

The efficacy of participatory development of technologies: experiences with resource-poor goat-keepers in India

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Abstract

The adoption by resource-poor livestock-keepers of technologies developed by livestock and forage researchers has been poor. It has been argued that a participatory approach to technology development can help to ensure that new technologies are more appropriate to livestock-keepers' needs and circumstances, and hence increase the likelihood of adoption.

This paper describes trials conducted in India by a goat research project that adopted a participatory approach, and assesses to what extent the postulated benefits of participatory technology development have been realised, and the factors affecting this. It describes trials involving two of the most promising technologies developed by the project. It then discusses: (a) the prospects for adoption of these and other technologies investigated by the project; (b) methodological issues relating to control groups; and (c) the challenges associated with achieving a high degree of participation by livestock-keepers.

Finally, it identifies what conclusions can be drawn, and lessons learned, from the project's experiences.

Keywords: Goats, participatory technology development, ethnoveterinary medicine

Introduction

Scientists have acquired a tremendous amount of knowledge about feed resources and ruminant production, nutrition and health in tropical countries. Despite this, resource-poor livestock-keepers' adoption of technologies developed by researchers has been limited, in relation to:

- enhancing fodder production and improving grazing management systems, (Acharya and Bhattacharya 1992; Sidahmed 1995);
- animal health treatments (drugs, vaccines etc.).

This is partly because technologies have often been developed without the involvement of the intended users, and without an adequate understanding of their farming systems and constraints. Constraints on any of the factors of production – land, labour or capital – can inhibit take-up of new technologies. By definition, such constraints are most severe among resource-poor livestock-keepers, for whom effective new technologies are most needed.

Some examples of constraints affecting livestock feed technologies, relating to each factor of production, will now be given. Insufficient land may make it impossible to grow fodder crops, because the farmer does not have enough arable land and the fodder crops compete with food or cash crops; insufficient labour may make stall-feeding, based on cut-and-carry, an unattractive option; and scarcity of cash may discourage livestock-keepers from purchasing inputs, such as green fodder, compound feeds or concentrates.

Government veterinary services in developing countries, although they may be free of cost in principle, tend not to reach resource-poor farmers. As little as 15-20% of the livestock populations in LDCs have enjoyed regular and affordable access to modern veterinary medicine and “there is little prospect that these percentages will change much in the foreseeable future” (McCorkle et al 1999). There is a need, therefore, to develop low-cost health-related technologies, based on locally available materials or expertise, that can be acquired without regular access to state veterinary services. Participatory Technology Development (PTD) can also

contribute here by identifying, testing and developing such technologies with livestock-keepers.

The potential advantages of farmer participation

Livestock research and development work has tended to lag behind crop production work in the development and application of methods for PTD. It is clear from reviewing the literature on PTD or farmer participatory research (FPR) that there are relatively 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 1997). Perhaps only five percent of case studies have a livestock focus. However, there has been increasing recognition that livestock research needs to give greater emphasis to farmer participation (Sidahmed 1995); and some researchers now believe that “participatory approaches are mandatory” for the development of forage options (Peters et al 2001).

It has been argued that PTD 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). More specifically, 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;
- farmers’ capacity and expertise for conducting collaborative research is built-up and becomes a valuable resource for future research programmes (Conroy et al 1999).

The BAIF/NRI Goat Research Project

Since October 1997 the BAIF Development Research Foundation (India) and the Natural Resources Institute (UK) have been managing a research project to identify and address feed-related constraints affecting goat production in India. The project has been working in various semi-arid regions, including south Rajasthan and Dharwad district, Karnataka. The project has worked primarily with poor people, belonging to scheduled castes or scheduled tribes, who either have small farms or are landless.

The project aims to develop technologies to ease or remove the constraints identified, based primarily on a *collaborative* relationship with goat-keepers, as described in Table 1. A collaborative approach is more participatory than the *contract* and *consultative* modes, which have probably been the ones most commonly used in on-farm livestock research. (The degree of farmer involvement increases in the modes to the right hand side of the table.) This article focuses on two of the most promising technologies developed by the project. It then discusses: (a) the prospects for adoption of these and other technologies investigated by the project; (b) issues relating to the use of control groups; and (c) challenges associated with achieving a high degree of participation by livestock-keepers. Finally, it identifies what conclusions can be drawn, and lessons learned, from the project’s experiences.

Table 1: Four different modes of farmer participation in agricultural research (Source: Biggs 1989)

1. Contract	2. Consultative	3. Collaborative	4. Collegiate
Farmers’ land & 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 & continuously collaborate in activities	Researchers actively encourage & support farmers’ own research & experiments

Materials and Methods

Methods used in diagnosis and needs assessment

The BAIF/NRI project team began by doing surveys in prospective project villages. The surveys involved rapid rural appraisals with groups of goat-keepers, using semi-structured interviews and mapping and diagramming. The surveys generated descriptions of the goat production and feeding systems. In PTD it is essential to identify priority needs: simple ranking was used to identify

major problems and their relative importance, and the results of the ranking were generally cross-checked with other survey findings. This was sometimes followed by participatory problem tree analysis to gain a deeper understanding of the nature of the constraint [*The use of this and other PRA methods is described in a recent publication of the project (Conroy 2002)*].

If an important feed-related problem was identified through the group discussions, more detailed livestock productivity data (e.g. on kid mortality) were often sought subsequently through individual interviews, using the ‘participatory herd history’ method (described in Conroy, 2002), as such data can help to identify critical periods in the nutrition of the animals.

Methods used in the trials

The project then established some ‘in village’ [Some of the participating goat-keepers were landless, so the usual term, ‘on-farm’, is not appropriate] trials to address the problem or need identified. The first few trials focused on supplementation of feed at critical points in the year, but more recent trials have included ones in which the treatments were anthelmintics. A summary of some of the trials is given in Table 2.

Table 2: Some trials on goats conducted by the BAIF/NRI Project

Challenge# addressed	Treatment/ technology tested	Timing of treatment	Key indicators	Monitoring period
Poor reproductive performance of female goats (low conception rate)	Tree pods supplement (combined with barley in first trials)	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 mortality in kids (< 60 days) in rainy season (in Karnataka)	Dewormer:- commercial OR- based on locally available material	Applied to does in late pregnancy and on day of kidding	Mortality during first 60 days after kidding Growth rates	3 months
High mortality in kids (< 60 days) in rainy season (in Karnataka)	Feed supplement	Applied to does in last 4-6 weeks of pregnancy and for one month after kidding	Mortality during first 60 days after kidding Growth rates	3-4 months
High mortality of young goats (6-9 months) in the rainy season (in Rajasthan)	Urea molasses granules (UMG)	Daily for 10 weeks during late dry season and early rainy season (mid-May to end July)	Mortality during early rainy season	4 months
Faster growth of young male goats to increase income	Barley supplement	Daily for 2-3 months for goats aged 3-6 months	Sale price and weight at time of sale	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	Age at which females reached sexual maturity	About 15 months## – from start of treatment to age at which females came into heat or conceived

A challenge can be a problem or an opportunity

Data from the 2001 trial are not yet available

The process of designing, monitoring and evaluating the trials was intended to involve goat-keepers actively. The trials were designed with a treatment and control group in the same village, so that a ‘with/without’ comparison could be made. This has been done either (a) by selecting different goat-keepers of similar socio-economic status for the two groups; or (b) having treatment and control animals belonging to the same owners. Non-experimental variables have not been controlled in any way, and, apart from applying the treatment, goat-keepers have been encouraged to follow their normal practices.

The project team concluded at the outset that it would be necessary to subsidise treatments to some extent, in order to: (a) encourage participation; and (b) to compensate people in the treatment groups for any potential risk to which their animals might be exposed, and for the time they contributed to the monitoring of the trial. People in the control groups were also provided with material incentives of a different nature that would not affect the outcome of the trial (e.g. provision of a breeding buck). However, the project team also considered it important that goat-keepers contribute to the costs of the treatment, as a demonstration of their interest in the technology to be tested and the problem being addressed. The project’s approach has been to phase out subsidies

where technologies prove to be effective.

Methods used in monitoring and evaluation

In most trials there has been a two-pronged monitoring system, comprising: fortnightly monitoring of goat productivity parameters (e.g. milk production); and monthly meetings with participants to discuss how the trials were progressing. The former provides quantitative information, while the latter provides qualitative information, including the goat-keepers' perceptions of how the animals are responding to the treatment and any issues that are concerning them. One or more literate persons from each trial village has been given training by the project in how to measure and monitor the relevant goat productivity parameter(s), and has been paid for doing this. Joint evaluation meetings with participants (from both the treatment and control groups) have been held at the end of the trials.

The trials

There is not space to describe all of the trials in this article. Instead, the focus is on describing two sets of trials involving the most promising technologies, namely:

- use of *Prosopis juliflora* pods as a feed supplement and
- use of trichomes of *Mucuna pruriens* pods as a dewormer.

Set 1: The use of tree pods to improve kidding rates

In Bhilwara District of Rajasthan there was evidence that feed scarcity in the dry season could be acting as a constraint on the reproductive performance, particularly conception rates, of female goats belonging to poor people. In on-farm trials in 1998 and 1999 breeding does were fed 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. *Prosopis juliflora* pods are a good source of protein and energy, possessing 12-14% crude protein on a dry basis (Wood et al 2001). The pods were collected when they appeared on the trees in April and early May and stored for use later. In 2000 and 2001 similar trials were conducted, but this time the treatment (again 250 grams/day) was entirely *Prosopis juliflora* pods.

Set 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, and the project conducted trials in 2000 and 2001 to address this. It was hypothesized that the kid mortality was linked to the worm burden of the does at that time of the year. Two treatments have been tested: (a) a commercial dewormer, *Fenbenzadole*; and (b) a locally available material known to have anthelmintic 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.

Results of the Two Sets of Trials

Set 1: The use of tree pods to improve kidding rates

The treatments 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 3. The difference in conception rates between the treatment and control groups is significant at the 5% level for the 1998 and 2000 data, using an exact chi-squared test; whereas the p-value for the 1999 data was almost significant at 0.055.

Table 3: Conception data for mature does

	1998		1999		2000	
	Pregnant	Not Pregnant	Pregnant	Not Pregnant	Pregnant	Not Pregnant
Treatment	24	0	39	11	34	3
Control	18	5	34	22	28	7

Data from the 2001 trial are not yet available

The incidence of twinning was also higher in the treatment groups (see Table 4), but the difference was not significant at the 5% level. An exact chi-squared test gives values of 0.37, 0.35 and 0.37 for the 1998, 1999 and 2000 data respectively.

Table 4: Twinning rates for does that kidded*

	1998		1999		2000	
	Twins	One	Twins	One	Twins	One
T	4	19	11	28	8	19
C	1	16	6	26	3	14

* Does that aborted are excluded
T = Treatment Group C = Control Group

The combination of higher conception rates and higher twinning rates results in higher kidding rates in the treatment groups, as can be seen from Table 5. Another way of expressing the data is in terms of the mean number of kids per doe. To see if the differences are significant an asymptotic Mann-Whitney test, adjusted for ties, was used. The p-values show that at the 5% significance level there is clear evidence that the mean number of kids per doe is higher in the treatment group in all three trials.

Table 5: Kidding rates (percent)

Group	1998	1999	2000
Treatment	116.6	100.0	116.6
Control	78.3	69.1	70.4
<i>P-value</i>	<i>0.01</i>	<i>0.02</i>	<i>0.006</i>

Set 2: The use of a local plant material as a dewormer

Mortality in kids less than one month old was less than 10% in the treatment group and control group, as is shown in Table 6. A chi-square test indicated that there was no significant difference in mortality rates between the three groups.

Table 6: Mortality* of kids from birth to one month of age

Group#	No. of kids born	No. of kids died	Mortality rate (%)
Control	35	3	8.5
MP	31	3	9.6
F	30	2	6.6
Total	96	8	8.33

* Kids that died accidentally were not considered for analysis
In group MP the treatment was the trichomes of *Mucuna pruriens* pods, and in F it was Fenbenzadole.

Table 7: Comparative parasitological egg count of does of different groups before and after treatment*

Sr.	Group	No. of does	Mean number of eggs/g of faeces	Difference between mean number of eggs	't'	'P' value
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No.		Day 0	Day 7	on Day 0 and Day 7	value		
1.	C	6	717	983	+ 267	- 5.59	.003
2.	MP	7	971	271	-700	9.72	.0001
3.	T2	7	757	114	-643	6.03	.0009

* In group MP the treatment was the trichomes of *Mucuna pruriens* pods, and in F it was Fenbendazole. C = control group

The parasitological faecal egg counts were significantly lower on the 7th day after deworming in both of the treatment groups, whereas the faecal egg count in the control group increased significantly (Table 7).

Table 8: Mean weekly weight of kids during first month after birth

Sr. No.	Group	Weights (kg)					Weight gain at 4th week
		Birth	1 st week	2 nd week	3 rd week	4 th week	
1.	Control	2.12	2.77	3.24	3.71	4.12	2.00
2.	MP	2.28	2.99	3.72	4.23	4.88	2.60
3.	F	2.23	2.94	3.56	4.19	4.81	2.58

Statistical analysis of the data summarised in Table 8 showed that the mean growth rates of kids in groups MP and F were significantly higher than that of the kids in the control group. The apparent difference in mean growth rates between the two treatment groups was not significant.

Discussion

This section focuses mainly on methodological issues and prospects for adoption.

Trial results

Set 1

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. Using *Prosopis juliflora* pods alone gave better results than a mixture of pods and barley. One possible explanation for this is that the goats are protein-deficient in the late dry season, but not energy-deficient. A large proportion of their feed is chopped cactus (*Opuntia spp*) at this time of the year (C. Wood, *pers. comm.*), which is a good source of energy, but not protein (C. Wood et al 2001).

Set 2

The faecal egg count data and the growth rate data strongly suggest that the *Mucuna pruriens*-based treatment is as effective against helminths in pregnant does as the commercial anthelmintic, *Fenbendazole*. Two factors could have caused the faster growth of kids in the treatment groups. It may be that the lower parasitological load in treatment group does during the preparturient period resulted in less parasitological infestation of their kids (Smith and Sherman 1994). It may also have resulted in increased milk production, and hence greater availability of milk to the kids.

The low mortality rate of kids in the control group (8.5%), as compared with observed rates of about 50% the previous year, is thought to have been due to differences in rainfall between the two years. Rainfall in 2001 was only about half of that in 2000, and the monsoon rains arrived later than usual: as a result, worm burdens of does may have been lower in 2001.

Prospects for adoption of technologies

There are several reasons why the *Prosopis juliflora* pods technology has excellent prospects for widespread adoption by poor livestock-keepers in India, namely:

- the pods do not have to be purchased;
- this tree species is found across a large area of the country;
- the trees grow on common lands and by roadsides, making them available to the landless; and
- the collection time occurs at a time of the year when many livestock-keepers are not particularly busy.

The cost:benefit ratio for this technology is in the range 1:2.5 to 1:5, depending on the assumptions made.

Both of the deworming treatments have very favourable cost: benefit ratios. That for Fenbenzadole is 1:39, while that for the *Mucuna pruriens* treatment depends on what opportunity cost, if any, is attributed to the labour involved. The participating goat-keepers said that in future they expect to use the *Mucuna pruriens* treatment, rather than the commercial one, because no cash expenditure is required. *Mucuna pruriens* is also quite widely distributed in India, and the labour required to collect the necessary number of pods, and process them, is minimal.

By comparison, the prospects for adoption of some other supplements tested by the project, such as barley and UMG (see Table 2), are not good. Barley is valued by goat-keepers as a high quality supplement, but there are problems with its adoption. If the barley is grown by the farmer it competes for plot space with other crops, notably wheat, which is an important staple: so more food for the goats means less food for the family. If barley has to be purchased, a similar dilemma arises for the family over allocation of scarce resources.

Although UMG makes use of a locally available waste material, molasses, it was more expensive (per kg) than other high quality supplements, such as barley or groundnut cake. In addition, livestock-keepers had a general preference for the traditional products.

Methodology - control group issues

Importance of control group

Some research trials have two or more treatment groups, but no control group, the comparison being made between the different treatments. However, the BAIF/NRI project's experience shows that it is important to have a control group. This is because without a control group, it would be necessary to make a 'before and after' comparison, and these can be misleading due to inter-annual variability. For example, as noted above, data collected in the Karnataka project area in the year 2000 revealed high kid mortality in the rainy season; while data collected during the trial in 2001 show that mortality was very low in the control group and treatment groups. Without a control group, it would have been tempting to infer, incorrectly, that the low mortality was due to the treatments.

Advantages and disadvantages of different control group arrangements

When making 'with and without' comparisons, between treatment group and control group animals, it is important that proper care is taken to minimise inter-animal variations. For example, in a feed supplementation trial it would be important that the general diet of the animals from the two groups was broadly comparable. This can be difficult to achieve if the owners of the control group animals are different from the owners of the treatment group animals. The former could be wealthier, on average, and hence giving their animals more high quality supplements; or control group members could be grazing their goats on different (and superior) pasture land to that of treatment group members. Both of these situations have arisen in trials of the BAIF/NRI project.

It is easier to avoid bias by having animals from different groups within the same herds, 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, as there is a risk that control group animals will get access to the treatment. Nevertheless, our experience has shown that 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.

Methodology - degree of goat-keeper participation

The project worked in villages where BAIF already had an operational presence, which greatly facilitated the establishment of a good rapport between the goat-keepers and the research team. Nevertheless, achieving a high degree of participation by livestock-keepers was a major challenge. It was achieved in the two sets of trials described in this article, but not in all of the trials. Livestock-keepers are likely to lack confidence and trust to begin with, while researchers and development professionals may find it difficult to give up their conventional roles of being experts who know (or are expected to know) the solutions to farmers' problems.

Addressing of a priority need

The research team generally *sought* to address a priority need of the goat-keepers. However, in a few of the trials it is questionable whether the project actually *succeeded* in this aim, due to inadequate discussions with them about the precise nature of the constraint and/or the suitability of the proposed treatment to address it.

Determination of treatment

In PTD, ideas for technologies to be tested are expected to be provided by participating farmers, as well as researchers, but in most of the project's trials it was the researchers who proposed the treatment to be used. Nevertheless, this was based on knowledge of livestock-keepers' experiences with similar technologies in other localities. In most trials, the participants appeared to agree that the proposed treatment was a sensible one, and made contributions ranging from 33% to 100% of the cost of the treatment.

Factors hindering a participatory approach

It is important to be aware of, and to address, factors that may hinder the adoption of a participatory approach. These include (see also Conroy et al 1999):

- researchers lacking experience and orientation in PTD;
- researchers not thinking in terms of the profitability of treatments;
- researchers lacking awareness of constraints on goat-keepers' factors of production (capital, labour and land);
- researchers not being fully committed to a participatory approach;
- pressure to move quickly from the diagnosis and needs assessment phase to the establishment of trials, arising from the short lifetime of some projects [*The BAIF/NRI project was originally expected to last for three years, but was given an extension, increasing the duration to four and a half years*], resulting in inadequate needs assessment;
- small project budget, resulting in insufficient staff time to encourage full farmer involvement;
- late scheduling of project activities (related to previous point); and
- staff turnover and involvement of inexperienced staff.

Factors facilitating increased participation

A high degree of participation is not usually possible from the outset. However, if researchers are committed to achieving it there is likely to be a gradual shift along the spectrum towards greater participation. In the experience of the BAIF/NRI project this may be due to one or more of the following factors:

- development of positive rapport between researchers and participants when successive trials are conducted in the same village;
- improved understanding by the researchers of problems or opportunities;
- the efficacy and profitability of the technologies is demonstrated, or improved through modifications; and
- technologies found to be ineffective are abandoned.

Conclusions

A number of conclusions can be drawn, and lessons learned, from this project.

- The experience of this project lends support to the view that the more and the earlier farmers and livestock-keepers are involved in the research process, the more rapidly appropriate technologies will be identified.
- To ensure the active involvement of goat-keepers in PTD it is essential that the research is addressing a need that they regard as important. Accurate identification and understanding of priority needs by researchers is likely to require

considerable time and effort, but this is thoroughly justified.

- Technology development is a gradual and iterative process. Thus, a number of trials may be required before a technology is developed that meets livestock-keepers' priority needs and is suitable for adoption.
- The project's experience suggests that one should avoid cash-based treatments when working with *very* poor people. For them, it is important to draw on inputs that are locally available, either on their farms or in the nearby environment; or which can be introduced easily.
- It is important to take steps to promote a participatory approach by the project, programme or agency. Some specific steps are listed below.
 - Any project will need at least one "process champion", preferably with prior experience of PTD, who strives to ensure that the project team adopt and maintain a participatory approach. Social science researchers and development workers are usually (but not always) better suited to this role than natural scientists.
 - The BAIF/NRI project sought to strengthen the capacity of BAIF's field staff to undertake PTD by providing them with relevant training, in the form of one-week courses in PTD. Many of them had not previously been involved in participatory research.
 - Exposure visits to other PTD projects (not necessarily involving livestock) would also be very beneficial.
 - The BAIF/NRI project introduced a procedure mid-project whereby, before any trial was authorised, the researcher was required to complete a protocol, and to provide, *inter alia*:
 - evidence that the researcher had done a thorough needs assessment (upon which the case for the trial is based) and understood well the problem or opportunity; and
 - quantified estimates of the cost of the proposed treatment and the likely or possible benefits, indicating good prospects for the treatment to be profitable.

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