revisit and refine the forecasting rules, recording sheets and the forecasting pack.
- The central challenge is to plan and implement the actual scaling up operation with is associated needs to train more stakeholders and partners.

3b. Monitoring and evaluation in Kilosa District

The main objective was to learn lessons for the continued implementation in CBF villages and for scale-up. The Kilosa pilot was carried out in the 01/02 armyworm season and since then CBF has been continued in all five pilot villages with only a small external input to provide pheromone lures and carry

out evaluation visits. The results of the monitoring and evaluation reported here cover the following:

1. Document the benefits of CBF
2. Examine the performance of the forecasters
3. Examine changes in farmer awareness of armyworms and control
4. Assess the forecasting information flow
5. Assess the role and participation of the different stakeholders
6. Identify improvements that could be made to CBF

Benefits of community-based forecasting

- Timely knowledge and information regarding impending outbreaks
- Timely preparation and control
- Reduction in crop losses, leading to high yields and income from crops
- Interactions fostered between village government, extensions and farmers
- Improvement in peoples' livelihood and welfare due to increase marketed surplus and more food for subsistence purposes
- Increased technical know how
- Increased production of crops prone to armyworm attacks especially cereals
- Farmers are now aware that armyworms can be forecasted
- Increased successful control

Performance of the forecasters

- Forecasters were recording correctly and making the forecasts correctly
- Forecasting was done every week
- Forecasters were maintaining the forecasting equipment correctly
- The forecasters continued issuing the forecasts
- All the original forecasters were available except one who had obtained a job in Morogoro

Changes in farmer awareness of armyworms and control

- Major outbreak reported in 2003/04 by 88% of the farmers
- Farmers reporting possibility of forecasting before outbreak is 72%.
- 72% reported that they were aware of how forecasting is done
- 88% of the farmers monitor their farms for armyworms
- 72% of the farmers controlled
- 70% of the farmers reported that there had been no changes in forecasting.
- Improvement; successful control reported by 75% of the farmers that controlled
- Fewer farmers (32%) now replant crops due improvement in successful control
- The main source of pesticide the govt.(40%), own (34%), non use of pesticides (26%)
- Own pesticide is mainly from within the village (22%)
- Pesticides from outside (12%) others did no indicate the source

- 70% use sprayers mainly those supplied by CBF project
- Yield loss due to armyworms has reduced from 100% to 41%

Forecasting information flow. Information flows from the forecasters to the village extension officers then the village government and subsequently to the district authorities. The main sources of information include: Forecasters, Fellow farmers, Posters, Village announcers, Extension officers, Village government, mosques, Village elders, and Media e.g. radio.

Role and participation of the different stakeholders

- The forecasters collect the forecast record and deliver information to the village extension officers for further dissemination
- Village extension officers undertake backstopping of the forecasters, dissemination of information to farmers, village government and the district authorities
- Village government is also involved in dissemination of information and distribution of pesticides where applicable
- District authorities provide logistical support and distribution of pesticides

Problems of forecasting and controlling armyworms

- Inadequate equipment and pesticides for controlling (pesticides, sprayers and spare parts for the prayers)
- Some pesticides provided by the government are not compatible with the sprayers (Pesticides mixed with diesel yet sprayers provided are used best with pesticides that are mixed with water)
- Information dissemination is not good; some villages do not have loud speaker for the village announcer
- Inadequate forecasters and forecasting equipment given the number of high risk villages esp. for scale-up
- Information on impending outbreaks does not reach all the farmers in the villages

Lessons learnt for continued implementation in original CBF villages and for scale-up to other villages

- Increase the number of forecasters by training more forecasters possibly for each village in the high risk districts
- Educate the community on armyworm management through regular meetings
- Avail sprayers and pesticides on credit
- Improve mode of information dissemination
- Include teachers/ schools in the CBF project
- Provide training, seminars and refresher courses for the forecasters
- Motivate the forecasters e.g. provide transport and some honorarium to the forecasters
- Identify other control methods, besides pesticides
- Regular village meetings to create awareness
- Government to provide pesticides early and in adequate quantities
- Provide seminars to the other farmers regarding the role of forecasting

- Give the forecasters protective clothing
- Encourage community initiatives for collective control
- Provide sprayers for hire
- Scale-up CBF to other high risk villages

Efforts of the villages to ensure sustainability of CBF

- Small token provided to the forecasters by the village government
- Village government facilitates photocopying of the data forms
- Some village governments pay Tsh 500 to the village announcers
- Neem tree planting groups established
- Village governments conducting regular meetings to create awareness
- Farmers considering CBF as their own and providing security to the traps during the forecasting period
- Information dissemination considered a responsibility of all the farmers
- Other villages considering forming information dissemination groups

4a. Overview of community–based forecasting initiative in Ethiopia

DLCO – EA

The work in Ethiopia was initiated following the Nairobi meeting at CABI, Aug 2004, held in connection with a USAID funded input to the CBF initiative. The Ethiopian effort was USAID-funded and following the 2004 workshop discussions were held with PPD officials. Site selection for the Ethiopian pilot was made on the basis of the expected severity of the armyworm infestation, accessibility and the presence of a DA. The districts selected were Konso in southwestern Ethiopia, and Fedis in eastern Ethiopia. Five PAs selected in each district. The Criteria for selection of farmers were: ability to read and write, willingness, and selection by the peasant association.

Socio – economic surveys were carried out as follows:

Fedis: 17 – 22 November
Konso: 13 – 17 December, 2004

Farmers were divided into 2 groups for interview (group interview) and the no. of farmers interviewed was Fedis 59 & Konso 104.

Farmers' perceptions about armyworm.

All consider armyworm as the major pest and many believe armyworm causes heavy damage/loss. The major crops affected are: teff, finger millet, maize and sorghum. Farmers had a variety of views on the occurrence of armyworm: many said comes with wind driven rain, some said comes from God in the sky, some also said comes from adjacent grassland and about 1% said it comes from moths.

Farmers' decision making practices. Most farmers like to control armyworm, but could not get insecticides on time. As a result, they use traditional methods such as digging a furrow, wood ash, removing weeds from sorghum and maize fields, mulching with dry grass, etc. All farmers reported that they

do not start control operations on time. Farmers know the presence of armyworm from: neighbours, DAs, and some detect by themselves

During the CBF training in the villages, 35 farmers and DAs were trained and the topics covered were: biology and identification, crops attacked and damaged, control methods, operation of pheromone traps, forecasting methods, and methods of disseminating warning. A field exercise involved pheromone trap site selection, trap installation and trap catch removing and recording. Video film and sample of armyworm were used as training aids and materials were provided:

Pheromone trap and a capsule
Forecasting manuals (Amharic)
Daily record sheets

A certificate presentation was carried out at the end of the training.

4b. African Armyworm Forecasting and Control in Ethiopia – A Closer Look

Kassahun Bedada, National Armyworm Coordinator

The African armyworm, *Spodoptera exempta (Walk.) (Lepidoptera: Noctuidae),* is an economically important, outbreak seasonal pest of pastures and cereal crops in Ethiopia. Crop farmers and pastoralists have been suffering due to armyworm infestation for many years. The area infested over the last 20 years has ranged from 10,000 to over 350,000 ha per year and from 1963 – 67 the total estimated loss due to armyworm infestation was 25,000 tons of cereals.

Some major armyworm infestation records in Ethiopia

Year	Total area infested
1986 crop season	92,396 ha
1994 crop season	366,414 ha
1996 crop season	246,186 ha
1997 crop season	78,437 ha
1999 crop season	92,449 ha
2004 crop season	11,160 ha

Although the level of infestation varies from year to year and from region to region, armyworm infestation is reported approximately every other year in Ethiopia.

Armyworm Forecasting & Control in Ethiopia is run by the government. The CPD distribute pheromone lure & traps and gives financial support. This is now implemented through the use of pheromone trap net works (about 100 pheromone traps) distributed in strategic locations in different Regions. However, most of these traps are broken or spoiled otherwise and no reliable records are expected from them.

To control armyworm, the Government provides pesticides, either bought or secured from donors. It provides spraying equipments and protective materials to be used by farmers through the regional agricultural bureaus. It

also gives financial support used to undertake control operation and during armyworm invasion the national armyworm coordinator, the crop protection experts in the Regional Offices & Plant Health Clinics coordinate control operations in different Regions. The woreda (= District) agricultural offices & the DA stations supervise and assist farmers in control operations.

In Ethiopia armyworm forecasting operations need large improvements so as to deliver timely information and warnings to farmer communities. The problems encountered in the foregoing forecasting operations are: i. the reports do not reach on time, ii. there is no suitable menu-driven data management system that could help to predict armyworm outbreak by using the simulated models for armyworm invasion. It is well known that forecasting could provide sufficient time to plan effective control strategy. So, beside improving the national armyworm forecasting service CBF can play a significant role to obtain data & disseminate information.

Short term forecasts: could they assist to tackle armyworm invasion? In 2004 DLCO-EA initiated community based armyworm forecasting in Ethiopia. Collaborating with the Regional Agricultural Bureaus and consulting historical data, 2 woredas - Konso woreda on southern part and Fedis woreda on the eastern part of the country - were selected. The main criterion for selection of woredas were: frequency of outbreak in the area, extent of damage in the area, and familiarity of the farmers to the pest.

To initiate CBF the sequence of activities was:

I. Information collection & analysis
   1. Questionnaire preparation
   2. Meeting with farmers community
   3. Selecting farmers
   4. Decision making

II. Implementation Process

   Manual preparation. A manual composed of the biology, identification, damage & control practices including forecasting rules was prepared by CPD and DLCO-EA. The manual was to include colour pictures of the different development stages of the pest so as it can also serve as a reference material.

2. Trainings

   On February 21-23 in Konso, and
   On March 26-28 in Fedis woreda,

3. Performance of trained farmers

   - Starting from Sunday March 27/05 the farmers in Konso have begun recording daily moth catches
   - The incoming reports were remarkably good that they included the

No. of rainy days and reasons when there was catches

From the other woreda – Fedis – beginning from April 10 only 5 week reports were dispatched and the reports were not as good as that of Konso (southern part). Due to several reasons evaluation of trained farmers is not undertaken in Fedis woreda.

Evaluation of Forecasting trials.
IT is proposed that evaluation of the trials to asses their strength and weakness should be made in a two stage process. In Ethiopia training of selected farmers was not made on time and this also caused a delay in the evaluations. Only the end-of-season evaluation was undertaken in Konso by CPD on July 2005

Lessons learned and achievements.
The selected farmers were willing, attentive and eager to undertake the work – in both woredas. Specially in Konso (Southern part) the farmers have showed that community based forecasting of armyworm can successfully be applied by farmers. In some villages at Konso many farmers have come to hope that with daily monitoring of armyworm moths by the selected farmers no armyworm infestation would occur in their surroundings. [Clearly, there is some confusion about the powers of forecasting – Ed]. In general the method followed to train farmers and the beginning of forecasting immediately is found suitable to undertake CBF in Ethiopia.

Problems
- Trained farmers were working individually not in pairs.
- Recording of catches were not properly made in some of the PA's & also permanent records are not available in some PA's.
- There was an unverified high NO. of moth catch reports.
- There was a shortage of stationary.
- Conveying the message of forecasting was poor.
- Trained farmers are found to expect some incentives

Problem on Government side
The plan to undertake (scale out/ scale up) CBF trail in 2005/2006 looks most unlikely due to budget constraints. Despite this, there is a fertile ground to wide scale implementation of CBF in the country. Regional agricultural offices, Plant Health Clinics, Woreda experts, DA's and many farmers become aware of the initiative. Although, some mistakes were done when presenting budget request to officials the CPD is convinced that the trial would bear fruit if implemented properly and it would do its best in the future.

5. The accuracy of community-based forecasting, are the farmers using the rules and other lessons from the CBF data collected so far

Four broad topics were discussed:
- Were the forecasting rules followed by the farmer forecasters?
- Did the forecasting rules predict outbreaks correctly?
- Was the farmer forecaster better than the rules in predicting outbreaks – why?
- Can the rules be changed to improve and simplify the forecast

The data from the pilot villages were grouped as follows. The 0405 season experience no outbreaks as was omitted from the analysis.

Kilosa 0102	Outbreaks
Kilosa 0203	Outbreaks
Kilosa 0304	Outbreaks
Kilosa 0405	None
Moshi & Hai 0304	Outbreaks
Machakos 0405	None

First we considered if the forecasting rules were followed by the farmer forecasters? When they do not adhere to the rules, two types of difference can occur: Farmer positive, Rule negative, and Farmer negative, Rule positive.

Farmer-forecast & rules
(Number & % of total forecasts)

	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Overall
Same	31 89%	60 86%	84 95%	64 94%	239 92%
Farmer +ve Rule -ve	3 9%	4 6%	0	2 3%	9 3%
Farmer –ve Rule +ve	1 3%	6 9%	4 5%	2 3%	13 5%

Possible reasons were identified were discrepancies existed between the forecast according to the rules and the forecasts as issued by the farmers. The possible reasons should be regarded as pointers to what may be causing the farmers to deviate from the rules. Theses might inform discussions in future participatory evaluations.

Events associated with 'Farmer +ve Rule –ve'

- One or more recent outbreaks had occurred (8 cases)
- Moths increased from 0 to 33 (but no rain & no previous outbreaks) (1 case)

Events associated with 'Farmer –ve Rule +ve'

- Didn't follow 'previous week rule' (7 cases)
- Farmer made an incorrect +ve forecast the previous week (1 case)
- Drop in moth catch from 195 to 35 (1 case)
- More than 4 weeks elapsed since last outbreaks (4)

Comparing forecasts and outbreaks was difficult because detailed information was not always available about the timing of the outbreaks. Outbreak report dates were posted when outbreaks were observed & reported. Sometimes moths arrive sexually matured and the laid eggs can start hatching the same week or the week after. On 29 occasions, a reported date was available. This was day 6.44 (i.e. Day 6 to 7) of the same week in which the forecast was issued with range Day 2 of the same week to Day 5 of the following week. In the analysis we define this as an outbreak occurring in Week t (i.e. matching the forecast).

Definition of a correct forecast – two options looked at:

Option 1: forecast & associated outbreaks, match – either both positive

or both negative (forecast includes previous week rule)

Option 2: following a positive forecast, an extra week is allowed within which the outbreak can occur (previous week rule omitted in making forecast)

Implication of different evaluation methods (Wk t **forecast** correct or not?)

Wk t-1	Wk t	Wk t+1	Correct (Option 1)	Correct (Option 2)
	Forecast +ve Outbreak		Yes	Yes
	Forecast +ve No outbreak	Out-break	No	Yes
Forecast +ve	**Forecast –ve** Outbreak		No	Yes

Forecasting rules correct by two evaluation methods

Evaluation assumptions	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Overall
Option 1	32 91%	51 73%	79 90%	47 69%	209 80%
Option 2	32 91%	62 89%	87 99%	58 85%	239 92%

Positive & negative rules incorrect (Option 2 method)

Forecast	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Overall
Positive (% of those positive)	0	4 19%	1 4%	8 36%	13 15%
Negative (% of those negative)	3 20%	4 8%	0	2 4%	9 5%

Positive & negative rules incorrect (Option 1 method)

Forecast	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Overall
Positive (% of those positive)	0	15 50%	9 26%	19 66%	43 36%
Negative (% of those negative)	3 27%	4 10%	0	2 5%	9 6%

Events associated with false rule negatives

- Moth and/or rain thresholds not met but a succession of outbreaks over several weeks continued (7 cases)
- Outbreaks occurred and moth threshold but not rain threshold, met (2 cases)

Events associated with false rule positives

- Longer delay (> 2weeks) before outbreaks started (7 cases)
- Thresholds exceeded later in season when earlier succession of

outbreaks had long ceased (4 cases)
- Forecast +ve due to 'previous week rule' but outbreaks did not continue (1 case)
- Thresholds still exceeded but outbreaks had stopped (2 case)

Comparison of Farmer forecasts and outbreaks (Option 1 method used to make a comparison between forecasting rules & farmer forecasts)

	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Over-all
Correct (% of all)	34 97%	59 84%	81 92%	51 75%	225 86%
Farmer false positives (% of those positive	0	10 36%	6 19%	17 59%	33 29%
Farmer false negatives (% of those negative)	1 11%	1 2%	1 2%	0	3 2%

Correct forecasts (% of total forecasts)

Forecast	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Overall
Farmer	34 97%	59 84%	81 92%	51 75%	225 86%
Rules	32 91%	51 73%	79 90%	47 69%	209 80%

Incorrect negative forecasts (as a percentage of negative forecast)

Forecast	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Overall
Farmer	1 11%	1 2%	1 2%	0	3 2%
Rules	3 27%	4 0%	0	2 5%	9 6%

Incorrect positive forecast (as a percentage of positive forecasts)

Forecast	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Overall
Farmer	0	10 36%	6 19%	17 59%	33 29%
Rules	0	15 50%	9 26%	19 66%	43 36%

When did farmer do better than rules?
- Recent outbreaks had occurred (6 cases)
- Moths above threshold but no rain (2 cases
- Didn't follow previous week rule (4 cases)
- Hadn't been outbreaks for more than one month (4 cases)

- Farmer issued a false positive last week, so predicted negative (2 cases)
- Lucky (1 case)

When did farmer do worse than rules?

- Recent outbreaks had occurred (1 case)
- Didn't follow previous week rule (2 cases)

Three possible alterations to the forecasting rules were considered: No 'previous week rule', No rain threshold, and Different moth threshold.

With & without the previous week rule (Option 1 evaluation method. Best result in bold)

	Previous week rule	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Total
Total correct % of total	With	**91**	73	**90**	69	**80**
	Without	80	**74**	89	**76**	80
Incorrect pos. % of positives	With	0	50	26	66	36
	Without	0	**48**	**17**	**59**	**31**
Incorrect neg. % of negatives	With	**27**	**10**	**0**	**5**	**6**
	Without	47	16	9	7	14

With & without the rainfall threshold (Option 1 evaluation method. Best result in bold)

	Previous week rule	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Total
Total correct % of total	With	91	**73**	**90**	**69**	**80**
	Without	**94**	66	85	68	77
Incorrect pos. % of positives	With	0	**50**	**26**	66	**36**
	Without	0	56	33	**65**	42
Incorrect neg. % of negatives	With	27	10	0	5	6
	Without	**20**	**3**	**0**	**0**	**2**

Optimum moth thresholds (Option 1 evaluation method)

	Kil 0102	Kil 0203	Kil 0304	M&H 0304	Total / aver-age
No. correct (threshold ≥ 30)	32	51	79	47	209
Optimum threshold minimum	≥1	≥73	≥85	≥199	≥90
No. correct	33	55	83	54	225
% improvement	3%	8%	5%	15%	8%

Main conclusions

These fall under three headings:

1. Situations in which the forecasting rules failed
2. Why the farmer forecasters might be doing better than the forecasting rules
3. Considerations for forecast modification

Situations in which the forecasting rules failed

- Outbreaks continued but catches dropped & therefore thresholds not met
- Thresholds were exceeded but outbreaks took longer to get going
- Thresholds were exceed but outbreaks had been & gone, one or more armyworm generations previously

Why farmer forecasters might be doing better than the forecasting rules

- Farmers use knowledge of occurrence AND non-occurrence of prior or current outbreaks to inform their forecast
- Farmers may or may not follow the 'previous week rule' perhaps depending what other information they have.
- Farmers sometimes make a forecast based just on moths
- Farmers sometimes alter a forecast if they made a wrong forecast last week

Considerations for forecast modification

- A two week rolling forecast would make evaluation easier but would it make more or less sense to the farmer forecasters?
- Dropping the previous week rule led to fewer false positives but more false negatives
- Dropping the rainfall condition led to more false positives but fewer false negatives
- A higher moth threshold led to an improved forecast

6. Economic evaluation of CBF

A number of uses for the economic evaluation were identified

1. Review of current project to look at value for money aspect
2. Likely future costs of wide scale implementation
3. Ability to prioritise areas where CBF should be introduced

Review of current project to look at value for money aspect

Costs

There are two types of costs associated with the project its implementation and maintenance, internal costs (those falling on the community) and external costs (those falling on the external organisations delivering the programme training etc)

Implementation (training etc)

The costs are broken down by the different activities associated with delivery

Collection of baseline data – peculiar to the early phases of the project, important in judging overall value for money of project but not repeated in later implementation phases

Providing training

Village meetings

2 x 0.5 day meetings to introduce philosophy and understanding of armyworm. Covers election of two trainees from village

External costs

Personnel

1 x trainer
1 x District Plant Protection Officer (or equivalent)
1 x Driver
1 x Village Extension Officer (or equivalent)

Equipment/Travel

1 x vehicle
Stationary
Subsistence for Trainer, DPPO, Driver and VEO
Travel costs for VEO
Refreshments?

Internal costs

Personnel

1 x Assistant Chief (or equivalent)
?? persons from community

Training Workshops

2 day workshop to train forecasters in use of trap and rules. Run for participants from 5 villages

External costs

Personnel

1 x trainer (maybe assistant trainer later?)
1 x DPPO
1 x Driver
5 x VEO

Equipment/Travel

1 x vehicle
20 x training packs
5 x forecasting kits
Hire of room
Subsistence for Trainer, DPPO, Driver and VEO
Travel costs for VEOs, Asst Chiefs and trainees

Internal costs

Personnel

5 x Assistant Chiefs
10 x trainee forecasters

Maintenance (running costs from year to year)

Breaks down into activities associated with weekly forecast generation, trap maintenance and monitoring and evaluation of performance.

One off cost of siting and fencing trap 1 man day?

Forecasting

Internal costs

1 person 1 hour per day checking and emptying trap and calculating forecast
Posters
Announcements
Honorarium?

Trap maintenance

Delivery of new septa and stationary each season and replacement of equipment 5 villages can be serviced in 1 day

External costs

Personnel
1 x DPPO
1 x Driver
Equipment
1 x vehicle
2 x lures
Insecticide blocks
Recording sheets

Monitoring and Evaluation

2 x 0.5 day meetings

External costs

Personnel
1 x trainer
1 x District Plant Protection Officer (or equivalent)
1 x Driver
1 x Village Extension Officer (or equivalent)
Equipment/Travel
1 x vehicle
Stationary
Subsistence for Trainer, DPPO, Driver and VEO
Travel costs for VEO
Refreshments?

Internal costs

Personnel
1 x Assistant Chief (or equivalent)
2 x Forecasters

?? Participants from community

Training of Trainers Workshops

Consisting of 20 trainees and lasting 5 days

External costs
Personnel
2 x trainers
10 x District Plant Protection Officers
10 x Assistant DPPOs
(1 x District Commissioner for official opening if required)
Equipment
Travel and subsistence
Training of Trainers Packs
Stationary
Room
(Allowance for DC)

Annual Planning Meetings

Meeting lasting 2 days with 3 nights S & T

External costs
Personnel
1 x National forecasting officer
? x DPPOs
Equipment
Travel & subsistence for NFO and DPPOs
Stationary etc

Coordination inputs from National Officer

National officer expected to provide 10 days per year input to programme with costs of incidentals and limited materials.

All the above require values putting against them so project members are kindly requested to provide figures (actual or estimates) where possible.

Benefits

Estimates of the benefits will be made from existing data collected in the early stages of the project, existing literature on the impacts of armyworm on productivity and any information contained within armyworm records held by National forecasters etc.

7. What are the key things that make CBF a success? Can we simplify the scale-up process yet retain the important elements of success

Brainstorming the question of ***what are the key things that make CBF a success***, workshop participants wrote two to three ideas each on cards. The cards were then displayed and ordered by the group into what appeared to be two natural categories: the nature of CBF itself (what is CBF) and the way CBF is implemented (How CBF is done)

What is CBF

List of cards contributed by participants:

- Good science
- Demand driven
- Appropriate technology
- A regional pest problem
- Helps the farmers to get control materials on time
- Farmers see armyworms as a problem
- Changes the farmers attitude in pest control
- Improves information dissemination
- It works (probably)
- Provides better forecasting than existing system

How CBF is done

List of cards contributed by participants:

- Genuine empowerment
- Effective engagement of communities
- Planning before implementation of CBF
- Availability of equipment
- Introducing CBF within the existing village structures, e.g assistant chief must be 'on-board'
- Their decision must be approved (supported?) by the DA (DA's) before announcement
- Targeting training
- Ownership – farmers given the chance to nominate one of their own as the forecaster
- Genuine participatory approach
- Institutional investment by government at all levels
- Community ownership

It was felt that in order to be taken up successfully that CBF must fulfil a real need and also be an appropriate technology to solve the problem [– perhaps an obvious truth but important none the less – Ed]. The set of 'What is CBF' cards make the point well. The armyworm problem is important and widespread and farmers are aware of it and want to do something about it. The CBF approach uses village level technology and has worked well so far, and importantly, farmers have seen that it does work.

The way in which CBF has been introduced to, and implemented in, the pilot villages has been highly participatory and the workshop group believed that this was an essential element of its success. Engagement of the community and the village authorities and offering aspects of the decision making to the villager's themselves has led in the pilot studies to ownership of CBF by the village. This is evidenced by the fact that pilot villages have continued to run CBF, in the case of the Kilosa pilot for a further three years following the initial training. In addition, local initiatives have arisen associated with CBF, e.g. a sprayer rental scheme and a contract sprayer group. As a sign of institutional investment, in some cases both village and district authorities have allocated some funding to allow CBF to continue.

8. Pool some initial ideas for the development of a proposal for further CBF work that might address a future call under the new DFID facility programme

This was approached as a natural progression from item 7. above. The next logical step for CBF is to continue the scale-up process. Pilots have now been carried out in Kenya and Tanzania as well as an initial pilot in Ethiopia. The number of villages reached has so far been a small proportion of the number which might benefit so the next challenge must be to test potential scale up approaches to devise effective ways to present greater numbers of villages the opportunity to develop CBF.

The process of implementing CBF which we have used so far was revisited to consider the problem of scale-up such that the key elements listed above would not be lost. It was felt that the basic structure of the training should remain the same but that a number of activities could be combined or condensed. In addition, further institutionalisation of CBF was proposed by introducing a training of trainers (TOT) workshop (Item 2, below) for the district (or equivalent) coordinators, probably the district crop protection officer (or equivalent). The TOT would cover both training in participatory approaches and training in CBF. It is envisaged that the district coordinators would then act as the key trainers and return to their districts to carry out the farmer-forecaster training in selected villages. A feasible TOT group might comprise DA's from 10 districts plus a deputy, making 20 people in total.

The first contact with the village would take approximately two consecutive half days to introduce the topic, hold a group discussion, call a village meeting and elect the farmer-forecasters (Items 4 & 5, below). It is envisaged that the national forecasting coordinator would back up the DA trainer but clearly it would not be possible for the national person to attend all village level activities. The training workshop would proceed as before with 4 representatives from each participating village (farmer-forecaster and deputy, village extension officer, and village authority e.g. assistant chief) attending a residential course in the district. Mid and end of season monitoring, with the l important ancillary function of offering encouragement, would take a short half day each. Were appropriate to raise the political profile of CBF, a 'launch' could be held in newly participating villages, although it was noted that the costs of such are often substantial.

Implementation, step by step

1. Planning meeting
2. TOT (both PS & CBF) District / Woreda co-ordinators
3. District planning meeting
4. Socio-economic survey & introduction to AW forecasting
5. Village meeting
6. Election of Farmer-Forecasters
7. Training WS
8. Forecasting tools pack
9. Forecasting (and data collection)
10. 'Launch'
11. Mid-season monitoring
12. End-of-season evaluation
13. Review meeting

Two slightly different models for scale up were discussed. In the first, District coordinators would be exposed to the TOT workshop without prior hands-on experience of carrying out CBF training in the villages. The advantage of this is that a relatively large number of DA's can be trained at the outset. In the second model, training of the DA would post-experience. Whilst probably better, it would mean that the burden of initial introduction of CBF to every district would have to fall on a single national person, so making the whole process o scale-up rather slow. There is no reason why a single training model should be used, and indeed, trying both approaches would itself be very instructive.

<u>Proposed methodology for the implementation of a scaled-up CBF programme</u>

The scaling-up of the CBF methodology needs to address issues at three different levels; regional, national and local or district level. A key requirement for all of these is a planning meeting to decide the strategy at each of the levels.

Planning meeting
(REGIONAL LEVEL)

NATIONAL LEVEL
At the national level decisions will have to be made on which districts will participate in the programme in any particular year, probably based on the risk of armyworm in that district. The training of trainers will then be organised (see section on training of trainers).

DISTRICT LEVEL
At the district level the purpose of the planning meeting will be to select which villages will be used in the implementation of CBF.

Socio-economic survey and introduction to community based forecasting

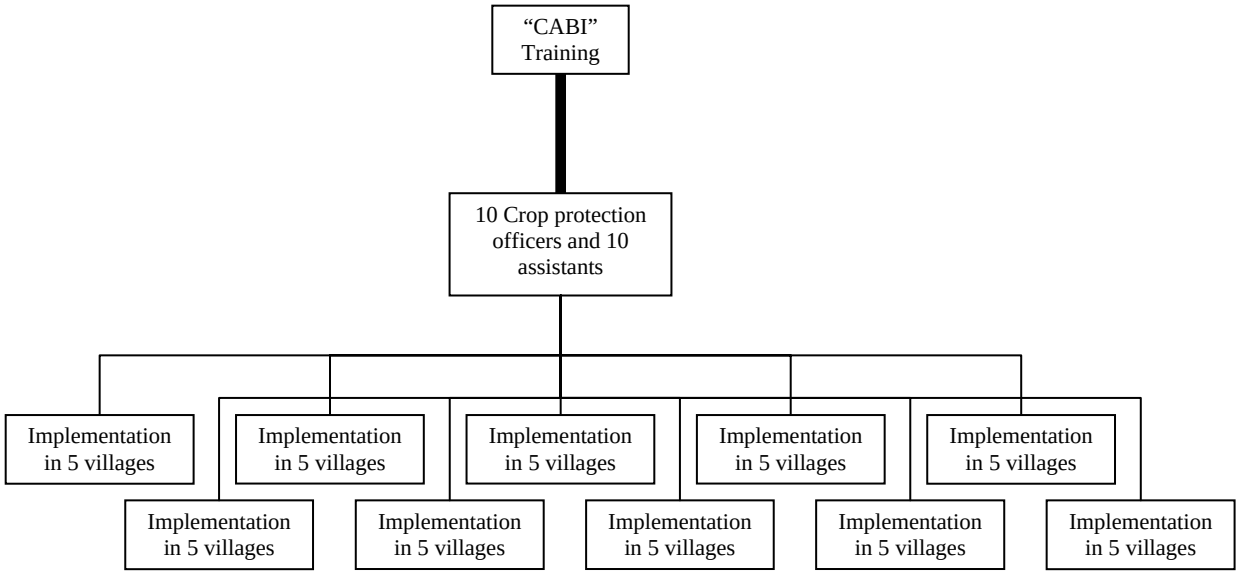
Whilst the S-E survey was an integral part of the development programme it is not clear that is has value in the general implementation process. The actual data will not have value but it is possible that the process of collecting to helps to engage the community with the process. The S-E survey can be combined with the initial village meeting to explain the forecasting process and to explore the different existing channels of communication within the village. The two farmers to be trained will be elected at this meeting. The process will be divided into two half day sessions run on consecutive days allowing two villages to be addressed in two days but still allowing sufficient time for the villagers to think about who they might elect to be trained.

Training workshop
The two elected farmers, the assistant chief (or equivalent) and the village extension worker (or development agent) will be trained how to operate the trap and to produce the forecast. (The extension worker (development agent) has the potential to be trained up as a trainer in future years perhaps)

Training of Trainers
The training of individuals within villages cannot be undertaken using the approach used to date i.e. the use of CABI staff and high level persons within the country forecasting service. Even if only the high risk districts within each country are considered there would be approximately 150 districts (Tanzania 22, Kenya 25 and Ethiopia ~100) each containing up to 200 villages. To train all the villages would simply take too long. A suitable approach to this may be to “train trainers” whereby the number of trainers is multiplied during the training process itself.

Various models for the training of trainers were considered. A “traditional” model whereby the most enthusiastic student from one previous session is selected to train other farmers was felt to be less likely to succeed with this particular programme since there is the need to embrace both the philosophy of community based projects and the participatory approach with the technical dimension of the forecasting. It was therefore decided that training the District Crop Protection officer with his assistant in each district and then using them to do the training in the villages would be more successful since the technique was less likely to be “diluted” by the training trickling down through a number of layers of farmers. This does have the disadvantage that the roll-out of the technology will be relatively slow in the first instance although ways of speeding this up could be considered later depending on the success of this strategy.

Proposed structure for “training of trainers” (To be implemented in whichever country is appropriate)



Both Kenya and Tanzania are now in a position to begin testing out the institutionalisation of CBF in a first phase of scaling up. The pilot in Ethiopia ran into some problems and the next step there would be a better supported and organised pilot.

The need for sustainability indicators was raised as becoming more important as more villages become trained. The workshop developed a list of sustainability indicators that might be used to assess whether CBF is becoming self sustaining within a village. These indicators apply at the village level but also in some cases to the district level and above:

Internal investment
Continued functioning of the system
Value perceived
Evolution of the system occurring
Reproducing itself (i.e. new villages starting up CBF independently)
Demand by non-participants
Institutionalisation

Research Issues. Along side the CBF training and implementation a number of research issues were considered necessary.

1. Forecasting rules. With the data collected from the pilots conducted so far possibilities are emerging for modifications to improve the forecasting rules. These include the level of detail with which it is necessary to collect rainfall information, the moth number threshold, and the inclusion of additional information, notably the presence of outbreaks at the time the new forecast is made. There have been some indications that the farmers may adapt the rules rather than simply make mistakes in their interpretation. Evaluation could usefully be extended to gain a better understanding of whether the farmer-forecasters are indeed making deliberate modifications. A key part of

forecast evaluation is accurate outbreak reporting. In the pilots carried out so far, outbreak reporting has been rather ad-hoc, and non-standardised making evaluation of the accuracy of forecasts somewhat open to interpretation.

2. Trap design. Rather than sources relatively expensive professionally produced pheromone traps, there are possibilities to produce simple traps from local materials such as plastic bottles or other containers commonly available in village shops. Whilst this would potentially make traps cheap and easy to make, they would become non-standardised, so making comparisons between traps less valid.
3. Impact & economics. As a body of data builds up during scale up the opportunity exists for more quantitative monitoring and evaluation
4. Currently each participating village has received a single trap. It may be that more than one trap per village would provide more accurate forecasts, or that several villages could effectively share the information from a single trap. Spatial corrections of trap data and outbreak reports might be used to investigate what are satisfactory trap densities for effective local forecasting.

9. Immediate action points

1. Modify the set of reporting forms to include more precise outbreak information. For purposes of objectivity, it was felt that a person different to the forecaster would be best chosen to make a written report of outbreaks occurring within the jurisdiction of the village. It was suggested that the assistant chief might be approached to fill this role. It is important not to make data recording too onerous. A simple but useful set of information about an outbreak might include: date seen, size of larvae, location perhaps in terms of sub-village location names, and crop infested. A separate form needs to be prepared for the assistant chief to use to record outbreak data. ***Countries (Kenya, Tanzania & Ethiopia) each to prepare an outbreak reporting form in consultation with the project team***
2. Investigate the possibility of preparing a small proposal for USAID in case funds are forthcoming at the end of the US financial year in September. ***Roger Day to engage Yenne in the first instance***
3. Produce a CBF flyer / poster to promote CBF to donors and others. ***Wilfred Mushobozi to send selected photos to John Holt to make a first draft of a flyer***
4. Watch out for the new DFID call and circulate details to project team. ***John Holt & Jon Knight***
5. Compile a list of data which would be helpful for the economic analysis. ***Jon Knight to prepare and send to Kenya, Tanzania & Ethiopia***
6. Compile workshop report and circulate. ***John Holt***

Annex 1, List of participants

Abdurahman Abdulahi , DLCO-EA, Ethiopia
Kassahun Bedada, National Armyworm Coordinator, Ethiopia
Roger Day, CABI Africa
John Holt, Natural Resources Institute
Daniel Karanja, CABI Africa
Martin Kimani, CABI Africa
Jon Knight, Imperial College
Francis Musavi, National Armyworm Coordinator, Kenya
Richard Musebe, CABI Africa
Wilfred Mushobozi, National Armyworm Coordinator Tanzania

Annex 2, Workshop Programme

Workshop for the project:

Economic evaluation and international implementation of community-based forecasting of armyworm

A 1-year UK Department for International Development Crop Protection Programme funded project. Annex 1 below details what the project is intended to do.

Programme

1. Overview of the Machakos trial, with some observations on how it went from the official view, and what they might want to do next.

Francis Musavi

2. Details of trial and its evaluation.

Richard Musebe

3. Monitoring and evaluation of the original CBF pilot villages in Tanzania. How are they doing when left to get on with CBF largely by themselves?

Wilfred Mushobozi

4. Overview of the community-based forecasting initiative in Ethiopia and what they might want to do next.

DLCO / MoARD

5. The accuracy of community-based forecasting, are farmers using the rules and any other lessons from the CBF data collected so far.

John Holt

6. Developing an approach to assess the economic value of CBF. What parameters shall we include and what data do we already have that could be used? [This is a discussion session to develop the approach]

Jon Knight (chair)

7. What are the key things that make CBF a success? Can we simplify the scale-up process yet retain the important elements for success? [This is a discussion session]

Martin Kimani (chair)

8. Pool some initial ideas for the development of a proposal for further CBF work that *might* address a future call under the new DFID facility programme (which is intended to take forward work carried out under the current DFID research strategy).

John Holt (chair)

Workshop at CAB International, Nairobi, from 5th to 7th September 2005, starting at 9.30 on the 5th Sept, finishing at lunchtime on the 7th Sept.

Workshop report collated by J Holt from whom copies may be obtained. 30th Sept 2005
Photos on front cover provided by W. Mushobozi.