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MATCHING LIVELIHOOD NEEDS TO TREE SELECTION IN HIGH POTENTIAL FARMING SYSTEMS: LESSONS FROM PARTICIPATORY RESEARCH IN NEPAL AND INDIA

M Warner, PG Bezkorowajnyj, RB Rana and JR Witcombe

Abstract

A participatory crop improvement project in Gujarat, India and the Terai, Nepal, funded by the Department for International Development and co-ordinated by the Centre for Arid Zone Studies, University of Wales, is improving crop production and tree use in areas where people have low incomes, but where the production potential is high. Surveys conducted by the project suggest that the last five years have seen significant changes in certain livelihood strategies, including an increase in biogas and crop residues as a fuel source, a shift from open grazing to stall-feeding and increases in the use of fodder crops and crop residues as livestock feed. The surveys also revealed a marked shortage of fuelwood. Conclusions are drawn on the future viability of 'trees on farms' as a strategy to meet the demand for fuel and livestock feed. An associated participatory tree selection methodology is presented. The approach incorporates lessons from the project's initial participatory crop improvement methodology—namely combining local plant material with a scientific search outside the local area—to improve the chances of introducing trees in ways which are viable as a livelihood strategy.

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Acronyms

AFT	agroforestry tree database
CGIAR	Consultative Group on International Agricultural Research
DFID	Department for International Development (UK)
FAMPAR	Farmer Participatory
FGDs	focus group discussions
FPR	farmer participatory research
HPPSs	high potential production systems
ICRAF	International Centre for Research in Agroforestry
IRD	informal research and development
ITK	indigenous technical knowledge
LPG	liquid petroleum gas
PCI	participatory crop improvement
PRA	participatory rural appraisal
PTD	participatory technology development
PTS	participatory tree selection
PVS	participatory varietal selection
RA	rapid appraisal

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1 LIVELIHOOD STRATEGIES AND PARTICIPATORY METHODS

The concept of sustainable rural livelihoods is becoming central to debates about rural development, poverty reduction and environmental management. The concept has gained ground as it has become clear that earlier definitions based on income or on the ability to meet basic needs do not capture the complexities of poverty. Sustainable rural livelihoods can be defined as "comprising the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (Scoones, 1998).

Scoones identifies three broad clusters of livelihood strategies open to rural people. These are agricultural intensification/extensification, livelihood diversification and migration.

"Either you gain more of your livelihood from agriculture (including livestock rearing, aquaculture, forestry, etc.), through processes of intensification (more output per unit area through capital investment or increases in labour inputs) or extensification (more land under cultivation), or you diversify to a range of off-farm income earning activities, or you move away and seek a livelihood either temporarily or permanently elsewhere. Or more commonly you pursue a combination of strategies together or in a sequence" (Scoones, 1998).

Planting trees on farms is one example of an intensification strategy increasingly adopted by farmers. However, many interventions to promote trees on farms are undermined by a weak understanding of household needs. For example, interventions that have sought to meet subsistence needs have been accompanied by under-estimations of the influence of market demands for wood products and fruits. An obvious case is households deficient in fuelwood perceiving an opportunity cost in selling wood to the market (Arnold and Dewees, 1995). Other interventions, because they depend upon credit (or payment by instalment) to cover start-up costs (nurseries, land preparation, etc.) lead to the encouragement of tree cash crops on unsuitable soils. Crude extension targets of forestry services and targets that demand the distribution of a quantity of seedlings, or the meeting of expressed numbers of plantings also contribute to the dissemination of inappropriate tree species (Arnold, 1991). Perhaps most importantly, there is a generally poor level of communication between extension staff and households, due either to a shortage of people trained in participatory skills, or people lacking in the ability to interpret and adapt these skills to the task of participatory tree selection.

Criticisms of participatory approaches

Participatory approaches to natural resource research and extension are a response to shortcomings in 'top-down' project diagnosis, planning and implementation. Broadly speaking, the different approaches share a common philosophy: that in marginal farming areas, the high degree of social diversity and physical vulnerability negates a 'top-down' approach to farm management—that development should not be imposed from outside, 'but should rather spring from the felt needs and aspirations of the people most directly affected' (Campbell and Gill, 1991).

Although the aims of participatory approaches have been welcomed, the manner in which they are operationalised is under suspicion. The criticisms are fourfold. First, participatory methods remain peripheral and isolated from conventional development policy (Thrupp *et al*, 1994). Second, these approaches are often techniques used only for information extraction—an outcome far removed from the goal of empowerment and self-mobilisation first envisaged (Mosse, 1994; Warner and Robb, 1996). Third, a wide range of tools and techniques are offered but with very little by way of guidance on how to select tools to achieve different ends, or how each is a component of an overall methodology[1]. Fourth, a laudable focus on indigenous technical knowledge (ITK), underpinned by a philosophy of 'farmer knows best', has in some cases led to the neglect of 'outsiders' science, such as the provision of modern crop or tree varieties which better meet people's livelihood needs.

Participatory technical development

Perhaps the approach least open to these charges is participatory technology development (PTD). PTD is a response to the desire to replicate the successes of the 'green revolution' in rainfed areas and the need to re-orient research within Consultative Group on International Agricultural Research (CGIAR) centres and national programmes towards small farmers' needs. The methodology involves several stages: the outcome of a participatory diagnosis is used as the basis for technology selection or development. The resulting technology is then tested and refined on farms with farmer participation.

PTD also has some critics. Genuine successes are few, held back by the lack of participatory and communication skills of research station staff and a tendency for solutions to be taken 'off-the-shelf'. An additional criticism is that whilst PTD has principally been promoted as a means to increase the relevance of international research centres (so that they better reflect the policies of their donors), its more natural function is as a tool for improving extension services and 'scaling-up' the benefits of research. As Bunch (1996) argues, participatory on-farm experimentation (which is a critical component of PTD) is a core principle of agricultural extension, not just research.

Over the last fifteen years, the farmer participatory model has begun to lead current thinking in agricultural and social forestry development in risk prone, low-resource, marginal areas. In the more favourable marginal environments—areas characterised by low productivity but amenable climates, irrigation infrastructure and fertile soils—the approach has generally remained largely 'scientific', based on centralised plant breeding and the regional or country-wide release of new cultivars.

The UK Department for International Development (DFID) has identified that a substantial proportion of these more favourable marginal environments are under-utilised, i.e. that they have a 'high production potential' that is not fully realised. As a result, a number of research projects within the DFID's Renewable Natural Resources Research Strategy are specifically targeted at what DFID term high potential production systems (HPPSs). One such project is the participatory crop improvement (PCI) project based in India and Nepal.

The higher productivity potential of these areas lends itself to scientific approaches and higher grade technologies than would be suitable for marginal areas. However, as socially diverse environments, farmer participatory approaches are still relevant. The PCI project set out to synthesise the best of both farmer participatory and scientific approaches to agriculture and social forestry development, drawing on conventional PTD, but with a marked leaning towards the role of PTD as an extension tool. To date, the PCI project has focused on improving the regions staple crops: rice, maize and wheat. This paper builds on the success of the crop methodology, proposing that a similar 'participatory-cum-scientific' approach be designed, aimed at trees on farms.

The remainder of this paper describes the PCI project and its methodology. Baseline data from the project are presented and a case is constructed for promoting trees on farms, justified on the basis that it is a viable livelihood strategy. Finally, a participatory-cum-scientific approach to tree selection is presented.

2 THE PCI PROJECT

The PCI project began in 1996 with funding from the Natural Resources Systems Programme and the Plant Sciences Research Programme of DFID. The project is managed by the Centre for Arid Zone Studies at the University of Wales in Bangor. The project is experimenting with new and improved crop varieties, agronomic practices and tree species.

The project is being implemented in the HPPSs of Chitwan and Nawalparasi districts of Nepal and the Lunawada district of Gujarat, India. In Nepal, project sites are organised in clusters of villages: East Chitwan Cluster, West Chitwan Cluster and Nawalparasi Cluster; and three clusters of three villages each in India.

In 1997, the project undertook comprehensive questionnaire surveys, collecting baseline information at the household level. In Nepal, all potential project-participants were surveyed (1,489 households). In India, the questionnaire was completed with a stratified sample

Box 1 Examples of agro-ecological and socio-economic diversity in HPPSs

- Perennial rainfall and/or irrigation infrastructure means that farmers have many different options for cropping patterns;
- Access to irrigation can vary spatially, limiting the options for farmers with smaller holdings and encouraging planting of crop varieties of shorter maturity;
- Increases in population lead to land fragmentation and variations in the size of farm holdings. Farmers on the smallest holdings often have a 'niche' crop requirement, trying to maximise yields on the one hand and minimise risk on the other;
- Predominantly privatised land ownership, with a wide variety of entitlements (e.g. freehold, shared-in, crop-sharing, leased land with fixed terms 'in cash' or 'in-kind'). Different types tend to promote different farming system objectives. For example, lease arrangements based on a fixed weight of grain encourages the leasee to maximise yields at the expense of quality;
- Although most households own land, the size of holdings can vary considerably;
- Poverty is an issue– HPPSs are characterised by great disparity in wealth status of households. Pockets of poverty are widespread and characterised by low quality housing, no domestic water supply, low education levels, land infertility, no access to irrigation, no savings and unmanageable debts.

of 60 households. Prior to the surveys, a participatory wealth ranking exercise was conducted in each of the study villages. This involved key informants placing individual households in one of three wealth categories relating to resource ownership and access—upper (resource rich) middle and lower (resource poor). Surveys on different strategies for meeting livelihood needs—for instance fuel and livestock feed—were designed to allow comparisons between current use and changes in use over the last five years for different wealth categories.

Participatory varietal selection

The participatory-cum-scientific methodology adopted for the project is termed 'participatory varietal selection' (PVS) (Joshi and Witcombe, 1998). PVS evolved from participatory varietal selection programmes undertaken in marginal environments in the 1980s. The approach enables farmers to select from a tailored set of improved crop varieties, selected on the basis of farmers' needs. PVS adopts the principles of farmer participatory research (FPR), involving low-resource farmers in the selection, experimentation and uptake of preferred varieties. Compared with centralised research approaches, PVS has been found to be more cost-effective and more relevant to the needs of marginal farmers (Ashby and Sperling, 1995).

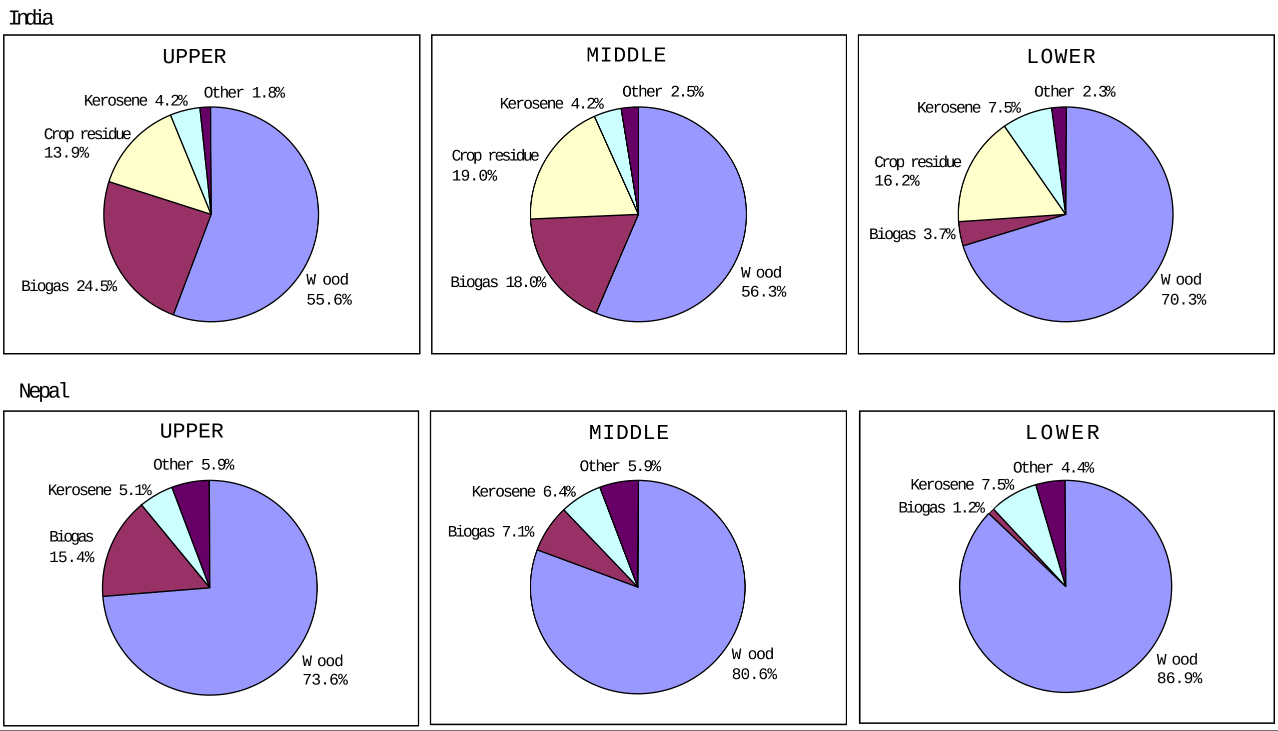
PVS is also appropriate to HPPSs because two of the key characteristics of low potential marginal environments also characterise high potential areas, namely:

- the diversity and complexity of the socio-economic and agro-ecological environment (Box 1);
- the potential of modern crop varieties remains under-exploited.

PVS in the project involves participatory techniques to identify agro-ecological and farming system constraints and desired crop traits (yield, taste, maturity, quality, etc.). The project then seeks to rectify the neglect of modern crop varieties. Centralised research stations have bred hundreds of modern crop varieties over the last 20 years, many of which have been untested in the HPPSs of the project areas. Thus the PVS methodology includes an explicit search for suitable modern varieties that overcome the physical constraints, meet desired use traits and improve on existing varieties. The approach then moves on-farm with participatory experimentation of the new varieties. Farmers are encouraged to compare immediate production benefits with the cost-benefit trade-offs of changes in agronomic practices, the wider farming system and overall livelihood sustainability.

The application of PVS in HPPSs in Nepal and India in the PCI project is helping to identify promising new varieties, such as short duration crop cultivars for rice. The next phase of the project is to involve village households in exploring the contribution that trees on farms can make to meeting livelihood needs.

Figure 1 Contributions of different fuel strategies



Evidence of a livelihood need for trees on farms

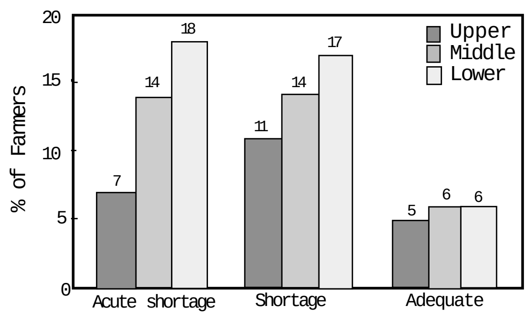
Over the last forty years, the introduction of irrigation and adoption of modern crop varieties across the project areas have brought with them increased economic wealth, agricultural expansion, intensification of cropping and land fragmentation. Combined with population increases, these changes have led to a decline in forest and tree cover. Overall, the economic and agro-ecological changes experienced in the project area have altered the way in which trees are utilised. Households have essentially reduced their total consumption of tree products and, at the same time, are shifting away from a subsistence dependence on trees for building materials, medicinal plants, wild crops and animals.

Fuelwood

In the study areas of Nepal and India the major source of fuel is wood (Bezkorowajnyj *et al*, 1998). Of the participating households, the lowest wealth group in the Nepal study shows an 87 per cent dependency on fuelwood as a source of fuel. Least dependent is the upper wealth group in the India study at 56 per cent (Figure 1). Households were also asked whether they considered their access to fuelwood to be adequate. The results show a marked shortage. In the Nepal study, 81 per cent of households consider there to be a 'shortage' or 'acute shortage' of fuelwood (Figure 2). A similar response was found in the project area in India.

These figures do not on their own necessarily demonstrate a demand for planting more trees. As Arnold and Dewees argue, tree planting is only one possible livelihood strategy for meeting fuel needs, since "a tree's potential to satisfy households needs for a particular product or service by no means assures that the farmer has an incentive to satisfy those needs through tree growing" (1995). For example, there may be financial or labour incentives to satisfy fuel needs through other products such as biogas, crop residues, kerosene, etc., which contribute to different fuel strategies (Figure 1). Because these data provide only a 'snap-shot' in time, households were questioned further about whether the relative contribution of each strategy had altered over time (Figure 3). Combining these data with focus group discussions allowed a general picture to be constructed of the viability of fuel strategies other than fuelwood.

Figure 2 Assessment of fuelwood availability by wealth group in the Nepal study area



Alternative fuel strategies—dung

Over the last ten years, both the India and Nepal study areas have experienced a transformation in livestock production from open grazing to stall feeding. This trend is not unexpected in HPPSs, where the fragmentation of land combined with irrigation infrastructure has substantially reduced the opportunities for open grazing. If livestock numbers had remained stable, the use of dung for burning would have been expected to increase as a consequence of the greater ease of collection. However, in the study area in India, while cattle numbers increased by eight per cent and buffalo numbers increased by 26 per cent, the use of dung for fuel has changed little over the last five years. This indicates that dung is being used to meet other livelihood needs, such as fuel for an increasing number of biogas units.

Alternative fuel strategies—biogas

In Nepal, decreases in the use of biogas units in all three wealth categories suggest that the easier access to dung associated with increased stall feeding is not realising a diversion of dung into biogas. Combined with the current trend of an overall decrease in cattle numbers, biogas therefore does not seem to offer a viable substitute for fuelwood.

In contrast, the India study shows significant increases in the use of biogas over the last five years for the two highest wealth groupings. Biogas now accounts for 24.5 per cent of fuel needs for the upper wealth groups, 18 per cent for the middle group and less than four per cent for the lower wealth group. This is most likely linked to the number of livestock belonging to each household. The largest number of livestock within the three wealth-ranked categories belong to the resource rich farmers (40 per cent of all animals in the project area). The poorer farmers who constitute a majority of the three groups own only 27 per cent of the animals.

It is conceivable that, with certain assumptions in place[2], the wealthiest group could completely replace its current dependency upon fuelwood with biogas within the next 15 years. The prospects are not the same for the poorest group. Here, both the current rate of increase in biogas and the overall proportion of biogas as a source of fuel are relatively small and it is very unlikely that biogas will ever completely replace fuelwood as an energy source. Hence, interventions to assist a shift to biogas might be a legitimate alternative fuel strategy for the wealthier groups, but is unlikely to be so for the resource poor.

Alternative fuel strategies—kerosene

In India and Nepal, kerosene accounts for less than eight per cent of the surveyed households' fuel source. Only for the poorest groups is there evidence to suggest that kerosene could be a viable substitute for fuelwood. For example, in the project area of India, if the 60 per cent increase in use of kerosene by the resource poor seen over the last five years were to continue (and given similar assumptions to the above[3]), the current level of fuelwood use could be replaced within about 40 years. The figure is around 50 years for the resource poor in the Nepal study.

In practice these events seem unlikely. For low income households, although the cash cost of kerosene may be lower than the opportunity cost of collecting fuelwood from distant sources, this has to be put in the context of strong cultural dependency on common pool resources. Kerosene is also a market-dependent commodity subject to fluctuations in reliability of supply and price.

Alternative fuel strategies—crop residues

In HPPSs, the availability of crop residues often rises in response to increases in cropping area associated with improvements in irrigation. However, in the Nepal study the use of crop residues for fuel is almost negligible. Available residues are primarily used as cattle feed, leaving little over for fuel (Figure 4). This situation contrasts with the Indian study where, across all wealth categories, crop residues contribute over 14 per cent of fuel and have risen between 15 per cent and 35 per cent over the last five years (Figure 3). If these trends continue, crop residues could be considered, at least partially, a viable fuel strategy. However, increasing dependence on straw for fuel will have a negative effect on long-term soil fertility as organic matter availability declines.

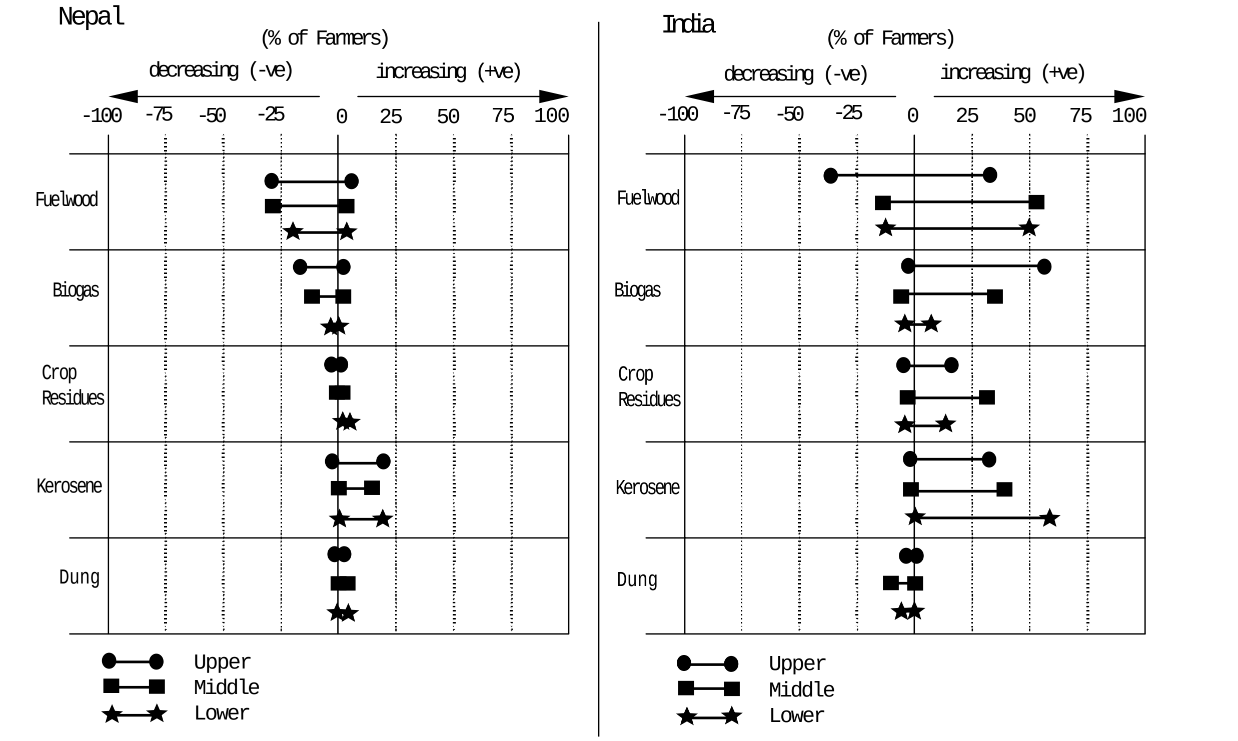
Other strategies

Commercial electricity supplies and liquid petroleum gas (LPG) are other non-fuelwood alternatives available in the study areas. The relatively high consumer cost of electricity (compared to other fuels) and its heavy dependence on subsidies and foreign inputs means that this alternative is unlikely to be supported by external agencies as a development intervention (CMIE, 1994; Reddy *et al*, 1991).

Summary of findings

Allowing for a small increase in the use of kerosene and assuming that current trends continue, the survey data from the PCI project suggests that for the poorest groups, there is no obviously viable fuel strategy other than fuelwood. The same can also be argued for the wealthier groups in the Nepal study, essentially because the viable alternative—biogas—is currently limited by a possible

Figure 3 Changes in fuel strategies over the last five years



decline in livestock numbers. The one anomaly is crop residues. Though currently negligible, it is conceivable that declining livestock numbers may increase its availability for fuel use.

The situation is different in the India study. While the same conclusions can be drawn for the poorest groups, the data suggests that biogas is a potentially viable option for all other groups.

For both studies, the findings—in the context of predominantly privatised land ownership across the study areas—provides justification for a targeted investigation of trees on farms as a strategy for meeting fuel needs. The key target groups would be resource poor households in India and all wealth groups in Nepal.

Figure 4 Contribution of livestock feed strategies

Livestock feed
A further livelihood need to which trees on farms might constitute a viable solution is the provision of livestock feed. The very low level of dependency on tree fodder across all wealth groups in both studies is striking (Figure 4). In the Nepal study, feed needs are predominantly met through crop residues and forage grasses, with concentrate a significant minority contributor for both buffalo and cattle. In the India study, the dominant feed is crop residues, with forage grasses and concentrate as minority contributors.

In both studies, the decrease in open grazing over the last five years seems to have shifted the source of livestock feed from grazing to crop residues (and in the case of the India study also to fodder crops) (Figure 5). Assuming current trends continue, crop residues (and fodder crops in the India study) are possible viable substitutes for forage grasses. In contrast to the previous analysis of fuel, trees on farms do not appear at first sight to be a viable strategy for livestock feed.

However, the rapid increase in stall-feeding (particularly in India) is a reflection not only of a decline in grazing land areas, but also the growing importance of dairy farming. Focusing only on the nutrient component of livestock feed, the trends found in the India study towards increased use of nutrient-rich fodder crops and concentrate are possibly satisfying the need to enhance milk production. There is an opportunity cost of growing fodder on arable land and tree fodder could provide a viable strategy for increasing production of both arable crops and milk. In contrast, the use of fodder crops has declined for all three wealth categories in Nepal. If this trend continues, if trees on farms are accepted as a viable fuel strategy and increases in the use of concentrates are constrained by price and supply, tree fodder may well provide a viable nutrient-enriching strategy for enhancing the quality of milk production.

Other livelihood strategies relevant to trees on farms
Fuelwood and tree fodder are but two ways in which trees on farms can contribute to meeting livelihood needs. Other livelihood needs to which trees on farms can contribute include provision of fruits, building and fencing materials, pesticides, fertilisers and medicine. This suggests that trees on farms could provide a viable strategy for meeting particular needs. However, there should be no assumption that households will perceive this to be the case, even when it can be shown that trees could make a contribution. When using participatory methods to rank and prioritise different tree options, more weight should be given to those trees which can meet a defined livelihood need and less weight to those that only play a subsidiary role.

3 PARTICIPATORY TREE SELECTION

In HPPSs, the issues of diversity and suitable but neglected plant material are equally as relevant to the selection of improved fuelwood and fodder trees as they are to crops. In terms of diversity, the geographical and seasonal variations in the water table, differences in land size and ownership and multiple uses for trees all suggest the need for a 'participatory' method of tree selection. At the same time, a wide variety of neglected tree species are available, some of which may be suitable for meeting the rising demand for fuelwood, improving the quality of milk production or meeting other livelihood needs.

Searching for suitable trees

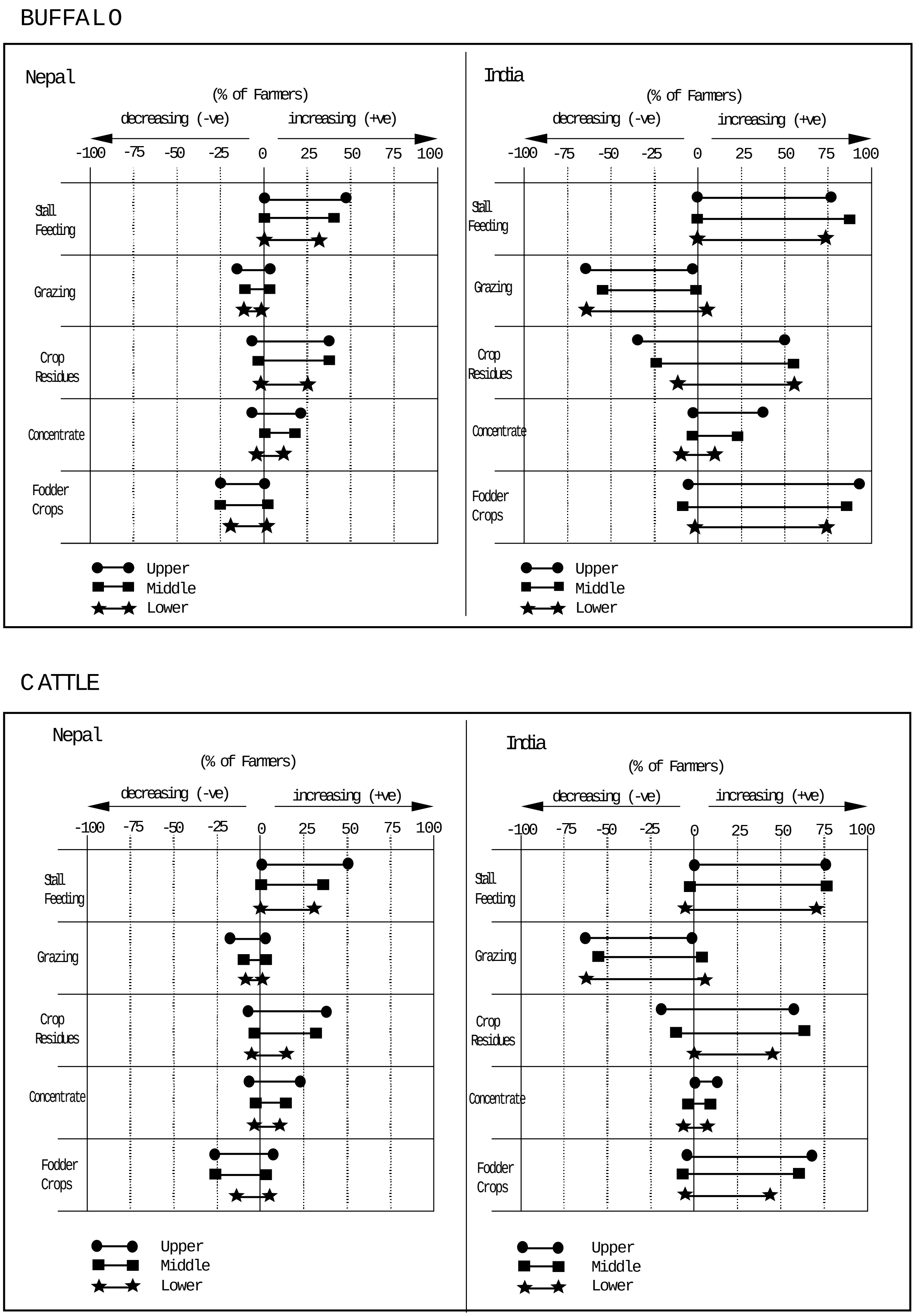
Several tree species used most frequently in the Nepal study area were identified in ten focus group discussions and the percentage of groups using specific species as a fodder and/or fuelwood source were recorded (Figure 6). Farmers in every group remarked on the desirable traits associated with production of fodder and fuelwood and some of the groups indicated the need for improving those traits for each species.

Over the last 50 years, significant progress has been made in research into the selection, breeding and propagation of trees for fuelwood, fodder and other livelihood needs. Initial inventories to identify suitable tree species, varieties or provenance with the desired traits can be compiled by conducting searches at scientific research stations. One such service is provided by the International Centre for Research in Agroforestry (ICRAF) in Nairobi, Kenya, in the form of its Agroforestry Tree (AFT) database. As well as searching scientific data bases, identification of successful past and present 'local' and 'regional' varieties enables the widest possible range of potentially suitable tree species to be presented to farmers.

This suggests that aspects of the PVS approach may be applicable to developing a method of participatory tree selection (PTS) for HPPSs. Exact duplication of PVS methodology, is however, unlikely to be effective. Differences between the management regimes of crops and trees means that substantial methodological modifications are required. Some of the key differences between the two approaches are shown in Table 1.

Higher labour and capital demands
Farmer involvement with new crop varieties tends to only marginally change the overall levels of labour and (to a lesser extent) capital in the farming system. In contrast, involvement with trees on farms may require significant changes—in particular the additional demands on labour and capital involved in nursery establishment, land preparation and tree protection. Gender is also a factor, as it is often women who are responsible for ensuring fuelwood/fodder needs are met. Experimenting with trees, especially where the

Figure 5 Changes in fodder use for buffalo and cattle over the last five years by wealth group



farmer is required to absorb the costs of such activities, can therefore be highly risk prone. To reduce this risk it is essential that interventions involving trees on farms are justified on grounds that it is a viable strategy for meeting a core livelihood need (Table 1, Stage 1).

Slower results

The results of farmers' experimentation with new crop varieties can be observed over short time periods. Measuring the success of tree establishment takes appreciably longer—years instead of weeks or months. The difference in timescale means that, unlike PVS methodology, pair-wise experimentation of different tree species over a short period is not an option, except for trees with exceptionally fast growth rates. A PTS methodology therefore has to rely on a two phased approach. First, trees are selected by a participatory 'matching' process that takes account of both agro-ecological and farming constraints, the various tree use traits associated with a particular livelihood need and the livelihood needs of the participating farmer. Second, participatory monitoring and evaluation is used to adapt farming practices and measure effectiveness (Table 1, Stages 3 and 4). Although the overall process is about identifying trees for private farms, the accuracy of the various matching and monitoring activities can be improved by drawing on the collective knowledge and analytical skills of groups rather than individual farmers.

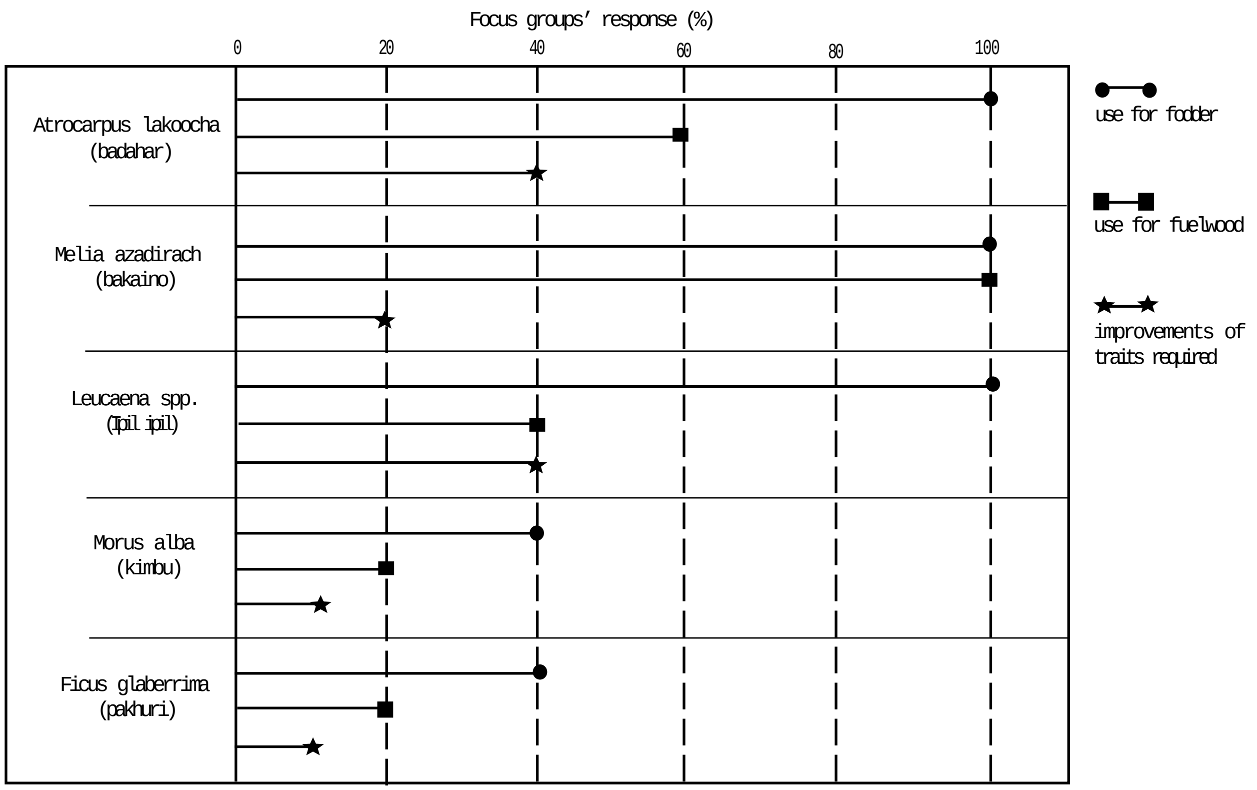
Participatory trials

The experimental stages in crops and trees differ in several important ways (Table 2). Farmer experimentation with new crop varieties generally carries low levels of risk in terms of returns on investment as typical farmer participatory (FAMPAR) trials are only implemented in a small area of the farmers field. Even if yields are worse than local varieties, the reduction in overall production is minimal. However, risks associated with experimental trees are different and can create greater difficulties in identifying species and provenance for planting (Table 2). These risks can be minimised by undertaking initial analysis of: (i) livelihood strategy alternatives (to ensure households have livelihood incentives to manage and protect the trees), and (ii) agro-ecological and farming system constraints and tree use traits (Table 1, Stages 1 and 2).

Scaling-up

PVS methodology has two principal components. The first version involves facilitated farmer participatory (i.e. FAMPAR) trials of 'searched' crop varieties. These trials generate both interest and enthusiasm amongst farmers, and, as quasi-formal experiments, provide data for analysis of the impact of new varieties on agronomic practices, farming systems and household livelihoods. The second version (Informal Research and Development—IRD-I) involves the direct handing out

Figure 6 Tree species most frequently used in the study area in Nepal



of 'searched' seed to farmers. Subsequent farmer experimentation is unfacilitated and evaluation is by informal (anecdotal) means.

With extension and scaling up in mind, IRD has a second variant—IRD-II. IRD-II uses only those varieties that a previous FAMPAR trial (or IRD-I trials) demonstrated and are preferred by farmers.

Because of the longer time it takes for tree species to develop and prove themselves, neither the IRD-I nor IRD-II variants offer a model for large scale PTS methodology. However, since the PTS methodology is explicitly designed to involve groups of farmers rather than individuals, it is likely to be a relatively cost-effective extension method in itself. For PTS then, scaling-up essentially involves conducting exposure visits for farmers in similar socio-economic groups and geographic areas and propagation of preferred species/ provenance.

4 CONCLUSIONS

The survey data on fodder and fuelwood in the two study areas provides a number of wider lessons for interventions involving trees on farms and for participatory natural resource research and extension in general.

A livelihoods needs assessment should be the starting point for interventions to promote trees on farms. Unlike many past needs assessments, the approach should seek to identify 'viable' and environmentally sustainable livelihood strategies, rather than a prioritised wish-list of livelihood goods and services. This can be achieved by redefining 'livelihood needs' as the broad underlying requirements, motivations and aspirations that govern the livelihood strategy choices of individuals, households and groups. Only if some good or service provided by trees on farms (such as wood or leaves) is shown to be a viable strategy (e.g. is preferred, technically feasible, cost effective, culturally consistent and environmentally

Table 1 Comparison of PVS and PTS methodology

Participatory varietal selection	Participatory tree selection
	Stage 1 Analysis of trees on farm as a viable strategy for meeting household needs: • increase household income; • secure access to reliable fuel source; • replace decline in fodder; • provide a coping strategy;
Stage 1 Participatory identification of farmers' needs for crop varieties: • agro-ecological constraints and opportunities; • crop traits (yield, maturity, quality, etc.); • farming system constraints.	Stage 2 Participatory identification of traits: • agro-ecological constraints and opportunities; • fuelwood traits (maturity, density, etc.); • fodder tree traits (seasonality, palatability, etc.); • farming system constraints.
Stage 2 Search for material which match farmers' needs: • neighbouring areas (local varieties); • regional/national search; • international search.	Stage 3 Search for species which match households' livelihood needs and desired traits: • indigenous technical knowledge; • neighbouring areas (successful local species); • regional/national search; • international search; • selection of preferred tree species (direct matrix ranking).
	Stage 4 Comprehensive participatory rural appraisal (PRA)/ focus group discussions (FGDs) to prepare for tree testing activities: • select areas and management regime for planting/testing tree species (common property areas, private lands, etc.); • nursery establishment; • training in tree management.
Stage 3 'On-farm' farmer experimentation: • facilitated farm-walks; • farmer-led data collection; • facilitated paired comparisons; • farmers perceptions/preferences; • selection of preferred varieties; or • unfacilitated experimentation (IRD-I)[1]	Stage 5 'On-farm' farmer experimentation: • facilitated farm-walks; • farmer-led data collection; • evaluation against farmer system, trait expectation and livelihood needs; • farmers perceptions/preferences; • selection of preferred species/provenance.
Stage 4 Scaling-up: • IRD-I; • IRD-II[2]; • community based and/or formal seed multiplication.	Stage 6 Scaling-up: • exposure visits; • seed/seedling propagation of preferred species/provenance.

1 Informal Research and Development (IRD-I)—the handing out of seed to farmers identified from Stages 1 and 2. Farmer experimentation is unfacilitated, and no control is imposed on the spread of seed from farmer to farmer.
2 IRD-II— as above, but the range of varieties distributed is limited to those identified as 'preferred' during Stage 3.

sustainable) for meeting some underlying livelihood need (such as fuel or livestock feed) is there then justification for pursuing this type of intervention further. That a particular tree species has multiple uses (fuelwood, fodder, root crops, medicines, building materials, shade, etc.) does not mean that the households will choose to utilise that species.

The above observation has implications for participatory methodology. It suggests that facilitators of participatory species or variety selection processes, who in the past have encouraged consideration of multiple tree uses as the basis of evaluating different tree options, might have inadvertently promoted uses not viable as livelihood strategies. One option to avoid this potential bias, is to create a clear separation between tree uses (and traits) which are viable livelihood strategies and those which contribute to a livelihood need in only a 'subsidiary' way. The evaluation of options would then concentrate on the 'viable' rather than 'subsidiary' uses.

There should be no expectation that a participatory methodology developed for one natural resource sector should be directly replicable to another. The PTS methodology, though drawing extensively on the crop-based PVS methodology, required a number of material modifications to accommodate differences between crop and tree management: difficulties of experimentation; timescale of observable results; changes to farming systems; and options for scaling-up.

Many current participatory tree selection methodologies could be improved by incorporating consideration of modern and wider sourced species. Omission of these alternatives is perhaps an indication of the reluctance of some of the new participation champions to embrace the scientific community, particularly the international research centres.

Finally, the identification of livelihood strategies was made possible in the project by a combination of data describing changes in different livelihood strategies over time, and data on the proportional contribution of different strategies to an overall livelihood need. These were used to give a crude indication of the time it might take for one strategy to replace another. The technique, although useful and powerful, does have some limitations. Similar data sets cannot so readily be compiled to predict future changes, and the historic data does not show the past rate of change. For example, in the Indian study it is not clear whether the observed rapid change from open grazing to stall feeding is likely to continue, or whether the past rate of change was linear or exponential.

Table 2 Comparison of PVS and PTS experimentation

Experimental trials	Participatory varietal selection	Participatory tree selection
Choice	In practice farmers test only one variety at a time to reduce risk of mixing seed.	Even if farmers mix seed from different species/provenance, the trees can still usually be identified at a later stage.
Uptake	Farmers are already growing crops as a livelihood strategy and can easily assimilate a new variety into existing farming practices.	Often trees on farms are a novel livelihood strategy and farmers have no prior experience of planting and maintenance of tree species. Therefore, significant adjustments in the farming practices are needed to accommodate trees and a much longer time frame is required to evaluate impact.
Risk	Farmers can forgo yield if crop fails.	Farmers can reduce risk by choosing under-utilised land, but opportunity cost of labour for tree maintenance and protection must be considered.
Risk avoidance	Farmers use small plots, and often grow new varieties for testing on their most marginal fields. Use of marginal fields is often unproblematic. If performance is adequate, then saved seed is sown on better plots the following season.	Farmers can plant a small number of trees on under-utilised land or on more marginal land. Unfortunately, the latter strategy may prevent or considerably delay uptake of promising species/ provenance because of misleading or poor results.
Comparison	Simple: Varieties tested against current practices/ farmers own varieties.	Complex: Compared to alternative livelihood strategies and opportunity costs.

ENDNOTES

1 This is illustrated by the rapid appraisal (RA) participatory approaches to social forestry described in IIEDs participatory methodologies series (Messerschmidt, 1995).

2 There are no constraints to increase in livestock numbers, constant increases in biogas at current rates, the proportional opportunity cost of other fuel strategies continue to be lower than for biogas, and other demands on dung and all other fuel remains constant.

3 As footnote two, but assumption is for a constant increase in kerosene use at current rates.

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