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Agricultural Research
& Extension Network

AgREN

Network Paper No.74

JANUARY 1997

NP 74

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

Julia Compton

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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The Agricultural Research and Extension Network is sponsored by the UK Overseas Development Administration (ODA). The opinions expressed in this paper do not necessarily reflect those of ODA.

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ISSN 0952–2468

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ACRONYMS

CBA	Cost-benefit analysis
GSS	Ghana Statistical Service
IIED	International Institute for Environment and Development, UK
LGB	Larger Grain Borer (*Prostephanus truncatus* (Horn))
MoFA	Ministry of Food and Agriculture (Ghana)
NGO	Non-governmental organisation
NRI	Natural Resources Institute
PHDU	Post Harvest Development Unit
PRA	Participatory Rural Appraisal
Tn	*Teretriosoma nigrescens*

Managing applied research: experiences from a post-harvest pest control project in Ghana

Julia Compton

The aim of this paper is to make some suggestions about improving the management of applied agricultural research projects in order to improve the speed and quality of benefits to farmers. Factors influencing research success are described under four headings: choice of objectives and approach to work; choice of research methods; project organisation and management; and liaison with other organisations. Examples are given from the experience of the Ghana Ministry of Food and Agriculture/UK Overseas Development Administration Larger Grain Borer (LGB) Project, a recently completed three-year post-harvest project with a 25-person team.

Important features of this project's approach included: maintaining a focus on practical results; building upon farmers' own experimentation; involving commodity traders in research and extension; basing research around farmer decision situations rather than packages; and addressing the extension problems raised by the development of a range of technical options.

Research methods which were integral to the approach included: a participatory research-extension cycle; the framing of research questions to obtain critical data needed for decision-making; rapid survey methods; rapid field methods of sample analysis; rapid proxy methods for client evaluation of trials; and frequent re-examination of the programme by the whole research team. Favourable organisational features of the project included: a 'critical mass' of researchers organised in an interdisciplinary team with an anti-hierarchical ethos; extensive group training for the whole research team; monthly meetings and quarterly reports used as management tools; a supportive institutional setting; flexible funding arrangements; and good central administration.

Finally, it is argued that where a farmer-participatory approach is adopted, this should not be a grafted-on activity, but an integral part of all project work. It is therefore necessary to look closely at all research questions and technical methods to make sure that they are compatible with this approach. In particular, work is still needed in many technical disciplines to develop rapid field methods of sample analysis which are compatible with rapid, participatory field studies.

1 Introduction

The aim of this paper is to make some suggestions about how to improve the management of applied agricultural research projects in order to increase the speed and raise the quality of benefits reaching farmers. The paper uses examples from the experience of a recently completed post-harvest pest control project, the Ghana/UK Larger Grain Borer (LGB) Project. Projects are clearly not the only possible format for applied agricultural research. However, they are a very popular mechanism for channelling investment in research, because they offer the possibility of defining clear objectives, inputs and a time-frame for the work. This makes it important that lessons about project management should be widely shared.

The paper begins by reviewing some of the common problems of applied agricultural research projects. Next it provides some background information on the LGB project. It then discusses four determinants of success in adaptive research project planning and implementation, giving examples from the LGB project. These are: choice of appropriate objectives and approach to work; choice of appropriate research methods; factors relating to project organisation and management; and good liaison with other organisations. It is argued that simultaneous attention to *all* these elements is necessary for project success. The paper concludes with a summary of the lessons in research project management which can be drawn from the LGB project's experience.

2 Common problems of research projects

Over the past two decades there has been much discussion of problems in applied research, and many suggested solutions, notably increased farmer participation in research. Despite this, a disappointingly large number of research projects still take a long time to achieve practical results for farmers. There is still a big gap between the 'frontiers of development thinking', as exemplified by many ODI Network Papers, and the practice of most agricultural researchers.

Applied research projects commonly:

(a) *are too slow in achieving results.* While research is by its nature an open-ended activity, with no absolute guarantee of achieving results within a particular time limit, a visitor to many applied research projects quickly gets the impression that things could be speeded up a bit. Sometimes there is no sense of urgency or clear direction to

the research. In other cases cumbersome research methods delay results, or the work is hampered by administrative problems, such as delays in the procurement of supplies or in making financial transfers.

(b) *are too academic.* There is often an unacknowledged conflict between the aims of the project and the need of professional researchers to 'publish or perish'. This can lead to irrelevant or poorly-targeted experiments, to slow, over-precise research techniques and to concentration on peer-reviewed publications at the expense of outputs for agricultural extension and ultimately for farmers.

(c) *come up with inappropriate technologies,* or technologies which can only be used by a minority of farmers (usually the richest). This often occurs when farmers are not consulted by researchers, or when only rich, 'progressive' farmers are consulted.

(d) *develop a useful technology, but fail to anticipate the detailed practical problems faced in using it on the farm.* Often researchers (through the medium of the extension service) exhort farmers to use the 'correct' procedures or equipment, rather than looking at the materials actually available to farmers and seeing how they can best be used. Locally adapted solutions tend to be more cost-effective in the short-term and more sustainable in the long-term.

(e) *'re-invent the wheel'* due to ignorance of what has been done earlier or elsewhere. This problem can occur when developing both technologies themselves and new research methodologies.

(f) *limit themselves to validating existing farmer practices.* Sometimes researchers restrict themselves to giving a sort of 'official seal of approval' to existing farmer practices, after checking that they 'work' to the researchers' satisfaction. For example, researchers may hold up so-called 'best farmer practices' (e.g. timely harvest) as a model to all, rather than searching for the reasons that other farmers do not use them (often not because of ignorance but because of time or other constraints). This is certainly an improvement from the days when farmer practices were disregarded or despised by researchers, but it represents a poor return on the research investment.

(g) *become isolated from other research and extension organisations.* Project ideas and results, even if good, may not be taken up by others without sustained investment in developing personal and institutional links with other stakeholder organisations. This can be a particular problem for projects which are developing new ways of working, such as farmer participatory research. It is also a perennial problem between research and extension in many countries.

Problems (b) – (d) are typical of traditional, 'top-down' research projects. Heavy criticism of this type of research has led to many recent projects and institutions putting, rightly, more emphasis on farmer participation in research. Unfortunately, farmer participation does not solve all problems, and participatory research projects may be particularly vulnerable to problems (e) – (g). They may also face additional problems such as lack of cost-effectiveness due to the very narrow applicability of results or the high costs of achieving them. For a discussion of this issue see Magrath *et al.* (1997) in this volume.

3 Some background on the Ghana/UK LGB Project

The Larger Grain Borer (LGB) (*Prostephanus truncatus*) is a small dark-brown beetle which is a serious post-harvest pest of stored maize and cassava. It originates from Central America, but was accidentally imported into Africa about 15 years ago and has since spread through 11 African countries. LGB can cause losses of 30% or more in maize value within a six month storage period. Farmers consider it to be a very serious problem. In fact, it was first brought to official attention by a group of Tanzanian farmers who marched into the Ministry of Agriculture to ask for help. Many millions of dollars have been spent in trying to control the LGB and limit its spread, and at least five international and donor organisations are currently involved in research into its biology and control.

The joint Larger Grain Borer Project set up by the Ghana Ministry of Food and Agriculture (MoFA) and the UK Overseas Development Administration (ODA) formed part of this international effort against the pest.[1] The project was established in January 1993 and ran until August 1996. Its overall purpose was 'to reduce post-harvest losses on the farm caused by insect infestation'. The project had two national managers (one British and one Ghanaian) based in the capital city, Accra, and a national component which was mainly concerned with monitoring the spread of the beetle, eradicating outbreaks in new, isolated areas, raising awareness of the new pest and producing and distributing extension materials. The research component of the project, which had 20–25 staff positions and a budget of £0.74 million over 3.5 years, was based in Volta Region in southeast Ghana, where the LGB had first entered the country. In this area LGB had already become established as a serious pest. The main objectives of the research component were to investigate the economic and social impact of the LGB, to develop and validate a range of technical options for maize storage, and to develop appropriate means of advising on these options.

Box 1. Recommendations and outputs by the LGB project research team

• Storage hygiene to prevent carry-over of LGB	# ***F***
• Experimenting with platform woods to prevent LGB carry-over	#
– changing platform woods	# ***F***
– smoking platform woods	*
– chemically treating woods used in platforms	*
• Attention to good variety husk cover	# ***F***
• Timely harvest	# ***F***
• Treatment of maize in husk with recommended chemicals	*# ***F***
• Shelling and treating grain with recommended chemicals	# ***F***
• Shelling at an 'action threshold' of infestation	* ***F***
• Improving the barn roof cover, especially using plastic sheeting, to exclude insects or thermally disinfest	* **R** ***F***
• Using builders' lime made from oyster shells between cobs	*C **R**
• Using wood-ash between layers of cobs	# **C R** ***F***
• Publicising methods which **do not** work against LGB:	
– smoking the store	# ***F***
– neem leaves	* ***F***
– previously-recommended maize storage chemicals, normal sun-drying	* ***F***
– dehusking maize	#
• Release of *Teretriosoma nigrescens* for biological control of LGB	# ***F***
• A training game for extension staff on maize storage decision-making and cost-benefit analysis	* ***F***

The project also tested and rejected as ineffective several more methods including improved sun-drying techniques, pulling visibly infested cobs from store (***F***), selecting and re-stacking visibly uninfested maize, neem oil, and several commercial dusts and insect growth regulators.

Notes: * Investigated for first time (in LGB outbreak area in Africa)
Method not new, but significant modifications or additions to recommendation made for local conditions
C Effective only for certain store climates
R Research is continuing to confirm and extend project results
F Farmers' input critical in developing or modifying recommendation

Source: Boxall and Compton, 1996

The research team was generally considered to be successful in meeting its three objectives. In three and a half years the team developed or significantly modified 11 main possible recommendations for farmers (Box 1), released a biological control agent for LGB (*Teretriosoma nigrescens*), carried out a detailed study of the socio-economic impact of LGB (Magrath *et al.* 1996) and produced various extension materials including a training game for extension staff. The team also made 11 published innovations in research and extension methods (Box 2). The Government of Ghana is currently continuing work on LGB in newly-invaded parts of Ghana with its own resources, largely using methodologies developed by the project.

By the end of the project, the LGB appeared to be a much less pressing problem for most farmers in the research area. In a 1996 survey of extension agents in Volta Region 65% of villages in maize-growing areas were said to have less LGB infestation than previously. In half of these villages extension staff said that the lower levels were due to farmers taking action against the pest.[2] Only in 18% of villages was it said that there was more LGB infestation than in previous years, and nearly half of these cases were in areas where the pest was reported for the first time. Moreover, the proportion of villages in maize-growing areas in Volta Region in which extension agents rated LGB as a 'serious' problem dropped from 31% in 1993 to 13% in 1996.[3] It is likely that climatic factors and the reduced storage period of maize in 1994–95 (due to shortages and high prices) were the main causes of the general decline in LGB populations over the project period. Nevertheless, farmer uptake of project recommendations is likely to have been partly responsible for the failure of LGB populations to bounce back, although no proof of this will be available for several years. Most farmers in the immediate project area are now aware of the LGB threat and take action to prevent LGB build-up in their stores, which is likely to be important in reducing overall LGB population build-up in villages.

4 Important aspects of managing applied research: objectives and approach

Five general aspects of the LGB project objectives and approach are discussed here: maintaining a focus on practical results; building on farmers' own experimentation; involving small-scale commodity traders in research and extension; basing research around farmer 'decision situations'; and resolving the extension problems posed by the development of a range of technical options.

Maintaining a focus on practical results for farmers

As mentioned above, there is a potential conflict in research between producing published scientific papers and producing practical results for farmers. Projects wishing for practical results must motivate scientific staff to give priority to the latter.

A high degree of farmer interest in finding a solution to LGB damage, plus frequent contact between farmers and researchers, were the key factors in giving the LGB Project a sense of urgency and keeping researchers focused on achieving practical results. It is hard to get distracted by arcane scientific questions if you continually have to face farmers who want to know exactly how far you have progressed since you last met them! This degree of farmer interest may, however, have been somewhat particular to the project and its circumstances: maize is an important food staple, and LGB is a new, destructive and high-profile pest in Ghana (Magrath *et al.* 1996).[4] Pressure for results also came from the Ministry of Food and Agriculture and the donor agency, which set tight deadlines and checked progress through quarterly research reports. However, for most project staff, farmer interest was the largest single source of motivation to produce results quickly.

Nevertheless, the conflict between time spent producing results and time needed to write them up for an international audience was not completely resolved within the LGB project. At least three ex-project researchers are now writing up academic papers in their own time, and there is a chance that some of the results will never be published outside project reports. Unfortunately, project reports have a short lifespan, as LGB staff learned when we failed to locate more than a small fraction of the reports produced by a very large, ten-year agricultural development project which immediately preceded the LGB project in the same region. Although farmers in several regions of Ghana now have access to project results, not all results have spread to neighbouring countries. Even for researchers in the same country, internationally-published papers may be the only available source of information on project work after a few years have passed. This makes documenting project activities an important concern (and one which should help other, similar projects avoid the hazard of 'reinventing the wheel'). There is, however, no easy solution to this conflict of priorities, and in the immediate project environment seeking solutions for farmers must remain the focus.

Building upon farmers' own experimentation

Farmers in the project area were very concerned about LGB damage and had themselves begun actively to experiment with control methods (Motte *et al.*, 1995). Over 60% of farmers visited in village studies had made some change to their storage practices within two years of first experiencing LGB damage (Magrath *et al.*, 1996). Some of the innovations they tried are shown in Box 3. While this summary indicates that farmers had some success with their experiments, failures were even more common and were often penalised by heavy losses to LGB. Experimentation by individual farmers is a slow and risky process, particularly in the post-harvest area since, unlike in cultivation where small patches can be devoted to experimentation, farmers normally use their entire maize store as an experimental unit.[5] Thus, the project saw the collection, discussion, testing and improvement upon farmers' ideas and experience as providing an important service to farmers.

Project activities which aided collation of farmers' experience included: frequent village visits and observation of stores, which made farmers aware of researcher interest in and respect for their ideas so that they regularly volunteered information (Magrath, 1993; Magrath *et al.*, 1996); focus group meetings with farmers to solicit opinions about proposed storage

Box 2. Methodological innovations in post-harvest maize research made by the LGB Project

• A method for rapid field assessment of insect numbers in maize cobs	*P*
• A method for rapid field assessment of weight loss in maize cobs using a visual scale	*F P*
• A method for rapid field assessment of value losses in maize cobs	*F P*
• An improved weight loss assessment method for laboratory work (the 'modified count and weigh method')	
• Testing and improving pheromone trap design for LGB	
• A method for determining the relationship between price and insect damage in maize grain, using panels of maize traders	*F P*
• A method for farmer group evaluation of treatments in maize storage trials	*F P*
• A method for cost-benefit analysis of maize trials based on farmer practice and trader valuation	*F P*
• An extensive method of monitoring the impact of a biocontrol agent for LGB	*F P*
• Training maize traders as extension agents for on-farm maize storage	*F P*
• Decision trees for advising on multiple technical options and focussing research	*F P*

Note: *F* Farmers' input critical in developing or modifying method
P Method useful in farmer-participatory research

Source: Boxall and Compton, 1996

Box 3. Examples of farmer experimentation with storage pest control
(Roughly in order of most common to least common practice, where known)

Smoke the store (build a fire underneath)	N
Layer neem leaves or spread neem leaf slurry between cobs	N
Layer wood ash between cobs	P
Use subsidised cocoa chemicals (e.g. lindane, organophosphates and fungicides)	N/P, H
Use the previously-recommended maize storage chemical (pirimiphos-methyl)	N
Get someone with 'good hands' to stack the store	U
Change the wood of the store to get rid of carry-over infestation	P
Cover store with a galvanised iron roof to heat up maize	N
Cover store with a plastic roof to exclude insects	E/P, H
Winnow and sun dry maize grain to remove insects	N/P
Move stored maize inside house to escape infestation by flying insects	N/P
Store maize on farm to escape high insect populations in village	P
Fumigate maize with phostoxin pellets	E/P, H
Appeal to supernatural forces	U
Put palm-oil residue in store to encourage predatory ants (one farmer)	U

E - effective against LGB
P - partially effective
N - not effective
H - likely to be harmful to health in some cases or if not done properly
U - unknown effectiveness; not tested by project.

methods before embarking on trials (Magrath *et al.*, in this paper); and monthly project meetings in which interesting field observations were shared with all project staff (see below). The project also made it a priority to provide information (via extension) to farmers about unsuccessful and/or potentially dangerous pest control methods. It is common for researchers and extension services to limit themselves to giving information about recommended practices, failing to mention things which do not work. Farmers, however, need good information about *all* the options available to them, since they may not be in a position to adopt the officially-recommended options (because inputs are unavailable or expensive, or simply because the proposed solutions are very inconvenient).

Involving commodity traders as well as farmers

Despite the fact that the price paid by traders for farm produce provides the main economic incentive driving the adoption of new technologies, it is not common for commodity traders to become involved in agricultural research aimed at small-scale farmers. By contrast, researchers in the world of large-scale commercial farming often depend on links with trading companies and large retailers for market research, extension and product development work (Schwartz, 1994). Many otherwise admirable participatory research projects fail to involve traders, possibly because of a long-standing mistrust of 'exploitative' traders in many cultures. For example, many participatory plant breeding projects depend on farmers, rather than traders, to judge the saleability of different cultivars. However, it is usually traders who have the best knowledge of what quality of produce the market demands, and traders are therefore in a good position to judge the economic benefits of many new technologies such as new varieties or pest control measures. The LGB project involved traders in pricing maize from trials and in developing a simple model of the relationship between insect damage and value loss (Compton *et al.*, 1995 and forthcoming; Magrath and Compton, 1995).

Private commodity traders can also potentially play an important role in agricultural extension, especially in post-harvest technology. In Ghana, small-scale traders travel widely and arguably reach more farmers than the extension services (Motte, 1995). Moreover, in most of West Africa the majority of traders are women, who can often talk one-to-one with women farmers (who again comprise the majority of farmers, particularly for food crops) more easily than can the mainly male agricultural extension staff. Women are more likely than men to come into contact with traders, as in many areas they have the primary responsibility for selling household maize. Since most traders themselves come from a farming background, they have experience of on-farm storage, and are therefore well able to understand the concerns of their suppliers.

In the LGB project area, there were several reasons why traders were willing to act as informal extension agents for new insect control methods in stored maize. First, richer traders often give production credit to farmers which is secured through a lien on the farmer's maize store. This gives them a direct interest in the maize quality, as it influences both the farmers'

ability to repay and the value of the collateral (i.e. the contents of the store). Second, many traders compete to keep particular farmers as their regular suppliers. In order to maintain farmer goodwill, traders often buy the whole store, including both good and insect-damaged maize; profit margins on the latter are smaller and less certain, so traders have an interest in maize held by farmers being kept in good condition. Traders may also provide other services to their regular suppliers, one of which is the procurement of chemicals used in storage for farmers in remote villages.

Over 500 maize traders were trained in storage pest control by the LGB project and their new knowledge was rapidly passed on to farmers and other traders (Motte, 1995; Semakor, 1995; Gbedevi, 1995; Compton *et al.*,1995). It is common for traders to be with the farmer at the time the maize store is dismantled (traders may even help to shell the maize). Insect damage is very visible at this time and this therefore provides a good opportunity for traders to exchange information with farmers about storage pest problems and potential solutions.

Basing research around farmer 'decision situations'

The farming systems approach to research has traditionally concentrated on developing 'packages' of technical recommendations suitable for different 'recommendation domains' (types of farmer and farming system). Packages generally prescribe a season-long sequence of recommendations, as in the examples of maize storage packages given in Box 4. Validation for packages is normally provided by replicated trials in which the entire package is compared to local practice.

The problem with such packages is that most small-scale farmers do not follow them. It is common for farmers to adopt only parts of a package, which makes results unpredictable (and sometimes technically worse than previous local practice). For example, many maize farmers in Ghana, having been recommended the first package shown in Box 4, have adopted the narrow ventilated maize crib but either do not dehusk the maize cobs, dehusk them without treating them with insecticide, or leave them in the crib far longer than recommended. The fact is that small-scale farmers rarely make season-long plans. Instead they make a series of separate decisions throughout the season, based on the options and constraints at each moment. An example of maize storage decisions made by farmers in the project area is given in Box 5.

The concept of 'decision situations' is not new but it is often ignored by agricultural researchers (e.g. Norton, 1976; Norton and Mumford, 1993). Adopting this approach leads to the following research

Box 4. Examples of season-long technical maize storage packages promoted in West Africa

Domain 1: Larger-scale maize farmers

'Use a recommended high-yielding variety, dehusk cobs at harvest and spray with an approved chemical, load them into a narrow ventilated crib, shell as soon as dry, treat with an approved chemical and store in sacks until disposal.' (GGDP , 1994)

Domain 2: Small-scale farmers

'Use a recommended variety with good husk cover, harvest at the recommended time, select only cobs with good husk cover, clean the structure before putting in the new maize, smoke when weevil infestation is noticed.' (Ouattara, 1987)

questions being posed.

- What options are currently available to farmers at each decision point?
- Are additional options needed?
- What information do farmers need to make better decisions?

These are quite different from the research questions addressed when developing a package.

The LGB project started out with a traditional farming-systems approach, and after the first year of working with farmers switched to a decision-based approach. After some understanding had been gained of farmer decisions and constraints, tools such as decision trees (Feakpi *et al.*, 1994) and a value loss model (Compton *et al.*, unpublished) were used to model farmer decisions, to point out critical gaps in knowledge and to focus research on issues of relevance to farmers.

Developing a range of technical options: from research to extension

Since farmers (particularly small-scale farmers) operate under a variety of different circumstances, it is unlikely that a single technical solution will suit all of them. Once this is recognised, it is not (in theory!) difficult for researchers to develop a range of technical options and for the extension service then to present farmers with a choice of options or the recommended adaptation for their particular circumstances. While this is certainly likely to be more effective than transmitting a single message to all farmers, it does have its costs. In particular it means that the task of extension staff becomes considerably more complex.

At the beginning of the LGB project the agricultural extension service in Ghana, as in many countries, was mainly geared to the transmission of single technical messages to contact farmers through the Training and Visit system. Many senior agricultural extension staff were initially doubtful about the concept of multiple technical options, which was seen as creating more

Box 5. Examples of sequential farmer storage decisions in the project area

What storage structure shall I build? *(traditional crib/improved crib/katchalla basket store/inverted cone/platform/kitchen loft)*

What roof should it have? *(long thatch/short thatch/tin/plastic)*

How should I store my maize? *(cob/shelled, husked/dehusked, selected/non-selected)*

Should the maize store be smoked? *(no/initially/occasionally/daily)*

Should I use a chemical? / Which chemical? / How much? *(recommended maize insecticides/non-recommended commercial insecticides/neem/ash/lime)*

If I only have a little chemical, how can I use it best? *(apply more thinly/apply to bottom layers/apply to outside/don't bother as it won't work)*

My cob maize is infested with insects - what should I do? *(leave/shell and keep/shell and sell/select and restack/dehusk and keep)*

My shelled maize is infested - what should I do? *(sell/treat with chemical/select/sun-dry)*

work for front-line extension staff and potentially leading to confusion on the part of both farmers and of some less well-educated extension staff. However, project experimentation showed that many front-line staff welcomed the change. Having more than one option to offer meant that they felt better equipped to respond to farmers' questions. Many also said that they preferred dialogue to the previously-dominant lecture format of meetings with farmers (Feakpi, 1995).[6]

The development of multiple technical options by the LGB project led to new research questions being raised in the area of agricultural extension methods. The challenge was to develop suitable training and supporting technical material to help extension staff advise interested farmers on the options most suited to them and to perform simple cost-benefit analyses to aid decision-making. The project developed decision trees, a training game to teach cost-benefit analysis and risk assessment (Compton, 1995) and other decision-making aids for extension staff (Feakpi *et al.*, 1994). They were used in pilot training exercises for extension staff in three regions in 1995. Development and testing of extension materials emanating from the approach is still underway (Compton, Motte and Addo, unpublished). A small part of the material currently being tested is shown in Box 6.

Some of the initial doubts of senior extension staff did, however, prove to be well-founded. Sustaining a dialogue-based extension format requires more dedication, technical understanding and empathy with farmers than a top-down lecture format, and not all front-line extension staff were prepared for this. Moreover, incorporating information on multiple options into a farmer group meeting, which is likely to remain the most common extension format, is not easy.

Since, however, the single-message extension system is increasingly being recognised as unsatisfactory, more work must be done to resolve these problems. One option is to group farmers at village level (according to various relevant criteria such as resource endowment and degree of initiative), but this is still a resource intensive activity. It is only likely to be possible on a wide scale if local para-extensionists are trained to perform some of the tasks (Defoer *et al.*, 1996). In many cases the unresolved question is, how far does the extension agent (or para-extensionist) need to go in matching farmers with technical options? Or, conversely, how able are farmers to chose the 'best' option from a menu? This is likely to vary according to the nature of the technology in question. Where technologies are 'knowledge intensive' and have only long-term effects it is likely to be more problematic than with material technologies such as pesticides or new seeds, the results of which are usually evident in the short-term (SWI, 1997).

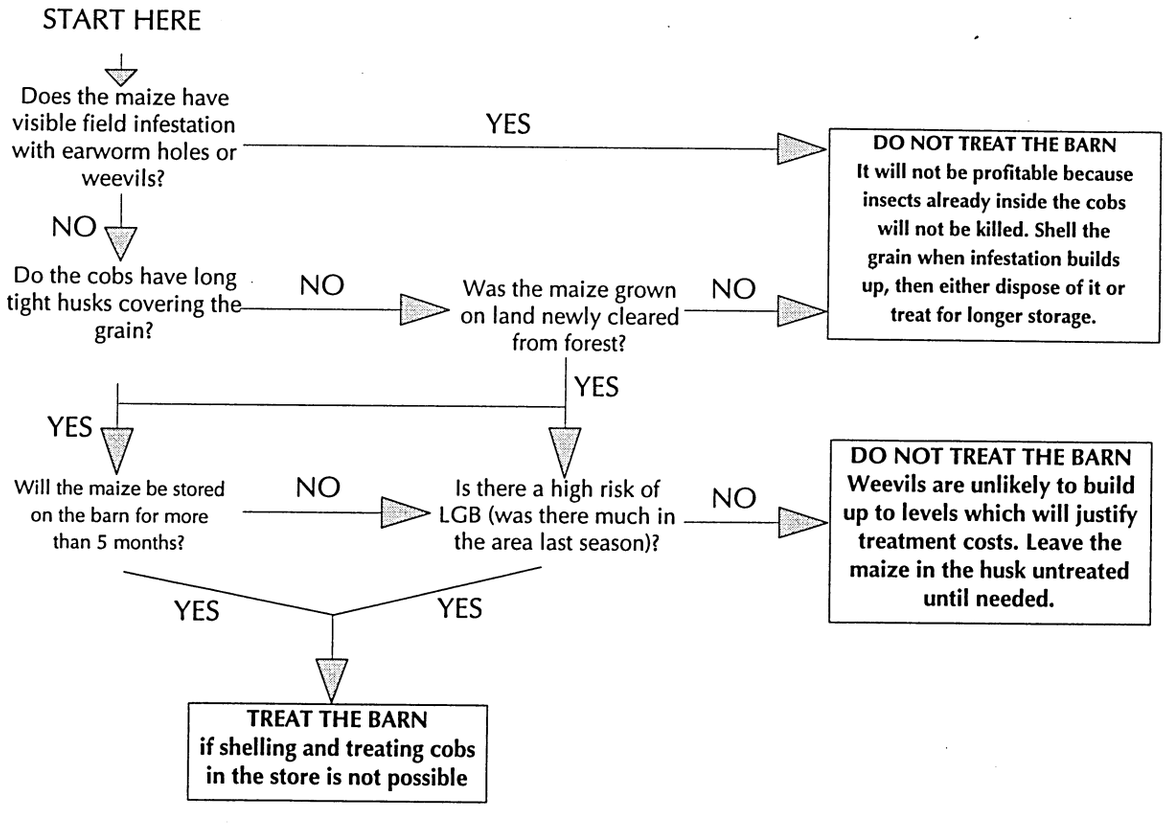
5 Important aspects of managing applied research: choice of research methods

The choice of research methods is a critical factor in both project productivity and in enabling farmer participation. Technical researchers, such as plant protection specialists, traditionally base themselves in the laboratory or research station, where they spend many hours taking detailed scientific measurements. Socio-economists, on the other hand, are (or were) famous for organising large-scale random farm surveys and then retiring to a computer to analyse them for the next year or two. Both are often too busy to talk to each other as much as they might have planned.

In many projects, the (welcome) advent of participatory methods has only partially solved this problem. Farmer participation is often sought only at the beginning of the research cycle, in the 'diagnostic'

Box 6. Testing materials for aiding decision-making: Example of a decision tree and associated case studies

DECISION TREE: SHOULD I TREAT THE MAIZE BARN WITH A CHEMICAL?*



* Note: 'Barn' is a common word for a store containing maize on the cob

Case studies for testing 'user-friendliness' of the decision tree with extension staff:

Case study 1

Charity, who is a trader living in Toh-Kpalime, had a small maize harvest in the minor season. She grew a local variety with long, tight husks. She plans to stack it in the barn in December and sell most of it in March to help with expenses for next year's planting. Although Toh-Kpalime village has LGB, Charity has never seen it in her barn or any of her neighbours' barns. Her husband has been using 'Actellic Super' chemical while stacking his large maize barn and is very happy with the result, so Charity wants your advice – should she invest in the chemical too?

Case study 2

Emmanuel, who is a farmer in Dormabin, had a large minor season maize harvest in early December. He sold off the major season harvest very quickly because it was too wet to store, but he plans to stack the maize from this new harvest after Christmas and keep it until May or June when prices are high. He hopes to be able to buy a bicycle with the money from sales. He says he cannot shell his maize because he has nowhere to keep the bags, and would like to know if it is worthwhile treating the barn with chemical, as he had a little LGB infestation in this barn last year and is afraid it will be worse this year. He grows Abeelehi (an improved variety with fairly good husk cover). The maize field was cleared from bush this year. Should he treat the barn?

Source: Compton, Addo and Motte unpublished.

phase. A common scenario is that the first participatory farm surveys are conducted by a multidisciplinary group, but the scientists then disappear into the laboratory to analyse all the samples they have collected, while the socio-economists find themselves left to write articles about the poor functioning of multidisciplinary teams! The main reason for this seems to be that the development of rapid, participatory, field-based methods in technical subjects has not kept pace with the development of such methods designed for the socio-economic component of research work.

Choice of research methods is discussed here under two headings: farmer and trader participation in research and the use of rapid methods.

Farmer and trader participation in research

Client participation in research is often presented as a moral issue, but for an agricultural project engaged in technology development it is also a practical imperative. At the very least, agricultural research projects should carry out effective 'market research' with all types of farmers before they commit themselves to any particular areas of work.

A large literature on participatory research is available, and details of the particular approach used by the LGB project are given in a companion paper to this one (Magrath *et al.*, in this paper). Thus, only a brief outline is given here.

The LGB Project followed a 'research-extension cycle' involving both farmers and maize traders (see Figure 1 in Magrath *et al.*, ibid). The project encouraged as much research work on farm as possible, on the grounds that contact with farmers maintains researchers' sense of urgency to solve their problems (see section 4) and also helps generate new research ideas. Introductory discussion meetings to find out how farmers viewed the storage pest problem were followed by close observation of farmer storage practices and meetings to discuss possible pest control options with farmers. Station trials were evaluated by farmers (as well as researchers), and maize from the trials was valued by traders (but see also Box 8). On-farm trials took place in farmer-managed stores with researcher-managed, farmer-applied treatments, evaluated independently by farmers and researchers. Researchers observed practical problems and technical difficulties (e.g. dose calculations for insecticidal materials) and tried to solve these with farmers. Sample analysis for surveys and trials was conducted on farm, in the presence of farmers, who were encouraged to watch and question methods and results. Extension recommendations were tested with farmers, and new methods for helping extension workers advise farmers on the choice between technical options were explored. MoFA extension agents were trained in new maize storage techniques, and fed back information to the research team (Box 7). Maize traders were also trained as informal extension agents (see Section 4). Experience from one round of the 'research-extension cycle' fed into the next round.

Box 7. Feedback from extension to research: getting the details right

Actellic Super® (permethrin/pirimiphos-methyl) dust was, at the beginning of the LGB project, the only recommended chemical for LGB control commercially available in Ghana. It was first developed for this purpose in Tanzania (Golob 1988) and is now a well-known chemical used in several African countries. In the first year of the project, therefore, extension training covered the use of Actellic Super® dust for storage of shelled maize grain, using standard international recommendations. The chemical proved popular, especially with larger farmers as well as other people storing maize as a commercial enterprise, such as traders and civil servants. However, project meetings with extension staff and visits to farmers who had used the chemical highlighted a number of problems with its use, including some confirmed reports of control failures, and some cases in which farmers feared failure due to seeing insect holes in the treated sacks of grain. Further trials by the project (Ofosu, 1994) verified the official recommendation and led to a number of small but important changes in detail. These included: changes in the dose (two different doses are now recommended depending on the planned period of storage); changes in the method of measurement of maize to be treated; emphasis on the need to winnow and clean the maize grain very well before treatment; and the proposal of a means of detecting control failures using a home-made sampling spear (insect holes in sacks are not a reliable indicator of control failure). The project also found many of the chemical sachets to be slightly underweight and held discussions with the local supplier about this. Later extension training therefore concentrated on these details, which were crucial to success of the technique under local conditions.

The use of rapid research methods

Slow and overly precise research methods can reduce research productivity. Rapid, field-based technical methods of analysis have many benefits including lower cost, greater speed, greater potential for increased sampling (especially important in small-scale farming systems, given their immense variability), and the greater participation of farmers and field staff in the analysis and interpretation of results. Rapid data analysis is equally important: there is no point doing a rapid survey, for example, if it then takes ten times longer to analyse the data than it did to do the fieldwork.

The LGB project speeded up work through:

- *Rapid surveys and methods of survey analysis.* Full details are given in Compton *et al.* (1995). In brief, the project: (i) formulated specific, practical survey objectives. For example, the question 'What are average crop losses from LGB?', which would need

an extensive random survey to answer properly, was reframed as 'Who has a problem with LGB?', 'What is the nature of that problem?', 'Where should the project direct its resources?'; (ii) used a range of rapid survey techniques to meet these objectives, including making use of secondary data when available, identifying key informants, conducting informal surveys and case studies and calling larger meetings of farmers; (iii) used rapid and flexible techniques of data analysis and presentation, in particular mapping. Computer-based analysis, which is very time-consuming, was used only for longer-term project studies such as the three-year study of losses and decision-making study (Magrath *et al.*, 1996).

- *Rapid field-based methods of sample analysis.* Rapid assessment methods for losses and insect numbers were employed next to the farmer's store after sampling the maize cobs. In brief, these involved dehusking the cobs one by one, tapping each on a white tray, counting the insects which fell onto the tray, and scoring the level of insect damage to each cob on a standard visual scale. Mean weight loss, mean value loss (more interesting to the farmer), and mean insect numbers per cob for the sample can then be determined from a simple calculation which is completed on the spot. (Compton and Sherington, unpublished a,b). These methods had many advantages over laboratory-based methods, the most important being speed and the ability to obtain final results in the field.

  SPEED: Given limited research resources, there is always a trade-off between the speed of processing samples and the number which can be processed. Rapid methods thus enable increased sampling, which in turn makes possible wider coverage and/or reduced sampling error. In large surveys, the use of a rapid method may also reduce the very real risk of data fabrication by bored enumerators, because using a rapid method takes no more time than inventing the answers (Poate and Daplyn 1993). Surprisingly, extensive calibration of the rapid methods used by the project against laboratory-based methods showed very little loss of accuracy and precision. Those errors in the estimation of losses from farm stores are more likely to be due to sampling problems than the visual scale *per se* (Compton and Sherington unpublished a,b).

  ON-THE-SPOT RESULTS: Obtaining results in the field has several practical benefits. The need for transport and handling of samples is reduced, and with this the risk of sample spoilage, misidentification and other laboratory errors goes down. Interesting and anomalous results can be double-checked and discussed with the farmer before leaving. Samples (in our case, maize cobs) can be handed back intact straight after assessment, avoiding the problem of how to compensate farmers for samples removed to the laboratory. Finally, and most importantly, farmers can follow and understand the whole process of analysis, which contributes to the participatory nature of the work (see Magrath *et al.*, in this issue).
- *Development of rapid proxy methods for client evaluation.* Client participation in the evaluation of research results can be time-consuming and costly (Magrath *et al.*, ibid), so one way of speeding up and cutting costs is to develop rapid proxy methods for researcher evaluation according to farmer and trader criteria. Such methods will not replace all client participation, but means that scarce resources can be channelled to involving clients where their opinions are most needed, rather than having them routinely evaluate every trial. Some of the methods developed by the project for rapid evaluation are summarised in Box 8.
- *Framing research questions to provide critical data needed for decision-making,* as discussed in section 4, also helped to focus and speed research.
- *Re-examining the research programme every month, as a team,* at the planning meeting (see section 6), rather than once a year. This made it possible to reschedule studies or to add additional studies to make the best use of staff or make opportunistic use of materials (such as insect-infested maize or wood) available from work which was coming to an end. The rapid analysis and feedback from each study (discussed below under 'quarterly reports') was essential to this process.
- *Simultaneous operation of surveys, on-farm studies, trials and extension activities.* Frequently, research projects of short duration (the LGB project was initially planned for 2 years and later extended to 3.5 years) have no time to produce extension recommendations, let alone get feedback on them. This is because it is often felt necessary to refine research findings before they are 'handed on' to extension. During the earlier phases of the project, the aim was to generate working hypotheses, which were refined as the project proceeded, rather than to produce definitive, publishable results. The initial survey was complete within three months of starting the project, while trials started within two months. Farmers and extension staff were informed of possible solutions to the LGB problem as these emerged. This allowed time for problems at the extension stage to be fed back into the research programme during the lifetime of the project. Such an approach does, however, entail some risks and may not be feasible for all projects, particularly those of a more exploratory or open-ended nature. The danger of commencing trials simply to be seen to be doing something should certainly be guarded against.

Box 8. Two examples of rapid proxy methods for client evaluation developed by the project

Objective	Client-evaluation method	Rapid proxy method (researchers)
Evaluate trial treatments for effect on insect damage	Farmer groups dehusk maize, classify cobs into damage classes, rank or score treatments (Motte *et al.*, 1996; Magrath *et al.*, 1996)	Researchers score treatments on the basis of visual damage scales based on farmer classification (Compton and Sherington, forthcoming)
Value maize from trials for cost-benefit analysis	Cobs from each farmer damage class are shelled together and the resulting grain samples are presented to maize traders for valuation (Compton and Magrath, 1995)	Researchers shell maize in standard damage classes based on farmer classification. Damage-price equations developed from work with maize traders are then used to value grain samples (Compton *et al.*, forthcoming). Work is in progress to calibrate visual scales to estimate cash value (Compton, Magrath and Ofosu, unpublished data)

6 Important aspects of managing applied research: project organisation

Important organisational features of the LGB project included: a 'critical mass' of researchers organised in an interdisciplinary team with an anti-hierarchical ethos; the selection of experienced staff; extensive training for the whole project team; monthly meetings and quarterly reports used as management tools; good choice of host institution; flexible funding arrangements; and good administration.

A critical mass of researchers

A prime factor in the success of projects as a format for research is that they bring together a group of researchers who work together for a single goal and often in a single location. It is common for researchers in developing countries to be isolated and overstretched, which drastically diminishes their productivity. Prior to the LGB project, this was the case with post-harvest maize research in Ghana. A handful of post-harvest researchers was scattered through three universities and three research institutes, mostly working on separate and unrelated studies. Moreover, researchers everywhere in the world famously suffer from competitiveness and unwillingness to share ideas, a tendency which is encouraged by physical isolation.

The LGB project research team had 20–25 staff members, of whom eight were university-trained.[7] The majority were regular staff of the Ministry of Food and Agriculture. The project also had several National Service Personnel (secondary school leavers on one year pre-university work experience placements) and some casual laboratory staff (mostly unemployed secondary school leavers) at peak times of year. The administrative flexibility to take on students and other staff at short notice was very important to research success, as was the integration of all such staff as fully participating members of the project team.

The existence of a large group of researchers made the project team a natural centre for short-term training placements, for example for post-harvest officers from other regions, for university students studying post-harvest subjects, and for researchers from neighbouring countries. Taking on short-term trainees can be an overwhelming burden for a small research group, but a large group has a large number of activities which can easily absorb visitors.

An interdisciplinary team

Including socio-economic and extension specialists in an applied research team is likely to be important to the success of the research. However, the process of integrating this expertise and building a cohesive interdisciplinary research team is equally important. Many technical projects now recruit socio-economists, in particular, with the idea of keeping the technical workers in touch with farmers' opinions. However, the socio-economist cannot function alone as the 'human face' of a technocratic team, as testified by several critical accounts (e.g. Maxwell, 1984; Horton, 1984). It is necessary that all team members have a common vision of the work which includes interest in a farmer-participatory approach.

There are two phases in building an interdisciplinary team: project preparation and project implementation. During the project preparation phase, two important steps are the recruitment of staff who are sympathetic to interdisciplinary work and the definition of shared research objectives. This is often not well-recognised, as was the case with the LGB Project. Although the project was fortunate to have several staff members who were sympathetic to and experienced in interdisciplinary work, such experience

was not an explicit criterion in staff recruitment, and not all staff were initially so inclined. Moreover, the original project document defined two separate research programmes: the 'socio-economic programme' and the 'entomology research programme', although there were some indications that these should work together. The donor did take an interest in strengthening interdisciplinary work and arranged a special briefing of expatriate staff to discuss this issue before the project started. However, most of the practical work of building an interdisciplinary team took place during the implementation phase of the project, and since this is a very common situation the lessons learned may be useful to other projects.

Key factors which contributed to building an interdisciplinary team were:

- the redefining of research objectives by and for the research team as a whole (not split by discipline) after the project began;
- the use of interdisciplinary teams on each project study, with different individuals responsible for each study;[8]
- mixing teams on different studies, giving everyone the chance to work with everyone else;
- frequent discussion of project objectives and results, both informally and in plenary monthly meetings (see below);
- in-service training in which the whole team was involved (see below).
- promoting disciplinary transparency, such that all team members would be aware of the objectives and methods of every study, and these would be open to debate. Everyone had a chance to undertake all field tasks, whether or not these would have been considered normal for their particular discipline. 'Blinding with science' (or with any other discipline) was discouraged.
- finally, the wearing of project T-shirts (initially developed as extension materials) as an unofficial uniform by many members of the research team also fostered a team identity and helped to identify new project staff to farmers on field visits. In retrospect, an official project uniform (such as a T-shirt or hat) might have been a good investment.

Anti-hierarchical ethos

Whatever one's own preferred management style, it must be recognised that the strict, hierarchical way of working which is typical of many conventional research setups can be counterproductive in applied agricultural research. There are several reasons for this. First, so-called 'junior' technical staff often have knowledge which is not available to 'senior' university-trained staff. If they do not feel that they are respected and valued members of the research team, they may not communicate this information to others in the project or use it to improve project work. For example, agricultural technical staff often communicate better with farmers than city-bred university graduates and may receive more honest feedback about ideas advanced by the project. Also, junior technical staff are often less mobile than senior staff and may therefore be aware of previous agricultural development work in the project area; their knowledge can be valuable to prevent the project reinventing the wheel. (As an example, one research project unwittingly set up an experiment which was virtually identical to that done by a previous project a few miles away: one of the technicians had actually worked on the previous experiment but did not think that anyone was interested enough in his opinion to mention the matter.) Second, the success of trials and fieldwork depends on all staff understanding the reasons behind their activities and feeling responsible for the success of the work. Third, the call for participation with farmers looks hypocritical if there is no equivalent respect for all project staff.

The LGB Project aimed to devolve research and extension responsibilities among staff as much as possible. For example, MoFA Technical Officers and District Post-Harvest Officers were encouraged to make substantial inputs into the design and implementation of studies and trials and to question objectives and methods. All staff were encouraged to take on responsibility for some part of the work, depending on their individual talents, which ranged from laboratory management to acting. All staff were also involved in manual field work (such as shelling maize or carrying baskets of cobs), especially at peak times of year. This helped to win the confidence and enthusiasm of technical staff, who had previous experience of senior staff disappearing into a cool office to do something 'more important' when any hard labour was to be done. It was important to maintain this atmosphere as new staff joined the project. One interview technique devised by the technical staff – which deterred at least two applicants – was to ask interviewees to join other staff in field labour.

The willingness of several senior individuals on the project to share ideas with all staff, to discuss and question methods, and to participate in field labour was a critical factor in the success of the anti-hierarchical approach. Their positive attitude meant that any other person who attempted to pull rank experienced social pressure against this behaviour. This underlines the importance of exploring senior staff attitudes to such issues during recruitment.

Experienced staff

Obvious though it may seem, it is worth mentioning the benefits of having experienced staff on agricultural

research projects. It is not uncommon to find research projects which are run by Ph.D. students or by inexperienced people fresh from university, partly in the interests of economy. Intelligence and dedication, even when combined with an interest in farmers' views and in a participatory approach, are no substitute for field experience. This shows up in the tendency to reinvent the wheel mentioned earlier, and in numerous small but costly experimental errors. Farmers, too, are more likely to take a participatory dialogue on a farming subject seriously when the researcher knows something about farming and about the subject: goodwill is a necessary, but not sufficient, condition for productive dialogue.

The LGB project was fortunate to be staffed by people with substantial experience in post-harvest grains, marketing, extension and participatory work with farmers. The senior entomologist, who was seconded to the project from the Ghana Crops Research Institute, had over 20 years of post-harvest experience. The expatriate staff were seconded from the Natural Resources Institute (NRI), an UK-based centre for post-harvest work which had previously managed four other field projects targeting the Larger Grain Borer (see e.g. Farrell *et al.*, in press). The team received technical back-up from NRI and was able to build on its experience. This 'institutional memory', which is lacking in many one-off projects, was very important.

In-service training

There are three main reasons why training is an important component of agricultural research projects. First, team-building requires that all team members share a common vision. This can be imparted by training. Second, if projects are to be sustainable, team members who stay on after the end of the project must be fully equipped and trained to continue the work. Third, if research is to be implemented effectively, *all* research staff must have a clear understanding of research objectives and methods. Many small, on-the-spot decisions have to be made during trials and field studies which will affect the quality of the data obtained. If study supervisors do not feel able to delegate these decisions without risking major errors, they will have to oversee every single activity personally and this will significantly lower the productivity of the project.

Virtually all projects include some element of staff training, but this is often individualised (e.g. short courses or degree courses away from the work site) and limited to senior staff members. Even if the content of such training is very relevant to the project work, which is not always the case (for example with some overseas courses), a returning trainee may find it difficult to make full use of the new ideas gained to improve the project, unless s/he is an enthusiastic and articulate enough advocate to bring others round to the new way of thinking. Moreover, when individuals are sent away for long periods of training they may miss critical moments in the project team's own development.

In the LGB Project, many in-service training sessions were held for all project staff. In most cases, other staff of the MoFA also participated. Subjects covered included: participatory methods, statistics, experimental design, data analysis, report-writing, computing, laboratory methods, and field research methods for individual studies. Most of these sessions were given by project staff with experience of the particular subject involved.

Training methods were informal, dominated by group exercises and discussions, and the subject matter was tailored to project needs. In two cases outside experts were engaged to give short courses. A major advantage of this was the prestige which being able to draw on international expertise brought to the course, especially when it wished to attract and persuade senior Ministry staff of the value of a new approach, as was the case with the 'farmer participation' course. On the other hand, the disadvantages were the cost and the difficulty of tailoring the courses to local needs; both the courses given by outside experts were later supplemented by sessions given by project staff.

Plenary training sessions offered a good general forum for discussion and team-building, as well as helping to make sure that everyone shared an understanding of subjects such as basic interviewing techniques and the purpose and correct use of blocking in replicated trials. Individual staff career development plans were not ignored, however. The project helped individuals to gain specific skills and qualifications which could help them in their future career, including degrees, computing skills and practical certificates such as driver's licences. This was an important factor in retaining staff enthusiasm for the hard work demanded by the project. In the final year of the project a consultant was taken on with the remit of discussing future plans with all staff individually and making detailed proposals for the continuation of work after the project (Sekou, 1995).

Monthly plenary meetings

It is easy for a complex research project to run into communication problems. Study and trial organisers often compete for laboratory staff, transport and facilities, and resentment can arise over small issues. Regular, formal meetings are essential to prevent this.

All LGB project research staff and collaborators (20-30 people) met once a month for about three hours. District staff had a financial incentive to attend these meetings, as travel and subsistence payments for the month were made on the same day. National project

management was also represented at most meetings.

The monthly meeting had three main sessions: report-back of the previous month's work; work plan for the coming two months; and administration. In the report-back session, which took more than half the meeting, *all* staff were asked to report on progress, by study. This provided some unspoken peer pressure for achievement of work goals, and also brought any misunderstandings out into the open. Staff were encouraged to report any interesting field observations they had made during the month and to discuss them in the meeting (these could be, for example, farmers' ideas or problems with the methods or equipment used in the study). Often, such a discussion would result in an immediate plan for follow-up action to check or test the observation.

In the planning session, a large calendar for the coming two months was put on a whiteboard at the front of the room and filled in gradually as study organisers called out their plans and personnel needs, and staff called in other commitments such as leave and meetings. This not only made everyone aware of all planned project activities (at times up to 15 studies and multi-site trials were running simultaneously), but it also made transparent the process of competing for staff and facilities at peak times, and forced the project to prioritise openly. Finally, in the administration session, all staff had an opportunity to air grievances or resolve problems openly, or to contribute to administrative decision-making. Recurring discussions included such subjects as: 'Is the mileage allowance enough to cover motorbike costs?'; 'How can we prevent overuse of the photocopier?'; 'Should we take on some casual staff this month?' The meetings thus helped to foster team spirit as well as improving communication.

Quarterly research reports

In theory the results of one research study are always a vital input into planning the next one. However, a classic problem in agricultural research is that the agricultural year rushes swiftly on from seed time to harvest, and often data analysis takes a back seat, especially when the experimental programme is ambitious. It is surprising how often scientists reply, when asked for their trial results, that they have not yet looked at the data. Yet frequently the main results may be obvious just from a visual inspection: for example, treatment A does not seem to work, and treatment B looks much better than the rest. If statistical analysis is needed to see if treatment C really is better than treatment D, this may mean that the results are not really sufficiently striking to be of interest to small-scale farmers. Given the variability of small-scale agriculture, approximate results from a large variety of environments (preferably on-farm) often give a better picture of a treatment's likely performance than detailed statistical analysis of one or two trials.

In the LGB project, the quarterly reports required by the donor agency developed into an important tool of research management. Quarterly progress reports were collected from each study organiser, and results were insisted upon even where these were only rough impressions (this was made clear, of course, in the reports). This improved project productivity and helped with planning subsequent studies. Regular, detailed reporting also provided an opportunity to verify that each study organiser was on top of his/her subject and had fully thought out the objectives, methods and analysis, thus maintaining good research quality.

Supportive institutional setting

The location, attitudes and managerial culture of the host institution are critical to the success of any research project. Institutions which are physically distant from farmers and their problems, which prioritise concerns such as the production of academic papers, or which have internal managerial problems are unlikely to be suitable hosts for a participatory, field-based project.

A further problem can arise if a project is based at an inappropriate level within the host institution. Projects frequently base themselves at the national headquarters of the host institution, usually in the capital city. This is rarely ideal, because headquarters staff are frequently overloaded with other activities and visitors, the capital city is usually some distance from the main farming areas, and city life provides many counter-attractions to project work. On the other hand, projects which have no national representation are likely to run into political or organisational problems originating at national level.

The LGB project's national management was based in the MoFA offices in the capital city, while the research team was based in a regional office of MoFA, opposite the regional agricultural extension offices. Most agricultural research in Ghana is based in research institutes under the Council of Science and Industrial Research rather than in the Ministry itself, although some MoFA departments carry out adaptive trials. However, there were many advantages to being based in the MoFA and the arrangement worked very well for the LGB project. The Ministry's extensive network of staff in rural areas helped the project make rapid contact with farmers and traders, and research-extension linkages were very strong due to the physical proximity of the extension department.[9] However, the future of adaptive research in the Ministry is currently under debate and it is not clear if the type of research developed under the LGB project will continue.[10] Since long-term institutional changes affecting research are frequent in nearly all countries,

this is perhaps an argument for investing in short-term research projects with a clear focus and time-limit (such as the LGB project), as long as the nature of the research problem makes this possible.

Flexible funding arrangements

Funding arrangements can influence project efficiency and morale. This section discusses several funding-related issues, including the question of who pays recurrent project costs, the amounts of those costs, and administrative flexibility for fund-holding.

In projects which receive finance both from a national government and from an international donor agency, the question of who pays recurrent costs such as travel, subsistence and fuel is often a touchy one. Commonly, the national funding agency has cash flow problems and finds it difficult to make such payments on time, while the donor agency refuses to pay them on the grounds that this will make the project work unsustainable. Meanwhile work may grind to a halt, as most staff cannot advance payments out of their own pockets. Although sustainability of the work is undoubtedly an important issue, it is the contention of this paper that it must be addressed at an early stage, during project planning. Once the decision has been taken to finance an intensive, relatively expensive project (for example, one which provides vehicles and expatriate staff), it is uneconomic to risk the outcome of the project by refusing to pay recurrent costs. The alternative solution, of course, is a low-budget, long-term research project using existing personnel in research institutions – this is normally more sustainable, but carries the risk that it will not be able to mobilise a critical mass of researchers to accomplish the research objectives, or that unexpected institutional changes will threaten the research set-up (see above).

The levels of such recurrent payments constitute another issue which can affect long-term research success. It is argued here that subsistence and other such payments made by projects should be roughly in line with local rates, even if they are paid by foreign donors. Certain aid donors are known for making very high subsistence payments. In part this may be because rates are a difficult moral point for many expatriates on international salaries, who feel uncomfortable about the differences between their salaries and those of locally-paid staff, and tend to compensate by boosting the rates of project payments. However, if project rates rise significantly above local rates, there can be several adverse effects: it may sour the relationship between project staff and others in the host institution who do not receive such payments; it may attract senior staff of the host institution (often not well-paid themselves), who then use their rank to supplant people who are actually involved with the fieldwork (this is particularly common at internationally-funded meetings and conferences, which often carry heavy subsistence payments); and it tends to skew the work unduly towards the types of activities which are eligible for payment. For example, if attending meetings carries special financial benefits while laboratory work does not, no-one will be very enthusiastic about doing laboratory work.

Finally, it is important for projects to have the administrative flexibility to manage their own budgets according to local needs. For example, it is beneficial to be able to make overtime or day-out subsistence payments when needed; some projects/donors only permit the payment of overnight subsistence, leading staff to invent reasons for overnight stays, or to compete for overnight trips while important work nearer to base is disfavoured. Problems over the use of project vehicles are also common. Many institutions/donors have a standard vehicle policy and insurance terms which cover urban and rural projects alike. In rural areas, in particular, numerous social obligations arise which may conflict with the policy, such as the need to give lifts to farmers when travelling from village to village (in remote areas, the project vehicle may be the only vehicle which has passed that week), or to help staff members with pressing family needs such as funerals of very close relatives. Project failure to comply with such obligations can affect the outcome of research when farmers become unwilling to collaborate or staff morale drops. Administrators of rural projects must thus maintain a difficult balance between minimising expenditure and other risks connected with using project vehicles, and keeping the project on a good footing with collaborators and staff. Centralised regulations restricting vehicle use to that expected in an urban environment can make this task very difficult, although guidelines are of course essential.

The LGB project was very fortunate to have, during most of its lifetime, a flexible local budget from the donor agency which enabled the project to advance money to cover recurrent costs (mostly travel and subsistence) much of which was later repaid by the MoFA as funds became available. The budget also permitted the payment of some overtime to Ministry staff, and other payments such as gratuities to traders who helped with the research (see Magrath *et al.,* in this paper). Such payments were critical to the high productivity of project research. All payments were in line with local rates and staff were generally accepting of these and willing to work very hard, although the rates formed an ever-interesting subject of discussion at project meetings!

Good central administration

The quality of central administration can make or break a project. It can be very demoralising if the arrival of key equipment is delayed or if overly-

bureaucratic rules stifle initiative. Over-centralised and inefficient procedures can drastically reduce productivity. For example, some international organisations require all procurement to be done through a malfunctioning central system, delaying the arrival of vital equipment. (One expatriate on a two-year project said that his project vehicle arrived "just in time to transport the drinks for my leaving party"!)

The national and international administration of the LGB Project was very efficient, particularly in managing procurement and maintenance of project equipment (see Box 9). There was also a long lead time for the project (not wholly intentional), which meant that imported equipment such as vehicles and laboratory supplies had arrived before work began. In addition, the project budget allowed for local procurement of materials and recruitment of local consultants, students and casual staff, avoiding some of the problems described above.

7 Important aspects of managing applied research: liaison with other organisations

For research projects, open communication and good linkages both with other departments within the host institution and elsewhere within the agricultural technology system are essential. These help prevent duplication of work, avoid contradictory messages being given to farmers and improve the chances that project work will be sustained in future.

The LGB project was partially successful in its liaison efforts. The project worked closely with several other departments of the Ministry, especially the agricultural extension services. Other stakeholders such as farmers, political officials, NGOs, schools, agricultural training centres and other post-harvest projects were kept informed and involved through yearly project workshops, other meetings, radio and TV programmes, contributions to newsletters and wide circulation of project reports. The project also hosted many visitors, including farmer groups and short-term trainees. Close contact was maintained with post-harvest researchers from neighbouring countries and LGB researchers around the world, to avoid duplication of research. Access to email, which came only six months before the end of the project, made a drastic improvement in international communication.

Nevertheless, in retrospect, even more effort could have been put into liaison and this could usefully have been spelled out as a specific project objective. On several occasions, project staff were surprised to discover other institutions or NGOs carrying out research which had previously been done by the project, or promoting technical options which had already been tested and found wanting. The original budget did not include adequate provision for liaison activities and resources had to be squeezed out of budgets for other activities. Finally, there was no formal linkage to 'upstream' (long-term, more speculative, better-resourced) research on LGB, which is currently carried out by a number of institutions including NRI (UK), the International Institute of Tropical Agriculture (IITA) and universities in several countries. Such linkages could run in two directions: uptake by upstream researchers of ideas generated by field projects, and review by field projects of proposals from upstream researchers. The LGB project generated a number of ideas for upstream research, but there is currently no formal mechanism for collecting these (together with those from other field projects) and reviewing them. Similarly, upstream research proposals are mainly generated and judged by the same institutions which implement the proposals (funding institutions rarely comment on details, although these may be critical to the success of the proposal), and there is rarely any formal procedure for 'peer review' by field projects. LGB project team members did have some opportunities both to propose research topics and to make comments on proposed upstream research projects on

Box 9. Motorbike maintenance

Motorbikes provided for project research work often have a short life-span and/or require heavy maintenance costs. Two common problems are careless bikers who fail to do basic routine maintenance and 'project mechanics' in a semi-monopoly position who charge over the odds for their work. Giving bikers a personal stake both in keeping the bike in good condition and in saving on maintenance costs goes a long way towards solving these problems.

The system developed by the LGB project was successful in keeping the 12 project motorbikes on the road during the project period (and to this day) at reasonable cost. After selecting individuals who needed motorbikes for project-related work, contracts were drawn up for the motorbikes to be sold to each individual, based on monthly payments to be completed before the end of the project. A fuel allowance calculated according to a specified rate per mile was paid monthly on presentation of mileage sheets. Claimed mileages were checked by the organisers of each research study involved, before being passed to administration for payment. (Payments were only made on approved project mileage, although bikers were also free to use their bikes for personal transport.) At the same time, a maintenance 'hard-running allowance', also based on mileage (for most of the project period this matched the fuel allowance), was paid into a special bank account. A record of each biker's holdings in this account was maintained, and individual bikers could draw on the funds they had accumulated to buy spare parts and pay for maintenance. This provided an incentive for bikers to seek out the lowest-cost maintenance to make best use of 'their' maintenance money. A reliable local mechanic was normally used, but riders were free to go elsewhere or bargain over rates if they felt he was overcharging. At the end of the project, any funds remaining to each biker's credit were used to buy spare parts for his machine. Meanwhile, the repayments on bike purchase were also paid into a special bank account, and at the end of the project these were made available to finance fuel costs for continuing research work.

LGB, but these were largely accomplished through personal contacts rather than any formal system. However, developing formal upstream-downstream linkages may be difficult in many cases given the multiplicity of institutions involved and the (often covert) competition between researchers from different institutions.

8 Summary: lessons to be learnt

Drawing on the experience of the Ghana/UK LGB project, this paper argues that simultaneous attention to selecting the right objectives and approach to the work, finding appropriate research methods, managing project administration effectively and investing in liaison with other organisations is necessary if applied research projects are to be successful. However, it must be acknowledged that the LGB project had some unusual features which might mean its experience would not be easy to replicate. It was a closely focused project, concentrating on the storage of a single crop after harvest, and to some degree on a single pest (LGB), in a single (although diverse) region of Ghana. Because the main target pest was new and highly destructive, farmers were very interested in the project outcome. It might not have been so easy to motivate the research team, or to secure such willing participation from farmers, if the research issue had been less well-defined, visible and immediate in its consequences (although there are many other such farming issues, especially in plant protection).

Even with these advantages, the positive features of the project described in the paper did not all arise by design. Some foundations for success were laid during project preparation (e.g. choice of a host institution with excellent contacts with farmers and extension), but some were due to good fortune (e.g. the genuine interest shared by staff in interdisciplinary, on-farm work). Moreover, the LGB project also had a number of weak points, of which the most serious is the question now raised as to whether the host institution will be able to carry out adaptive research in future (although some research is continuing at present).

In spite of these caveats, it is hoped that some aspects of the LGB project's experience may be useful in setting up new, applied agricultural research projects. In particular, it is suggested that:

- The project document should have clear overall goals, yet be flexible in detail, encouraging innovation by the team on the ground.
- The relative priority given to practical results for farmers and to publications should be clearly spelled out and budgeted accordingly. Frequent contact with farmers and extension staff is desirable to give researchers a sense of urgency.
- The project team should include staff with scientific, practical farming, socio-economic and extension expertise.
- The majority of research goals and activities should not be separated by discipline
- Staff recruitment should specify the need for on-farm experience and also experience (or at least proof of interest) in interdisciplinary team work. Back-up support and advice in specific technical areas should be made available.
- A suitable host institution with compatible goals and institutional culture should be sought. A regional research base with a national administration was a successful combination in the LGB project.
- Ample provision should be made for in-service training for the whole research team, which should be seen as a team-building exercise as well as a chance for individuals to gain specific skills. Training in participatory work, interview techniques and research skills (such as experimental design, computing, data analysis and report-writing) is likely to be useful.
- Provision should be made in the budget for liaison activities such as workshops and meetings, and investment in improved communications, such as email. Contact with other researchers, in particular, is invaluable to prevent duplication of effort.
- Administrative delays in setting up projects are common, and the time should be used to best advantage, especially if equipment is to be imported. Team members should be encouraged to communicate with each other and with other researchers in the same field in advance of the project's official start date. Ideally, there would be a pre-project workshop to facilitate this.

Finally, farmer-participation is a very popular buzz-word among international donor agencies at the moment. But agricultural problems cannot be 'participated' out of existence. Increased attention to farmer participation, although welcome, should not make technology-development projects lose sight of overall goals. Moreover, where a participatory approach is adopted, it is important to make sure that this is integrated into all activities and used by all members of the research team, rather than being grafted on as an independent activity undertaken only at certain times or by certain team members (typically the socio-economists). It is also important to look critically at the specific research questions asked and the technical methods used to make sure that these are all compatible with a farmer-participatory approach. In many technical disciplines, work is still needed to develop rapid, field-based methods of sample analysis which are compatible with rapid, participatory field studies.

Endnotes

1. The project was managed in Ghana by the Post-Harvest Development Unit of MoFA and in the UK

by what was then the Natural Resources Institute of ODA.

2. The other villages in which LGB had declined were mainly denoted as ones in which 'less LGB appeared in 1996'. In a few cases, the decline was attributed (without evidence) to the biological control agent which had been released against LGB.
3. Sources: LGB Research Team Quarterly Report 8 (ed. J Compton) (n = 414 villages) and unpublished survey data, LGB Project FLS Survey, 1996 (n= 389 villages). 'Don't knows' (but not 'nones') were excluded, as were the three most southern districts.
4. For example, LGB was discussed in the Ghana parliament following farmer complaints about damage, an 'honour' rarely accorded to other pest insects. Senior members of the government had good reason to sympathise: at least one had experienced severe losses to LGB in his own grain store. LGB also provoked the collapse of an NGO-sponsored village credit project by destroying the grain stored cooperatively as collateral.
5. Farming families in the project area usually have one or two maize stores with the median size of a store being about 500 kg of cobs. In the most common store type ('ewe barn'), maize is stacked on a platform in orderly rows in a cylindrical stack, with no exterior supporting walls. It is difficult to subdivide such a stack for experimental purposes: in research station trials, stacks are occasionally divided with a complex arrangement of chicken-wire and wood, but this is expensive and would be impractical for farmers. An experiment, such as the use of a chemical which is not effective against LGB, thus normally involves the entire maize store and failure can cost farmers dearly. We visited one farmer who had tried four different practices to save his maize from LGB; none worked and he had to purchase extra maize from the market to feed his family.
6. Over the project period, the extension service as a whole moved towards introducing extension based on a dialogue with farmers, which was simultaneously being promoted by a number of other institutions in Ghana.
7. One was on secondment from the Crops Research Institute, two were British expatriates and two to three were research students from national universities and polytechnics.
8. The term 'project study' refers to a coherent group of project research activities with a single objective. This could be a field or laboratory study or group of trials.
9. An earlier plan to base the research team in an agricultural research station rather than in the regional Ministry offices would have made the logistics of on-station trials easier, but would probably have reduced the links to farmers and extension staff.
10. The Post-Harvest Development Unit, in which the project was based, was moved during the second year of the project from the Crops Department of MoFA to the Agricultural Engineering Services Department, which has less history of adaptive research work.

Acknowledgements

The opinions expressed in this paper are the responsibility of the author and not of any of the institutions involved in the LGB project. Many ideas arose from working with my colleagues on the LGB project research team, especially Tony Ofosu, Priscilla Magrath, Felix Motte, Samuel Addo, Rose Feakpi, Monica Awuku, and Hilarius Penni, to whom many thanks. Not all of them may agree, however, with the opinions expressed here. Thanks to all who commented on drafts, especially Diana Carney for her incisive questions and additions. The Ghana/UK LGB Project was managed in Accra by Mr Robin Boxall and Mr Kwaku Nicol, and in the UK (NRI) by Dr Peter Golob.