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74a. MANAGING APPLIED RESEARCH: EXPERIENCES FROM A POST-HARVEST PEST CONTROL PROJECT IN GHANA

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74b. COST-BENEFIT ANALYSIS OF CLIENT PARTICIPATION IN AGRICULTURAL RESEARCH: A CASE STUDY FROM GHANA

Priscilla Magrath, Julia Compton, Anthony Ofosu, and Felix Motte

The two papers in this volume were prepared by members of the same project team, the Ghana Ministry of Food and Agriculture/UK Overseas Development Administration Larger Grain Borer Project. They are therefore presented together although they address different aspects of the work that this project conducted to combat infestation by the Larger Grain Borer (a pest of stored maize).

Paper 74a examines questions relating to research management, a subject which is frequently ignored when discussions of the content of a research project commence. Paper 74b focuses on the costs and benefits of the various different activities within this project, notably the participatory versus the non-participatory elements. It presents a detailed assessment of the relative costs and contribution to meeting project goals of each research activity undertaken. This disaggregation of research activities in turn makes the potential complexity of a project such as this - which in project terms was relatively well-bounded- apparent and thus underscores the need for effective research management and for the lessons presented in paper 74a to be closely observed.

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Cost-benefit analysis of client participation in agricultural research: A case study from Ghana

Priscilla Magrath, Julia Compton, Anthony Ofosu, and Felix Motte

Participatory approaches to research are becoming popular in aid projects and in some national and international research institutes. But while research projects themselves are often subject to rigorous financial and technical appraisals, research methods tend to escape any kind of economic analysis. Although participatory approaches are often adopted for practical reasons, to increase the effectiveness and productivity of research, attempts to estimate net benefits of client participation are rare. One reason for this may lie in the difficulties of applying conventional cost-benefit analysis (CBA) techniques when the benefits of participation are often hard to measure and may be spread over many years. Ideally, one would want to compare a range of projects with similar goals, but varying levels of client participation. In the absence of comparative data from other projects, this paper explores the possibility of assessing the incremental costs and benefits of client participation in research within a single project, the Ghana/UK Larger Grain Borer project. This project included a range of research activities with varying types of client participation. The CBA involves comparing the costs, level of participation and contribution to achieving research goals of each research activity. Overall costs and benefits of client participation are then estimated.

The analysis is useful in highlighting the relationship between choice of research method and achievement of stated research goals. In a world of shrinking research budgets, it is hoped that it will stimulate debate concerning the cost-effectiveness of participatory methods, compared with conventional, research institute-based methods, achievement of wider project benefits, in this case a reduction in farm storage losses. This problem could be addressed through improved monitoring of benefits from individual projects, and through comparative analysis of data from several projects with similar goals.

1 Introduction

Much has been written in general terms about the benefits of client participation in agricultural research (Chambers, 1992; IIED, various), but it is rare to see an economic analysis of the costs and benefits of participatory research as compared to other approaches. Instead, the decision to use participatory methods is usually based on ideological belief or practical reasoning. Ideological reasons for using participatory methods include the feeling that conventional research methods are extractive and therefore unethical, and the belief in the potential for participation to lead to political empowerment. Where this is the case, participation may become an end in itself. Practical reasons for using the methods include the belief that the quality of research will be improved if local knowledge and ideas are incorporated, and that adoption rates of technologies will be higher if the technologies match local requirements.

Cost-benefit analysis (CBA) seems to have been ignored, both as a technique for deciding which research approach to adopt, and in the evaluation of participatory approaches. One reason for this probably lies in the difficulty of applying conventional CBA approaches to participatory research projects, as this paper will explore. There are, however, two main reasons for conducting CBA of participatory approaches. First, estimating overall net benefits from client participation can help research institutions decide whether or not to adopt participatory approaches in their work. Second, it can help researchers to select the most cost-effective method - amongst the many participatory methods on offer - for achieving the stated goals of the research.

Cost benefit analysis for project planning can be broken down into a number of steps: defining the goal or desired outcome of the activity; identifying alternative means of achieving this goal; enumerating the relevant costs and benefits; and measuring and comparing these costs and benefits in order to select the best alternative.

The first problem encountered in a CBA of different approaches to agricultural research is that 'conventional' institute-based research and farmer participatory research may not have the same objectives. The adoption of a participatory approach can lead to changes in the attitudes and goals of researchers, and an accompanying shift in emphasis from the generation of technology to the solving of clients' problems, or to enhancing farmers' ability to tackle their own problems. Even where shared objectives can be defined (for example, to maximise adoption rates), institute-based and participatory projects are unlikely to agree on the definition of all benefits. For example, increased farmer experimentation, or the formation of farmer extension groups might be seen as an output/benefit of a participatory project, but may not be valued or even noticed by an institute-based research project. Since proponents of the two types of research develop their own criteria for assessing success, they naturally continue to view their own research as successful on its own terms.

Even where this problem does not occur and the two 'camps' do reach agreement on the definition of outputs/benefits, these may be hard to quantify. This difficulty is accentuated if benefits are spread over many years. For example, increased farmer awareness of the problem, higher adoption rates for solutions, or greater competence of extension staff to deal with the problem may take several years to secure. Research projects often finish before such benefits become evident.

This paper proposes one way to get around some of these problems. The alternative route which it adopts is to estimate the incremental costs and benefits of participatory activities within a single project, the Ghana/UK Larger Grain Borer Project, by comparing the actual project with a hypothetical alternative without the participatory work, but with the same goals. The Ghana/UK Larger Grain Borer (LGB) Project (hereafter the LGB project) is apt for such an analysis since a wide range of activities were undertaken within the project (including conventional research station-based trials, on-farm trials, and a range of complementary participatory activities) and components of the project can be quite readily disaggregated in the analysis.

The paper is organised as follows. The following section provides an introduction to the approach and activities of the LGB project, emphasising in particular the iterative technology development process and the variety of different activities undertaken which drew both farmers and traders into the research process. Section 3 provides a brief analysis of the types of participation within the project. In Section 4 a cost-benefit analysis is presented in three steps: (i) the relative costs of different research activities are examined; (ii) costs are then related to the level of client participation in each activity and their contribution to achieving research goals; and (iii) an assessment of overall costs and benefits of client participation is then made. Section 5 looks at the costs and benefits of participation from the point of view of the participants, farmers and traders. The final section provides a conclusion and some reflections on the use of participatory research methods.

2 The Larger Grain Borer project

The Larger Grain Borer project was initiated in Ghana in 1993, to assist farmers in combating a serious, new pest of stored maize and dried cassava chips, the Larger Grain Borer (*Prostephanus truncatus,* (Horn)) (see Compton, this issue). LGB was seen as a threat to food security in Ghana, where maize is the most important grain crop and is produced by 70% of all farmers (GSS, 1995). The project included a national awareness and extension programme based in the capital city, Accra, and an adaptive research and extension programme based in the Volta Region, where the LGB problem was at its most serious when the project was designed. The analysis presented here is based on the Volta Region programme.

Project approach

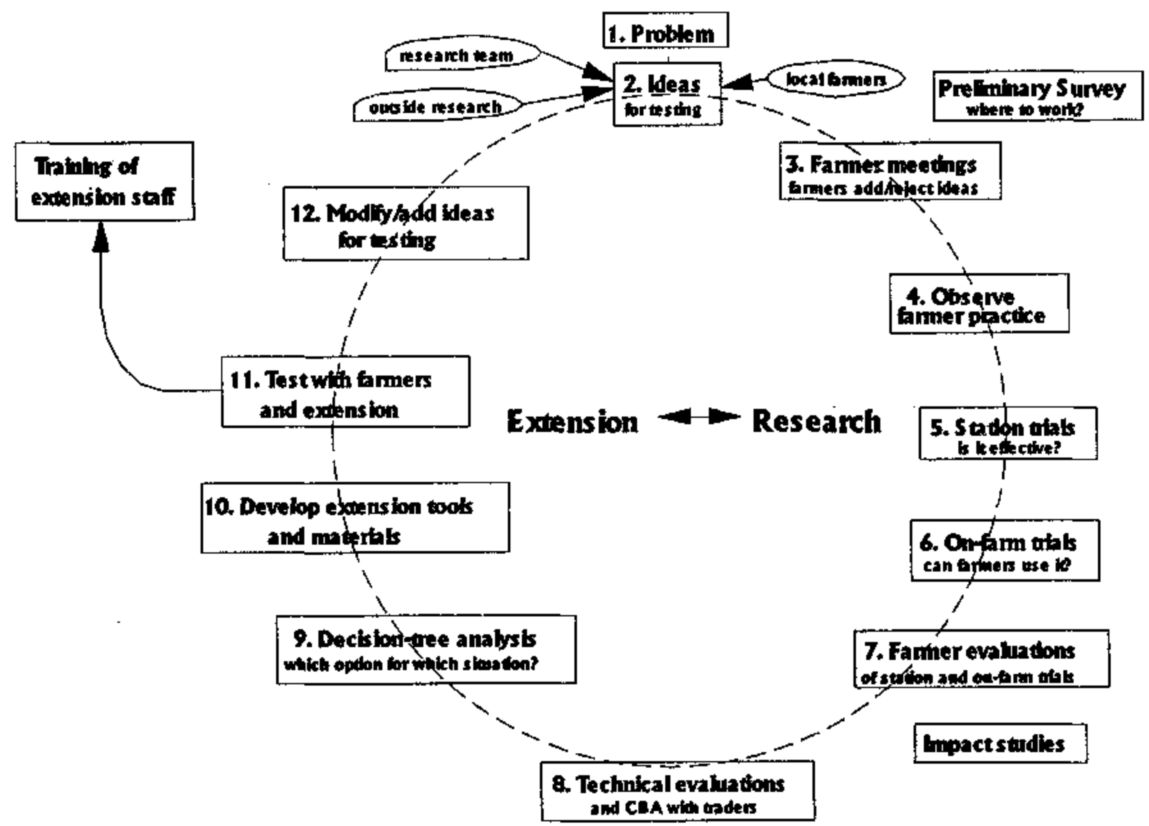
The objective of the LGB project, as laid down in the original project proposal, was 'to reduce post-harvest losses on the farm caused by insect infestation'. This was to be achieved through provision of 'cost-effective and socially acceptable methods of protecting produce against LGB'. Other activities were to: assess the social and economic impact of LGB; raise awareness; monitor the pest; and establish an extension and training programme.

Although knowledge of the local situation was clearly required if technologies were to be 'cost-effective and socially acceptable', the project could conceivably have been implemented with a low level of farmer participation, using, for example, socio-economic surveys coupled with technology development at the research centre. However, the research team aimed for a high level of client participation in the belief that this would increase its success in meeting farmers' needs and in generating high quality research results as quickly as possible. Other salient aspects of the project approach were that the research should be interdisciplinary, should develop close links with extension, and should follow a process approach whereby project objectives and activities would be modified in response to results from previous activities.

The activities undertaken by the project research team contributed to the satisfaction of three inter-related research goals: (i) assessing the social and economic impact of LGB; (ii) developing a range of methods for controlling the pest; and (iii) disseminating research results, mainly through the government extension system.[1] The relation between these activities is illustrated in Figure 1. The figure is intended to show how the project adopted an iterative approach to technology development, involving a cycle of experimentation and consultation.

Stage 1 of the cycle was the definition of the problem for research, in this case how to control storage losses from LGB. A rapid, preliminary survey was undertaken to assess the distribution and impact of the pest, and thereby to define priority work areas. The second stage involved the generation of ideas for testing. These came from previous research in other countries and from the research team, farmers, extension staff and others. They were refined through farmer meetings (stage 3) at which farmers were invited to describe their experiences with LGB and any control measures they had tried or heard of. Project ideas were then explained and participants were asked to rank their preferences for control methods, using local materials displayed on the ground. Stage 4, observation of farmer practice, took

Figure 1. The research-extension cycle



Used by Ghana/UK Larger Grain Borer Project. (After J Compton, 1995) place in tandem. An interdisciplinary team spent one week in each of seven villages during the maize harvest of 1993, observing, joining in, and discussing harvest and storage practices. The aim was to investigate how new control methods could build on and be integrated into current practice.

Testing of these ideas was done through formal station trials (stage 5) to assess effectiveness, and for the most promising treatments, through on-farm trials (stage 6). These allowed the team to assess popularity and practical problems of application under farmers' conditions. For the station trials, farmers from nearby villagges were invited to the station, and were presented with samples of maize from each trial treatment. They were asked to de-husk the maize, sort it as they would their own maize, and then rank and score the samples. In the on-farm trials volunteer farmers selected a treatment for their maize store, and applied it under project team supervision. Results of both on-farm and station trials were monitored by both farmers and the research team. One advantage of farmer evaluations was that results from them could be fed immediately into the next trial, whereas statistical analyses of data from researcher evaluations were not available until much later.

Maize traders were also involved in evaluating trial results (stage 8). Samples from each trial treatment were sorted into damage classes, then maize in each class was shelled. The maize traders were presented with the shelled maize samples and asked to price them, as they would maize in their local market on that day. The data was used in cost-benefit analyses of the trials (Magrath and Compton, 1995). In addition to control methods tested via station and on-farm trials, the project managed the release and monitoring of a biological control agent in conjunction with farmers (see Box 1).

Steps 9—11 involved working with the extension services (see Compton, this issue, for details). Decision-tree analysis was used to examine circumstances under which particular options for controlling LGB would be appropriate, as well as to identify gaps in the research (step 9) (Feakpi et al, 1994; Feakpi, 1996). Different ways of presenting this information, including decision trees, tables of options, and texts using short sentences, were tested with farmers and extension staff (steps 10-11) (Compton, Mode and Addo, unpublished data)). Step 12 involved the modification of practices to be incorporated into the following season's cycle, based on ideas generated during steps 1-11.

This approach to technology development can be contrasted with a typical, research institute-based approach, in which the focus is on technology development through formal trial programmes, with little input from the end users. The research process in this case tends to be linear, rather than cyclical, as illustrated in Figure 2. With less feedback from outside the research station there is less pressure for continuous modification, and researchers tend to come up with fixed 'packages' which are then handed over to the extension service to be recommended to farmers. This approach to research and extension remains more common than farmer participatory approaches, despite the fact that farmer uptake of the resultant packages tends to be low, and restricted to better-off farmers, since the packages fail to match the diversity of conditions and situations and the poor resource base of the majority of farmers in developing countries (Farrington, 1995; Compton *et al,* 1995b; Compton, this issue.)

Assessing the social and economic impact of LGB

Researchers commonly assess the impact of new storage pests by attempting to answer the following question (often implicitly rather than explicitly formulated): 'what are average weight losses in farm stores before and after the arrival of the new pest?' The estimated increase in losses is then used as a justification for implementing research programmes to reduce losses.

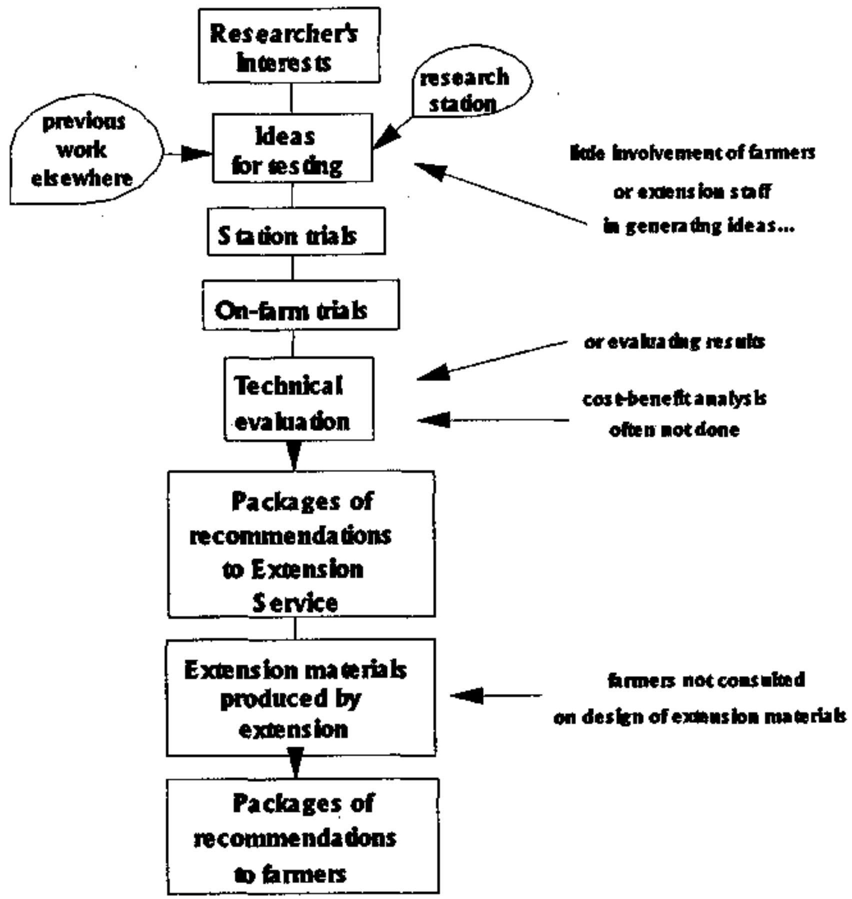
One problem with formulating the question in this way is that it can only really be answered through the implementation of an expensive large-scale random survey. More seriously, answering this question may not help in making policy decisions. For example, it is implicitly assumed that farmers passively accept losses from new pests rather than taking action to minimise them, which is what they in fact do (Motte *et al,* 1995). Furthermore, weight loss, the measure

Box 1. Farmer participation in classical biological control

The LGB project managed the release and monitoring of a biological control agent, *Teretriosoma nigrescens,* commonly referred to as Tn. This was a classical biocontrol programme, since Tn is a natural enemy of LGB from its place of origin (Central America).

Tn had been released in several other African countries, most recently in neighbouring Togo, though the Ghana LGB project undertook more detailed monitoring than had been done previously in Africa. The monitoring programme involved farmers as collaborators, which is relatively unusual for biological control programmes (Addo et al, 1995). Farmers were involved in: preliminary meetings to discuss the release, in which many farmer concerns were raised; setting insect traps to monitor levels of Tn and LGB (this job was done by extension staff or post-harvest officers in some villages); and monitoring of LGB and Tn levels in stores (20 farmers in each of 20 release and 20 non-release villages were involved). Benefits of farmer collaboration were that: (i) farmers' enquiries generated new research questions concerning the best time and place for Tn release to achieve maximum survival rates; (ii) farmers helped conserve insects by not using insecticides which kill Tn but not LGB; and (iii) farmers looked after monitoring traps, instead of destroying them.

Figure 2. A conventional research-extension set-up



most commonly used, often shows a poor relationship to loss in market value, which is the more relevant concern for policy decision-making. The whole question of the risk of pest attack is also not addressed by this question, although it is a very important parameter in decision-making about pest control.

Under the LGB project, the research problem was reformulated as follows: 'For whom is LGB a real problem? Is intervention needed on behalf of these farmers?' This question was addressed through a number of related studies including: the preliminary survey, mentioned above; a detailed *Study of Losses and Decision-Making,* on-farm cost-benefit analysis; two related market studies, which aimed to estimate the economic value of on-farm losses; and focus group meetings on the wider impact of LGB on the community. These studies are explained in more detail below. Results from them fed into the technology development and extension cycle at various points.

Study of Losses and Decision-Making

The objectives of this study were: to assess losses in farmer maize stores from LGB and other factors; to assess the economic impact of losses and farmer responses to LGB infestation; and to examine factors affecting the risk of LGB attack. Since these questions required detailed analysis of individual cases it was decided to work with a relatively small sample of farmers. About 10 volunteer farmers from each of five villages with a history of LGB infestation were invited to join the study. These farmers were visited on a monthly basis to discuss problems (based on a questionnaire) and to observe and make a rapid loss assessment of their stores.

Most sample maize stores consist of cob maize, neatly stacked in rows on a platform, with the base of the cob visible from the outside. One way of assessing losses is simply to observe the outer wall of cobs for signs of damage. In this survey, if the farmer had already started removing maize for the family's use, a second method was used, involving removal of a sample of 20 or 30 cobs from the store (the cobs were returned to the farmer after assessment) (Compton and Sherrington, forthcoming a,b). To counter any bias in the volunteer sample, a further 20 farmers from each of the same five villages were selected to participate in the study, using a semi-random method (based on a transect walk through the village). Since these farmers had not volunteered to participate in the study, only short visits were made to them during which stores were inspected for insect damage (but samples were not removed) and a more limited set of questions about decision-making was asked.

Cost-benefit analysis of farm storage

In the CBA of farm storage, the objective was to assess the damage level and market value of a small number of case study stores on the day upon which the stores were dismantled (farmers in contact with the project were asked to notify the team when they planned to take down their store). Research team members spent up to a full day with farmers. Questions asked included why the owner had decided to remove the maize from store that day (was insect infestation a factor?); whether the level of loss was acceptable, and how farmers sort and use good and damaged maize.

Market studies

The two market studies both aimed to estimate the relationship between insect damage and market price, in order to assess the financial losses to farmers of insect damage in their stores. In the market survey seven markets were visited and samples of good and damaged maize were bought from traders for laboratory analysis. In the trader panel study, groups of traders from four markets were presented with pre-prepared samples with different quality characteristics and were asked to assess their current market (Compton *et al.*, forthcoming c). Trader panels were organised, roughly one per quarter, from June 1993 to June 1994.

Focus group meetings on the impact of LGB

The aim of these meetings was to provide information on the wider social and economic impact of LGB in the community. Focus group meetings were held in the villages and markets included in the above studies. Farmers produced causal diagrams showing the implications for families and communities of serious LGB infestation. Traders produced calendars showing patterns of supply and demand and the incidence and impact of damaged maize in the markets.

3 The nature of participation in the project

'Participation' has become a label which brings credibility to those working to reduce poverty in developing countries. It has even been suggested that research proposals which do not include a reference to participation are less likely to secure funding (Richards, 1995). This may be one reason why the term tends to be used loosely and can refer to anything from people's presence at a meeting to their political empowerment through gaining real control of development processes. It is therefore important to define what we mean by participation.

The nature of participation within the LGB project was determined by the main objectives of the research team in adopting a participatory approach, ie. to focus on the problem, and to generate good results fast. This fits what Farrington and Nelson (1997) has described as a 'functional approach' to participation, which is more common in government programmes, as opposed to the 'empowerment approach', which tends to be more common with NGOs working for community development. The nature of participation also varied with the activity in question. Because of this it will be useful to draw on classifications or categories of participation developed by others, to avoid confusion. A number of schema have been developed (Okali *et al*, 1995, pl 20ff), including that developed by the World Bank Learning Group, which is useful for comparing specific activities, since it describes what each party participating in the activity does (Paul, 1986).[2]

Paul (1986) describes four stages which entail increasing levels of participation: information sharing, consultation, decision-making and initiating action. Table 1 uses a modified form of this schema to describe participation in LGB project research activities. Since every activity incorporated elements of information sharing, this category is not denoted. Instead, two levels of consultation are distinguished - a superficial level (single symbol), such as is achieved in short, one-off interviews, and in-depth consultation (double symbol), which could include intensive focus group meetings lasting a couple of hours, or repeated contact over a period of time, such as in the monthly *Study of Losses and Decision-Making,* or the monitoring of the biological control agent, Tn. Activities through which farmers influenced decision-making are shown by a triple symbol. Such influence was evident in: the selection of trial treatments; the design of trial methods; making recommendations to the extension service; and the design of extension materials (Feakpi et al, 1994, Feakpi, 1996). The degree of participation in research activities is discussed in more detail in Section 4.

An important feature of client participation in the project was that it began early and continued throughout the duration of the project. There was no period during which no participatory work was being done. This contrasts with other programmes which have involved clients only at certain stages in the project, such as at the beginning (diagnosis) and at the end (evaluation) (Farrington, 1995).

4 A Cost-Benefit Analysis of participation in the Larger Grain Borer Project

This section proposes a method for assessing the costs and benefits of participatory research, using the Larger Grain Borer project as an example. The CBA consists of three steps:

(0 comparing the relative costs of each research activity;

(ii) relating these costs to two factors: the contribution of each activity to achieving research goals and the level of participation in the activity;

(iii) grouping together all participatory activities, and assessing their overall impact on the costs and benefits of the research.

Relative costs of research activities

Table 2 shows the relative costs of the research activities undertaken along with their purpose and intended benefits. These are grouped according to the two main research goals: (i) assessing the social and economic impact of LGB; and (ii) developing a range of options for control of LGB. The third goal of disseminating research results is not included in the CBA.

In a cost-benefit analysis costs are generally broken down into: (i) investment costs, including site preparation (for example, office refurbishment) and capital costs (such as vehicles and equipment); and (ii) operating costs, which are incurred only once the project has started. Operating costs are in turn divided into fixed costs (such as staff salaries and project management costs) which are incurred regardless of activity levels, and variable costs (such as for materials used in trials), which increase directly with the level of activity (Irvin, 1978). Investment costs and fixed operating costs are not included in Table 2 since it is difficult to apportion their use between the various activities. However, vehicle costs are reflected in the data provided on distances travelled, and staff costs are reflected in the number of days' work involved.

The variable portion of operating costs are shown in the table as 'variable cash costs.' According to Table 2, station trials incurred the highest variable cash costs of all the activities. The cost of the maize, store construction and maize treatments came to almost 55 million cedis (£5,500), 60% of total cash costs for research activities. Station trials are not in themselves participatory, but in the project station trials were complemented by five activities involving client participation: (i) farmer meetings; (ii) observation of farmer practice to develop ideas for trials; (iii) on-farm trials for treatments which station trials had shown to be promising; (iv) farmer evaluation; (v) trader evaluations of station trials. These activities were relatively low cost, adding just over 1 million cedis, thereby increasing the costs of the experimental programme by 20%.

The research activity which incurred the second highest variable cash costs was the *Study of Losses and Decision-Making,* the main study of social and economic impact undertaken by the project. This cost 1.8 million cedis (£1,800), mainly accounted for by staff overnight subsistence payments. Other impact studies cost considerably less. Together, the preliminary survey, milling survey, cost-benefit analysis of on-farm storage, focus group meetings and two market studies added just over half a million cedis, increasing the costs of impact studies by 31%.

Table 1. Assessment of the level of participation, contribution to achieving research goals and relative costs of activities of the LGB project, Ghana

Activity	Frequency of contact	Number of villages/markets	Level of participation	Contribution to research goal	Investment (cash, time)
GOAL 1: Assessing the impact of LGB					
Preliminary survey • of farmers • of extension staff	 Single visits Once/year	 36 villages 100 staff 500 villages	 @ @@	 ** **	 $$ $
Losses studies • monthly • farmers' CBA • milling survey	 Monthly visits Single visits 4 visits	 5 villages 15 farmers 4 villages	 @@@ @@ @	 **** *** *	 $$$$ $ $
Impact meetings • with farmers • with traders	 Single visits Single visits	 5 villages 4 markets	 @@ @@	 * *	 $ $
Market studies • market survey • trader panels	 Weekly visits 5 visits	 7 markets 4 markets	 @ @@	 *** *	 $$ $
GOAL 2a: Developing a range of methods for controlling the pest: generating ideas for testing					
Review of secondary literature	-	-	-	*	$
Meetings with other researchers	Irregular but frequent	Various	-	**	$
Exploratory farmer meetings	Single visits	10 villages	@@	*	$
Observations of farmer practice	Single visits	5 villages	@@	*	$$
Monthly farm visits: • Losses survey • On-farm trials	 Monthly Monthly	 5 villages 15 villages	 @@@ @@@	 *** ***	 $$$$ $$
Farmer visits to research station: • Farmer evaluations • Best farmer visits[†]	 Single visits Single visits	 10 villages Various	 @@@ @@	**	$
GOAL 2b: Developing a range of methods for controlling the pest: testing technologies					
Station trials	-	-	-	****	$$$$
Farmer evaluation of station trials	Single visits	10 villages	@@@	**	$$
Trader evaluation of station trial results	Single visits	4 markets	@@	*	$$
Rapid assessment method to evaluate station trials	-	-	-	*	$
On-farm trials		15 villages	@@@	**	$$
Tn release and monitoring	Monthly	40 villages	@	**	$$

[†] Best farmer awards are given at the annual Farmers' Day rallies, held in each district and region of Ghana. The project awarded study tours of the project, including station trials, as prizes. Best farmers were often those with greater access to resources. They sometimes had interesting ideas, based on their own experimentation and observations.

Key

@	= inform, superficial consultation	$	= < 100,000 cedis and < 100 days
@@	= in-depth consultation	$$	= > 100,000 < 0.5 million cedis and > 100 < 500 days
@@@	= clients contribute to project decision-making (not necessarily decision-making in the specific activity)	$$$	= > 0.5 million < 1 million cedis and > 500 < 1000 days
		$$$$	= > 1 million cedis and > 500 days

NB: US$1 = 650 Ghanaian cedis

Table 2. Intended benefits and estimated costs of research activities of the Larger Grain Borer Project, Ghana

Activity (1)	Purpose	Intended benefits to project	Estimated costs of research activities						
			Description of cash costs	Variable cash costs 1993 cedis (2)	Cash costs as % of total	Project personnel days (3)	Personnel days as % total	Distance travelled (km) (4)	km travelled as % total km
GOAL: ASSESSING THE SOCIAL AND ECONOMIC IMPACT OF LGB									
Preliminary survey	Define priority work areas	Research focused on the problem	Subsistence	221,354	2.5%	128	3%	7,000	7%
Losses studies Survey of losses and decision-making	Understand on-farm losses and decision-making	Assess benefit of technologies; better recommendations; predict adoption	Subsistence; annual gift to farmers	1,794,351	20.0%	1,155	31%	32,900	35%
Cost-benefit analysis of farm storage	Estimate value losses in farm stores	Assess benefit of technologies	Sample bags	6,000	0.1%	30	1%	450	0%
Milling survey	Understand type/ quality of staple foods eaten	Assess impact of LGB on maize consumption	None	0	0.0%	20	1%	800	1%
Impact meetings Farmers and traders	Understand impact on family and community	Understanding the problem	Refreshments	20,739	0.2%	33	1%	1,820	2%
Market studies Market survey	Understand quality-price relationship	Assess economic value of losses	Sample bags; samples	84,951	0.9%	375	10%	11,180	12%
Trader panels	Understand quality-price relationship	Assess economic value of losses	Refreshments and payments	230,793	2.6%	140	4%	1,400	1%
GOAL: DEVELOPING A RANGE OF OPTIONS FOR CONTROL OF LGB									
Station trials (incl. technical evaluation)	Test efficacy of technologies	Better adoption of technologies	Maize store treatments	5,431,347	60.4%	730	19%	9,731	10%
Exploratory farmer meetings	Develop ideas for trials	Research more relevant to farmers	Refreshments	80,431	0.9%	37	1%	1,200	1%
Observe farmer practice	Fit technologies to local practice	Faster adoption	Subsistence	425,068	4.7%	74	2%	1,340	1%
Farmer evaluation of station trials	Undertake rapid assessment and test popularity	Future research more relevant	Refreshments and payments	243,484	2.7%	66	2%	630	1%
Trader pricing for CBA of trials	Conduct CBA of trial treatments	Better recommendations	Refreshments and payments	177,894	2.0%	99	3%	549	1%
On-farm trials	Assess on-farm viability and popularity of treatments	Better recommendations	Treatments	176,274	2.0%	260	7%	16,000	17%
Biological control	Release and monitor biol. control agent	Reduce impact of LGB	Leaflets	100,000	1.1%	628	17%	10,000	11%
TOTAL FOR ALL RESEARCH ACTIVITIES				8,992,684	100.0%	3,775	100.0%	95,000	100.0%
TOTAL STATION TRIALS				5,431,347	60.4%	730	19.3%	9,731	10.2%
TOTAL PARTICIPATORY ACTIVITIES				3,561,337	39.6%	3,045	80.7%	85,269	89.8%

Notes

(1) Extension and training work is excluded.

(2) Costs are in Ghanaian cedis. £1 = 1,000 cedis, US$1 - 650 cedis, deflated to 1993 rates using the consumer price index for food for maize costs and that for non-food items for other costs.

(3) Personnel time excludes project management and administration.

(4) Activities aimed to cover all agro-ecological zones in which LCB was a problem.

Costs for these covered materials, such as sample bags, refreshments for participants, and payments for traders who priced maize and for farmers who evaluated station trials (a task involving de-husking and sorting sacks of project-owned trial maize).

Activities with the highest cash costs were not always the most time consuming. The *Study of Losses and Decision-Making* required the most time, using 1,155 staff days, or 31% of the total. Station trials used about two thirds of this, and biological control just over half. The market survey and on-farm trials were the next most time consuming activities.

Relative contribution to achieving research goals

Table 2 shows that the costs of different activities varied widely, with the cheapest costing less than 1% of the most expensive and using only about 3% of the time required for the most time consuming activity. Did the most expensive studies contribute most to achieving the research goals? What impact did the level of participation have on the cost-effectiveness of the activity? For answers to these questions we must refer back to Table 1.

In Table 1 cost-effectiveness is assessed in relation to the two research goals: (i) assessing the social and economic impact of LGB; and (ii) developing a range of options for control of LGB. This second goal is split into two stages. First, generating ideas for testing and second, testing itself. A system of symbols is used to grade each research activity in terms of: (i) level of participation; (ii) contribution to research goal; and (iii) investment required (combining both cash and staff time costs). Unlike costs, contribution to research goals and level of participation are neither quantifiable nor objectively verifiable, which means that the results and conclusions are open to debate. However, the exercise is useful as it makes relationships explicit, and offers them in a format which encourages debate about the relative cost-effectiveness of different research methods.

For the first goal, assessing the social and economic impact of LGB, it is suggested that the *Study of Losses and Decision-Making* made the greatest contribution, followed by the preliminary survey and market studies. Why was the losses study more successful? Monthly visits to farmers and their maize stores proved to have many advantages. Regular farm visits allowed the team to build personal relationships with each farmer, and much was learned through the resulting open discussions. Monthly visits were also crucial to understanding the storage process. Since stores can be constructed and dismantled at any time, much would be missed if visits were only occasional or random. Monthly visits also allowed the team to build up a picture of how farmers' storage decisions change in response both to what is happening in the store and to other factors, such as changes in market prices and the family situation. None of this would have been revealed from one-off meetings. Thus, although this survey was the most expensive project activity, it was nevertheless considered to have been cost-effective.

Studies involving monthly visits also generated most ideas for testing, for similar reasons to those outlined above. Many ideas came from incidental remarks made during discussions with farmers who knew the research team well. Conversely, one off meetings, such as the focus group meetings on LGB impact, and meetings to test ideas, contributed least to achieving research goals. This was because it proved very difficult to assess the value of information from such one-off meetings. First, it is hard to assess whether the gathered group is representative of the wider community. Second, information given can be hard to interpret. Tools developed to tackle this problem often compound the problem of interpretation, since the tool is unfamiliar to participants (IIED, various). 'Results' in the form of diagrams often give a false sense of truth, and are sensitive to the way in which the exercise was explained (Magrath *et al.*, 1996b). Thus, in the experience of this team, results from such rapid participatory appraisals need to be backed up by observation, or to be fed into other, longer term activities. They . are more useful early in research programme, since they can raise issues which can later be pursued in more depth using other methods.

Many of these points can be illustrated through a comparison of results from the monthly *Study of Losses and Decision-Making* and the one-off focus group meetings to discuss LGB impact. Both studies aimed to increase understanding of the social and economic impact of LGB, but each used different methods and generated different types of result.

According to the focus group meetings, losses from LGB led to: (i) loss in income leading to failure to pay school fees; (ii) hunger; (iii) shortage of maize seed next season; (iv) a tendency to move away from maize cultivation; and (v) social disgrace, as farmers failed to fulfil social obligations (see Magrath *et al*, 1996a for more details). The impression from these meetings was that LGB had had a very big social and economic impact. But how could we tell whether people were exaggerating, or what proportion of farmers were really affected in the manner suggested?

According to the *Study of Losses and Decision-Making*, 72% of case study farmers, who were selected from five LGB infested villages, had experienced LGB attacks in a year of high LGB incidence (the first year of the study). These farmers lost between 15% and 45% of the market value of their maize, representing up to 5% of average household incomes (see Box 2). About 20% of case study farmers had had to buy *maize*, because LGB had damaged their household stocks. Others substituted cassava for maize in their diet.

Box 2. How big are the losses caused by LGB?

According to the *Study of Losses and Decision-Making*, 47% of the case study stores visited over four storage seasons from 1993-5 had LGB. These farmers suffered losses consistently higher than those whose stores had only indigenous pests. Results from 96 case study farmers showed that the most common local pest, the maize weevil, gave rise to losses in the market value of the maize of between 5% and 10%, while value losses from LGB ranged from 15% to 45%. The resulting level of financial loss would be equivalent to about 5% of average total household expenditure

These estimates, however, are likely to understate the full financial impact of LGB since they do not account for the **timing** of the pest attack. Value losses were measured by comparing the current market value of the damaged maize with the current value of equivalent samples of good quality maize. However, since the seasonal variation in maize prices in Ghana is very high, with pre-harvest prices as much as three times their post-harvest low in some years, the financial loss to farmers depends crucially on **when** LGB enters the store, as illustrated in the following example.

Alfred noticed that the damage level in his major season store was higher than usual. Having stacked the maize in September 1993, he decided to take the store down in January 1994, after only 4 months of storage. Like many farmers in Papase, a maize surplus area in the forest zone, he had originally planned to keep the maize for sale in the lean season (June-July).

The LGB project team estimated value losses to be 30% at this time, because of the high levels of both LGB and weevils. This meant that Alfred would receive only 70% of the current price for good maize, (6,500 cedis), if he sold the maize immediately. But prices then increased, reaching their peak in July at 15,000 cedis per 100kg bag. Alfred's income in January was, then, only 35% (70% x 50%) of the income he could have earned from selling at the peak price, as he had planned. Although he would have incurred further storage costs by storing until July, the estimate of 30% value loss underestimated the full financial impact of LGB damage.

About half the case study farmers who had LGB in their stores dismantled the store earlier than planned, and many of these subsequently sold the maize to avoid further damage.

Source: Magrath *et al*., 1996.

The monthly survey helped place results from the focus group meetings into perspective. It appeared that these meetings were exaggerating impact, or suggesting effects which applied to a small proportion of farmers. This may have been because of the way the exercise was explained to participants or due to the failure on the part of researchers to probe further and to assess the incidence of the suggested impacts.[3] However, on the positive side, the meetings did raise issues not covered explicitly in the monthly study, such as the shift out of maize production, the shortage of seed, and the risk of social disgrace if maize stocks were destroyed. These could then be explored through other studies.

The focus group meetings were always intended to be complementary to the *Study of Losses and Decision-Making*, with each providing a cross-check against the other (a form of 'triangulation'). However, the conclusion is that the meetings on their own could contribute little to the research goal, because of doubts over the validity of results. Only in combination with the long term monthly survey did the results prove useful.

What about the relationship between levels of participation and the contribution of each activity to meeting research goals? Focus group meetings on LGB impact and meetings to test ideas for control appeared very participatory, with everyone contributing enthusiastically to the discussion. However, the long-term activities, such as the monthly losses study and the on-farm trials, actually provided more scope for farmers to influence project decision-making, in terms of, for example, providing ideas for trial treatments (losses survey), or suggestions for modifying treatment application methods (on-farm trials). Monthly visits allowed time for farmers to develop their ideas and to gain confidence in discussing them with the research team. However, it should be pointed out that participants were never given the scope to design or manage research activities directly as in other farmer participatory research projects. Rather, their ideas and experiences fed into the research team's planning process.

In conclusion it can be said that long-term studies, although more expensive, not only contributed more to achieving research goals, but also provided greater scope for more meaningful participation in the project than rapid participatory appraisals. For the first goal (assessing LGB impact), activities with higher levels of participation tended to contribute more to achieving research goals. They also generated more ideas for control methods. However, when it came to the third goal of testing technologies for LGB control, the station trials, which did not involve clients directly, contributed most. Despite the wealth of information gleaned from on-farm trials and observation of farmer practices, none of the recommendations made by the project team could have been made with confidence had the station trials not taken place. It is important to note, however, that this observation may be specific to the LGB project; station trials will not always provide an appropriate means for testing technologies, especially where on-farm conditions cannot be replicated at the research station.

Overall costs of participatory research

We have seen that most research activities under the project involved farmers or traders to some extent, but that the level of participation and also the cost-effectiveness of these activities varied widely. However, for comparison with other projects which may involve very little client participation, it is useful to group all activities involving farmers and traders together, and to examine the overall impact of client participation on the costs and benefits of research. In order to do this, project activities must be split into station trials (no client participation) and 'other participatory activities'; the bottom line of Table 2 shows the relative costs of each of these, split into components. While the cash costs of station trials accounted for more than 60% of total cash costs, staff time spent on 'other participatory activities' was four times that used in the station trials, while distances travelled were nine times greater.

Not all costs are detailed in Table 2. A programme involving only station trials is likely to incur lower transport costs, since there would be little or no field work. However, to counterbalance this, equipment costs are likely to be higher. Laboratory-based analytical methods often require more expensive equipment than rapid, field based participatory techniques. Rapid field-based loss assessment in the LGB project required only a set of standard photographs illustrating the visual scale, a white tray on which to count insects, a standard form, a clipboard and a pencil. The method does, however, rely on previous calibration of the visual scale against more conventional techniques (Compton and Sherrington, 1996 a, b). The method also reduces the costs of verifying data, since this can be done on the spot, together with the store owner. When laboratory based methods are used, faulty data either have to be rejected or require further follow up visits at additional cost (see Compton, this issue). Project management and administration is, on the other hand, likely to be more complex and time-consuming for participatory projects, because of the increase in the number and types of institutions involved. Training costs may also be higher if, as with this project, all staff are trained in a wide range of skills, including not only analytical and laboratory methods, but also communication skills, interviewing techniques and simple presentation of research results.

Overall benefits of participation in the Larger Grain Borer project

In the opinion of the research team, client participation was crucial to achieving project objectives, and greatly increased the productivity of research. As mentioned in a companion paper (Compton, this issue), by the end of the project, the team was able to recommend a range of different options for controlling LGB in farm stores. Farmer input was instrumental in the development of 9 of these. Farmer participants also contributed directly to the release and monitoring of the biological control agent, Tn, and in the development of extension materials covering all control measures. Both farmers and traders contributed to the assessment of on-farm storage losses, and their social and economic impact, and to assessing cost-effectiveness of recommended treatments.

From the point of view of researchers on the team, interaction with farmers and traders made a concrete contribution to the development of popular and cost-effective technologies in the following ways:

(i) New ideas for possible control methods were suggested by farmers. For example, some farmers were found to be covering their maize stack with plastic sheeting to provide a barrier against insect attack. This was tried in station trials and subsequently included in a recommendation to farmers.

(ii) Ideas for testing were evaluated by farmers (for example, one idea for LGB control, the use of a local week, acheampong, was dropped after farmers rejected it as too poisonous). This can save costs in testing technologies which will not be popular (although there is a risk that potentially popular ideas will be rejected because a few farmers who happen to have contact with the project do not like them).

(iii) Farmers evaluated station trial set-ups, to ensure that conditions matched those on farms as closely as possible. This is a crucial contribution, since resources will be wasted if trial conditions are so different from the farm as to render results useless (de Villiers, 1996);.

(iv) Observation of the environment in farmers' stores led to an improved understanding of LGB infestation and its relationship to farmer behaviour. For example, the importance of carry-over infestation (whereby newly stored maize rapidly becomes infested with LGB which has remained nearby in storage structures or other materials), became clear from observation of the same storage platforms, in the same locations over several seasons. It would have been hard to examine this phenomena through trials based at a research station.

(iv) Assessment of losses was done in a more meaningful way. Understanding maize losses from the farmer's point of view helps determine the importance of the problem, and how keen farmers are to take action. Also, farmers' methods of sorting and valuing maize can be incorporated into cost-benefit analyses of technologies being tested, providing a better guide to cost-effectiveness and popularity than standard loss assessment techniques.

(v) Continuous interaction kept the team aware of the urgency of finding solutions to the LGB problem (see Compton, this issue).

While the specific benefits will vary with the research programme, the above points are likely to be fairly general to problem-oriented agricultural research projects.

Box 3. Model to estimate the relationship between adoption rates and reduction in losses (savings)

Assumptions

Scenario	Scenario 1: High risk of LGB	Scenario 2: Low risk of LGB
Probability of LGB in Volta Region	50%	33%
If LGB, % maize crop affected	40%	30%
Value loss from LGB infestation	30%	15%
Average maize production in Volta Region, 1992–94 (tons)	56,290	56,290
Maize price (cedis/ton)	100,000	100,000
Treatment cost as % maize value	8%	8%

Estimates

Average proportion of annual production affected	20%	10%
Value loss if no action taken	6%	1.5%
Savings if 1% of farmers adopt control measures	0.06%	0.015%
Savings net of treatment costs	0.055%	0.014%
Cash savings for % adoption (cedis)	3,107,208	769,034

This said, the ultimate aim of the project was not to conduct research as an end in itself, but to assist farmers in reducing losses from LGB in their maize stores. This is, therefore, a standard by which the project might be judged. Measuring the project's contribution to reducing losses is, however, complicated for a number of reasons. First, some farmers may take action to control LGB with no input from the project. According to the *Study of Losses and Decision-Making,* 45% of case study farmers had made changes to their storage practices in an attempt to control LGB. Some were influenced by their interaction with the project, while others were experimenting with their own ideas, often existing practices used against indigenous pests, most of which were ineffective (see Compton, this issue).[4] A second reason why the project's contribution to limiting losses is difficult to measure is that the incidence of LGB may fall for reasons not related to farmer behaviour, such as climatic factors.

If, though, the project did lead to an increase in adoption rates of measures to control LGB, how much maize might have been saved?

Information from project surveys and other sources can be used to model the relationship between adoption rates and financial losses. Box 3 shows one possible model for doing this. For simplicity, the model is for Volta Region only, since this is where the research work was concentrated. The project also had a national component, and a similar exercise in impact assessment at the national level has been published elsewhere (Magrath, 1996).

Two scenarios are illustrated: one which assumes 'high' risk of loss, the other 'low' risk. In the high risk model it is assumed that LGB attacks Volta Region every two years and that, when it attacks, 40% of stored maize is at risk. Thus, over a period of two years, 20% (50% times 40%) of the maize crop is at risk. Estimates from project surveys suggest that if no action is taken, maize attacked by LGB is likely to lose about 30% of its financial value. This means that, with no action, the maize crop suffers a 6% value loss (30% loss for the 20% of the crop at risk). However, farmers with experience of LGB are likely to take action. Let us assume that LGB attack is equally distributed among small and large stores. Then the 20% of the maize crop affected belongs to 20% of the farmers. Every 1% of affected farmers taking effective action reduces overall maize value losses by 0.06% (6% times 1%). The average cost of controlling LGB (using one or more of the project recommendations) can be estimated as about 8% of the maize value. So savings net of treatment costs would be a little less, around 0.055%.

Average maize production for Volta Region from 1992-4 was 56,290 tons, which was worth 5,629 million cedis at average 1993 prices. Thus, a 1% increase in farmer adoption rates would save 3.1 million cedis (0.055% of 5,629 million) per year. Total project costs for the Volta Region component were about £740,000 or 740 million cedis. If the project increased adoption rates by 20%, then this would pay back the project costs in 12 years. An adoption rate of 40% would pay back in 6 years.

Using the lower estimates (LGB attacks every three years, 30% of the maize crop is at risk each attack, and losses for an LGB infested store with no action are 15%) savings would be only three quarter of a million cedis per year, giving a 24 year pay back period if adoption rates increase by 40%.

What then is the likely increase in adoption rates due to project activity, and what was the contribution of the participatory approach? Post-harvest officers and extension staff were asked to make estimates of adoption rates with and without the LGB project activities for all regions of Ghana (Magrath, 1996). They estimated that, in the absence of participatory LGB project activities, 20% of farmers in Volta Region who were at high risk from LGB would adopt LGB control measures. In the presence of the project, adoption rates would increase to 30% after one year and 60% after four years. Thus, by the year 2,000, the project would have increased adoption rates by 40% over the 'no project' alternative. If the assumptions of the model described above are accepted, then the resulting reduction in losses would cover project costs in 6-24 years (depending on which LGB risk scenario is taken).

Although a direct comparison is not possible, the research team believes that current and future adoption rates would be considerably lower if the project had not involved fanners, traders and extension staff in a participatory approach. About 4,000 farmers and traders, representing 1.3% of all households in the region, had some contact with the project. Perhaps because LGB was considered by farmers to be a serious problem, information about methods of control tended to spread fast. About a quarter of case study farmers in the *Study of Losses and Decision-Making* were using project recommended control measures by the second year of the study, even though the team aimed to observe, rather than change farmer practice through this study.

Other farmers mentioned learning of control methods from extension staff, who were trained regularly by the project as new experimental results became available. Post-harvest officers working in regions of Ghana in which LGB was a problem but the research programme was not active observed lower rates of adoption of LGB control measures.[5] They believed that adoption rates would increase if similar participatory research activities were undertaken. However, continuous monitoring of actual adoption rates would be necessary to confirm the assertion that project activities have had a sustained impact. In addition, comparison with projects which are less, and more participatory is needed to confirm that rates of adoption are higher when client participation in research is high.

Finally, it must be mentioned that involving clients in research also has its disadvantages from the point of view of agricultural researchers. A well documented problem, also experienced in this project, is the tension between allowing participants greater control over the research process, and obtaining data which is amenable to conventional methods of analysis. The LGB project on-farm trials disappointed some members of the research team because of their failure to generate results which could be analysed statistically, even though other useful results were produced (Magrath *et al*, 1996b). Another problem is the difficulty in interpreting results of participatory activities such as diagrams produced in farmer meetings (as mentioned above, diagrams produced by farmers in focus group meetings on LGB impact proved somewhat misleading). Third, farmer participatory research may limit thinking to ideas which fit the current farming system. For example, the LGB project focused research on storage systems prevalent in the Volta Region of Ghana. One possible problem with this is that results have limited applicability outside the project zone. In Ghana, further research will be needed in other areas in which store types and practices are different. Another possible problem is that ideas from outside might be more effective in solving local problems in some cases. One post-harvest example is the metal bin, an imported storage technology which has proved popular in Latin America (Jonathan Coulter, NRI, UK personal communication).

5 Costs and benefits of participation to participants

Costs to participants

From the point of view of the project, involving farmers and traders introduced savings as well as costs. Participating farmers and traders provided valuable resources to the research programme, not only in terms of their knowledge and experience (which are difficult to value in money terms) but also in terms of time and material resources. These contributions reduced project costs but represent significant investments on the part of participants. In a social cost-benefit analysis the opportunity cost to farmers and traders of their participation would need to be estimated.

An attempt is made to illustrate these costs in Table 3. The on-farm trials and the *Study of Losses and Decision-Making* were able to make use of farmers' maize stores without payment. The value of maize included in these studies is estimated at about 8.6 million cedis (£8,600 or US$13,231). This is almost as much as the project's estimated total variable costs (for both participatory and non-participatory work) of 9 million cedis (see Table 2). However, although the project benefited from the maize (and would have had

Table 3. Estimated costs of participation to farmers and traders

Activity	Purpose	Participants	Benefits to participants	Value of maize in study (1)	Number of farmers or traders	Farmer/trader days	days as % of total
GOAL: ASSESSING THE SOCIAL AND ECONOMIC IMPACT OF LGB							
Preliminary survey	Define priority work areas	Farmers	Increased awareness of LGB and potential to control it		1,440	360	9%
Losses Studies Survey of losses and decision-making	Understand on-farm losses and decision-making	Farmers	Storage advice Annual gift Learn research results	3,327,218	590	708	17%
Cost-benefit analysis of farm storage	Estimate value losses in farm stores	Farmers	Storage advice	225,000	15	15	0.4%
Impact Meetings Farmers and traders	Understand impact on family and community	Farmers Traders	Exchange ideas		240	120	3%
Market studies Market survey	Understand quality-price relationship	Traders	Storage advice		140	728	18%
Trader panels	Understand quality-price relationship	Traders	Storage advice		225	113	3%
GOAL: DEVELOPING A RANGE OF OPTIONS FOR CONTROL OF LGB							
Station trials (including tech. evaluation)	Test efficacy of technologies	Farmers			0	0	0%
Exploratory meetings	Develop ideas for trials	Farmers	Exchange ideas Storage advice		300	150	4%
Observe farmer practice	Fit technologies to local practice	Farmers			60	30	1%
Farmer evaluation of station trials	Undertake rapid assessment and test popularity	Traders	Learn research results Exchange ideas		185	93	2%
Trader pricing for CBA of trials	Conduct CBA of trial treatments	Farmers			120	60	1%
On-farm trials	On-farm viability and popularity of treatments	Farmers	Storage advice Maize treatment	1,037,194	145	242	6%
Biological control with Tn	Release and monitor biol. control agent	Farmers	Storage advice	4,000,000	800	1,440	35%
TOTAL				8,589,413	4,260	4,058	100%

Notes

(1) Estimated average store size, for Loss Study: case study stores 150 kg; transect stores 100 kg; on-farm trials 150 kg
Current price deflated using FOOD component of CP – see note (2), Table 2.
Shelled maize estimated at 70% of volume of cob maize.

to purchase a large proportion of it to get the same benefits from laboratory work), farmers themselves did not lose the maize. In fact, in most cases, farmers' use of the maize was not greatly affected by the study, which means that the opportunity cost to farmers was considerably lower than the total maize value.

It is estimated that farmers and traders contributed over 4,000 days of their time to LGB project participation over the three year project period. If this time is valued at the minimum wage rate it represents a cost of 6 million cedis (£6,000 or US$9,230). In most cases farmers and traders were not paid for their participation but contributed because they felt they would gain from it (cases in which they were paid for their work comprise less than 10% of this total - see below).

> Box 4. Benefits of participation to farmers and traders
>
> - Earlier access than non-participants to researchers' knowledge and to the results of the experimental programme. Those who participated in some activities (the survey of losses, and the on-farm trials) received regular monthly advice on their maize stores.
> - The opportunity to influence the research according to their needs.
> - Their knowledge and opinions were valued, giving them increased confidence. This was particularly true for women farmers who have less contact with extension staff and other outsiders.
> - Exchange of ideas, and learning from other farmers and traders, both within the village and from other villages.

Benefits of participation in research to farmers and traders

The research team benefited from farmer and trader involvement in the research. The general population at risk from LGB also benefited from the new knowledge and techniques generated. But what about those who participated directly in the research, giving up their time and other resources? As with the costs, the benefits to participants would need to be included in a social cost-benefit analysis. Box 4 shows the benefits which might be expected.

About 2,000 farmers and traders were directly involved in project research activities, and many more attended one-off village meetings which dealt with LGB control. Most activities included an evaluation of the exercise by participants. For example, during the two year losses study, a general meeting was held at the end of each year, in each study village, at which farmers aired their views about their involvement in the study and the team presented research findings. In general, the response from both farmers and traders was enthusiastic.

However, in some cases involving farmers and traders in research tended to raise expectations. For activities which required farmers to contribute time on a regular basis rewards were expected. There is some debate among practitioners of participatory approaches about whether remuneration is appropriate, especially if the participants are supposed to be the main beneficiaries of the exercise (PLA Notes 22, p.6). Certainly, farmers' and traders' assessments of benefits from participation are likely to vary, but the benefits to the project were very clear. As a consequence the project felt that remuneration was appropriate for some activities. Where farmers or traders provided labour and skills (for example, shelling or pricing maize samples) they were paid at local wage rates. Where there was a long-term involvement, as in the *Study of Losses and Decision-Making,* token gifts were given at the end of each year. Farmers participating in on-farm trials received free treatments for their maize storage.

A major problem with any remuneration, however small, by a project with external funding, is that it is often not possible for government departments to sustain it after the end of the project. There may therefore be greater justification for making payments to participants if the primary objective is to generate research results during the project lifetime, as was the case with the LGB project. Although it was hoped that participatory approaches would be sustained within the MoFA post-project, it was always understood that their form would change, in order to fit current resources and practice. However, another reason for providing remuneration, especially when participants are expected to contribute substantial amounts of time, is to ensure that poorer people are not excluded from participation because they are less able to afford the time.

Despite the attempts by the project to compensate farmers for their time and effort (both materially and in terms of advice and information), some farmers were still disappointed. Farmers' expectations of rewards are often based on previous experience with outsiders. They have learnt to expect advice and free inputs and it can take time to introduce the idea of an exchange of knowledge in a joint research activity.

Other disadvantages faced by participating farmers were that they could not always obtain inputs for recommended practices which they had heard about;[6] and survey and trial work involved the removal of maize from their stores, to which some farmers objected.[7]

Sustainability of benefits

The overall sum of benefits to fanners from the project research depends in part on the sustainability of beneficial project impact. It is hoped that the benefits of the project will be sustained through: improved storage pest control practices implemented by farmers and traders; implementation of more effective research and extension practices by staff trained under the project; and the adoption of research methods pioneered by the project by other projects and organisations. Some of the researchers on the team who had no previous experience of participatory approaches, aim to incorporate it into their future work. According to one:

> *'Here in Ghana, researchers tend to spend 100% of their time at the research station. They are interested in producing publications, and they forget who their real clients are. If they were to spend 50% of their time with farmers, listening to them, they would do a much better job.'*

However, further support to research and extension is required both to sustain the achievements of the LGB project in Volta Region and to extend the benefits to other areas of Ghana. This is already happening. The Post-harvest Development Unit (PHDU) of the Ghanaian Ministry of Food and Agriculture is placing a high priority on LGB research and control, and extra personnel have recently been moved to high risk LGB areas outside Volta Region. It is hoped that this work will continue, and will be supported by external funding where this is requested.

6 Conclusion

Whereas rapid rural appraisal was initially developed with the explicit objective of making research more cost-effective, this focus on cost-effectiveness seems to have been neglected in the 'participatory' movement. Indeed there has been a tendency to accept any research activity as long as it can be termed 'participatory'. However, it is the experience of this project that participation alone is not sufficient to ensure that research will be productive and useful to clients. Participatory activities, as all research activities, should be assessed critically in terms of their contribution to achieving these goals. Even when participation is seen as an end in itself, with the main goal being empowerment of participants, it is still desirable to find more effective, and lower cost ways of achieving this goal.

This paper has attempted to illustrate how a cost-benefit analysis of participatory research might be conducted. The CBA involved three steps. First, project activities were disaggregated, and their costs were compared. Second, these costs were examined in relation to the contribution of each associated activity to one or more research goals and the level of participation which the associated activity entailed. Finally, the costs of all activities involving clients were summed, and their impact on overall costs and benefits was assessed. It should be pointed out that the LGB project did not plan to carry out a CBA of participatory research from the start and this should be borne in mind when assessing the results of the analysis. Had it done so, costs data might have been collected in a more systematic manner.

However, it is not costs but benefits which are the most difficult to assess. Improving estimates of benefits requires not only better monitoring over the long term but also comparison with other more and less participatory projects. An interesting finding of the CBA was that activities typical of participatory appraisal work, such as farmer focus group meetings, turned out to contribute less to research goals than some other activities. Long-term activities involving repeated visits to the same farmers contributed most to achieving the research goals of assessing social and economic impact of LGB, and generating ideas for trials. Furthermore, individual farmers involved in these activities were able to influence certain project decisions, such as trial set-up and technologies tested in the trials, because of their frequent contact and exchange of ideas with the research team. But the greatest contribution to research goals was not always made by the most participatory activity. The station trials, for example, were found to make the greater contribution to the goal of testing technologies.

It was estimated that participatory activities collectively increased research programme costs by 66% and accounted for 80% of researchers' time. Since CBA of research methods is not generally done, and standard methods are not yet available, it is difficult to judge whether these costs are high or low. However, a number of features of this project tended to increase the relative costs of participation.

First, social and economic impact studies played a prominent role in the research programme. This reflected the lack of relevant secondary information available to the project and the researchers' commitment to understanding the nature and extent of the LGB problem as experienced by local farmers so that recommendations made would be relevant, popular and cost-effective. Impact studies also supported the development of new technical methods, based on farmer practice, in particular a method for assessing losses in market value of maize damaged by insects. Impact studies comprised 71% of the costs of participatory work, and 26% of total operating costs for the research programme. The emphasis on methodology development (see Compton, this issue) reflects the fact that, despite the proliferation of participatory methods, in general the application of these methods in post-harvest work has so far been limited.

Another factor which increased costs was the desire to cover all relevant agroecological zones in the field work. Visits to the most distant areas required overnight stays, and therefore, subsistence payments to staff. 63% of the costs of participatory work were for staff overnight subsistence. Clearly, other projects working in smaller areas may be able to reduce this cost.

Benefits of client participation in general included: the generation of new ideas for trials; a better understanding of interactions between insect and farmer behaviour (easily missed in more 'technical' projects); better judgement of which technologies would be popular, and why; and maintaining a sense of urgency to solve the problem as experienced by farmers. Longer term benefits in terms of reduced on-farm losses are difficult to assess at this stage, although indications are that loss-reducing technologies were adopted earlier and are spreading more rapidly than would have been the case had this been a non-participatory, research station-based project. This is, though, difficult to confirm in the absence of data from comparable projects.

Although this paper does not claim to provide a comprehensive guide for CBA of participatory projects, it does strive to show that such analysis is both possible and profitable and should, therefore, be more widely adopted. If more work were to be put into this area, analysis would become more sophisticated and research as a whole would be expected to become more cost effective. Though some participatory techniques might be criticised in particular circumstances, overall participatory research would be likely to be more defensible (as it would be backed by hard data) . This would be an important step forward.

Endnotes

1. Project activities are described in more detail in Boxall and Compton (1996) and in project quarterly reports.
2. ODA uses a slightly modified version of this schema in its Stakeholder Analysis (ODA, 1995). Another schema by Biggs (1989) is designed for evaluating an institution or project as a whole and describes the quality of the relationship between researcher and client.
3. This might have been difficult for sensitive issues such as hunger and social disgrace.
4. In this survey, the intention was to observe and understand farmer practices, rather than to influence them directly. However, interaction with the research team kept the survey farmers in touch with the results of project experimental work.
5. An LGB awareness and extension programme was implemented at the national level, but a more limited range of technical options for LGB was available in the other regions; research is still needed in these areas.
6. Government policy was that input distribution should be via the private sector and it was difficult for the project to become directly involved.
7. Some farmers believed that 'touching the barn' by removing maize led to infestation. Sampling was therefore usually done once the farmer had already started removing maize.

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