PARTICIPATORY TECHNOLOGY DEVELOPMENT WITH LIVESTOCK-KEEPERS: A GUIDE

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Foreword

This guide draws heavily on the field experiences of a collaborative project involving BAIF Development Research Foundation and the Natural Resources Institute. The project has been seeking to identify and address feed-related constraints affecting goat production in semi-arid India. The four-year project, which finishes on 31 March 2002, is funded by the Livestock Production Programme[1] of the UK's Department for International Development, whose support we gratefully acknowledge.

This guide is intended for use by livestock researchers and development practitioners in India and elsewhere: since many field-level staff in India do not speak English the guide will also be available in Hindi. A companion guide on participatory situation analysis with livestock-keepers has also been published. Copies of this and other reports produced by the project can be obtained by contacting us at the addresses given below.

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CONTENTS

1. INTRODUCTION

Livestock research and development work has tended to lag behind crop production work in the development and application of methods for PTD. A review of some books on PTD and farmer participatory research reveals that there have been very few documented examples of projects in which livestock are a central focus (Chambers *et al*., 1989; Clinch, 1994; Okali *et al*., 1994; van Veldhuizen *et al*. [Eds], 1997). Perhaps only five percent of case studies have a livestock focus. Why is this?

One reason is that livestock research as a whole has received far less funding than crop research, and the level of funding has not reflected the importance of livestock in rural and peri-urban livelihoods in most developing countries. Another reason for the lack of PTD work in the livestock sector is that problems are commonly experienced (or perceived to exist) in conducting on-farm trials involving livestock. They are briefly summarised in section 2.5. Such problems either do not exist, or are less acute, with crop research. A third factor is that animal scientists have tended to be more interested in academic studies than in the actual needs of livestock-keepers: hence there has been a "lack of participation and interest among animal scientists" in on-farm animal research (Amir and Knipscheer, 1989).

The case for participatory research is just as strong in relation to livestock as it is in relation to crops; and there has been increasing recognition that livestock research needs to give greater emphasis to farmer participation (Sidahmed, 1995; Other refs?). Indeed, for the development of forage options, some researchers now believe that "participatory approaches are mandatory" (Peters *et al*., 2001). However, to be effective, such research needs to avoid the pitfalls often associated with livestock research. This guide is intended to help researchers (in both government agencies and NGOs), and livestock-keepers[1], to do just that – to design and conduct participatory experiments that lead to the development of effective technologies that will benefit resource-poor farmers. It is aimed at two main audiences: government researchers who have only limited experience of participatory research in villages; and NGO staff working in the field, who have little, if any, experience of participatory technology development. It does not pay much attention therefore to theoretical issues, and only covers very basic aspects of statistical analysis of experimental data.

The guide draws heavily on the experiences of a goat research project in semi-arid India managed by BAIF Development Research Foundation and the Natural Resources Institute (hereafter referred to as the BAIF/NRI project), whose focus has been on easing seasonal feed scarcity. It also draws on some of the limited literature available. The project conducted several trials with goat-keepers over a four-year period (1998-2001). Most of them involved feed supplementation, but in three of them the treatments were anthelmintics. The problems addressed included: low conception rates of female goats, low milk yield and high mortality rates in young goats (see also Table 2.1).

1.1 Types of Agricultural Research

Technological NR research practised by professional researchers may be conceived as three points on a continuum. At one end, strategic research pursues knowledge concentrating on understanding causality and process which have potentially global application. Applied research, mid-way on the continuum, involves using the process and understanding generated by strategic research and applying these to address more specific issues, problems or

[1] The term 'livestock-keeper' is used in this publication rather than 'farmer', because not all people who keep livestock are farmers.

opportunities with a view to making recommendations. At the other end of the continuum, adaptive research takes proven applied research, or good practice from elsewhere, and makes adjustments for it to work in specific situations and locations.

We should not forget that many rural people also conduct their own research, but usually in a more idiosyncratic way than do researchers. Having less time and resources than full-time researchers, but more local knowledge, the majority of local people are more likely to engage in an adaptive type of research, i.e. trying out ideas and technologies borrowed from others and seeing how they work for themselves, making adjustments along the way. This has implications for the way in which professional researchers manage relationships with their farmer clients.

1.1.1 Different modes of farmer participation in local research

Researchers can conduct research on-farm (or on animals, or on a local site belonging to a community institution) in a number of different ways, not all of which involve a high degree of participation from local people. A widely used classification system for different types, or modes, of farmer participation in on-farm research based on Biggs' (1989) typology is summarized in Table 1.1. The degree of farmer involvement in decision-making varies from mode to mode, and increases in the modes to the right- hand side. These four modes are really different points on a continuum. There are no clear dividing lines between them, and a project may gradually move from one mode to another during its lifetime: indeed, it is common for projects to begin in the consultative mode and to shift to the collaborative mode as researchers and farmers (or livestock-keepers) develop (a) a common understanding of experimental objectives and the best ways of achieving them and (b) a relationship based on trust.

Table 1.1 Four different modes of managing farmer participation in agricultural research

	Contract	**Consultative**	**Collaborative**	**Collegiate**
Type of relationship	Farmers' land and services are hired or borrowed, e.g. researcher contracts with farmers to provide specific types of land.	There is a doctor-patient relationship. Researchers consult farmers, diagnose their problems and try to find solutions.	Researchers and farmers are roughly equal partners in the research process and continuously collaborate in activities.	Researchers actively encourage and support farmers' own research and experiments.

Source: Biggs (1989).

The traditional mode, in which the researchers are dominant and farmers least involved, is the *contract* mode. The contract mode involves formal experimentation in specific on-farm situations, but the farmers' views are not actively sought by the researchers. The *consultative* mode, classically exemplified by applications of the farming systems research approach of the early to mid 1980s, includes "diagnosing farmers' practices and problems, planning an experimental programme, testing technological alternatives in farmers' fields and developing and extending recommendations" (Tripp, 1991). In this mode, it is the researchers who provide the solutions, plan the experiments and finally recommend what is best practice.

In the *collaborative* mode, the ideas for interventions to be tested may also come from farmers or other knowledgeable people in the locality, and are the product of discussions between the researchers and NR users. In the case of the *collegiate* mode, it is the farmers themselves who play the lead role in identifying what the content of the experiments will be, and the manner in which they will be conducted.

Different agencies have different reasons for promoting participatory experiments. For some, the primary aim is functional, i.e. to develop effective and adoptable technologies for poor households more efficiently. For others, particularly NGOs, the primary aim may be to empower poorer and weaker sections in social, economic and/or political terms. This guide focuses mainly on the functional dimension of participatory experiments. The terms 'participatory technology development' (PTD) and 'participatory experiments' are used interchangeably, and refer to the *collaborative* and *collegiate* modes. Most of the examples and experiences that the guide draws on are from research done in the consultative and collaborative modes.

1.2 The Advantages of Farmer Participation

Resource-poor livestock-keepers are usually short of cash for purchasing inputs for their animals, such as feed or medicines. Thus, for them it is important to draw on materials that are locally available on their farms or in the nearby environment; or which can be introduced easily. Unfortunately, researchers who have developed technologies away from the farm, on research stations, have tended to develop ones that are unaffordable or cannot be introduced easily.

A participatory approach to technology development can help to ensure that new technologies are appropriate to farmers' and livestock-keepers' needs and circumstances, and hence increase the likelihood of adoption (Conroy *et al*., 1999; Reijntjes *et al*., 1992). Examples of technologies developed by the BAIF/NRI project are given in Boxes 1.1 and 1.2. Greater participation of the intended users can mean that:

- applied and adaptive research will be better oriented to farmers' problems;
- farmers' knowledge and experience can be incorporated into the search for solutions, and highly inappropriate technologies can be 'weeded out' early on;
- the performance of promising technologies developed on-station can be tested under 'real-life' agro-ecological and management conditions;
- researchers will be provided with rapid feedback on the technologies tested, and promising technologies can be identified, modified and disseminated more quickly, reducing the length of research cycles and saving time and money[2];
- farmers' capacity and expertise for conducting collaborative research is built-up and becomes a valuable resource for future research programmes (Conroy *et al*., 1999).

1.2.1 Livestock feed technologies

Scientists have acquired a tremendous amount of knowledge about the feed resources and nutrition of ruminants, both large and small (Acharya and Bhattacharyya, 1992). Despite this, the adoption of technologies developed by researchers, for enhancing fodder production and improving grazing management systems, has been disappointing, particularly among resource-poor livestock-keepers (*ibid*.; Sidahmed, 1995; Peters *et al*., 2001). This is partly because feed technologies have often been developed without the involvement of the intended users, and without an adequate understanding of their farming systems and constraints. These include: (a) fodder crops, which the farmer cannot grow because (s)he does not have enough

[2] More conventional procedures have involved 'pre-screening' by researchers, followed by a minimum period for running trials to generate statistically valid results before making 'recommendations'. These might then have to pass through a committee structure before being 'released'. When farmers participate more actively in the technology screening process, they also formulate their own recommendations while doing so (Sutherland and Kang'ara, 2000).

arable land and they compete with food or cash crops; (b) urea treatment of straw, which is only appropriate under a limited set of conditions[3]; and (c) inputs that have to be purchased, such as compound feeds or concentrates, and are too expensive and may not be available locally.

BOX 1.1 THE USE OF TREE PODS TO IMPROVE KIDDING RATES

In Bhilwara District of Rajasthan, India, there is evidence that feed scarcity in the dry season is a constraint on the reproductive performance, particularly conception rates, of goats belonging to poor people. On-farm trials in 1998 and 1999 fed breeding does a mixture (250 grams/day) of *Prosopis juliflora* pods and barley for 10 weeks, during the later part of the dry season when fodder scarcity is most acute. The pods were collected when they appeared on the trees in April and early May and stored for use later. In 2000 a similar trial was conducted, but this time the treatment (again 250 grams/day) was entirely *Prosopis julifora* pods.

The mature does in the treatment groups had higher conception and twinning rates than those in the control groups, and hence higher kidding rates. The mean number of kids per doe in the treatment groups was significantly higher than that in the control groups, providing clear evidence that the treatment results in does producing more kids than they would otherwise have done (see Appendix 4 for details). Using *Prosopis juliflora* pods alone gave a cost:benefit ratio of 1:2.57. More optimistic assumptions give a cost:benefit ratio of 1:5.

An example of a feed-related technology developed under the auspices of the BAIF/NRI project is given in Box 1.1. This technology has excellent prospects for widespread adoption by poor livestock-keepers in India because: the pods do not have to be purchased; the tree is found across a large area of the country; the tree grows on common lands and by roadsides; and the collection time occurs at a time of the year when many livestock-keepers are not particularly busy.

1.2.2 Livestock health technologies

Government veterinary services in developing countries, although they may be free of cost in principle, tend not to reach resource-poor farmers. In India, extension services are characterised by biases that result in them tending to neglect poor rural livestock-keepers, and particularly goat-keepers (Matthewman *et al*., 1997). Most extension organisations focus on large ruminants "almost to the complete exclusion of other species" (ibid). They also tend to focus primarily on intensive systems; and to be concentrated in higher potential areas. In other words, livestock-keepers in relatively remote areas, particularly those with smallstock, are unlikely to be reached by state veterinary services.

There is a need, therefore, to develop health-related technologies based on locally available materials or expertise. Where these technologies are based on indigenous technical knowledge they are generally categorised as ethnoveterinary medicine. They include: improved housing, technologies for the treatment of wounds, and materials with anti-helminthic properties for de-worming animals. PTD has a vital role to play in developing such technologies. An example of a health-related technology developed under the auspices of the BAIF/NRI project is given in Box 1.2.

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[3] The required conditions are: (a) fine straws are in good supply; (b) green fodder is relatively scarce; (c) a plentiful supply of water is readily available; (d) plastic covering and urea can be obtained cheaply and reliably; and (e) high market prices for animal products allow the purchase of inputs (Bayer and Waters-Bayer, 1998).

BOX 1.2 THE USE OF A LOCAL PLANT MATERIAL AS A DEWORMER

In the Karnataka project area high kid mortality during the rainy season was identified by goat-keepers as their main problem. The project conducted trials in 2001 to address the problem, which was thought to be linked to the worm burden at that time. In one trial two treatments were tested: (a) a commercial de-wormer, *Fenbenzadole*; and (b) a locally available material known to have antihelminthic properties. There is evidence that mortality rates are higher for kids of does that have a heavy worm burden, so the treatments were given to does in late pregnancy and on the day of kidding.

The locally available material that was used was the trichomes (hairs) from the pods of a leguminous creeper, *Mucuna pruriens*: the dose, which is mixed with a lukewarm sugary solution (jaggery), is 20 mg per kg body weight. The idea of using this material came from the fact that members of a local caste specialising in buffalo-keeping were known to use it. There was very little mortality in kids less than one month old, even outside the treatment groups, probably due to the low rainfall; but among kids aged 31-120 days there was higher mortality in the control group. Both treatments were very effective in reducing the worm burden of the does (shown by analysis of faecal samples before and after their use), and hence in improving their condition. In addition, the kids of does in the treatment group grew faster than those of does in the control group, which is thought to be because the former group were producing more milk. The treatments also have very favourable cost: benefit ratios. The goat-keepers said that in future they expect to use the local material, rather than the commercial one, because no cash expenditure is required.

2. WHEN TO DO PARTICIPATORY TRIALS

Farmer participation should not be initiated for its own sake. In many situations farmer participation in research is beneficial, but it is not always absolutely necessary. It is not simply a question of where the research is conducted, on-farm or on-station. The key issues are when is farmer participation likely to be (a) beneficial and (b) cost-effective? This may be influenced not just by where the research is carried out (on-farm or on-station), but also by the objectives, the type of technology, the level of risk involved, and the researcher's attitude and objectives.

2.1 Project and Institutional Objectives

Project and institutional objectives have a major bearing on which mode of farmer participation researchers should choose. There are three general objectives that are often associated with farmer participatory research (FPR) projects. *First*, there is the development of technologies to improve agricultural and NR productivity, and also to improve rural livelihoods and food security. A *second* objective is human resource development (to enhance the capacity of the stakeholders to diagnose problems and respond to them) and a *third* possible objective is institutional development. The latter two objectives may be linked to a broader agenda, in which the development organizations involved seek to *empower* poorer groups of society.

Government research services are generally concerned with all of these objectives, but emphasize the first. Where this objective is given overriding importance, a mix of the *consultative* and *collaborative* modes will generally be most appropriate. Through the application of these modes it is expected that national experts will build-up the skills and experience required to conduct FPR more efficiently, and thereby address objectives two and three. Development projects, particularly those involving NGOs, may also be concerned with all three objectives, but place more emphasis on the second: in this case a mix of *collaborative* and *collegiate* modes is the most appropriate.

BOX 2.1 Determining what Percentage of Seeds in Tree Pods are Digested

The BAIF/NRI project wanted to know whether or not goats were digesting most of the seeds in the *Prosopis juliflora* pods. The seeds are highly nutritious, but have a hard outer casing that might prevent them from being digested. If most of them were not being digested there would be a case for grinding the pods before feeding them to the goats, and the project wanted to know whether it would be worthwhile conducting an experiment in which the treatment would be ground pods.

To get the answer to this question it was necessary to quantify the number of seeds going into the goats and the number of seeds coming out; and to do the latter required the collection and analysis of all of the goats' faeces. This could only be done in a controlled situation where the animals were stall-fed, so the trial was conducted at BAIF's Central Research Station. The trial showed that the vast majority of the seeds were digested by the goats, which was contrary to perceptions of field staff.

2.2 Experimental objectives and type of technology

Whether PTD is appropriate (and if it is, which mode to use) will depend partly on specific research, or experimental objectives. Unlike the project and institutional objectives, experimental objectives are largely technical and often technology specific. Some kinds of trial are more appropriately conducted on station: an example of such a trial is given in Box 2.1.

There are situations in which on-farm trials are appropriate, but in which anything beyond the very limited involvement of farmers may be detrimental to the achievement of these research objectives: here the contract mode would be most appropriate. This applies to trials in which quantified biophysical information on the interaction between the technology and the environment is the primary requirement.

Where experimentation has more than one objective, each objective is likely to have implications for data requirements, and for the approach taken. The requirements of the different objectives can be conflicting, necessitating trade-offs between the optimal approaches (Coe, 1997). Where there are substantial conflicts it may be preferable to have separate experiments, with different degrees of farmer involvement. Suppose, for example, one objective is that given in the example above: another is to investigate how the technology performs under farmers' management conditions, and the third is to obtain farmers' assessments of the technology. In this case, one experiment (in the contract mode) is required to achieve the first objective; and a second one (in the consultative or collaborative mode) is required for the other two objectives, which are relatively compatible. The experiments may run in sequence, or in parallel, depending on the projects' time-frame and resource base, and the researcher's instincts about the applicability of the technology.

Participatory research is not appropriate for all types of technology. Where the targeted livestock-keepers have limited knowledge about the research topic or the biophysical nature of the problem (e.g. viral diseases), or have little understanding of the technical solution on offer, the benefits of FPR in the more 'upstream' experimental activities are likely to be minimal. Another, related, consideration is the extent to which participating farmers would have scope for manipulating or adapting the technology being researched: livestock vaccines, for example, offer less scope for adaptation than do drugs for controlling animal parasites or diseases.

2.3 Potential Problems in Livestock Trials

Various problems have been identified as being commonly associated with livestock trials: these are described below (Amir and Knipscheer, 1989). Later sections of this guide discuss ways of avoiding or minimising these problems.

Life cycle duration Evaluation of animal performance often requires a longer period than crop performance evaluation: it has been suggested that experiments involving the former generally last for more than a year, whereas those involving the latter are generally less than four months in duration (Amir and Knipscheer, 1989). This may be incompatible with the ceilings imposed by donors on the duration of research projects (Morton, 2001), which often have a maximum of three years; and livestock-keepers may lose interest in the experiment after a while, or animals may die during the trial. The monitoring periods for a range of trials are given in Table 2.1, the longest being about 15 months.

Life cycle synchronization Animal production is not synchronized (to the extent that crop production is), so it can be difficult to find enough animals in the same age category and the same production phase, and to ensure comparability between animals in treatment and control groups.

Monitoring effort Animals may need to be monitored once or twice a month, whereas crops usually can be checked less often. This can be a problem for researchers. It can also make demands on the owner's time that (s)he may resent, particularly if (s)he does not see the need for such detailed quantitative data.

Mobility The mobility of livestock means that environment-animal interactions are difficult to describe and measure, and factors that are not included in trial treatments are difficult to control. (Difficult to measure and control non-experimental factors.)

Number of observation units. Animal performance in a small farm setting is measured as production per animal (whereas crop yield data are averages of a large number of plants): consequently, statistical variability of treatments between animals or animal groups tends to be greater than between, for example, fertiliser treatments.

Risk-bearing: Owners reluctant to risk experimentation As animals are large and valuable, compared with crop plants, the owners may perceive controlled trials and experimental interventions on their animals as too risky, particularly where they are unfamiliar with the technology.

Inter-annual variability in livestock productivity Productivity varies considerably from year to year due to factors such as rainfall and outbreaks of disease, which may make it difficult to isolate the effect of a treatment.

Identification of experimental animals This can be a problem if they belong to herds that include non-experimental animals. The larger the herd, and the more similar the animals, the greater the potential problem.

Ensuring the treatment is only given to experimental animals Animals belonging to the same herd often eat from the same feed container. Thus, for example, if a feed supplement is only intended for breeding does, it may be difficult to ensure that kids do not consume it too.

Table 2.1 Some Examples of On-Farm Livestock Experiments

Challenge addressed	Treatment/ technology tested	Timing of treatment	Key indicators	Monitoring period/duration of trial
Some Trials on Goats Conducted by the BAIF/NRI Project				
Poor reproductive performance of female goats	Tree pods supplement	Daily for 10 weeks during scarcity period (mid-May to end July)	Conception and number of kids born	7-8 months, from mid-May to December
High kid mortality in goats	Dewormer	Applied to does in late pregnancy and on day of kidding	Mortality rate 30 days after kidding	2-3 months
Faster growth of young male goats to increase income	Barley supplement	Daily for 2-3 months for goats aged 3-6 months	Weight of males and sale price	About 9 months – from start of treatment to age at which most males had been sold
Earlier sexual maturity of young females, to increase no. of kids produced	Barley supplement	Daily for 2-3 months for goats aged 3-6 months	Weight of males and sale price; age at which females reached sexual maturity	About 15 months[1] – from start of treatment to age at which females came into heat or conceived
A Trial on Chickens Conducted by the Western India Rainfed Farming Project				
Increase meat and/or egg production by chickens	Four breeds of poultry new to the area. (Local birds as control.)	Not applicable	Weight gain, production capacity, market price, adaptation to hot local environment. Owners' preferences.	12 months
Hypothetical Trials on Large Ruminants				
Improving draft power so that land is prepared more quickly	Modified plough	Ongoing for two weeks	Efficiency of ploughing. Effect on oxen. Farmer acceptability.	2 weeks
Increasing milk production by cows	Two types of fodder	Each daily for 10 days, with 5 day gap in between. Different sequences for different cows.	Milk yield	25 days

[1] A comparison was made with female goats not receiving the barley, and these did not normally conceive until they were about 18 months old.

2.4 More on Risk-bearing

If a high level of risk is involved in the planned research, it will not usually be appropriate to engage a high level of farmer participation. This is particularly true early on in a project, when researchers are establishing rapport and credibility with farmers. When good rapport has been established, researchers can afford to take more risks ‘publicly’ because the collaborating farmers will be able to understand that to identify a suitable technology, a number of possibilities may need to be tried out on a small scale. Early on this is difficult, because farmers who have not been exposed to formal experimentation tend to view an agricultural research trial like an extension demonstration.

The BAIF/NRI trial described in Box 1.2 represented a potentially serious risk to the participants. The goat-keepers, who do not normally de-worm pregnant animals, were concerned that giving anthelmintics to does in late pregnancy might result in them aborting. The researchers were also concerned, and bore this factor in mind when selecting a commercial drug for use as a treatment. After a review of the literature, and discussions with animal scientists, the BAIF staff selected a drug that was considered to be least likely to cause abortion. The researchers did not pressurise the goat-keepers to participate in the trial, but took several steps to win their trust until the people saw them as friends and guides. They: visited each prospective trial participant; analysed faecal samples of goats that were sick and weak; provided or arranged veterinary assistance to them; and discussed the issues with them in several meetings. The trial only went ahead after the goat-keepers had chosen to participate despite the risk. Fortunately, abortions did not materialise. In this case, some researchers might have decided to do an on-station trial first, so that they could be more confident that the problem would not arise, provided they had the facilities to do that.

Where the lives of people’s animals are at risk anyway from the problem to be addressed by the trial, the livestock-keepers are more likely to accept the risk of a potentially effective treatment. For example, in a trial in Kenya, designed to address the life-threatening disease of mange in goats, the “farmers were willing to carry the risk of experimental failure rather than lose their animals” (Sutherland and Kang’ara, 2000).

3. ESSENTIAL CONDITIONS FOR PTD WITH LIVESTOCK-KEEPERS

3.1 Institutional Capacity

To implement participatory research effectively certain institutional requirements need to be met. First, researchers’ organizations and their main collaborators need to have a *commitment* to FPR. Secondly, they should have an appropriate and sufficiently broad mandate. For example, for some projects/technical areas (e.g. watershed management) a wide range of expertise/programme activities may be required: consequently, a research organization that focuses on fodder and grassland, for example, may not have a broad enough mandate to respond to local people’s priorities (e.g. water conservation) or to take an integrated approach.

The more narrowly focused its mandate, the less flexibility the agency has to respond to livestock-keepers’ priorities. This was an issue for the BAIF/NRI project, given its focus on easing seasonal feed scarcity. Nevertheless, we were still able to include experiments on antihelminthics and on water supply, because both worm burden and water intake (Conroy and Rangnekar, 2000) are related to and interact with feed and nutritional status. In one district, however, goat-keepers did not identify any problems that the project could address within its mandate, so we withdrew after conducting the needs assessment. The two main problems here (in Vidisha District, Madhya Pradesh) were theft and predators.

Even if an organization has the mandate, it is often the case that not all of the expertise required is found within it, and it may be desirable for two or more to collaborate on a particular project or programme. National agricultural research organizations and NGOs often have complementary strengths and weaknesses, the former being stronger on technical matters than social ones, while the latter are weak on technical ones, but strong on participatory approaches (Farrington, 1998). It should be borne in mind, however, that their objectives may differ, which can give rise to complications. Does the organization have a good track record for effective collaboration with others?

Third, research organizations need the *capacity* to apply FPR – commitment alone is not enough. FPR needs to be undertaken in a flexible manner: a process approach (as opposed to a blueprint approach) is required. Plans, and possibly objectives, may need to be updated and revised periodically. The iterative nature of FPR may not be easily reconciled with time-bound structures and funding. Researchers need to assess whether their organizations and/or their donors are sufficiently flexible to enable them to take a 'process' rather than a 'blueprint' approach to research implementation. If they are not, it may be best not to embark on FPR.

3.2 Involving Livestock-keepers

3.2.1 Engendering ownership of the experiments among livestock-keepers

Creating ownership of the experiments among livestock-keepers is a vital aspect of PTD. The ownership of the experiment not only decides the success of the trial, but also helps in disseminating the experimental results for further adoption. The first step of engendering ownership of the experiment is that the researchers themselves should own the trial, and be committed to a participatory approach. They should become a role model to the people because of their actions, and because the people can see that they practise what they preach. Their sincerity and honesty should attract the people and encourage them to work together.

Once people start trusting the researchers then the task of creating ownership of the experiment among livestock-keepers themselves becomes easy. The researchers should promote the concept of self-help among the people; and ensure the involvement of livestock–keepers, particularly the women, in decision-making at every stage of the research. By cultivating the habit of respecting everybody's views, the researchers can encourage their active participation in the experiment. Besides regular meetings, researchers can also encourage a group of livestock keepers to visit the houses of all trial participants in a week, to see the animals involved and to assess the status of the trial. All these things build up the confidence of the livestock- keepers and develop their sense of ownership of the research.

3.2.2 Contributions from/by livestock-keepers

Subsidies can become a mechanism for securing farmers' involvement in trials and treatments that they do not really consider to be worthwhile: for this reason they should be avoided or minimised. On the other hand, there are potential problems in avoiding them altogether from the outset. First, this may make it difficult for resource-poor livestock-keepers to participate in trials, particularly where the treatment has to be purchased. Second, many rural people have a dependency mentality, having become accustomed to receiving government handouts, and hence are reluctant to pay for things themselves when they are working with development agencies. This is particularly the case in India.

Unless the livestock-keepers have a strong sense of ownership of the trial, and believe that it is very important and has a reasonable chance of success and profitability, they are unlikely to pay for the whole treatment themselves, particularly if it is one that they are not very familiar with. This is illustrated by the experience of a de-worming trial in Kenya, in which only about one-third of trial participants who had agreed to purchase anthelmintics actually did so; and even they did not follow the application regimes that the researchers had agreed with them (applying the treatment less often) (Mulira *et al*., 1999).

The treatments used in the trials conducted by the BAIF/NRI project were subsidised to varying degrees. The basis for this was that the technologies were new to the goat-keepers, and that they were therefore taking a risk (financial and potentially to the health of their goats) in applying them. Urea Molasses Granules was the newest of all the treatments, so a 100% grant was given for this. In this kind of situation the researchers should develop a clear understanding with the livestock-keepers that the size of the subsidy will be reduced, year by year, as the goat-keepers become familiar with the technologies and see the benefits they have on their animals (assuming, that is, that they are effective!).

3.2.3 Incentives for participants in control groups

For most kinds of trials it is desirable to have a group of animals that do not receive any treatment (see sections 5.4.2 and 5.4.4), so that comparisons can be made between the two groups to see what difference the treatment made. The non-treatment group is known as the 'control' group. If the owners of the control group animals also own the treatment group animals, motivation is not likely to be a problem. However, if they are different to those of the treatment group (see section 5.4.3 for a discussion of this kind of design) motivating the control group owners to participate actively in the control group can be a challenge. They may be reluctant to participate, because they do not see themselves or their animals gaining anything from their involvement in the trial.

If this situation arises, it should be pointed out to them that if the technology on trial proves to be effective they too will benefit after the trial has been completed. If that is not enough of an incentive, however, they can be offered some kind of material incentive. For example, in the BAIF/NRI project control group goat-keepers participating in a trial focusing on milk yield were given metal drink containers; and in other trials a breeding buck was made available to both the treatment and control groups.

Apparently, ICRAF do not carry out on-farm feeding trials comparing treatments and a control, only different treatments, partly because of the issues raised (Morton, 2001). We would argue strongly in favour of having a control group, and finding ways of motivating them, such as those just mentioned. They are just as important to a trial as the treatment group members, so researchers should put just as much effort into developing their sense of ownership and involve them fully in group meetings, etc.. If there is a need to hire the services of a local monitor for monitoring the trial, preference can be given to someone from the control group.

3.3 Resources

3.3.1 Human resources

Researchers' attitudes are very important. They should have respect for the views and knowledge of the people with whom they intend to work. They should be prepared, for example, to traverse difficult terrain and climates, leave home early and return late, spend time in the project area, and hold interviews at times that are convenient for local people. This is particularly important when working with women.

FPR/PTD requires staff skills that are often scarce. Many researchers in national agricultural research organizations may lack experience and aptitude in working with farmers in a participatory way. While many NGO staff may have little, if any, experience of research.

FPR, and particularly collaborative research, poses many methodological challenges, some of which are discussed later.

It may be necessary to have staff from a number of disciplines, so that an interdisciplinary approach can be taken. The precise nature of the disciplines will depend to some extent on the constraints and opportunities that livestock-keepers identify as being most important. For example, if heavy worm burdens appears to be a serious problem, a parasitologist may be required to identify which helminths are involved and to advise on an effective treatment. Alternatively, if the focus were on improved forage production, then a forage agronomist and livestock nutritionist might be needed. However, the basic minimum should be one livestock scientist and one social scientist or agricultural economist.

Ideally, at least one member of the research team should have had some previous experience of participatory research. In addition, it is generally desirable, and sometimes essential, to have at least one woman in the team, to facilitate interaction with female livestock-keepers.

There is often a need for training of research staff in participatory research methods. To some extent it may be possible to provide 'on-the-job' training, but if funds permit short (2-day to 2-week) formal courses would be ideal. (For a valuable training manual in PTD, oriented to the collegiate mode, see Veldhuizen *et al*., 1997.)

3.3.2 Financial resources

The financial resources required for collaborative research are often underestimated. Monitoring and analysis may be more time-consuming than they are in more conventional research modes. With on-farm experimentation there is generally more variability in the experimental data than is the case with the contract mode, and consequently data may need to be obtained from a larger number of fields, farmers, etc., if the effect of the technology being tested is to be detected. It may also be necessary to carry out more detailed monitoring of farmers' management activities to explain some of the variability in results between herds (see section 5.4.3). It will also take time, and hence money, to build-up an effective working relationship.

3.3.3 Time

Research projects normally have a fixed duration, which is usually no more than 3 years. Research scientists need to consider whether FPR can deliver/meet objectives in the time earmarked for the project, while bearing in mind the need to (a) allow for delays and complications, and (b) develop a rapport and partnership with participants. For example, if they have not worked closely with local communities already a long lead-in time may be required to develop the necessary rapport to work effectively with them.

4. GETTING STARTED

4.1 Needs Assessment

Any type of livestock research, whether participatory or not, should be based on a sound understanding of what livestock-keepers see as their priority needs - their main constraints or opportunities. In the case of PTD this is an essential foundation for the whole process, since people are unlikely to invest time and effort on research that they consider to be unimportant.
Obtaining an accurate understanding of needs and priorities can be difficult and time-consuming, and may require at least two phases of discussions with farmers. Directly asking people their most pressing problems may merely generate well-known 'shopping lists'.

Problems are likely to be described in terms of a lack of an input (which the farmer hopes the project will provide): for example, where there is a high mortality rate, livestock-keepers may characterize the problem as a "lack of veterinary medicines". It is important to identify the underlying cause of the problem, rather than just the symptoms.

Getting farmers to rank problems or priorities, starting with the most serious or important, provides more information than simply making a list; it also reduces the risk of researchers distorting farmers' views to fit in with their own personal interests or priorities. A companion guide to this one, entitled *Participatory Situation Analysis with Livestock-Keepers: A Guide* (Conroy, 2001), provides valuable guidance on conducting needs assessments with livestock-keepers, including the use of problem-trees to identify underlying causes. (See also Veldhuizen *et al*., 1997.) Researchers should seek to increase their understanding of what is required and possible as the research progresses.

Ideally, the researchers assist livestock-keepers in tackling their most pressing production problems. However, not all of these problems can be easily solved by improved technologies (although there may still be scope for influencing policies or institutions) and their research institute may not have the expertise (or resources and willingness) to address certain problems. Nevertheless, so long as the issue is a reasonably high priority for the local people, and researchers are also convinced, there is likely to be potential for fruitful collaboration.

The broader the scope of the project, and the greater the variability of the systems and situations of the target group(s), the more time and effort will be required for the needs assessment exercise.

4.2 Scheduling

The timetable for the research needs careful consideration. There are often conflicting demands regarding the pace at which research progresses. The short duration of many research projects (often no more than 3 years) may encourage researchers to establish on-farm trials as quickly as possible, so that they can gather data for a minimum number of seasons or years.

On the other hand, it is desirable to avoid rushing because this can undermine the participatory approach as farmers/users are not given an equal say in the design of the research, and they may not develop a sense of ownership. It may be desirable to focus on interacting with fewer farmers and villages during the first season or year so that staff become familiar with a participatory approach. This is a time when effective relationships are developed with participants, research opportunities are identified, and the technologies to address them are agreed.

It is important that the research team members are not over-ambitious and do not spread themselves too thinly. A narrowly focused approach will be preferable where:

- resources are limited;
- staff are relatively new to PTD; or
- a lot of time needs to be invested in building up rapport with the communities.

Where the approved duration of the research is longer (say up to 5 years), it may be best to have an initial phase of observing farmers' own informal trials or current practices, in relation to selected issues. This helps the researchers understand problems and potential solutions from the farmers' viewpoint, gain deeper insight into the differing problems of individual farmers or sub-groups, and prepares them for participatory research if they are new to it.

Observations of this kind can be conducted concurrently with exploratory trials, in which the researcher contributes ideas.

In many cases a preliminary needs assessment (taking a few weeks or months) is followed quickly by exploratory experiments. Through monitoring these experiments and discussion at the end of the season, the process of assessing, and reassessing, needs continues. This works if researchers allow themselves enough time for quality interaction with farmers, carry out genuinely exploratory experiments, maintain an open mind on the problems, and do not insist on repeating the early experiments over several seasons in order to obtain 'conclusive' data.

4.3 Identifying Where to Work and with Whom

4.3.1 Selecting farming systems and zones

In determining the areas and production systems in which the participatory research will be conducted, both biophysical and socio-economic factors are relevant. Secondary data sources should be consulted, and full use made of whatever information is already available so that duplication is avoided. In many countries maps already exist that identify the various agro-ecological zones: information on the spatial distribution of different livestock species and ethnic groups can be obtained from census data.

Some of the information required may, however, have to be collected by the project through short overview surveys, to enable characterization of farming systems in a way that is most relevant to the project. Initial characterization can be modified as further information is collected during the course of a project, and if time is pressing target groups can be developed iteratively, during needs assessment, monitoring and on-farm experimentation.

Table 4.1 Characterisation of Some Small Ruminant Production Systems in Various Districts of Semi-Arid India

District (State)	Livestock Type	Category of owner	Production system*	Main Product(s)
Bhilwara (Rajasthan)	Goat	Small or marginal farmer	Semi-intensive, commercial	Meat
Udaipur (Rajasthan)	Goat	Small or marginal farmer (tribal)	Extensive, semi-commercial[2]	Meat
Tonk (Rajasthan)	Sheep	?	Extensive, commercial	Wool, meat
Bhavnagar (Gujarat)	Goat (& LRs)	Landless/near landless Pastoralist[1]	Extensive, commercial	Milk
Vidisha (Madhya Pradesh)	Goat	Small or marginal farmer	Extensive, liquid asset	Meat
Pune (Maharashtra)	Goat	Landless agricultural labourer (women)	Liquid asset	Meat
Dharwad (Karnataka)	Goat	Small or marginal farmer	Extensive, semi-commercial	Meat
Dharwad (Karnataka)	Goat	Landless/near landless Pastoralist	Semi-Commercial	Meat

* Most production systems are grazing systems with little or no stall-feeding.

[1] Pastoralist is defined here as a household in which at least two-thirds of its income comes from sale of livestock and livestock products or livestock-related activities. Thus, their livestock production systems are commercial by definition.

[2] Semi-commercial means that the sale of animals to meet contingencies (i.e. use as liquid assets) and the sale of animals as a profit-making enterprise are both important.

If a project is oriented towards a particular commodity (e.g. buffalo), it may adopt a different approach to targeting from one which is oriented to a particular area or category of farmers. It may, for example, be appropriate to choose an area that is known to be important for the livestock species concerned. In the case of the BAIF/NRI project, the researchers were aware that the main purpose and benefits of goat-keeping vary, and production systems vary accordingly from one area and group to another. Although some of the problems encountered are broadly similar, the most appropriate technologies for addressing them may also vary. Thus, we chose to work in districts that between them represented a range of different production systems (see Table 4.1).

Initially, the project was only working in Rajasthan (with small and marginal farmers) and Gujarat (with landless or near landless pastoralists). We also wanted to work with landless labour households, in which one or more members were involved in agricultural wage labour. This type of goat-keeper was not very common where we were working initially, so we expanded the project coverage into Maharashtra and Karnataka, where they constituted a larger proportion of the rural population. We also wanted to work more with women, and we knew where there were landless women goat-keepers in Maharashtra.

Multi-locational or multi-production system trials have a further benefit. Scientists gain a clearer picture of production variability in the on-farm trials (from location to location or production system to production system), so they are in a better position to judge the situations and locations (recommendation domains) in which the new technology could be successfully applied (Waters-Bayer, 1989).

4.3.2 Selection of research locations

Practical considerations will inevitably limit the choice of specific research locations – 'villages', 'communities', or perhaps a network of local specialists. The further away these locations are from the researchers' base(s), and the greater the distance between the participating farmers, the greater the costs in time and fuel, and the less contact there is likely to be between participants and researchers. Trade-offs may be necessary between the extent to which the locations included are representative, and the resource costs involved. A guiding principle is that well-informed choices are always preferable to the selection, by default, of non-representative situations (e.g. adjacent to research stations, major roads, previous projects, a researcher's home village, etc.).

Where researchers or collaborating organizations have already been working with certain villages for some time, and have developed a good rapport with community members, this may be a strong reason for selecting such villages in preference to others, provided they are reasonably representative of villages in the area concerned. This can save time and resources in that a good rapport with participants already exists, and the project may easily access valuable secondary data about livelihood systems, social and economic composition and problems and priorities.

4.3.3 Selection of type of livestock

In cases where a project is working in a particular geographical area, and is not tied to any particular livestock species, the researchers will need to decide which livestock species they are going to prioritise. Selection criteria that should be considered are:

1. the potential for research to address livestock-keepers' (not researchers') priority problems associated with the most important type(s) of livestock;
2. where research is likely to produce the greatest benefit, taking account of the seriousness of the problem (e.g. size of mortality rate) and the number of animals experiencing it; and
3. what kind of research is likely to provide the greatest benefit to the poorest groups.

For example, an area-based adaptive research project in Kenya selected goats, rather than cattle, as the primary focus, for two reasons. First, the principal problem associated with cattle, tick-borne diseases, was considered not to be amenable to research; and second. The ownership of goats was more widespread so more farmers, including women, stood to benefit (Sutherland and Kang'ara, 2000).

4.3.4 Identifying participant livestock-keepers

Options for engaging participants include: (a) volunteering (as individuals or community representatives); (b) delegation of selection to the community; (c) probability sampling (for a discussion of conventional approaches to sampling in agricultural projects see Casley and Kumar (1988)); (d) guided purposive selection. Researchers have tended to take a somewhat *ad hoc* approach, and/or to favour options (a) or (b), on the basis that they are more participatory than (c) and (d).

Approaches (a) and (b) tend to bias the selection, skewing participation away from the poorest, for two reasons. First, within communities power is distributed unevenly and often volunteer or community-nominated participants are male and resource richer. Second, for many of the poorest a prolonged involvement in research activities is not attractive, as they are preoccupied with more pressing livelihood issues. FPR projects need to engage in more systematic selection strategies if they want participants to be generally representative or from particular socio-economic groups. The selection procedure needs to be discussed with the collaborators, and agreement reached on criteria and objectives.

Purposive rather than completely random selection is likely to be the most feasible approach. Purposive selection requires a prior understanding of the socio-economic composition of the village or community and inter-household relations so that farmers' views and reactions can be seen and understood in context; the project should seek to improve its understanding of the local social structure as it progresses.

Techniques such as wealth-ranking and social mapping, if used with skill and sensitivity, can provide the kind of information that is needed initially (see Conroy, 2001; Pretty *et al.*, 1995; Veldhuizen *et al.*, 1997); and secondary data should be utilized when available. If the relevant information is not available when the initial participant selection process takes place, and volunteer or delegated sampling is used, the project should subsequently check the characteristics of the participants against those of the community as a whole. Additional participants can then be selected if necessary, to make the sample more representative of the target group.

Table 4.2 Categorisation of Resource-Poor Poultry-Keepers in Namakkal District

Category 1	Category 2	Category 3
Farmers – where house, agricultural land, poultry and other livestock are close together	Farmers – where house, poultry and other livestock are in one place, and agricultural land in another	Landless – who live in a colony, with poultry and livestock in the house itself

Research objectives are also likely to influence the type of collaborator required. If the research is focused on a particular type of livestock, or a particular kind of livestock production system, then the participants will have to be people who meet these criteria. For example, in a scavenging poultry project working in Tamil Nadu's Namakkal District, three categories of production system were identified (see Table 4.2), and each category is likely to be represented roughly equally when trials begin. The project has a health focus, and the research team think that poultry kept by Category 1 people may be less at risk of contagious diseases because of their relative physical isolation. (See also Table 4.2).

If the research is testing a new technology the project staff may decide that it is necessary to select willing risk-bearing participants with more resources (e.g. land, labour, equipment) and/or previous positive experience in technology innovation.

For programmes that run for a long time, there is a question of whether to continue collaborating with the same small group of livestock keepers, or to change every so often. Generally, this issue has to be looked at in relation to research objectives, and to the importance of maintaining rapport and relations with the community. In practice, it is likely to be expedient to maintain contact with some of the more interested farmers over a period of years, and also allow space for new farmers to join in as others decide to drop out or as new opportunities arise as the experimental programme expands.

4.3.5 Selection of experimental animals

The type of animal selected will be determined to a large extent by the nature of the trial. For example, if the experiment is focusing on weight gain in young animals the animals selected will have to be from the relevant age group; whereas, if it were focusing on conception rates they would have to be mature females. Within each of these categories, however, there is scope for varying degrees of precision. This relates to the problem of inter-animal variability. In order to minimise variability the animals should be as similar as possible.

In one of the first trials conducted by the BAIF/NRI project, which focused on young goats, the age spread of the young goats was quite large, creating unnecessary variability and making the use of a standard treatment for all of them questionable. In a similar trial the following year the age of the goats selected was more homogeneous. To minimise inter-animal variability in trials that are focusing on milk production, it may be necessary to select animals that are all of the same lactation, and perhaps ones that are all at a similar point in the lactation cycle.

Another consideration is that where animals in the treatment group belong to different people from those in the control group (see section 5.4), the animals in each group should belong to many different owners. Otherwise, the practices of someone owning a large number of animals could become confounded with the comparison between treatment and control groups. For example, in the BAIF/NRI project's first Bhilwara trial, 13 of the 25 goats in the treatment group were owned by one person. Thus, although the treatment group does produced more kids than those in the control group, the difference could have been due to this one goat-keeper having superior goats or feeding practices, rather than to the treatment itself.

4.4 Identifying Interventions

In the early stages, the aim of the discussions with farmers is to reach agreement on the research agenda. Deciding on the research agenda is a process which should be based on an adequate understanding of the local farming system, including interactions between various components and enterprises in the system, and who is involved in, decides on and benefits from the various activities. This understanding will help to reduce a long list of possible experiments, to one or two which are most useful and likely to bear fruit. While dialogue between researchers and farmers in this process is essential, dialogue with other knowledgeable researchers may also be vital, in order to avoid duplication and unproductive experimentation. If a consultative mode is used within a national agricultural research system (NARS) setting, further discussions and consultation with other specialists on the extent of the problem and what can be done about it may be required after the needs assessment. Within a community-oriented collaborative mode, this is a joint process between the local people and the researchers.

Whatever the mode, to sustain a credible partnership with farmers and other stakeholders, the probable relevance of possible interventions needs to be gauged through careful study and widespread consultation. If researchers are convinced, but the collaborating farmers are reluctant, it may be worth organizing a farmer tour to visit an area where this technology is being practised, or to a research station, before trying to introduce it in an on-farm experiment. The researcher should try and avoid the temptation to tell the local people what to do early on in the discussions. Ideas for interventions may come from any of three general sources (for examples of each, see Box 4.1):

- members of the local communities
- other livestock-keepers or NR users in the region
- researchers (and extensionists), based on their own organization's work or the general body of scientific knowledge.

The local people should be encouraged to develop their own ideas initially. It may be useful to discuss ways in which group members have already tried to tackle the problem previously identified, and what effect this had. Discussions should also screen indigenous technical knowledge and previous experimentation by villagers. Often there are recognized specialists within or near a community, and it may be worth identifying these and inviting them to join in discussions, or making visits to them later for more in-depth discussions. For example, in Rajasthan there are local specialists in animal health care in many villages, called *Gunis*. In recent years there have been numerous initiatives in different parts of India (by NGOs, KVKs etc.) to document ethnoveterinary knowledge and practices, so it would be wise to check whether there are any relevant studies available in your area or nearby.

BOX 4.1 IDENTIFYING INTERVENTIONS – SOME EXAMPLES

Examples from the BAIF/NRI Project

Members of the local communities In a feed supplementation trial in Dharwad, Karnataka, the idea for the treatment came from one of the goat-keepers. The treatment was a mixture of sorghum and horsegram.

Other livestock-keepers in the region In a de-worming trial in the same district the idea for the treatment came from the practice of another ethnic group from a nearby area, who keep buffaloes (see Box 1.2). The treatment was the trichomes (hairs) from the pods of a leguminous creeper, mixed with jaggery, a lukewarm sugary solution.

Researchers or extensionists In a supplementation trial in Bhavnagar, Gujarat, the researchers suggested the use of Urea Molasses Granules, which they had recently tested in a pilot project elsewhere in Gujarat.

An example from the DAREP project, Kenya

Mange had been identified by goat-keepers as a major problem. Farmers considered commercial products for treating it to be too expensive, and had started looking for locally available alternatives. The project staff sought to identify alternatives by holding a number of group discussions and by visiting local herbalists, and came up with a list of eight local concoctions already being tried by farmers. The list was further screened through discussion with farmers, and a trial was designed comparing three of the local treatments with two of the recommended commercial ones and a herbal treatment of Neem solution.

Source: Sutherland and Kang'ara, 2000

4.4.1 Understanding the nature of the problem

This issue is discussed in the companion volume to this one, where tools for determining priority needs are described (Conroy, 2001). These include: (a) participatory problem tree analysis, which livestock-keepers can use to separate the core problem from its causes and effects; and (b) the participatory herd history method, which is a quick method for generating reasonably reliable baseline data on kidding rates, mortality rates etc. Understanding the nature of a problem correctly requires researchers to know what the objectives of the livestock-keepers are.

Sometimes the livestock-keepers (or the researchers) may not know, or be sure of, the nature of the problem; but they may have an informed hunch as to the cause. In these situations it is essential for both parties to discuss and explain their ideas and hypotheses before selecting treatments. One common problem that is sometimes poorly understood by goat-keepers is that of high worm burdens, which can result in high mortality rates in kids due to a combination of factors. A high worm burden in the mother may lead to a dramatic reduction in milk production, thus weakening the kid; and if the kid itself then becomes infected it will have a poor chance of survival (Peacock, 1996). However, the goat-keepers may not realise that helminths are causing the death of their kids, nor understand the life cycle of helminths and their effect on the goat's physiology. If so, the researchers will need to educate the livestock-keepers on "the underlying principles of the technology effect" (Mason *et al*., 1999).

This is similar to the situation with integrated pest management of crops, where 'farmer field schools' have been developed as an educational tool (Ooi, 1998). The high importance livestock-keepers attach to visible problems may also mean that they prefer to take a curative approach (i.e. respond to the problem when it appears) rather than a preventative one. This was found to be the case in one de-worming experiment on cattle and sheep (Mulira *et al*, 1999).

4.4.2 Determining the size of the treatment

This should be based on a combination of technical and cost factors. For example, the quantity of a supplement or a drug should obviously be related to the size of the animal. However, the cost of the treatment should also be taken into account (see next section). Livestock scientists may be inclined to choose the quantity that will have the biggest physical effect, but that is not necessarily the most profitable size of treatment. Furthermore, poor livestock-keepers are usually very short of cash, and therefore have to ration what they have among different items of expenditure: thus, they may not be prepared to incur the full cost of what the scientist considers to be the ideal quantity. If enough animals are available for the trial it may be possible to test two or more different quantities of a treatment.

4.4.3 Screening technologies for profitability

It can be useful to make a simple appraisal of the likely profitability of the proposed treatment, particularly those that involve the purchase of an input. If the treatment has been clearly defined the cost is usually easy to calculate and predict. The size of the benefits is uncertain, of course, but comparing potential benefits with a range of "guesstimates" of the benefits will give some indication of whether the technology concerned is worth investigating. (See Table 4.3 for an example.) If, as happened with one of the proposed treatments in the BAIF/NRI project, the expected benefits are about the same as the predicted costs it would be advisable to reconsider the proposed trial. This test can be a useful check on ideas coming from researchers with a technical background, who may not be used to thinking in terms of profitability.

Table 4.3 Estimated Profitability of Tree Pods as a Supplement to Increase Kidding Rates (Indian Rupees)

1. Cautious Assumptions	**2. Optimistic Assumptions**
COST	
Price of pods = Rs 3/kg	Price of pods = Rs 2.5/kg
Cost of pods treatment per doe = Rs 3 x 0.25 kg/day x 70 days = Rs 52.5	Cost of pods treatment per doe = Rs 2.5 x 0.25 kg/day x 70 days = Rs 43.75
1A. Cost of pods treatment for 10 does = Rs 525	2A. Cost of pods treatment for 10 does = Rs 437.5
BENEFIT	
Extra 3.5 kids per 10 does	Extra 4.5 kids per 10 does
Value of 1 kid = Rs 300	Value of 1 kid = Rs 500
1B. Value of extra 3.5 kids = Rs 1050	2B. Value of extra 4.5 kids = Rs 2250
PROFIT	
Net benefit (profit) per 10 does = Rs 525 (1A -- 1B)	***Net benefit (profit) per 10 does = Rs 1812.5*** (2A -- 2B)
BREAK-EVEN POINT	
Minimum extra kids needed to break even = 1.75 (525/300)	Minimum extra kids needed to break even = 0.875 (437.5/500)
BENEFIT:COST RATIO	
2:1 (1B:1A)	5.14:1 (2B:2A)

There are several different tools for analysing the profitability of treatments or interventions. They have differing degrees of sophistication and slightly different uses, and each has its advantages and disadvantages. The ones described here are among the simplest available, and should be adequate for most types of on-farm trials. For information about other techniques the reader is referred to Amir and Knipscheer (1989) and to standard text books in agricultural economics.

Partial-budget analysis is a simple method for estimating the profitability of a treatment, which involves the tabulation of expected gains (benefits) and losses (costs) due to a relatively minor change in farming methods. (The term partial indicates that the change only occurs in one component of the farm.) It is widely used to determine the profitability of a single intervention. Table 4.3 is an example of a partial budget analysis from the BAIF/NRI project. It assumes that the goat-keepers' primary objective is to maximise the number of kids produced, so that they can either be sold or retained to maintain or increase the herd size. The value attributed to a kid under the cautious assumptions is the value it would fetch if sold shortly after birth; whereas that under optimistic assumptions is the price it would fetch at about six months of age (say Rs 800), minus the cost of rearing it during that six months (say Rs 300).

Sometimes it is more appropriate to develop partial budgets for a whole herd than for a single animal, as in this example. Profitability has been estimated per 10 does, rather than per doe, because the treatment does not affect every individual: some does will produce more kids than they would have without the treatment (e.g. one instead of none, or twins instead of one), but others will be unaffected. The analysis shows that the treatment should be profitable, even on the basis of cautious assumptions.

Costs of items that are not traded can be difficult to quantify. In the earlier example, there is a small market for tree pods, so the market price has been used in the analysis. However, the goat-keepers were collecting the pods themselves, so it would have been more appropriate to estimate the labour cost of doing so; but since there is no wage payment involved, determining the labour cost is not entirely straightforward. To do this it would have been necessary to estimate the *opportunity cost* of labour: that is, the cost of collecting the pods would be equivalent to the value of the best employment alternative that the goat-keeper had foregone so that (s)he could collect them.

For example, if (s)he had had to give up two days of wage employment at a rate of Rs 40 per day, then the labour cost of collecting them would be Rs 80. In rural areas, the opportunity cost of labour tends to vary considerably over the course of a year: it depends partly on how much work is available, with wage rates being higher during busy periods. As it happens, the pods are collected at a time of the year when there is little work available, so the opportunity cost would be quite low in this case. If there was no alternative work available, then the opportunity costs would be zero.

Break-even analysis In partial budgets there are always a few key factors that affect the balance of gains and losses. Break-even analysis determines the level at which the gains and losses are equal: this level is known as the break-even point. Generally, break-even analysis is done by manipulating the most uncertain key factor. When used in association with partial budgeting it can be used as a measure of risk, indicating at what value of a critical factor a new technology is expected to no longer be profitable to a farmer.

Break-even analysis can be applied to the tree pods example, where the number of additional kids is considered to be the most uncertain factor. Thus, the researcher (and livestock-keeper) wants to know, given the estimated costs of the treatment, what is the minimum number of extra kids required to enable the owner to break even. The results are given in the bottom row of Table 4.3.

Benefit:cost ratio is simply the ratio of benefits to costs. It is normally calculated in financial analyses that take account of the flows of costs and benefits over many years (the duration of the activity – e.g. a commercial poultry unit), and that discount future costs and benefits. Thus, in a financial analysis it would be the ratio of discounted benefits to discounted costs. For simple technologies that have fairly immediate effects there is no need to do a discounted cash flow, but it can still be very useful to calculate benefit:cost ratios. They show how much extra benefit the livestock-keeper is likely to get for each unit of cost incurred – in other words they give an indication of the likely size of the return for a given level of investment.

If farmers behave rationally then they will be most likely to adopt those technologies with the highest returns, all other things being equal. The benefit: cost ratios have been calculated for the tree pods technology in Table 4.3. However, where significant cash expenditure is involved, particularly in 'one go', they may not be able to access enough money to pay for the all of the input; or they may avoid spending money if they believe there is a high degree of risk involved.

4.4.4 Standardising the treatment

For trials that are seeking to quantify the size of the benefit brought about by a particular treatment it is important to standardise that treatment across all the animals in the treatment group. (This will not be an objective in some trials, which may be more interested in seeing how the livestock-keepers modify a treatment developed by researchers.) For trials in which the treatments are feed supplements it is desirable to provide participants with a measure (e.g. a beaker) that corresponds with the quantity of the treatment.

For treatments that are more complicated, such as ones requiring the processing or mixing of ingredients, it may be necessary for the researcher to provide the treatment. For example, in the trial to address mange in goats (see Box 4.1), the local concoctions were supplied and prepared by the researcher (Sutherland and Kang'ara, 2000).

4.5 When to experiment

Sometimes it is necessary to consider whether an experiment is required. If you know of a technology that has proved effective in similar situations elsewhere, it may be appropriate to introduce it without following a rigorous process of experimental planning, implementation and evaluation? While everything new to an area may be seen, in certain senses, as an experiment by farmers, not everything new may need a formal experimental design. Through discussion with farmers, especially any with some experience of laying out trials, it may be possible to classify those interventions which require a formal experimental design, and others which can be introduced or tested in a less formal and less resource intensive way.

5. DESIGNING TRIALS/EXPERIMENTS

5.1 Identifying Experimental Hypotheses

Once a treatment has been chosen for a formal experiment, it needs to be formulated in terms of a precise hypothesis. It is important to involve the livestock-keepers in the process, and it need not be difficult to do so. The format (Veldhuizen *et al*., 1997) illustrated by the following example can be used.

If… I give a dewormer to my does in late pregnancy and at time of kidding

Then… Their kids are less likely to die young

Because… 1.Their mothers will produce more milk and thereby make them stronger
2. Their mothers will not transmit worms to them through their faeces.

Veldhuizen *et al*. (1997) stress the importance of hypothesis formulation in the context of the collegiate mode as follows:

> "This is a crucial step in the dialogue between farmers and outsiders. It helps the researchers and collaborators to define more precisely what they want to try out and why, and enables them to analyse more clearly the results of the trial. It is a planning, monitoring and evaluation tool. It helps both parties to understand each other's logic better. It provides an opportunity to check the reasons for the problem and prevents jumping to conclusions about possible solutions".

5.2 How Many Livestock-Keepers and Animals should be Involved in an Experiment?

In considering this question it is necessary to bear in mind a number of factors.

1. The cost and logistics of meeting participants and collecting data.
2. The quality of interactions with participants versus the quantity.
3. The time required to process and analyse monitoring data.
4. The minimum number of sample units (fields, animals) required to be able to draw general conclusions and for statistical analysis (if required).

Trade-offs may be required between factors 1, 2 and 3, on the one hand, and the fourth factor. Poor judgement may lead to serious errors of one kind or another. Too few sample units (point 4) may mean that the sample is not representative or that firm conclusions cannot be drawn from the data. Too many sample units, on the other hand, may mean that the researchers are overwhelmed by the amount of data that they need to collect and analyse, and that this results in errors of recording, coding, data entry or processing. In addition, limited interaction with livestock-keepers may result in them not identifying strongly with the trials, and not understanding or correctly following the trial design. Further discussion of these issues, and conflicting views, can be found in: Casley and Kumar, 1988; and Chambers, 1997. The issue of minimum sample size, with particular reference to statistical tests, is discussed further in Appendix 1.

One general guideline is that is best to avoid being over-ambitious to begin with – mistakes in small trials are less costly than mistakes in large trials. Where statistical analysis is not involved, there are no hard and fast rules for determining sample size. One suggestion, however, is that in the initial phase, if fieldworkers are learning to work in a participatory mode with farmers, the number of experimenting farmers per fieldworker should be limited to, for example, a maximum of 2–3 villages with 5–8 experimenting farmers in each (Veldhuizen *et al.*, 1997).

One factor that should be taken into account when determining the number of animals required is the probability of some animals leaving the herd during the course of the trial - due to sale or death, for example. The necessary number of animals should be added to the minimum to allow for this. Researchers can, of course, try to persuade livestock owners not to sell their animals until the trial has finished, but in a participatory trial this possibility cannot be ruled out.

5.3 How many Treatments?

Since farmers' situations may differ considerably, it will probably be desirable to test several interventions through experimentation. However, more interventions will generally mean that more participants and resources are needed, if statistical analysis is to be done. There may have to be trade-offs between the number of experiments required by the range of situations in which the project is operating. From the point of view of data analysis, it is better to collect meaningful data on a few experiments, or on one experiment with a modest number (1–2) of treatments, than inadequate data on a larger number. (An example of a two treatment trial (using anthelmintics) was given in Box 1.2.) However, from the individual farmers' point of view, it may be preferable to have a large number of simple (i.e. with and without or before and after type treatments) experiments which carry fairly low risk and may be superimposed on existing farming practices. (An example of a 6-treatment trial is given in Box 4.1.) There is room for negotiation between researchers and livestock-keepers on this topic.

5.4 Experimental Design

Experiments seek to test hypotheses by comparing treatments: there must, therefore, be some basis for comparison. In principle, the animals on which the treatment or intervention is to be tested can be compared:

- *before and after* the intervention; or
- with animals on which the treatment was not tested (a *with and without* comparison); or
- with animals on which a different treatment was tested.

Each method has its advantages and disadvantages, which are discussed in the following sections. Which is more appropriate may depend to some extent on the nature of the experiment.

5.4.1 The 'before and after' method

The *before and after* method can be used in such a way that the comparison is made for the same animal. When this method is used "a sequence of experimental treatments is randomly allocated to each farm animal, and there are several different treatment sequences" (SSC, 2000). Each animal is given a treatment for a fixed period of time, and then changes over to another treatment. For example, a cow's milk yield can be measured before feed supplement 'X' is given and after, and then before and after feed supplement 'Y', and so on; and the effect of each supplement can be determined in this way.

When used in this way the before and after method has the major **advantage** of excluding inter-animal (and inter-farm) variation as a factor influencing the parameter being measured: this kind of variation is usually larger than within animal variation, at least in the short-term (Statistical Services Centre, 2000). If, instead, the comparison had been made between one group of four cows that were receiving the supplement and another group that were not, differences between the two groups could have been influenced by several other factors, such as general differences in diet between them or differences in the stage of lactation or parity. However, this method also has potential **disadvantages.**

First, any changes that occur may be influenced by extraneous factors that have changed over time, such as rainfall or forage availability, and these could be more important than the effect of the treatment. It is not well-suited, therefore, to experiments lasting several months, in which the before and after data are from different years or different seasons. An example of inter-annual differences is given in Box 5.1. **Seasonal variations** may also be marked, for example growth rates or milk yields between dry seasons and rainy seasons.

BOX 5.1 THE INFLUENCE OF INTER-ANNUAL DIFFERENCES: AN EXAMPLE

The BAIF/NRI project's work in semi-arid regions of India has identified situations in which inter-annual variations in rainfall can have a significant impact on livestock. This is particularly so in relation to mortality rates of young goats in the rainy season. This was a major problem in some places, so the project introduced treatments intended to reduce mortality. Mortality rates were 25-50 percent in the baseline year, which had 'normal rainfall', but fell off dramatically (to say 5 percent) the following year, when rainfall was low. Fortunately, we had used the '*with and without'* method, and we knew that there was little mortality in the control group, and hence that the reduced mortality rate was not due to the treatment. In this case, use of the 'before and after' method to determine the efficacy of the treatment could have been highly misleading, falsely attributing the improvement to the treatment[4].

Another factor suggested by goat-keepers to explain the inter-annual difference in mortality rates was that they had increased their application of disease-control measures, following the discussions with the project team the previous year, which had raised their awareness of the problem and the need to address it.

Second, 'before and after' experiments have more scope for "going wrong". For instance, if treatment periods are long, or there are too many of them, the whole trial becomes too long and the farmer loses interest and fails to complete the trial….

Third, this kind of experiment can also have carryover (or residual) effects. This is when a treatment given in an earlier period still has some effect in a later period when a different treatment is being given… This could be a problem with lactation experiments, if one treatment is started shortly after another one has finished.

5.4.2 'With and without' experiments

The disadvantage of this method is that inter-animal variability can be high, and this can make it difficult, if not impossible, to separate out the effect of the treatment. When this method is used, therefore, steps should be taken to minimise this kind of variability.

Inter-animal variability arises from two sources: (a) the genetic make-up of the animals and their ages; and (b) environmental factors, including the owner's animal husbandry practices (e.g. housing, feeding systems). It is important, therefore, that animals in the different groups

[4] A good researcher would have noted the difference in rainfall and would have realised that this non-experimental factor could have had a significant influence. Nevertheless, (s)he would not have known which factor was more important and the trial would have had to be repeated.

being compared are of similar breeds and ages, and that the environmental conditions experienced by the groups are broadly similar. Some differences in the latter may be unavoidable, however, in which case they should be noted and referred to when the results of the experiment are being interpreted and discussed. (This matter is discussed further in section 6.1.2.)

If environmental conditions between different experimental groups are substantially different, it may not be possible to draw any meaningful conclusions from the experimental results, and valuable time and resources will have been wasted. An example of different environmental conditions between groups undermining an experiment is given in Box 5.2.

BOX 5.2 EXAMPLE OF NON-EXPERIMENTAL DIFFERENCES BETWEEN TREATMENT AND CONTROL GROUPS

In one of BAIF/NRI project trials, testing the effect of feed supplementation on the health and growth rates of young goats, the control group goats were on average of similar weight to those in the treatment group at the end of the experiment. The researchers need to know why this was – did it mean that the treatment was ineffective?

The control group participants were from a different hamlet to those in the treatment group, and investigations revealed that this had confounded the trial results. The two groups used different grazing areas, and the one used by the control group members was superior to that used by the treatment group[5] (it was only after the trial that the project staff discovered this).

A second factor identified by the investigations was that people in the control group were generally better off than those in the treatment group, so when they saw the young goats of the latter group growing faster they regarded this as socially unacceptable and started giving the supplement to their own goats.

5.4.3 With and without animals – within same herd or between herds?

If the 'with and without' design is the one selected, the next decision is whether animals in the different groups should be from different herds or the same herds. In other words, should control group animals belong to the same livestock-keepers who are testing the new technology, or to different livestock keepers; and if there are two treatments, should they be applied to animals in the same herd? In many cases the answer to this question may be determined by the normal size of the herds: where herds are very small, and tend not to contain two comparable animals, the inter herd option will have to be used. But where herds are large enough, which of these options is preferable?

A potentially major **disadvantage** of the different herd option is that there may be differences between the practices and circumstances of livestock-keepers in the two groups (as illustrated in Box 5.2), and these may confound the influence of the treatment. The BAIF/NRI project's experience highlights the need to ensure that households in the treatment and control groups are similar, so that differences in non-experimental variables are minimised. An example of the problems that can arise is given in Box 5.2. On the other hand, this approach means that animals in the different groups are kept apart, which can be **an advantage** (see below).

[5] In planning the trials the project team had concluded that the treatment and control groups should be in the same village, partly to avoid this kind of problem.

The converse applies when using animals from the same herd. Having animals from different groups kept together can present problems, particularly where the treatment is some kind of feed, and particularly where all of the animals in the herd normally feed from the same container. Animals in the control group may get access to the treatment: or animals in one treatment group may eat feed intended for animals in another treatment group. In addition, if the owner sees animals in the treatment group benefitting from the treatment, (s)he may be tempted to divert some to animals in the control group[6]. This problem can also arise in the between herd method, but in that situation the owner in the control group would have to obtain the treatment him/herself.

In de-worming experiments there could also be inter-animal interactions. If worm eggs are eliminated from animals in the treatment group(s), this might lead to a decrease in the worm burden of animals in the control groups, since one source of infestation would have been removed, i.e. the faeces of other animals in the herd.

5.4.4 Conclusions

The *before and after* method is not well-suited to experiments lasting several months, in which the before and after data are from different years or different seasons. The *with and without* method would be preferable in this kind of situation. When the before and after method is used in experiments of short duration (say 2-3 weeks), it is important to leave a sufficiently long gap between treatments to ensure that there are no carryover effects from one treatment period to the next.

For trials of longer duration than a few weeks *with and without* comparisons are likely to be more reliable than *before and after,* provided proper care is taken to minimise inter-animal variations. It is easier to achieve this, and avoid bias, by having animals from different groups within each herd, rather than making a ‘between herds’ comparison. However, the ‘within herd’ approach can be problematic for certain types of treatments, particularly ones involving feed supplementation. Nevertheless, it can work if the owner understands and agrees with the purpose of the trial design; and if there is a good rapport between the researchers and the livestock-keepers, and frequent visits by the researchers.

We have seen that both *with and without* comparisons and *before and after* ones have their potential weaknesses. When experiments are being conducted using the *with and without* design it can be useful to collect baseline data as well so that a *before and after* comparison can be made, provided this can be done at a reasonably low cost (see section 6.1.2). The two sets of data can then be cross checked with each other.

Some trials have two or more treatment groups, but no control group, the comparison being between the different treatments. However, the example in Box 5.2 illustrates why it is important to have a control group.

Most of the above discussion and conclusions was concerned with trials that are seeking, amongst other things, to ascertain the biophysical effect of a particular technology or treatment. In order to isolate the effect of the technology the variability in other (non-experimental) factors needs to be either minimised or understood in such a way that it can be taken into account. However, there are two other types of trials in which isolating the effect of the technology is less important, namely: trials that are primarily concerned with ascertaining livestock-keepers’ attitudes to a new technology; and trials designed to test the suitability and efficacy of a technology under a range of conditions.

[6] This is a common problem, according to Amir and Knipscheer. They give the example of a farmer administering anti-helminthic drugs to his/her control animals after observing the benefits for the treatment animals (Amir and Knipscheer, 1989).

Whatever the nature of the trials, experimental design issues should be discussed with participants before any trials are initiated. A series of meetings may be required: these are sometimes referred to as Farmer Experimental Design Workshops (Reintjes *et al* 1992; Veldhuizen *et al*., 1997). Researchers may need to remind themselves that the design is as much the livestock keepers' as their own.

6. MONITORING OF EXPERIMENTS

Monitoring is a vital part of an on-farm trial and resources should always be made available for it to be undertaken effectively. Without adequate data collection and management the value of a trial will be greatly diminished. Monitoring of participatory trials usually requires a combination of qualitative and quantitative information.

6.1. What data, why and how often?

The type of data that needs to be collected will depend very much on the nature of the experiment. If it is a trial to test the acceptability of a technically proven technology to farmers, then it may be enough to record their views at the end of the trial period. On the other hand, if the experiment is to determine whether a previously untested treatment increases conception rates significantly, more quantitative data will be required.

6.1.1 What data?

When determining what type of data are required it is important to take account of how the data will be analysed to produce useful and meaningful results. The type of data may be either qualitative (e.g. body condition) or quantitative (usually biophysical). *Qualitative* data are often needed to *explain* what has been happening: for example, why farmers applied a certain level of input at a certain time, or (in a relatively unstructured trial) why some farmers applied one treatment while others applied a different one. The type of data to be collected should ideally be *agreed* between the researchers and the livestock-keepers before the experiment commences. To some extent this will follow from the nature of the hypothesis[7].

Biophysical trial data Important indicators of the efficacy of treatments should be incorporated into the monitoring system. For example, in a trial comparing tree forage supplements for dairy cows, the criteria selected by farmers were: milk output, feed intake and condition of the animal (Mason *et al*., 1999). In another trial, this time on worm control methods, the indicators were: state of animal's coat, size of appetite, body condition, and presence or absence of diarrhoea (Mulira *et al*., 1999).

Collecting Data to Explain Variation In on-farm experiments it is not only treatments that affect animal performance, but non-experimental variables (NEVs) as well. In participatory experiments NEVs are often not controlled or standardised, so if we are interested in exploring the causes of farm-to-farm or animal-to-animal variation it is necessary to monitor the NEVs (characteristics of the farm, farmer or animal, including farmer management practices) that might affect the performance parameters that the trial will be monitoring. Therefore, it is important to identify what ancillary data need to be collected before (baseline)

[7] For example, for the hypothesis described in section 5.1, obvious indicators to be monitored are: the quantity of milk produced, kid mortality rates and growth rates, and the presence or not of worms in the kids (e.g. through faecal egg counts).

and during the trial. These data will be used in the subsequent analysis in three different ways (Statistical Services Centre, 2000):

- to explain some between and/or within animal variation, and thus improve precision in respect of important objectives;

- to explore the behaviour of different groups of animals or farms, as identified by the objectives of the study; and

- to help to explain unexpected findings that emerge in the analysis.

Process data Depending on the nature of the trial, researchers might also want to record data that are not directly related to the treatment and its effects. For example, it may be helpful to collect data that provide some indication of the nature of livestock-keepers' involvement in the technology development process or their relationship with the researchers, such as:

- how many people have been attending group meetings?
- who attends and who does not (e.g. men versus women, rich versus poor)?
- how many suggestions for treatments have come from livestock-keepers, as compared with researchers/
- how many participants have made modifications to treatments suggested by researchers?
- are livestock-keepers maintaining their own monitoring records?
- are livestock-keepers processing or summarising monitoring data in any way?

6.1.2 How frequently and for how long?

Frequency This needs to be carefully considered, because the process of collecting monitoring data can be quite time-consuming for the owners, if they have to be present while the data are collected or are to be involved in collecting the data themselves. Researchers and livestock-keepers may have different views on the amount of data required or the frequency with which it needs to be collected. It is important for researchers to listen to people's views: compromise may be necessary. The principle of optimal ignorance, which is one of the fundamental tenets of participatory rural appraisal (PRA), is equally applicable here – which is that one should only collect the data that one knows one needs, and should not worry about being ignorant about things that one does not need to know.

Duration The duration of the monitoring period will depend on the nature of the trial. Table 2.1 gives monitoring periods for several different kinds of trial, which range from two weeks to 15 months. Basically, the monitoring period should be long enough for data to be collected that show whether or not the treatment had the hypothesized effect. Where there is also good reason to expect the treatment to have a side-effect, it may also be worthwhile to extend the monitoring period to see whether the side-effect materialises. For example, in the BAIF/NRI project's deworming trials we monitored how long a period passed before the does conceived again; and we found that the kidding interval of does that had been in the treatment group was shorter than that of those in the control group.

6.2 Collecting Baseline Data

A common weakness of PTD is that researchers often do not collect adequate baseline data to enable a comparison to be made between before and after situations. The participant farmers may not see the need for this, as they may think it is enough to hold the information in their memories. For the researcher, however, baseline information can greatly increase confidence that the intervention or treatment has made the difference that participants say it has.

Once the foci of the experiments and the hypotheses have been identified the type of baseline data needed forcomparisons will be apparent. At this point researchers and participants can decide how useful such data would be and with what ease and accuracy (recall errors could be a problem) they could be obtained. The BAIF/NRI project has developed a diagramming technique, called the Participatory Herd History Method, that facilitates recall and reduces the likelihood of any misunderstandings between the researchers and the livestock-keepers: this is described in the companion guide to this one (Conroy, 2001). This method has since been used in a slightly modified form for collecting information from poultry-keepers, where it has also proved to be very effective: for example, it has enabled the research team to quantify mortality rates and to determine the contributions of different factors (e.g. disease, predation).

6.3 Who Monitors and How?

In the collaborative research mode both the researchers and the participants will play a role in monitoring. Alternatively, where participants are illiterate, or where measurements of biophysical data are somewhat complicated, one or two literate local people (perhaps older schoolchildren) in each village can be trained to carry out the monitoring and maintain records of the data. Both parties (livestock-keepers and researchers) could keep records of the same data. For example, if livestock weight is one of the variables being monitored the participants may keep records in their homes on their own recording cards or in school exercise books, and the researchers (or local monitors) might record the same data themselves.

6.3.1 Data recording by illiterate livestock-keepers

Farmers can be assisted in designing simple formats (sheets or notebooks) for recording the information periodically. Where many community members are illiterate extra thought may need to be given to devising record sheets etc. that are intelligible to them. Various PTD programmes have given calendars to farmers to note important events: symbols can be used where necessary. In some cases, schoolchildren interview at fixed intervals the other family members involved in the experiments and do the recording (Veldhuizen *et al*., 1997).

The BAIF/NRI project staff have encouraged participating goat-keepers to monitor and record the effect of the treatment themselves. Since most are illiterate, we developed a monitoring form that they can understand that is based on symbols rather than words and numbers. However, the goat-keepers did not see any need to quantify or record changes in their animals, and were content to rely on their observations and their recall.

In most trials in the BAIF/NRI project the monitoring system had two components. There was fortnightly monitoring of goat productivity parameters (e.g. milk production); and monthly meetings with participants to discuss how the trials were progressing.

6.4 Processing Monitoring Data

Every effort should be made to speed up the collection and analysis of data. This helps to reduce errors and speeds up the dissemination of results back to the farmers. It is important to be clear at the outset which members of the research team are expected to analyse the monitoring data, and in what ways. Field staff may not be used to analysing data, and may assume that this is only done by senior members of the team. It is desirable, however, that field staff undertake at least preliminary inspection and analysis of the data, so that they know what is happening to the trial animals. Where it is possible to computerise the data locally this will facilitate analysis.

In the BAIF/NRI project there has in a few cases been a time lag of weeks, if not months, before the data collected by the field staff has been entered into a computer and analysed by the researchers. Livestock-keepers, on the other hand, are doing real-time monitoring, observing changes in their animals week by week, if not day by day. Thus, when joint monitoring meetings have taken place the researchers have not always been aware of important trends, and hence they have not been able to make the most of the meetings and to investigate certain issues promptly.

This problem is not insuperable, however. Field staff can be trained to enter data into computers, or to do simple mathematical exercises (e.g. determining means) using calculators. They can also be trained to convert data into media that are amenable to visual inspection, including graphs or histograms, which can be highly informative (Casley and Kumar, 1988).

6.4 Physically Distinguishing Animals to be Monitored

Where there are several animals in a herd it may be necessary to identify the experimental animals in some way, and, where necessary, to distinguish between ones in different groups. There are various ways in which this can be done, including: painting horns, tagging and ringing (for poultry). Livestock-keepers may have strong views on the acceptability or otherwise of different options, so it is important to discuss this matter with them before making a decision. There may be a local technique that can be adopted or adapted.

Members of the family who own the herd will probably have no difficulty identifying individual animals. In India, there is a widespread practice of giving a name to each animal, and every family member is well acquainted with these names. The names may be based on the colour of the animals, their behaviour, season of birth, place of birth/purchase, identification mark, etc. Owners also sometimes give the name of a god, goddess or river to their animals. The PTD team should ensure the participation of all the family members during identification of animals for trials, to avoid confusion. The name and identification marks of each animal should be recorded in the monitoring notebooks of the researchers and participants, so that they can be easily identified by any of the team members. In India, livestock keepers also paint their animals during some festivals as a mark of love. Hence, painting of horns with different colours for different groups can also be an appropriate technique for identification of animals in the trial.

6.5 Methods for Measuring Treatments and Performance Indicators

6.5.1 Measuring treatments

Whenever a trial is conducted on livestock, whether it is PTD or a researcher-managed trial, accurate measurement of treatments is important. For example, to assess the effect of feed supplementation or deworming, it is essential to feed or drench the animals respectively with the recommended quantity of input as per the trial protocol. At the research station, where facilities are available, it is easy to measure such inputs every day; but it can be difficult to measure such inputs in the field. In PTD, it may not be possible to use the exact quantity of input, but a high degree of accuracy can be achieved by developing local methods to measure inputs that are convenient for the livestock-keepers, as is illustrated by the following examples.

First, if you wanted to provide a supplement of 200 grams of sorghum + Horse gram mix, or 250 grams of *Prosopis juliflora* pods, to the does, it would be very difficult to weigh the materials every day, as this requires more time as well as a weighing facility. To overcome this problem, local measures should be developed to feed the recommended quantity of supplement. Such issues should be discussed in a group meeting before the initiation of the trial. In the meeting, the appropriate quantity of supplement should be weighed on a balance in front of all partners and family members. Subsequently, it should be measured with some kind of local measure. Generally, in Indian villages every house has a measure (called a '*Sher*') that is in daily use to measure grains or flour. Once the capacity of the measure (sher) is made known to all partners, there is no need to weigh the input everyday.

Second, in the BAIF/NRI project deworming trial (see Box 1.2), 20 mg of trichomes (hairs) of *Mucuna pruriens* pod are applied per kg of body weight. A local plastic spoon has been selected by the PTD team to measure the recommended quantity of trichomes to drench the animals. The team have established that one level plastic spoon of 4.5 gms capacity contains 500 mg of trichomes, while one two-finger pinch of trichomes weighs 100 mg.

In other situations more approximate measures may need to be adopted or may be adequate. For example, in the BAIF/NRI goat project, to measure 250 grams of *Prosopis juliflora* pods, the Karnataka staff have developed measures like two handfuls of adult male.

6.5.2 Measuring performance parameters

Weighing animals The weight of animals is an important performance indicator in many types of trial. It reflects the growth and health of animals, and also their value. It is important that animals are weighed carefully, particularly if they are pregnant. In India, owners do not like to see their animals becoming scared or uncomfortable.

Weighing non-pregnant animals is not at all difficult, but weighing does that are in an advanced stage of pregnancy is more risky, if they are not handled carefully. One type of weighing system is a small wooden platform attached to a spring balance, where the animal is lifted up onto the platform for weighing. The disadvantage of this system is that animals will not stand calmly, because of shaking. It is also difficult to carry the wooden platform from house to house, because of its weight.

To avoid this problem the BAIF/NRI project team in Dharwad, Karnataka, has developed a another simple weighing system. It consists of a piece of rectangular gunny bag cloth with 4 holes at appropriate distance, with rope attached to each of the four corners so that it can be hung from the weighing balance. Using this system, the goats can be weighed comfortably.

Measuring milk yield Nowadays in India standard measures are available every where to measure milk yield. Nevertheless, some families use a local measure, like a tumbler, to measure the quantity of milk.

7. EVALUATION: Assessing the Effect of Interventions

Meetings or workshops attended by both farmers and researchers need to be held at which the outcome of the experiment can be jointly assessed. The results of the experiment are systematically described and discussed according to the criteria defined during earlier group meetings. The original objectives of the experiment, and the criteria for success, are reviewed.

7.1 Qualitative Assessment

Assessments can be based partly or entirely on participants' subjective opinions, based on observation, taste, feel, etc. For example, people's preferences for different breeds (e.g. of poultry or goats) are often based on the animals' appearance (e.g. colour, shape) as much as any quantifiable production parameters. Where participants' own judgements are the main consideration, their willingness or otherwise to 'adopt' the technology that has been tested will be the main indicator of its efficacy.

Participants may not need any quantitative data to persuade them of the merits of the treatment. For example, in a trial to address mange in goats the "visual results … were so impressive, and farmers were so enthusiastic, it was not necessary to wait for statistical analysis before reaching a conclusion on the efficacy of the treatments" (Sutherland and Kang'ara, 2000).

Based on quantitative data collected by trained monitors, trials conducted by the BAIF/NRI project provided clear evidence that selective supplementation with tree pods resulted in does producing significantly more kids (through higher conception rates and higher twinning rates) than they would otherwise have done (see Box 1.1 and Appendix 4). It would have been a mistake, however, to rely on quantitative data alone in evaluating these trials, as these could give a misleading picture: participants' views are also of paramount importance. For example, goat-keepers sometimes prefer to have one kid rather than twins, because: (a) one kid may have a better chance of survival; and/or (b) some milk may then be available for consumption by the owner's family. They could, therefore, regard twins as a disbenefit rather than a benefit, but this point would not be captured by quantitative data, and hence the results could easily be misinterpreted.

7.2 Quantitative Assessment

If hypotheses were formulated, and relevant variables monitored, some quantitative summary data should be available that can provide a basis for the joint assessment: for example, the percentage of farmers who rated a technology highly, or the average performance of a technology according to some objective assessment. For example, in an agroforestry project, data were collected on where farmers planted selected species, their preferred uses of different species, their opinions about the effect of the species on crop yields (positive, negative or no effect) and their mean ratings of the species against various criteria (Coe, 1997).

Table 7.1 Farmer Evaluation of Fodder Trees Using Matrix Scoring[1]

Fodder Tree Species	Creamy milk	Milk output	Health of animal	Ease of collecting leaves	Ease of marketing milk	Palatability
Calliandra	13	9	9	12	12	12
Sesbania	6	7	7	3	6	7
Grevillia	1	4	4	5	2	1

[1] This table aggregates separate scores of male and female groups: the differences between the groups were minor. Each group had ten counters to allocate between the three tree species against each criterion.

Source: Adapted from Mason *et al.*, 1999.

Participants' assessments can be quantified in various ways, for example, through scoring and ranking exercises. Matrix ranking is useful in that it also shows the criteria on which the rankings are based. The results obtained by each participant need to be noted against each of the main criteria, distinguishing between the different treatments. The results of all the experimenters can be summarized by calculating averages: simple tables may provide an effective way of presenting this information (Veldhuizen *et al.*, 1997). An example of matrix scoring is given in Table 7.1.

7.2.1 Profitability analysis

The methods that were described earlier in section 4.4.2 can be used again to see whether the original profitability analysis has been confirmed, and to see how different treatments compare with each other.

7.3 Statistical Analysis

There is often scope for some statistical analysis of data in participatory research. With *farmer-designed* trials quantitative assessment data will be in the form of scores or yes/no answers: for example, did a farmer adopt the technology or not? With *researcher-designed trials* quantitative data will be a mixture of continuous biophysical data, such as milk yields or growth rates, and categorical data such as scores or ranks.

Meaningful statistical analysis and interpretation of *biophysical data* is sometimes problematic in participatory research, particularly in the collaborative and collegiate modes, due to high levels of variability. However, the problem may not be as acute as some observers have suggested, particularly with advances in computing power and the development of more user-friendly software for statistical analysis (for further details see Appendix 2; also Martin and Sherington, 1997). An example of statistical analysis of data from a participatory livestock trial is given in Appendix 4?.

7.3.1 Analysing data when it is collected

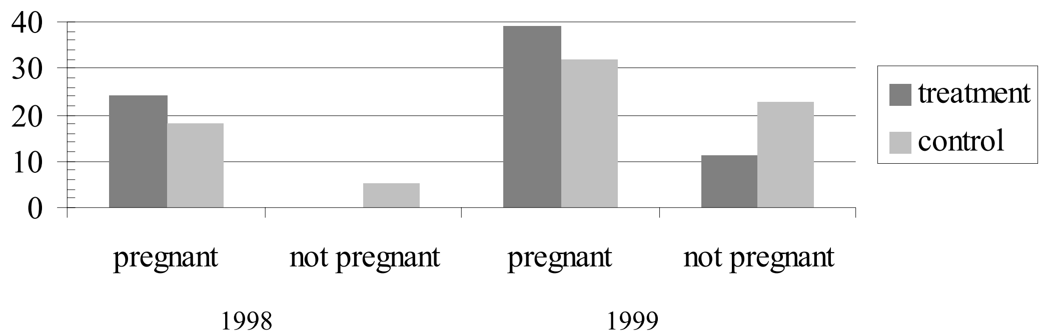
One area where the project has experienced some difficulty with a participatory approach is in joint monitoring. The difficulty is that there has been a time lag of weeks, if not months, before the data collected by the field staff has been entered into a computer and analysed by the researchers. Goat-keepers, on the other hand, are doing real-time monitoring, observing changes in their animals week by week, if not day by day. Thus, when joint monitoring meetings have taken place the researchers have not always been aware of important trends, and hence they have not been able to make the most of the meetings and to investigate certain issues promptly. Examples of issues only identified after completion of trials include:

- convergence in the weights of kids in the treatment and control groups, due to various factors including (a) control group members starting to apply the treatment and (b) treatment group members starting to give the treatment to the whole herd; and
- some goats producing more milk after construction of a water trough, while others' milk production is unaffected.

Box 7.1 Graphical presentation

Graphical representations of experimental data are generally easier and quicker to interpret. For example the data in Appendix 4, Table A4.1, can be represented as a bar graph, which more clearly emphasises the important differences.

Conception data for mature does



This problem is not insuperable, however. Field staff can be trained to enter data into computers, or to do simple mathematical exercises (e.g. determining means) using calculators. They can also be trained to convert data into media that are amenable to visual inspection, such as graphs or histograms: see Box 7.1 for an example.

Where local staff do not have access to a computer, or don't know how to use one for data analysis, they should be encouraged to do simple forms of analysis (e.g. using a calculator to estimate mean weights, and plotting a graph manually to show changes over time for both trial and control groups).

8. ACHIEVING WIDER IMPACT

NGO projects or programmes that adopt a participatory approach to technology development with resource-poor farmers tend to be very resource-intensive, with high unit costs per farm household (Farrington, 1998). A number of factors contribute to this. First, the technology development process is slow, since it usually requires considerable time to be spent on developing the capacity of project staff and farmers or livestock-keepers, and building up a positive rapport between them, before it can function effectively.

Second, it requires a multi-disciplinary team, and a few organisations may need to be involved since often no one organisation possesses the necessary skills and expertise. This itself can be costly, and it also slows down the technology development process, because staff from the different organisations need to get to know each other and the organisations themselves need to sort out how they are going to relate and to develop a *modus operandi*.

Third, points one and two mean that the research is only undertaken with a relatively small number of farmers or livestock-keepers, and hence the size of the benefits generated (assuming the project does develop effective technologies) is small relative to the high unit costs (per farmer or village) involved. Fourth, it has also been argued that even if there were serious efforts to disseminate the technologies, the spread effect would be limited, because the farming and livelihood systems of resource-poor farmers and livestock-keepers are so varied and complex that no one technology is likely to be appropriate for a really large number of them (Okali *et al.*, 1994).

The obvious counter-argument to the above points is that conventional research processes themselves have a poor track record in developing technologies that are suitable for adoption by resource-poor farmers and livestock-keepers (see section 1) – and that is why many researchers have advocated PTD as an alternative approach. However, this counter-argument does not entirely address the points raised. It could still be argued that both approaches are rather ineffective at developing technologies suitable for adoption by a large number of resource-poor people, and that the costs of both of them outweigh their benefits. Neither governments nor donor agencies are obliged to fund agricultural R&D, and nor are they obliged to give priority to RPFs. Indeed, there has been a reduction in donor funding for agricultural R&D precisely because of dissatisfaction with its limited impact.

The concerns over the efficacy of PTD deserve to be taken seriously. Agencies involved in PTD, if they are genuinely concerned about poverty reduction, should in any case be asking themselves how they are going to maximise the benefits from the technologies they have developed with livestock-keepers, by disseminating them as widely as possible. In addition, if their experience confirms that PTD can be more effective than conventional technology development processes, they should be seeking to promote the more widespread adoption of this approach.

This section looks at how PTD projects can maximise their wider impact. There are various ways that they can do so. They can extend their impact spatially, or geographically, by encouraging other development agencies operating outside of their immediate project area to promote the uptake of the technologies they have developed (see section 8.1 below); and by promoting the effective use of PTD by sharing their experiences with other agencies, including the benefits they have seen arising from its use (see section 8.2). They can also extend (i.e. sustain) their impact temporally by: strengthening the capacity of livestock-keepers to experiment; and by institutionalising PTD within the project's lead organisations.

8.1 Disseminating Technologies Developed by the PTD Project or Programme

This section covers issues that are not specific to livestock research and development, and which have been covered in other publications, so they are only discussed very briefly. For further details readers are referred to the following publications: Norrish *et al*., 2001;Reijntjes *et al*., 1992: and Veldhuizen *et al*., 1997).

8.1.1. Determining the size and nature of the recommendation domain

Farming Systems Research and Extension developed the concept of the 'recommendation domain', which is the agro-ecological and socio-economic space within which a technology can feasibly be adopted and used effectively. Three factors[8] that may determine the size of the recommendation domain are:

1. the number of households involved in producing the relevant commodity (e.g. maize or scavenging poultry);
2. how widespread the production constraint or opportunity[9] is; and,

[8] Another is the resources (land, labour and money) available to the farmer or livestock-keeping household.

[9] Product markets (e.g. for milk) are better developed in some areas than others. Good transport systems can link livestock producers to urban areas, where the demand for milk and meat is often relatively high, and where prices are often higher. Good market prices for products may justify the adoption of input technologies (e.g. certain fodders) that would not have been financially attractive otherwise.

3. in the case of technologies based on locally available materials, the geographical distribution of the local material.

With regard to livestock, these three factors can be illustrated by the example of the de-worming technology described in Box 1.2. Let us take them in reverse order. *Mucuna pruriens* is found in a particular type of habitat, within a certain range of annual rainfall. It may not be found in areas with an annual rainfall of less than, say, 600 mm: such areas would, therefore, be outside the recommendation domain for the deworming technology developed by the project, unless the material could be purchased at low cost by goat-keepers in such areas.

The production constraint is high kid mortality (and slow growth of kids) in the rainy season, apparently due to high levels of worm infestation. Not all goat-keepers in India face this constraint, so the researchers ideally need to identify (through surveys, talking to key informants, analysis of secondary information etc.) how widespread the constraint is. Finally, if the technology were only effective in deworming goats, the recommendation domain would be affected by the number of goats and goat-keepers.

In general PTD projects have perhaps not given enough consideration to the question of how widely the technologies they develop can be disseminated. Where the lead agency is an NGO it may only be concerned with adoption of technologies by resource-poor people in its project area, such as a few dozen or hundred villages in a particular district.

As was mentioned earlier, some people have argued that the recommendation domains for technologies suitable for use by RPFs are small, because the farming systems of RPFs vary so much. Some have gone so far as to say that, in complex, diverse and risk-prone environments, "the 'recommendation domain' is, for all intents and purposes, reduced to the scale of a particular field or farm" (Okali *et al*., 1994). This very pessimistic view is not borne out in the case of the technologies developed by the BAIF/NRI project, for which the recommendation domains appear to be potentially very large.

For example, if we consider the *Mucuna* deworming material again, there are probably hundreds of thousand, if not millions, of goat-keepers in India whose animals are seriously affected by heavy worm burdens and who have access to *Mucuna pruriens* locally. Furthermore, we know that it is already used effectively in de-worming buffaloes, and it might, therefore, be effective in treating all major types of domestic ruminants.

With regard to the other example given earlier (in Box 1.1), *Prosopis juliflora* is very common in India over a large geographical area. The project does not know how widespread the problem of low conception rates is, but this could also be very widespread. Furthermore, in Karnataka the project has been testing the technology as a means of addressing a different constraint, that of high kid mortality in the rainy season. Preliminary evidence suggests that it improves the health of pregnant does and increases their milk production, and that their kids are healthier and grow faster. Thus, in this case the technology has been adapted[10] to address a different problem, and hence in effect the recommendation domain has been extended.

8.1.2 Promoting use of the technology in the recommendation domain

Through development agencies Once the domain has been mapped out, the next step is to identify agencies that are working on livestock development within the domain; and then to develop a strategy for reaching them effectively. In the case of relatively small PTD projects, with limited resources, the presence of potential target organisation(s), with the capacity to

[10] In this case, because the tree pods are being stored for use in the rainy season pest damage appears to be a greater threat, and the technology has been adapted through the introduction of fumigation.

disseminate findings on a larger scale, could be a criterion for selecting the area in which the project is going to work. If communication is established with target organisations early on in the project, and then sustained over time, the likelihood of them taking an interest in the project's findings will be greatly enhanced. In the case of larger projects (or programmes) it may be possible for certain target organisations to be active collaborators in the project.

Agencies that the BAIF/NRI project has been targetting include: (a) BAIF itself (BAIF works in six different states of India); (b) relevant donor-assisted projects, such as the Western India Rainfed Farming Project and the Andhra Pradesh Rural Livelihoods Project, both of which are supported by DFID; and (c) rural development NGOs. Government livestock extension services are also a target, but they are so weak in relation to poor smallstock keepers that their contribution to disseminating the technologies is likely to be very limited.

Livestock development agencies can be reached through several media, including:

- Published materials (reports, articles, picture books, posters etc.);
- Conferences, workshops, and livestock/agricultural shows;
- Tailor-made meetings or workshops, specifically for dissemination purposes;
- Electronic media (websites and email); and
- Radio and television.

Directly to livestock-keepers Livestock-keepers are, of course, the ultimate target group. Farmer-to-farmer extension tends to be highly effective, because the extensionist (the farmer or livestock-keeper involved in PTD) has a high degree of credibility with his or her peer group arising from the fact that he/she has actually used the technology, understands their situation and can speak from first-hand experience. Arranging visits to project villages during, or immediately after, trials can be very effective, as the visiting livestock-keepers can then see the technology being applied and/or see the benefits derived from using it.

Farmer-to-farmer extension is constrained by the fact that it is a very resource-intensive process, and hence can only reach a limited number of farmers or livestock-keepers. Thus, other methods (such as videos, slide shows and posters) with the capacity to reach a much larger number of potential users need to be utilised.

8.2 Building Livestock-Keepers' Capacity for Participation[11]

This section deals briefly with the question of institutionalising the research capacity of farmers. Farmers have been doing their own research for many years, and will continue to do so, with or without support from funded agencies. What then is meant by building or institutionalising farmers' research capacity? The idea here is that through project inputs, organisational arrangements can be established to facilitate better interaction between researchers and farmers. This should help to ensure that: (a) researchers have a better understanding of farmers' (or livestock-keepers') production systems and priority concerns; and that (if necessary) this re-orients their research programmes accordingly; and (b) livestock-keepers are able to draw on researchers' knowledge more effectively. In a number of projects, farmer research groups have been effectively used for performing these functions. Groups formed may be empowering, but the main aim is to enliven and sustain the flow of interactions (mainly information exchange) between researchers and farmers, and also between farmers themselves (Sutherland and Martin, 1999).

[11] This sub-section and the following one draw heavily on two references, which should be consulted for further information: Sutherland and Martin, 1999; and Sutherland *et al*., 2001.

From the point of view of pragmatic research efficiency, and not wasting farmers' time, farmer research groups do not need to be 'sustainable', but need only exist as long as they are performing a useful function in the research process - useful, that is, to both the farmers and the researchers participating. However, because formation of effective groups can be resource intensive, higher returns to establishment may be achieved if the groups facilitate dialogue between formal sector researchers and farmers on a semi-permanent basis. In some villages there may be *existing* groups with which researchers can work, rather than establishing new groups. The BAIF/NRI goat project worked with established women's self-help groups (SHGs) in one district; and in another district we are working with women's SHGs on research to improve backyard poultry-keeping. A few tips for those wanting to work with farmer/livestock-keeper research groups are provided in Box 8.1.

Box 8.1: Tips for starting and managing Farmer Research Groups (FRGs)

1. *Starting groups:*

- Study the past history of farmer group formation and existing group structure and norms
- Select representative villages/communities with reference to zonation.
- Evaluate existing groups and select ones with potential.
- Conduct awareness raising through PRA, public relations activities, technology marketing, participatory planning
- In the above, define image of outsiders through clear presentations
- Provide guidelines for farmer research groups composition /establishment (e.g. secret ballot for electing group leaders)
- Use well established farmer research groups to help establish new farmer research groups in other areas

2. *Managing the working relationship*

- Monitor representativeness of group members,
- Provide training for transformation to empower groups and researchers
- Conduct regular reviews of research priorities/results Support of village information systems - linking farmer groups.
- Stimulate farmer to farmer in-season visits.
- Experiential learning by researchers in linking with farmer group.
- Establish co-ordinated information management mechanism on the research side to reduce conflicting images and messages being presented to FRGs by different researchers
- Discuss processes (biological and ecological) as well as products with farmers
- Discuss ideas of experimentation with farmers.
- Listen, discuss, and resolve conflicts arising within the group
- Work with a limited number of communities/groups and encourage farmers to make group size self-regulating through their own mechanisms
- Invite FRG representatives for workshops and ensure FRGs a role in the research planning process.

Source: Sutherland and Martin, 1999

8.3 Sustaining and Promoting PTD within Lead R&D Agencies

Conventional natural resources organisations tend to be categorised as either concerned with research or development, and are given corresponding mandates. Since PTD straddles this artificial division it does not fit easily into most existing organisations, and this jeopardises its chances of becoming institutionalised within them. Research organisations may see it as a marginal adjunct to their mainstream research agenda[12]; while extension or development agencies may see it as peripheral to their central mandates and as less important than development work *per se*.

Careful consideration needs to be given, therefore, to where PTD initiatives should be located institutionally. On the one hand, locating them in conventional, hierarchical mainstream

[12] Reward systems in research organisations tend to be strongly dependent on the extent to which staff are able to publish articles in respected scientific journals. Such journals tend to be prejudiced against material based on on-farm trials, particularly participatory ones, because it may not satisfy conventional criteria for experimental design and statistical rigour (Chambers, 1997; Morton, 2001).

organisations may mean that progress is slow and difficult at first: on the other hand, locating them in a small and progressive organisation (or free-standing unit within a larger organisation) may seriously reduce the chances of PTD becoming institutionalised within mainstream structures or organisations. Thus, when PTD projects or programmes are being designed it is desirable to conduct an institutional assessment of the potential host organisations (see Box 8.2 for guidance on this).

BOX 8.2 Strategies for location

An institutional assessment should:

- Provide a clear understanding of the organisation's policy, including commitment and understanding from senior management, on implementing participatory client-oriented approaches,
- Review the past experience of the institution with participatory approaches and evaluate the current institutional capacity (and resources) for participatory research,
- Design a programme within the policy of the host institution, building on past positive experiences of participatory research – if possible involving some of the same staff. If necessary build appropriate training into the project design,
- Weigh the relative importance of institution capacity building versus production of technical results. As a rule of thumb, there should be confidence that building capacity in participatory research will improve the applicability and uptake of technical results – if there is doubt that this will be the case, then very carefully consider the amount of emphasis placed on participation in the programme,
- If more than one institution is critical to achieving a successful outcome, consider options for partnership in implementation.

Source: Sutherland and Martin, 1999

Much PTD work has been funded on a project basis by particular donors, and there is a risk, therefore, that when the project ends the use of a participatory approach to technology development by the organisation(s) concerned will also end or quickly fade away. Sustaining and promoting the use of PTD requires commitment from senior management, and the retention and nurturing of a critical mass of expertise among the staff. The danger is that staff who have been trained in, and worked on, PTD will gradually either:

- move on to new jobs elsewhere, or
- be transferred to a different type of job within the organisation, or
- be transferred to a different location where their line manager is not receptive to PTD, or
- continue in the same post but without the financial and other support needed to sustain their involvement in PTD.

These threats to the sustained use of PTD highlight the importance of having a strong commitment from one or more senior managers. If that is not present at the outset of a project it is something that the senior project staff should cultivate during the course of the project. Box 8.3 lists some tactics for working within hierarchical management structures, in a way that gently challenges and changes part of it.

BOX 8.3: Tactics for using participatory approaches within hierarchical management cultures

- Respect established modes of communication and meeting procedures from the start of the project,
- Invite management to observe or officiate at meetings and events which use alternative more participatory methods,
- Include in the budget training for management in participatory approaches,
- Spend time explaining new approaches and involving management in planning and decision making,
- Keep management fully informed of all activities,
- Form a programme steering committee which includes the key management representatives one is hoping to influence

Source: Sutherland and Martin, 1999

8.4 Promoting PTD outside Lead R&D Agencies

Three types of factor may be discouraging other organisations from getting involved in PTD, namely:

- Lack of skills and relevant experience;
- Negative attitudes towards PTD; and
- An unsupportive working environment.

Organisations that have been successfully involved in PTD can help to overcome the first factor by providing short training courses for staff from other organisations; or just by inviting them to the project area and briefing them on the work that has been done and the methods used. By publicising their successes they can also help to counter the second factor.

With NGOs lack of research and scientific skills may be the main constraint, whereas with government researchers it is more likely to be lack of social skills or inappropriate attitudes (e.g. a sense of superiority and a belief that scientists have nothing to learn from farmers). Unfortunately, there is probably little they can do to counteract the third factor, which includes lack of *incentives* (or even perceived disincentives) for this kind of work; and lack of *resources*, including funds to cover the travel and subsistence costs of fieldwork (see Part 4 of Chambers *et al*. [Eds], 1989; Chambers, 1997; Sutherland and Martin, 1999).

9. CONCLUDING COMMENTS

It should be clear from this guide that PTD with livestock-keepers is not something that should be embarked on lightly. There are several potential pitfalls associated with on-farm livestock experiments. Furthermore, the process of PTD itself requires a wide range of skills, and an organisational enabling environment within which it can flourish and hopefully take root. Some of the requisite skills may be in short supply, and a desirable enabling environment (e.g appropriate organisational mandates and structures) is often lacking. These and other factors (including research objectives, project resources and staff skills) should be taken into account before participatory experimentation is selected as the approach to be taken.

The experience of the BAIF/NRI project has shown that on-farm trials can 'work' for goats. The project's experience in relation to the potential problems described in section 2.3 is summarised in Table 9.1. The fact that it was possible to avoid or overcome all potential problems at least some of the time is probably due to a combination of factors: (a) BAIF staff had a good rapport with the goat-keepers from the outset; and (b) goats are in some ways easier to work with in on-farm experiments than large ruminants are.

Table 9.1 The Project's Experience with Common Difficulties

Type of Difficulty (D)	Yes	No	Some-times
1. Life cycle duration		✓	
2. Life cycle synchronization			✓
3. Monitoring effort – problem for researchers		✓	
4. Monitoring effort – problem for goat-keepers			✓
5. Mobility/variability of non-experimental factors			✓
6. Number of observation units			✓
7. Owners reluctant to risk experimentation			✓
8. Inter-annual variability in livestock productivity			✓
9. Identification of experimental animals			✓
10. Ensuring treatment only given to trial animals			✓

The project's experience suggests that a number of factors make goats more amenable to on-farm trials than large ruminants are. First, the life cycle duration of goats is shorter, making it possible to conduct trials on an annual basis and generate results within a few months. Second, many households own several goats, which makes it easier to include a reasonable number of observation units in the trials. Third, owners are probably less averse to involving their goats in experiments, than their large ruminants, due to their relatively low unit value. However, PTD can be undertaken with large ruminants too, provided that trials are not unduly long and do not pose any significant risk to the animals.

In the appropriate circumstances, and with careful consideration of the methodology to be followed, PTD can greatly increase the effectiveness of livestock research. We hope that this guide will assist researchers and development practitioners in: determining when to adopt PTD with livestock-keepers; avoiding potential problems; and maximizing the benefits generated by it.

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APPENDIX 1 Statistical Analysis of Experimental Data in Participatory Trials

The subject of statistical analysis of on-farm trials could be the subject of a guide in itself, and it is not possible to cover it comprehensively in this guide. However, some information is given here to provide the reader with a basic orientation on some key points. Perhaps the main point underpinning this appendix, as well as the main body of the report, is that we believe that the difficulties of doing statistical analysis of data from participatory on-farm trials have tended to be overestimated, and that the revolutionary advances in computing power and software have created new possibilities for analysis of data. If you are planning trials whose objectives are such that statistical analysis would be desirable, consult a biometrician at an early stage and get their advice on points relating to the design of the trial.

1 Some General Observations[13]

The main role of statistical ideas and techniques is to assist in the interpretation of data and to help design studies so that the data can be interpreted in a useful fashion. In the analysis of data, statistics has two major functions. Firstly, it can assess whether apparent effects demonstrated by the data are 'genuine' or whether they could be due to chance. This prevents over-interpretation of the data. A related feature is that statistical analysis allows precision of estimates of effects to be calculated. Secondly, statistical analysis can separate effects which may be partially confounded. As a simple example, farm size and gender may have an effect on the variable under study. However, if men tend to have larger farm areas than women, the effects of gender and farm size will be partially confounded. A simple summary of the data will not separate the two effects and a more sophisticated analysis is needed. Additionally, with datasets where many variables are recorded for each subject, multivariate statistical techniques can be used to explore relationships between variables and/or between subjects.

There has been a tendency among participatory researchers and scientists trained in on-farm research to assume that statistical methods are only feasible and applicable to researcher-managed work on research stations. For example, Okali *et al*. argue that standardised trials "present numerous problems which are now all too familiar to on-farm researchers ….[e]ven with the benefits of standard designs and statistical rigor, conventional on-farm trials are plagued with variability" (Okali et al., 1994). This has also been identified as a particular problem with livestock trials, as was mentioned in section 2.3. However, numerous features of data analysis in farmer-managed research (e.g. analysis of trials where input levels and environments vary among sites) may be amenable to modern statistical methods.

Analysis of variance was developed for comparing two or more treatments in a designed experiment, including factorial experiments. For computational reasons, its use was originally restricted to 'balanced' experiments, where each treatment had an equal number of replicates, but modern computing power has overcome this limitation for multi-factor trials/surveys.

Improved methods to handle hierarchical data have also recently been developed. Such data can frequently occur in on-farm research where some factors operate at a different level to other factors. For example, in an experiment, land cultivation over the whole farm may be done either by oxen or manually, while another factor, such as weed control can be varied within a farm. Similarly in a socio-economic study, some factors will apply to a whole village whereas others apply to individual households.

Analysis of variance is only suitable for numeric data measured on a continuous scale, but extensions of this method (Generalized Linear Models) allow similar analyses for binary and categorical data (logistic models and log-linear models, respectively). Other models can allow

[13] This sub-section was written by Ms. Sian Floyd, a former biometrician at NRI.

for an ordered categorical response, for example, a score of 1 to 4 for rating a crop variety in terms of cooking characteristics.

Statistical software packages The main statistical packages for implementing the above analyses were, until recently, command-driven, and tended to be used mainly by professional statisticians, whereas the more popular, menu-driven packages did not have the necessary advanced facilities. This is currently changing.

SPSS was the first of the major packages to have a menu-driven Windows version and this will handle most of the required analyses, although its output is not always easy to interpret and it lacks some important details. There is also a menu-driven Windows version of Genstat that is far more 'user-friendly' than earlier versions, allowing non-specialists to gain access to its powerful analytic tools.

2. Sample Size

Where statistical analysis is planned, the minimum number of sampling units (farms, animals) should, in principle, be based on the number required to show a certain difference (e.g. in yields) between different treatments, or between treatments and controls, at a given (e.g. 80%) confidence level and significance level (see Casley and Kumar, 1988). The margin of error (comprising both sampling and non-sampling error) also needs to be taken into account. Sampling error depends partly on the 'population' sampled: if there is wide variation in the universe, sampling error will be high for a given sample size and design. In other words, higher variability requires more replication for the detection of differences between control and treatment groups. Thus, it is desirable to have some information, early on, of the degree of variation in the universe. An estimate of the likely amount of variability amongst the animals can often be obtained from previous experiments or relevant literature.

It is not only sampling error that needs to be taken into consideration when determining sample size. Other practical matters also need to be considered. For example, if the minimum number of sampling units is deemed to be high, this could create problems in terms of finding a village with enough suitable animals to conduct the trial. There is then a risk that field staff may be forced to select a village with which the research team has not yet established a good rapport, making it difficult to get the villagers' cooperation.

Statistical Analysis of Non-Parametric Data: An Example[14]

This appendix describes how data from two trials organised by the BAIF/NRI project were analysed using statistical tests. The trials are the ones referred to in Box 1.1, in which tree pods were fed to breeding does to increase their conception rates. It shows that the effect of a treatment can be detected despite the large amount of variability commonly found in participatory trials, and it illustrates how this type of data can be analysed using s simple test for significance – the chi-squared test.

The treatment had the desired effect, with does in the treatment groups having higher conception rates than those in the control groups. The conception data are summarised in Table A1. Although it is clear that does in the treatment group have a higher conception rate, it is useful to quantify this difference statistically. Such differences are not necessarily due to the treatment: they could be due to chance.

[14] This subsection was co-authored by Mr David Jeffries, a former biometrician at NRI.

Table A1 Conception Data for Mature Does

	1998		1999	
	Pregnant	Not pregnant	Pregnant	Not Pregnant
Treatment	24	0	39	11
Control	18	5	32	23

The 1998 data were tested using an exact chi-squared test (see Box A2). This gave a p-value of 0.022, giving significant evidence that the conception rates are different for the two trial groups. It is clear from the cross-tabulation that this is caused by the 100% conception rate for the treatment group. The results were not conclusive, however, as there were only three goat-keepers in the treatment group, one of whom owned 13 of the 24 mature does. The difference could, therefore, have been related to inter-owner differences and non-experimental variables.

In order to eliminate this factor, the trial was repeated in 1999 in another village, with larger numbers of goat-keepers (13 and 14 in the treatment and control groups respectively) and goats. The conception rates (see Table A1) were again different between the treatment and control groups. An asymptotic chi-squared test gives a p-value of 0.055, indicating that at the 5% level there is no evidence to reject the null hypothesis of equal pregnancy proportions for the treatment and control groups. However, the p-value is very close to the 5% level, and a pragmatic interpretation is that there is some evidence that those animals taking the supplement have a higher conception rate, but further experimentation is necessary to quantify the strength of this inference.

Box A1 Analysis of cross-tabulations

The two cross tabulations (for 1998 and 1999) in Table A1 are an extremely common method of presenting data and there is an extensive literature on their statistical analysis. The aim of the analysis is to test for independence between the rows and columns. For example in this case to test whether there are any differences in conception rate between the treatment and control.

The most common form of the test is the chi-squared test. This is an asymptotic test and as a rule of thumb it should not be applied to tables with cell counts of less than four. Clearly the cross tabulation for 1998 has a cell count of zero and the test is not appropriate. However in these cases a numerical test can be used, which measures how unique the actual table is compared to all possibilities with the same row and column totals [Sprent].

For the 1998 data in Table A1 a numerical (often called an exact) chi-squared test gives a p-value of 0.022 and hence significance at the 5% level. The standard chi-squared test gives a p-value of 0.016, which in this case is similar to the exact result. Note this is not always the case and if in doubt it is advisable to check by using the numerical method. The data from 1999 can be analysed using the conventional chi-squared test, as the cell counts are all ‘large’.

Like many statistical tests the chi-squared test is a hypothesis test. Hypothesis tests are interpreted using p-values and usually tested at the 5% level. (This means that if the p-value is less than 0.05 (5%) there is evidence for rejecting the null hypothesis).

A more detailed analysis of the data can be undertaken by considering the number of kids born to each doe. The combination of higher conception rates and higher twinning rates results in higher kidding rates (number of kids/number of does, expressed as a percentage) in the treatment groups, as can be seen from Table A2.

Table A2 Kidding Rates (percent)

	1998	1999
Treatment	116.6	100
Control	78.3	69.1

Table A2 summarises the data, but a more detailed description can be obtained by giving the number of kids produced by each group of does as shown in Table A3.

Table A3 Distribution of kids born

	1998		1999	
	Treatment	Control	Treatment	Control
No kids*	0	5	11	23
Single	19	16	28	26
Twins	4	1	11	6
Mean	1.2	0.8	1	0.7

* Note this row refers to those does that were not pregnant. The two does that aborted have been dropped from the sample for this analysis.

It is clear that the mean number of kids born is higher for the treated does in both years. A Mann-Whitney test (adjusted for ties) was used to compare the two treatments and control group for both years.

Box A2 Non-parametric tests

The most common test for comparing the mean values of two different groups is a t-test, but the t-test assumes a continuous normal distribution for the observations. The distribution of the number of kids cannot even be claimed to be continuous and it would be difficult to justify the use of the parametric t-test for this data.

The Mann-Whitney test is a non-parametric equivalent of the t-test. However the Mann-Whitney test quantifies whether two distributions differ in location (i.e. mean or median). For this application the medians of the treatment and control groups for both years are all 1 and in this case the difference in location, equates to a difference in means.

The Mann-Whitney test is based on calculating ranks for each observation [Sprent] and is available in many standard statistical packages, but for data like this the test should be adjusted for tied ranks.

The Mann-Whitney test, (adjusted for ties) for differences between the mean number of kids in the treatment and control group gave a p-value of 0.02 in 1998 and 0.01 in 1999. At the 5% significance level there is clear evidence that the mean number of kids per doe is higher in the treatment group for both years.

Box A3 Numerical methods

When there are many ties the Mann-Whitney test can give misleading results. There is an alternative type of non-parametric tests based on permuting the data. This is an example of a randomisation test and as computing speed continues to increase these tests are likely to become more common.

The basis of the test is a random allocation of the responses to each group to quantify how rare the observed data is (Manly, 1998). For each randomisation the difference between the means is measured by the standard t-statistic. Since the data do not satisfy the necessary assumptions for a t-test, the t-distribution cannot be used to quantify how extreme the observed data are. As an alternative the randomisation distribution of the t-statistic can be used to quantify the significance of the mean difference for the observed data.

Randomisation tests have the advantage that they are easily programmed and no specialist statistical software is required. Although many permutations have to be used (1000 or more), this should not be a problem as the results of tests are not required in real-time.

Randomisation tests were performed with 1000 permutations being used for each year. For 1998 the test gave a p-value of 0.024 for a difference of 0.35 between the treatment and control groups and for 1999 the p-value was 0.026 for a difference of 0.3. These tests confirm the inference of the Mann-Whitney tests and reinforce the conclusion that treated goats are significantly more fecund than the goats from the control group.

Box A4 Confidence intervals

The mean differences between the treatment and control groups have been estimated and found to be significant, but the accuracy of the differences has not been established. A concise and informative method for showing the accuracy of the mean difference is to give an interval for the estimated true difference between the mean of the treatment and control groups. This is called a confidence interval and the 95% confidence interval is usually quoted. The 95% confidence interval can be interpreted as being an interval, which has a 95% chance of containing the true difference between the means.

There are techniques for calculating confidence intervals using the Mann-Whitney test, but they are difficult to apply and do not always give useful results. An alternative technique is to use the randomisation distribution to numerically estimate the 95% confidence intervals (Manly, 1998).