Irrigation Policy Research in Nepal: Using PRA Methods to Investigate and Incorporate Indigenous Knowledge

Gerard J. Gill[1]

Having chosen the above title some time ago, I must confess to feeling a certain trepidation when I came to write the paper. However on closer examination, it basically consists of four elements which I should like to try to link together in a meaningful way. The relationships look like this:

$$\begin{array}{ccc} \textbf{Irrigation} & \longrightarrow & \textbf{PRA} \\ \uparrow & & \downarrow \\ \textbf{Policy} & \longleftarrow & \textbf{Indigenous Knowledge} \end{array}$$

The presentation will begin with a few observations about irrigation in Nepal and move on to PRA as it has been developing in recent years, particularly in the realm of policy analysis. Next an example will be given of how PRA techniques have been used as an aid to process documentation in one particular indigenous hill irrigation system, with a view to assessing policy implications. Wider policy implications flowing from this and other PRA research will then be suggested, paying particular attention to irrigation policy.

IRRIGATION

Officially sponsored efforts at irrigation development in Nepal have not been an unqualified success. This is especially true in the *Tarai*, where there has been a huge investment in officially-planned irrigation infrastructure. The farmers who are supposed to be the beneficiaries, however, point out that this investment has been largely ineffective. There are many examples of irrigation canals that are permanently dry, and numerous instances right across the *Tarai* belt of schemes that function only intermittently (e.g. in the Sunsari Morang Irrigation Project, Bagmati Irrigation, Narayani Irrigation, Chitwan Lift Irrigation, Marchwar Lift Irrigation, among many others). Moreover, most functioning irrigation schemes provide water only for main season paddy and not for winter crops. They suffer from design and construction faults and from problems of poor management, siltation, and lack of repair and maintenance. Absence of any form of consultation with potential users when these schemes were designed and constructed has been largely responsible for their poor performance (Gill *et al* 1992).

This stands in sharp contrast to the many thousands of successful indigenous irrigation schemes in Nepal, some of which date back for centuries and are still functioning. Numerous studies have shown how highly productive these can be. To take an example close to the site of this Workshop, the 1,200 ha East Rapti system has cropping intensities that average 300 per cent. Yields

TABLE 1: **Yield Levels in an Indigenous Nepalese Irrigation Management Scheme (East Rapti) cf. District Averages**

	Yield (quintals/hectare)			
	Main Season Paddy	Summer Maize	Wheat	Mustard
East Rapti	30-50	20-30	25-30	6-10
Chitwan Average	24-30	14-18	13-15	5-6

Source: East Rapti: Khatri-Chhetri *et al* 1987: Table 1; Chitwan averages calculated from CBS 1991, various tables

too are high in comparison with District averages (Table 1). This is not exceptional: there are many thousands of such schemes throughout Nepal. Their cost to the country in foreign exchange and other scarce resources is virtually nil.

PARTICIPATORY RURAL APPRAISAL (PRA)

This is obviously not the place to provide any detailed description of PRA. The discussion here will be limited to the role of this approach in policy analysis for agriculture and related resource management (including irrigation).

Recent efforts to conduct policy analysis under the program on which the present author serves have been frustrated by the unreliability in the official statistical data base. The following illustration will demonstrate how seriously awry policy can go when reliance is placed on misleading statistics.

Statistics on cultivated area in Nepal derive from two principal sources, the decennial National Agricultural Census and the ongoing cadastral survey. Nowhere is the mutual inconsistency of official statistics demonstrated more clearly than when one compares these two sets of figures. This is done in Table 2. Note that in the hill districts of every one of the country's five Development Regions the cadastral survey figures are at least double, and can be as much as eight times as high as those of the agricultural census, and how over the surveyed hill districts as a whole, the cadastral figures are almost four times as high as the Census estimates.

TABLE 2: **Estimates of Total Cultivated Area in Hill Districts of Nepal's Five Development Regions***

Development Region	National Agricultural Census (hectares)	Cadastral Survey (hectares)	Ratio of Census Figure to Cadastral Figure
Eastern	231,444	766,637	1 : 3.3
Central	308,658	669, 365	1 : 2.2
Western	210, 813	980, 891	1 : 4.7
Midwestern	51, 581	439, 632	1 : 8.5
Far Western	28, 003	205, 297	1 : 7.3
Total	830, 499	3, 061, 822	1 : 3.7

* Includes only those 69 percent of the country's hill districts which have been cadastrally surveyed so far. The data for this table were collected and compiled from the Agricultural Census and Cadastral Survey reports by Ms Devika Tamang.

Balogun (1989) has presented a detailed analysis of the figures for the Western Development Region in which he concluded that the apparent trend of increasing cultivated area in the hills is actually the result of combining these inconsistent statistics. He found that when a district's cadastral survey is completed, this figure is substituted for the previously-used Census figure in the official estimates, a process which can produce huge jumps in estimated cultivated area at district level.

When examined at district level, the jumps in the estimates of cultivated area can be as high as 2,000 per cent, which is, of course, literally unbelievable. However, because the Cadastral Survey is proceeding only slowly - with just one or two hill districts being completed each year - the resulting jumps in the estimates at district level are lost in the overall regional or national figures. This in turn produces the apparently steadily increasing - and "statistically significant" - trend in area under cultivation that was mentioned earlier. It is not a real trend, of course, but a spurious one caused by the progressive substitution of high estimates for low ones.[2] However many of Nepal's agricultural and natural resource management policies are based on this false perception.[3]

The rational for using PRA for policy analysis springs largely from a belief in the participatory approach, but it is reinforced by a lack of faith in the official estimates. I have written elsewhere (Gill 1992) on the role of participatory research in policy analysis for natural resource management, therefore the presentation will not be repeated here. The actions taken in fulfillment of this role have been to use PRA in most of the Program's policy analysis, the most significant being to establish a network of researchers across the *Tarai* belt, all of them trained in PRA methods. Their services are used as and when required. To date they have conducted the first round of a study on trends in foodgrain productivity, and assisted in a series of drought assessments. The component of this policy analysis which relates to irrigation is not insignificant (some of it was reported above), but it has not so far been focused on indigenous knowledge, and will not therefore be further referred to here. What will be reported on is the work of two researchers who have used the PRA approach to investigate indigenous systems of irrigation management.

PRA IN POLICY ANALYSIS

The use of the participatory approach in policy analysis is obviously of very close interest to the theme of the present Workshop. The "central questions" identified in the Workshop Announcement make it obvious that policy analysis is to be a central concern. The "objectives" section very properly identifies a major strength of PRA in gaining valid information and "making it simultaneously available to those being studied and those engaged in the study", but a serious weakness with respect to "comparing information across study sites" is also correctly pinpointed. This is indeed a central issue when attempting to use PRA for policy analysis. It is essentially an approach for micro-level analysis, and the policy analyst is trying to adapt it for macro-level research.

The problem identified in the Workshop announcement is essentially that of attempting to generalize from small samples. Once we have more experience with our Tarai Research Network, it may be possible to address this issue with some confidence, but for the moment I have no answers to offer, other than to suggest that PRA may be less amenable to providing immediate answers to specific policy issues than to generating hypotheses to be later tested by carefully targeted conventional methods - questionnaires, but "kept light and kept light" to paraphrase Chambers.

Another problem with using PRA for policy analysis is linking the cooperation rural people provide to any benefit they might ultimately obtain. Participatory approaches have until now been used primarily by NGOs as a first phase in a participatory approach to development of a specific, fairly limited geographical area. Discernible benefits to local people, which can clearly be attributed to the participation exercise, are foreseen, and can probably be promised from the outset. In the case of participatory policy analysis this is not the case. The benefits, to the extent that they ever do materialize, are macro in scale, affecting many farmers in many parts of the country. If and when they do occur, it will not be at all obvious to villagers that they resulted from a past PRA exercise.

I do not pretend to have discovered the answer to this difficulty. All I can say is that in attempting to adapt PRA for policy analysis, our teams have explained to the farmers the purpose of our investigations, and have frankly told them that there would be no exclusive or immediate benefits from cooperating with us, merely a *possibility* of better policies that will ultimately benefit all or most of the farmers of Nepal. This explanation and rationale seems to have been accepted by our cooperators.

INDIGENOUS MANAGEMENT SYSTEMS

Natural resource management in Nepal has had exceptionally bad press. Media reports tend to ascribe soil erosion in the hills and mountains, and consequent flooding in the plains of Nepal, India and Bangladesh to non-sustainable resource use - in such forms as deforestation and cultivation of steep slopes - by Nepali villagers. Even allegedly serious reports have produced some astounding predictions, such as the World Bank report of 15 years ago that predicted that by 1993 there would no trees left in the hills of Nepal! (World Bank 1978).

The accusation implicit in all these prophecies of doom is as inaccurate as it is unfair. The Nepali farmer is blamed for deforestation and "resultant" soil erosion and flooding. The scientific evidence, however, shows that the overwhelming bulk of soil erosion in the Himalayas is attributable to the fact that this is the youngest, largest, least stable and fastest-growing mountain chain on earth. Massive geological pressures are compounded by climatic forces which subject the region to extreme variation in temperature, wind and precipitation, all of which contribute to an exceptionally high degree of annual soil loss (Carson 1985, Verghese 1990).

What scientific evidence there is, indicates that while there has certainly been resource degradation in Nepal due to human activities, the nature, magnitude, and recency of this component have all been exaggerated. In fact much of the "degradation" itself has been more apparent than real. Gilmour notes that the only nationwide survey of forest cover, a Land Resource Mapping Project study that examined changes in the area and condition of Nepal's forests between 1964 and 1978, "indicated that the area of forest had not changed significantly between the two dates" (Gilmour 1991: 36).

Table 3 divides up the agriculturally-related natural resource base of Nepal according to whether it is managed by government agencies or local farmers (or farming communities). Clearly, even in irrigation, where the role of official systems is relatively high, the bulk of these resources are

***TABLE 3:* Management of Nepal's Natural Resources ('000 ha)**

	Irrigation	Forests	Pastures	Arable Land
Government or Agency	297 (30%)	168 (3%)	n/s (-)	n/s (-)
Farmers or Community	675 (70%)	5, 350 (97%)	1, 745 (100%)	3, 052 (100%)

n/s = negligible (less than 0.5%)

Sources: MoWR (1989) (irrigation) and MoFSC (1988) (forests, pasture, arable land).

managed by the farmers themselves without official intervention.

To sum up the argument so far: (a) the bulk of the Himalayan resource base is managed by the local population, and (b) contrary to popular (or journalistic) opinion, the bulk of the degradation that has occurred to this resource is attributable to nature rather than the activities of the local population. In fact, as will be argued here, existing evidence points to the fact that this population is actually both skilful and careful in natural resource management, having in many cases developed indigenous management techniques that are both sustainable and productive.

Indigenous knowledge and indigenous systems of managing natural resources has begun to attract a belated degree of positive interest in Nepal in recent years, although this level of attention is still inadequate in relation to what remains to be known. Indigenous management systems of forests, irrigation, pastures, livestock, and soils have all been the focus of recent research (see Rusten 1989, Tamang 1990, Gilmour and Fisher 1991, Devkota 1992, Tamang 1992, Rai and Thapa 1993, Messerschmidt and Rai 1993, Tamang *et al* 1993 among many others).

One aspect of these systems that has received relatively little attention, however, is their dynamics: how are they changing over time, how do they react to challenges, threats and opportunities; to the changing policy environment in which they find themselves. Since the present Workshop takes resource information systems as a central concern, the area in which I intend to focus the remainder of my paper on, is this dynamic aspect of indigenous management systems. In particular I will focus on process documentation.

THE DYNAMICS OF INDIGENOUS SYSTEMS

To use the word "dynamics" in relation to indigenous management systems is to focus attention on an important area of misunderstanding, namely the distinction between "indigenous" and "traditional". The misunderstanding is to some extent responsible for the lack of any attention to indigenous management systems until recently, and for the continuing lack of interest in them in many influential circles. "Indigenous" is mistakenly identified with "traditional", which is in turn seen as equivalent to old-fashioned, unchanging, unprofitable and unproductive.

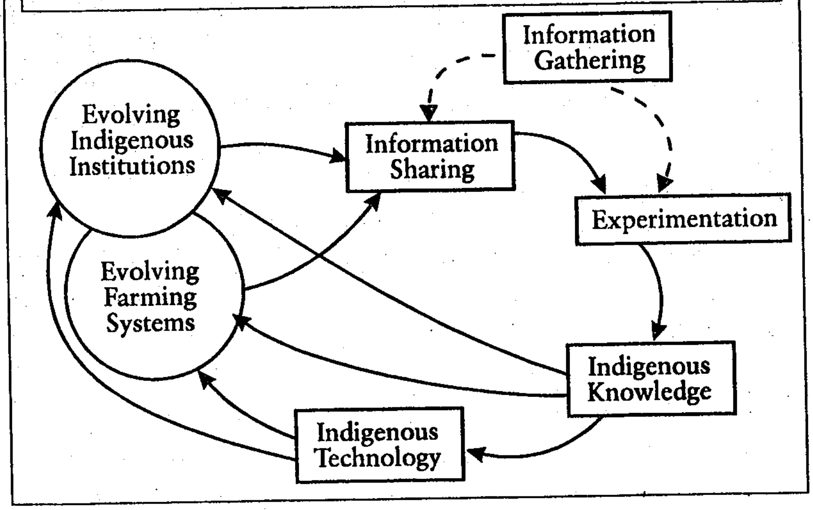
While indigenous systems may be traditional they need not be, just as traditional systems may not be indigenous. "Traditional" is purely a function of time. "Indigenous" refers to place of origin. If a system changes, it is by definition, no longer traditional. But it will still be indigenous if the initiative for that change came from within the system itself, rather than being imposed from outside. The new element in the system need not itself be indigenous. It may be a new crop, new piece of machinery or other innovation imported from outside, but if the initiative for its incorporation comes from within the system it remains indigenous.

Changes which are imposed from outside, however - as in the case of colonial or feudal systems - can never of themselves be indigenous (although they may trigger indigenous adjustment mechanisms). But if they remain in place long enough they will *ipso facto* become traditional. Traditional systems are inward-looking, static and equilibrium seeking. Indigenous systems can be outward-looking, dynamic and improvement-seeking.[4]

Figure 1 presents a hypothesis generated through semi-structured interviews with farmers in the area that will be described in the case study. It illustrates a plausible scenario for the way the process of change in indigenous natural resource management systems is fuelled and the state of flux maintained. Information is gathered from the outside world either formally, for example through the extension service, or informally through observation and informal exchange.

The person who gathers this information is assumed to share it with others or experiment with it, or both. The end product of this part of the process is indigenous *knowledge*. This knowledge may be incorporated directly into farming systems, community systems and institutions, or it may be incorporated into new ways of doing things. (An example of this is a synergistic technique Kavre farmers have discovered of mixing fertilizer, water and compost.) This part of the process engenders indigenous *technology*, which can then be fed into systems at the farm or community level. The results of this incorporation can in turn be shared with others, and so fed back into the further evolution of the various systems. An hypothesis implicit in Figure 1 is that these indigenous systems undergo a continuing process of change, fuelled by the selective pulling in of useable information from the outside world. The "information gathering" stage in the process is not essential, however. Alternatively or additionally, ideas may be generated within the system itself. This information, whatever its source, is modified through experimentation (or trial and error), thus feeding into the process of knowledge and technology generation, and ultimately being incorporated into system evolution.

FIGURE 1: **The Process of Generating Indigenous Systems: Hypothesized Relationships**



THE CASE STUDY

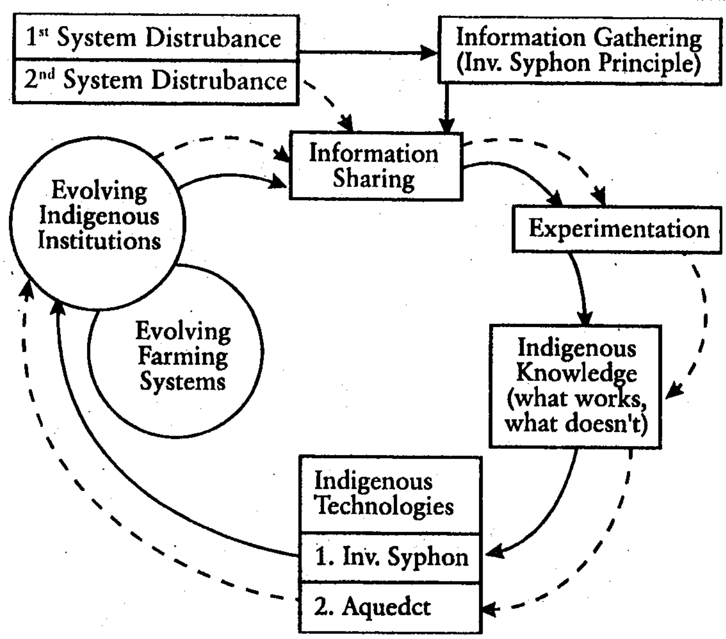
While it cannot be claimed that the above hypothesis has been rigorously field-tested in Nepal, at least some empirical evidence can be offered in the shape of a case study. During field work in the Jhikhu-Khola watershed of Kavrepalanchok District during the 1990-91 winter season, an example was found of the principle of the inverted siphon incorporated into a farmer-designed and managed irrigation system. This is basically a device for using atmospheric pressure to move water upwards (although this must be balanced by a larger downward movement). The example observed in Kavre, on investigation, transpired to have been installed as a reaction to a problem caused by one farmer withdrawing from the irrigation scheme, so that a vital section of the main canal system was lost. The siphon, which was made from an old oil drum and some 8 cm PVC piping, enabled the water to be carried across and along about 300 meters of gulley, thus by-passing the section of canal that had been taken out of the system. It was found that the idea of the inverted siphon had come from outside, as a result of an officially-sponsored "Farmer Visit" by the Chairman of the local farmers group. He had seen a *pukka* inverted siphon in an agency-managed irrigation system and realized that if their irrigation network could apply the same principle, they could solve the problem caused by the dissenting member's withdrawal. The chairman on his return to the village explained what he had seen to other group members who then experimented with many different ideas until they found the combination of materials and techniques that could do the job.

What is truly fascinating about this example is that by the following September, the inverted siphon - of which the farmers had been so proud only nine months earlier - was no longer in use, having been displaced by further developments. What had happened was that two neighboring farmers applied to join the irrigation network and it was seen that by accepting their membership the distance across the gulley could be drastically cut. The farmers now brought in their second technological innovation, replacing the siphon with a stone aqueduct to take the water over the gulley. This was about around 40 cm wide and three meters high at its highest point, and about eight meters long. The canal system fed into two parallel lengths of the same 8 cm PVC pipe laid across the top of the aqueduct to make a leak-proof conduit taking the water to the channel on the far side of the gulley.

Why replace a functioning system that had been developed with such care? Cost is not the answer. Because it has to follow the gulley contours, the inverted siphon would need more piping than the aqueduct. But even so, an aqueduct would be many times more expensive than the siphon[5]. The real reason is that siphons, as pressurized systems, are difficult to keep airtight and leak-proof. The aqueduct, although more costly to construct, does not suffer from this drawback.

This brief case study provides a fascinating set of insights into the processes at work when indigenous systems are evolving. Even a verbal description of what took place constitutes an important piece of process documentation. However it is possible to go further, by re-interpreting the above information in terms of the theoretical model presented earlier as Figure 1. This is done in Figure 2. Here the institutional system, (i.e. the farmer-managed irrigation network), originally in equilibrium, is disturbed by the loss of a vital component. This triggers information gathering from the outside world, in the shape of a scientific principle, which is then shared with fellow scheme members. The process of experimentation thus triggered ultimately resulted in the generation of indigenous knowledge (what will work and what will not), which in turn results in the generation of a new indigenous technology (the oil drum, PVC piping and the technique for keeping the connection airtight). This new technology is then incorporated as an "object" in the indigenous system, just as siphoning the wa-

FIGURE 2: **The Process of Generating Indigenous Systems: A Case Study**



ter becomes a new process. This innovation is shared by all members. A further disturbance then occurs in the shape of applications from new would-be members, opening up the prospect of simplifying the technology. A second round of experimentation is then sparked off — this time without any discernible information-gathering from the outside world - leading to the development of a new technology and its incorporation into the system. In Figure 2 the solid lines represent the process triggered by the first disturbance, and the broken lines those initiated by the second one.

POLICY IMPLICATIONS

Although it would be out-of-place to attempt to draw specific policy recommendations from a study such as the one just outlined, some general principles for policy formulation do begin to emerge from this and other studies of indigenous systems of managing Nepal's natural resources. However it should be emphasized that in describing the strengths of indigenous systems and the rationale behind them, I am not attempting to paint an idealized or romanticized picture of the rural population of Nepal. The farming community of this country is no better, and no worse than any other cross-section of society. However, they do have the singular advantage of living in a particular place (as often their families have lived for generations), earning a living from a frequently hostile and unforgiving environment, faced with the prospect of paying the price of failure in a way that few people with formal qualifications and professional salaries are ever called upon to do.

Nor in describing the intricacies of indigenous systems am I arguing that farmers' knowledge cannot be improved upon. Indeed farmers themselves implicitly admit that improvement is possible through their constant experimentation with new ideas and their incorporation of new technologies like fertilizer, PVC and concrete piping into their production systems, and through the adoption of non-traditional institutional entities like committees, and processes like book-keeping, into their indigenous institutions. The problem is that farmers' exposure to non-traditional technologies and institutional mechanisms is haphazard and fragmentary. A great deal of their time and ingenuity is wasted because they are unable to view the full range of technological and institutional options in order to choose what might best fit into their farm- and community-based management systems, and because they do not have access to the methodological refinements of modern scientific investigation.

While, by definition, "traditional" and "non-traditional" systems do not overlap, indigenous systems such as those described earlier embrace both. They characteristically retain what their designers see as "good" in traditional systems, while simultaneously reaching out to capture and assimilate elements of the outside world which can either replace or augment what is seen as "not-so-good". However, while the designers of indigenous systems are likely to be very familiar with the traditional systems of their area, so that they can pick and choose at will, the extent to which they can capture elements of the exogenous world is constrained by a number of factors, as listed below. All of these conditions are necessary, and probably sufficient, for adoption. They are also hierarchical, in that they have to be fulfilled cumulatively in the given order.

1. **They must be seen:** To take a perhaps extreme example, the llama of the Andes may be an extremely appropriate beast-of-burden for the farmers of the middle mountains of Nepal, but if these farmers are unaware of the beast's existence, they can hardly adopt it!

2. **They must be seen as appropriate:** Obviously, even if a potential innovation is known to exist, farmers will not adopt it unless they see a viable role for it within the systems they control.

3. **They must be affordable:** In chronically capital-scarce systems like the ones in Ne-

pal, it is quite likely that technologies that could be economically viable will remain unadopted on the grounds that the necessary capital is unavailable. There will doubtless be trade-offs between criteria 2 and 3, with elements that are viewed as "best" on technical grounds being rejected in favor of ones which are less good but affordable.

4. **They must be available:** A technology may be seen as both affordable and appropriate, but not be adopted because it is simply not available. Chemical fertilizer certainly falls into this category in Nepal, with frequent complaints being heard from farmers that it is almost never available in the required quantities at the appropriate time.

Taking the farmer as the producer of indigenous systems, and the scientist as representing the "non-traditional" world, cooperation will permit expansion of the area of overlap between the two. Scientists, engineers and other change agents can help farmers speed up the process of developing indigenous systems in two principle ways. First they can use their wider geographical/historical experience to help expand the area that is "seen" by the farmers - not just by bringing additional ideas to the farmers' attention, but by helping systematize this process of discovery - or at least making it less subject to random influences. Second they can (preferably in an inter-disciplinary mode) use their deeper technical know-how to help make the "inappropriate" more appropriate - or to create the "appropriate" where it did not previously exist - by a process of careful and sensitive (i.e. sensitive to the farmers' needs and circumstances) research, adaptation and design. Similarly they can make the "non-affordable" affordable, stripping away unnecessary elements in non-traditional design, using low-cost local materials where possible and substituting labor-intensive for capital-intensive manufacturing processes.

The role of other change agents parallels that of the applied scientist and engineer. For example, banking institutions can help ease the capital constraint. Economists can help make the "non-affordable" affordable by, for example, identifying profitable new market outlets for final products which may in turn either increase the profitability of investment, expand the investible surplus, or both. Those responsible for the supply of agricultural inputs might be persuaded to match the flow of these more closely to the cycle of agricultural operations.

The plea here is for balance; for a realization that both farmers and scientists have vital roles to play, and that these roles are highly complementary. The farmer's technical knowledge has to be extremely broad and systemic, encompassing all of the objects and processes in the farming system as well as the interlinkages within the system and with other interacting systems. By comparison, the knowledge of the "scientist" (here defined to include the engineer, economist and extensionist and many other change agents) is deep, but narrowly-focused on a single discipline. When the historical-cum-geographical perspective is examined, the situation is reversed. The scientist's knowledge, by virtue of his or her formal education, encompasses a wide historical and geographical perspective, but it is relatively shallow, whereas farmers have detailed and sharply-focused information on the characteristics and capabilities of the limited geographical area in which they live and work.

Too often scientists assume that their own competence overrides that of the farmer, leading to some fundamental mistakes. For example in the area of technical know-how, a single-crop agricultural research-extension system may ignore the other, equally important, elements of the farming system. In the geographical-historical realm, the scientist's wide but shallow knowledge can lead to faulty recommendations through, for example, the inappropriate transfer of technologies and their accompanying preconceptions from the developed (by-and-large temperate) world to the developing countries of the tropics and subtropics, or from one imperfectly-understood tropical setting to another.

Before closing, two notes of caution must be sounded. First, it has become fashionable in agricultural research circles to speak of adopting a "client-oriented" approach. Given the recent history of official-farmer relations in Nepal, this terminology is dangerous. While purporting to be more responsive to farmers' needs, it carries the danger that it actually reinforces the familiar top-down, "scientist-knows-best" set of attitudes. The very word conjures up images of a "patron-client" relationship. Even where a relationship of dependency is not implied, the fact remains that a "client" is a lay person who hires a specialist. For example, if someone is involved in a court case and knows nothing about the law, he or she hires a lawyer and so becomes that lawyer's client. In describing the farmer as a "client" we are implicitly accepting that the same type of relationship should exist. The lawyer's partner, on the other hand, is a colleague, a fellow member of the practice, maybe someone specializing in another aspect of the law. That is the type of analogy we should be aiming for once we recognize the value of indigenous systems: partnership, not clientage; collegiality, not dependency. Ultimately, of course, the farmer will engage scientists to solve particular problems and perform specific tasks (like soil analysis), but Nepali farmers have not yet reached the stage of regarding scientists in this light, and for the present the terminology is best avoided.

The second note of caution concerns the word "farmer" itself. Just as "scientist" has been used throughout this discussion as a shorthand term for all agents of change, so the word "farmer" is also shorthand. The farming community is not, of course, a homogeneous group: at times problems can and do arise within it, and factionalism can result. Often the interests of the better-off will conflict with those of the worse-off, those of women will be at odds with those of men, those of adults conflict with those of children; often there is likely to be a complex of more than one such conflict, each interacting with the other(s) at various levels. Such heterogeneity does not generate a single universally-applicable or universally-equitable set of farming, irrigation, community forestry (or other) systems. At best it will be reflected in a series of technical, economic and social compromises. Sometimes, then, it may be necessary to remind ourselves that *indigenous* does not necessarily imply *equitable*, and that the essentially political process of policy formulation has sometimes a powerful role to play in ensuring that, even after a "partnership" relationship has been established, resources do not continue to be targeted exclusively towards the "progressive farmers" (which usually means the relatively wealthy and influential farmers). Consideration must also be given to the more disadvantaged sections of rural communities.

Notes

1 Program Leader, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International. The usual disclaimers apply.

2 For a plausible set of conjectures as to the true situation, see Gill 1992.

3 See ADB 1991 Main Report p.15 for an illustration of how this mistaken view continues to influence policy formulation in agricultural research.

4 For a theoretical discussion of the differences between traditional and indigenous systems and of interactions between indigenous and non-traditional systems, see Gill 1993.

[5] Even if local materials and members' labor were used to build the aqueduct, so that no cash costs were involved, these materials and labor could have been put to other uses, so that there are opportunity costs in using them.

References

ADB 1991: "Nepal Agricultural Research Study (A Study Team Report prepared for the National Agricultural Research Council and the Asian Development Bank), Kathmandu.

Campbell, Lorna and Gill, Gerard J. 1991: "Participatory Rural Appraisal for Nepal: Concepts and Methods"; Research Support Series No. 4, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International, Kathmandu.

CBS 1991: "Statistical Yearbook of Nepal"; HMG National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu.

Chambers, Robert 1992: "Rural Appraisal: Rapid, Relaxed and Participatory"; Discussion Paper No.311, Institute of Development Studies, Sussex, England.

Devkota, Padam L. 1992: "Traditional Systems of Forest and Pasture Management: A Case Study from Central Nepal"; Research Report Series No. 21, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International, Kathmandu.

Gill, Gerard J. 1992: "Policy Analysis for Agricultural Resource Management in Nepal: A Comparison of Conventional and Participatory Approaches"; Research Support Series No. 9, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/Winrock International, Kathmandu.

Gill, G. J., D. Tamang, G. B. Thapa and M. B. Thapa 1992: "Trends in Foodgrain Production and Productivity in the Nepal *Tarai*: Interim Report"; *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International, Kathmandu (unpublished report).

Gill, Gerard J. 1993: "Indigenous Systems in Agriculture and Natural Resource Management: An Overview"; in Tamang *et al* (editors).

Gilmour, Donald A. 1991: "Trends in Forest Resources and Management in the Middle Mountains of Nepal" in Shah *et al* 1991.

Gilmour, D.A. and R.J. Fisher 1991: "Villagers, Forests and Foresters: The Philosophy, Process and Practice of Community Forestry in Nepal"; Sahayogi Press, Kathmandu.

Khatri-Chhetri, T.B., N.K. Mishra, S.N. Tiwari, G.P. Sivakoti and A. Sukla 1987: "Lessons form Inventory Preparation of Irrigation Systems of Budhi Rapti River, Chitwan, Nepal"; in "Irrigation Management in Nepal: Research Papers from a National Seminar"; International Irrigation Management Institute, Institute of Agriculture and Animal Science and Winrock International, Rampur and Kathmandu.

Khon Kaen University 1987: "Proceedings of the 1985 International Conference on Rapid Rural Appraisal"; Khon Kaen, Thailand.

Mascarenhas, J., P. Shah, S. Joseph, R. Jayakaran, J. Devavaram, V. Ramachandran, A. Fernandez, R. Chambers and J. Pretty 1991: "PRA in India: Review and Future Directions"; *RRA Notes* No. 13, International Institute for Environment and Development, London.

Messerschmidt, D.A. and N.K. Rai (Editors) 1992: "Readings in Social Forestry and Natural Resource Management for Nepal"; Research Support Series No. 10, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International, Kathmandu.

MoFSC 1988: "Master Plan for the Forestry Sector, Nepal"; Main Report; HMG Ministry of Forests and Soil Conservation, Kathmandu.

MoWR 1989: "Master Plan for Irrigation Development in Nepal"; Working Paper No. 1, Department of Irrigation, HMG Ministry of Water Resources, Kathmandu.

Rai, N.K. and M.B. Thapa 1993: "Indigenous Pasture Management Systems in High-Altitude Nepal: A Review"; Research Report Series No. 22, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International, Kathmandu.

Regmi, Shibesh C. 1993: "Rapid and Participatory Rural Appraisal: A Handbook" (in Nepali); Research Support Series No. 11, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/Winrock International, Kathmandu.

Shah, P.B., H. Schreier, S.J. Brown and K.W. Riley 1991: "Soil Fertility and Erosion Issues in the Middle Mountains of Nepal"; Integrated Survey Section, Topographical Survey Branch, Kathmandu and Department of Soil Science, University of British Colombia, Vancouver, Canada.

Tamang, Devika 1990: "Indigenous Forest Management Systems in Nepal: A Review"; Research Report Series No. 12, *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International, Kathmandu.

Tamang, Devika 1993: "Living in a Fragile Ecosystem: Indigenous Soil Management in the Hills of Nepal"; Gatekeeper Series No.SA41, International Institute for Environment and Development, London.

Tamang, D., G.J. Gill and G.B. Thapa (Editors) 1993: "Indigenous Management of Natural Resources in Nepal"; *Policy Analysis in Agriculture and Related Resource Management*, HMG Ministry of Agriculture/ Winrock International, Kathmandu.

Verghese, B.G. 1990: "Waters of Hope: Himalaya-Ganga Development and Co-operation for a Billion People"; Centre for Policy Research, New Delhi.

World Bank 1978: Nepal staff project report and appraisal of the Community Forestry Development and Training Project, Washington D.C. (quoted by Gilmour 1991).