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AGRICULTURAL RESEARCH FOR RESOURCE-POOR FARMERS : THE FARMER-FIRST-AND-LAST MODEL

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RURAL POVERTY AND RESOURCES

AGRICULTURAL RESEARCH FOR RESOURCE-POOR FARMERS: THE FARMER-FIRST-AND-LAST MODEL

Robert Chambers and B. P. Ghildyal

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Abstract

The normal 'transfer-of-technology' (TOT) model for agricultural research has built-in biases which favour resource-rich farmers whose conditions resemble those of research stations. A second emerging model is 'farmer-first-and-last' (FFL). This starts and ends with the farm family and the farming system. It begins with holistic and interdisciplinary appriasal of farm families' resources, needs and problems, and continues with on-farm and with-farmer R and D, with scientists, experiment stations and laboratories in a consultancy and referral role. FFL fits the needs and opportunities of resource-poor farm families better than TOT. FFL approaches promise a greater contribution from agricultural research to the eradication of rural poverty in India.

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'The future of our agriculture...depends on the success with which we can help the small and illiterate farmers to take the many small steps which alone can lead to improved methods of farming'.

M.S. Swaminathan 1982:63

Resource-Poor Farmers: Need and Opportunity

The economic and social benefits from agricultural research can be extremely high. Benefit-cost ratios can exceed those for almost any other form of investment. The dramatic advances in productivity achieved in the green revolution in irrigated wheat in Northwest India in the late 1960s present what is perhaps the internationally best known example. It is true that the pre-conditions (groundwater, canal water, electrification, infrastructure, land consolidation, potential access to inputs, etc.) were in place to provide an almost ideal environment for the new stiff-and short-strawed HYVs of wheat when they were introduced. But behind the success also lay the imagination of scientists who brought to bear their powerful skills on a perceived need and opportunity. The argument we will develop in this paper is that agricultural scientists today are also faced with a need and an opportunity; that it is different; and that it requires a different solution through new methodology and skills.

The green revolution strategy was evolved in an era when the problem of poverty and hunger was seen largely as a problem of production, of growing more food. Since lack of food could lead to undernutrition and starvation, it seemed logical to attribute under-nutrition and starvation, when they were found, to food shortages. If enough food could be produced, hunger would be vanquished. Given the diagnosis, the strategy was well conceived. It concentrated on those farmers and those areas with the greatest apparent potential for producing more food. If it favoured the better-off farmers and the better-endowed areas, this was justified since they presented the conditions in which the new high-yielding technologies generated on research stations could most readily be adopted. The Intensive Agricultural District Programme, thought out on these lines, was targetted to districts with good irrigation and good infrastructure. It was a policy of consciously betting on the strong, and its successes in Northwest India are well-known.

In the past decade there have been significant shifts in understanding of poverty and hunger and in priorities. In terms of the Indian economy, total food production remains very important. In 1983 India imported about 8 million tons of foodgrains[1], following five years of stagnation in total foodgrain production. Although performance in 1983-4 is much better, there remains a need to achieve much higher and more stable production, with an aggregate gross demand for foodgrains estimated at 225 million tons by the year 2000. Vast rainfed dryland areas have yet to register significant progress, and they constitute some 75 per cent of the cropped area of the country, contributing about 42 per cent of total food production. Attention has shifted towards giving higher priority to raising production on these rainfed lands.

Supporting this shift, it is also recognised that increased food production alone is not sufficient to overcome rural poverty. In the new understanding, most elegantly and eloquently demonstrated by Amartya Sen (1981, 1982), famines and family food shortages result much less from shortages of food supply, and much more from lack of means to grow it or of income to buy it. This is especially so in India where as a result of public information, political commitment, and good organisation, and in contrast with China, food supply shortages are not permitted to occur on any scale. In the words of M.S. Swaminathan: 'Famines in India are often famines of work rather than of food, since when work can be had and paid for, food is always forthcoming' (1983:461-2). For overcoming rural poverty, much more important than total food produced is the question of who produces it and who can obtain it. This directs attention towards the needs and interests of those who were largely by-passed by the green revolution technologies, the tens of millions of farm families who are resource-poor.

A resource-poor farm family is defined as one whose resources of land, water, labour and capital do not currently permit a decent and secure family livelihood. Such families include many though not all of those with marginal (0-1 ha) and small (1-2 ha) farm holdings and many others with more than 2 ha

1. Report of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, 1982.

but whose land is infertile, vulnerable to floods or erosion, or subject to low and unreliable rainfall. The abbrevation RPF refers to resource-poor farm or resource-poor farmer according to context.

Three major reasons can be given for orienting more agricultural research to serve the interests and fit the conditions of RPF families, so defined:

i. social justice. RPF families include many of the poorest and most vulnerable people. Their numbers are very large. At least three-quarters of operational holdings in India are less than 2 ha (Kalra 1981) and they must now (1984) number over 60 million. However, some farmers with less than 2 ha (e.g. with reliable irrigation and good soils) are not RPFs, and some with more than 2 ha (e.g. with poor soils and unreliable rainfed conditions) are RPFs. If arbitrarily these are taken as cancelling out, we would have some 60 million families, or about 300 million people, in this category[1]. Substantial breakthroughs in adoptable technology for only, say, 10-20 per cent of RPF families would thus have a massive impact on poverty in numbers of poor people who would benefit.

ii. production. The social justice argument is enough in itself. But in addition, RPFs comprise perhaps between one third and one half of the area of land under operational holdings, much of it rainfed. Increases in the productivity of this land would therefore have a substantial impact on total production. The production potential on RPFs will almost always be less than on resource-rich farms, but past relative neglect and failures promise that whatever potential exists for increased production is still largely unexploited. Moreover, there is potential for reducing risks for RPFs, which is very important for them, besides enabling them to increase production.

iii. employment. Improved farming systems for RPFs should generate productive work round more of the year. High proportions of additional income among the poor, such as

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1. Many caveats deserve to be made concerning this figure. Even if the true figure is less, however, the magnitude would remain very large.

RPF families, are also spent on locally produced consumption and capital goods, and these purchases in turn generate employment for others.

The question is, then, how agricultural research can be oriented efficiently to serve the needs and conditions of RPF families. To seek answers to that question, we will examine two contrasting models for agricultural research.

Model A: Transfer-of-Technology[1]

The transfer-of-technology (TOT) model is deeply embedded in the thinking of many professions and disciplines around the world. It is part of the structure of centralised knowledge in which power, prestige and professional skills are concentrated in well-informed 'cores' or centres[2]. These cores or centres generate new technology which then spreads (or does not spread) to the peripheries. Highly trained civil mechanical and agricultural engineers, medical scientists, agronomists and others develop technologies in laboratories, workshops and experiment stations, and then attempt to transfer them to would-be clients. This approach has had immense successes in industry and agriculture with resource-rich clients. For example, in the development of mechanisation through combine harvesters, tractors and threshers by agricultural engineers, and the development of high-yielding technological packages by plant-breeders and others have enabled many of the research-rich increase their productivity and profitability. But the approach has also had severe shortcomings for would-be clients who are resource-poor.

In most agricultural sciences, the "cores" or centres in which research is conducted are experiment stations, glasshouses and laboratories, supported by back-up services, with provision for controlled conditions, with excellent access to inputs, without significant cost or labour constraints, and without the requirement that a crop must be marketed and make a profit. Scientists in experiment stations, glass houses and laboratories generate or test new technologies and then pass them over to extension services to transmit to farmers. In political and scientific meetings, speeches

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1. The model is also described by Robert Rhoades (personal communication) and his colleagues at CIP (The International Potato Centre), Colombia, as the vertical transfer model.

2. For this perspective and argument presented in more detail, see Chambers 1983:4-10, 75-82 and 168-169.

about the vital importance of the transfer of technology are a predictable feature. Physical, biological and social scientists alike have held the transfer of technology from scientists to farmers to be a central concern. The model has until recently been part of the valued and respected structure of thinking of almost all professionals concerned with agricultural research, not only in India, but worldwide.

In practice, as is now only too well known, the transfer or technology often presents intractable problems with resource-poor farmers. When RPFs did hot adopt 'good' new technology, both social scientists and agricultural scientists at first attributed this to ignorance. The large-scale social science research in India in the 1960s on 'diffusion of innovations' assumed that the technologies were good and appropriate. A major premiss was that if small farmers did not adopt them, it was because they did not know about them, or did not know enough about them. The prescription that followed was for more and better extension, as the Extension Directorates of the Agricultural Universities testify. The standard phrase, so often repeated, that 'We must educate the farmer', exactly reflects the underlying pattern of thought. 'We' have the relevant knowledge. Ignorant farmers do not have it. We must teach the ignorant farmers.

But there is now much evidence and understanding that when RPFs do not adopt technology it is usually not from ignorance but because the technology does not fit their needs and their physical, social and economic conditions. Technologies, whether biological or physical, bear the imprint of the conditions in which they are generated. They are then adoptable in similar conditions, but often not adoptable where conditions differ. As it happens, many conditions on research experiment stations and in laboratories are close to those of resource-rich farmers (RRFs) and sharply different from those of RPFs. The contrasts are presented in Tables 1 and 2.

Table 1. Typical Contrasts in Physical Conditions[1]

(Not all apply all the time, but most apply most of the time)

	Research experiment station	Resource-rich farm (RRF)	Resource-poor farm (RPF)
Topography	flat or sometimes terraced	flat or sometimes terraced	often undulating and sloping
Soils	deep, fertile, no constraints	deep, fertile, no constraints	shallow, infertile, often severe constraints
Macro and micro-nutrient deficiency	rare, remediable	occasional	quite common
Plot size and nature	large, square, small bunds	large, small bunds	small, irregular, bunds larger where present
Hazards	nil or few	few, usually controllable	more common - floods, droughts, animals grazing crops, etc.
Irrigation	usually	usually available	often non-existent
Size of management unit	large, contiguous	large or medium, contiguous	small, often scattered and fragmented
Diseases, pests, weeds	controlled	controlled	crops vulnerable to infestation

1. Tables 1 and 2 have been slightly modified in the light of the comparison of experiment stations and farmers' fields in Catling 1983:11.

Table 2. Typical Contrasts in Social and Economic Conditions

(Not all apply all the time, but most apply most of the time)

	Research experiment station	RRF family	RPF family
Access to seeds, fertilisers, pesticides and other purchased inputs	unlimited, reliable	high-reliable	low, unreliable
Seeds used	high quality	purchased high quality	own seed
Access to credit when needed	unlimited	good access	poor access and seasonal shortages of cash when most needed
Irrigation, where facilities exist	fully controlled by research station	controlled by farmer or by others on whom he can rely	controlled by others, less reliable
Labour	unlimited, no constraint	hired, few constraints	family, constraining at seasonal peaks
Prices	irrelevant	Lower than RPF for inputs. Higher than RPF for outputs.	Higher than RRF for inputs. Lower than RRF for outputs.
Priority for food production	neutral	low	high

As a result of the contrasts in Tables 1 and 2, the conclusion could be a final entry in each table:

	research experiment station	RRF	RPF
Appropriateness of technology generated on research experiment stations for the receiving environment	very high by definition	high	low

There are other well-known contrasts. RRFs are primarily concerned with commercial production; and in their better controlled and more favourable environments they are not exposed to risk as a dominant management factor. RPFs, in contrast, have assurance of their own food supply as their highest priority, with cash from sales of produce as a highly desirable but secondary benefit; and in their poorly controlled and unfavourable environments, they are much preoccupied with minimising risk. Paradoxically, too, resource-rich farming systems are often simpler, with monocropping more than intercropping, with larger fields, fewer varieties of plants grown, and less significant crop-animal interactions. When these contrasts, and those in the tables, are taken together, it is easier to understand why so much new technology has been adopted by the resource-rich and not by the resource-poor. Most non-adoption by RPF families can be explained by the inappropriateness to their special needs and resources of the technology to be transferred.

Nevertheless, the TOT model remains dominant, almost universal. Before examining a more promising emergent model, it will be useful to ask why this is so. Four main reasons can be suggested.

1. the proven power of the model

The TOT model has demonstrated strengths, especially in plant-breeding and varietal development. Much basic research requires controlled conditions and precise and difficult measurements which are best achieved in laboratories and on research stations. The model has contributed to great and conspicuous increases in food production, most notably in the green revolution.

2. international transfer of the model

The TOT model has itself has transferred and reinforced internationally. The approaches of the Land Grant Colleges in the United States have been transferred to the Agricultural Universities of India. In the United States the model developed technology primarily for the resource-rich. The high-input capital-intensive monocropping generated on research stations fitted their conditions and was one factor in displacing smaller-scale more subsistence farming systems and families. Many of the resource-poor could not make it and sold out, but could then move to the booming cities which were on the whole able to provide them with livelihoods. Scientists from the rich North have thus little reason to question the model. For them it has worked and it continues to work. They do not have to face the problem of tens of millions of resource-poor subsistence or near subsistence farmers for whom the model does not fit, and for whom migration to the cities is not a feasible large-scale solution.

3. scientists' rewards and motivations

There are strong professional reasons why agricultural scientists should follow the TOT model. At the international and national level, there is the prestige attributed to "high" technology, seed breeding, and expensive and sophisticated equipment and methods of research. Norman Borlaug received the Nobel Prize for applications of this model. Then there is personal convenience in working in office and laboratory, and on a research experiment station rather than on-farm or with-farmer. Further, for gaining professional recognition and for minimising risk of not gaining it through failed experiments, in-laboratory and on-station work in controlled environments is to be preferred. The environments of resource-poor farmers are very complex. There are too many stresses with too many interactions. Moreover, the research methodology for such environments is not well established. It is safer for professional advancement and recognition not to share the farmers' risks. And at a deeper psychological level, the values and thinking which place the scientist on a pedestal as a pandit, generating new knowledge and dispensing it to the surrounding masses, is personally gratifying.

4. interlocking biases against the resource-poor

Scientists' rewards and motivations interlock with other well-known biases of professional behaviour, contact and perception towards those rural people who are better off to the neglect of those who are poorer[1]. Scientists are often urban-based. Their rural visits have spatial biases - urban, tarmac, and roadside, and towards large villages and village centres - concentrating attention where the better-off tend to be located. Other biases concern contact with those with higher status, more influence, greater wealth, and better education - in short, the resource-rich, to the neglect of those with lower status, less influence, less wealth, and less education - in short, the resource-poor[2] Scientists meet adopters

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1. For more detailed description of these and other biases, see Chambers 1983:7-25 and 171-179.

2. RRFs, or those likely to be RRFs, are considered to be the better informants. Thus Shanker et al. (1982: 74-75) in suggesting interviewees in reconnaissance surveys, list:

   - farmers who hold leadership positions
   - farmers identified by the extension service who will often have tried recommended practices
   - innovative farmers who have successfully developed improved technologies
   - women farmers who are both members and heads of households
   - 'Above all, farmers who are representative of major farming systems in the area'

   A case can be made out for this list. But the first three types of informants are more likely to be RRFs than RPFs, and the women and the farmers representative of major farming systems may exhibit an RRF bias unless a deliberate and explicit attempt is made to identify RPFs.

more than non-adopters. It is progressive, resource-rich farmers on whose land demonstrations are most often laid out, and who provide hospitality and cups of tea for visiting officials. Then there are also biases of modernity and capital-intensity: it is the tractor, the pump, the thresher, the inorganic fertiliser and other purchased inputs, which attract attention. In their own backgrounds, too, many scientists come from relatively rich families, often urban, and few have known life in an RPF family. They are also 'season-proofed' in that they do not personally experience, as a farmer does, the vagaries and difficulties of dependence on the monsoon. Nor does their income depend on uncertain agriculture: their pay cheques are regular and monthly, not seasonal and variable.

When these and other factors are taken into account, it is more than understandable that agricultural scientists have difficulty appreciating RPF conditions and that they do not doubt that the TOT model is appropriate for their work. They have good reason to embrace it and little reason to question it: they rarely meet or interact with RPFs; their research is heavily weighted towards the conditions of the resource-rich; and it is from the resource-rich who adopt, much more than from the resource-poor who do not adopt, that they get most of their feedback on the value of their technology.

the model modified

In the light of disappointing experience with transfer of technology to RPFs, many modifications have been made to the TOT model. No summary description can do justice to these, but some at least deserve to be mentioned to indicate the scale and scope of the effort that has been made, and to set subsequent discussion in perspective.

Some of the changes to the TOT model have taken the form of organising feedback to researchers on problems in adapting and adopting their recommendations. Thus T and V (D. Benor and M. Baxter 1984) provides for feedback from extension to research and is designed to generate demands on the research system for recommendations. IRRI's constraints research (De Dutta et al 1978) is another example where yield gaps are measured between performance on the research station and on farmers' fields and then attempts made to see how farmers' conditions could be altered to enable them to do better or how research priorities should be changed. The Operational Research Project (ORP) in India also illustrates this pattern. It is seen as a step in the process of technology generation which provides scientists with opportunities to test, verify and perfect their new technology while it is operated under field conditions. In the words of recent guidelines 'It is not experimentation but only a step to verify the results of successful experimentation conducted elsewhere'. In all these three examples - T and V, IRRI's constraints research, and the ORP in India - despite modifications for feedback, the basic TOT structure remains unchanged. The research comes first to develop the technology which may then be adapted and perfected following experience with its use in on-farm conditions.

The TOT model and modifications to it are well exemplified in major agricultural research programmes (see e.g. Research Highlights, 1981, Indian Council of Agricultural Research, Krishi Bhavan, New Delhi 110001). For example, as is well known, research on major food crops is conducted through All India Coordinated Crops Improvement Projects located in Agricultural Universities and Central Institutes. The experiments are primarily carried out at Experiment Stations, with emphasis on varietal improvement, production technology and plant protection. Under different All India Coordinated Soil and Water Management Projects, special technologies are developed for specific problem areas, such as reclamation technology, dryland technology and so on. Operational Research Projects have been implemented for specific problem areas such as the management of alkali soils, composite fish culture, control of cotton pests, dryland agriculture for semi-arid red soils (Sanghi 1982), and so on. For small, marginal and landless agricultural labourers, the Lab-to-Land programme was started. The major thrust was the introduction of new technologies for diversification of labour use and the introduction of supplementary sources of income such as apiculture, aquaculture, sericulture, and home crafts. A number of 'Transfer of Technology Centres have been created in Agricultural Universities, Central Institutes and other Government organisations and voluntary agencies.

These programmes present progressive modifications of the model and attempts to offset its biases. There has been increasing emphasis on on-farm trials and demonstrations. The All India Coordinated Project on National Demonstrations has been organised and implemented. The attention directed to problem environments focuses on farmers who are often by definition resource-poor. The Lab-to-Land programme is explicitly directed towards them. The establishment of Krishi Vigyan Kendras in backward areas for training farmers in new technology follow the same pattern of a thrust towards the resource-poor.

It is, however, fair to say that the outcomes in terms of adoption of new technology by RPFs has been disappointing. The old explanation of 'ignorance' on the part of RPFs has been partly superseded by attempts to understand farmers' conditions and constraints. Technology generated by research is tested on farmers' fields under farmers' management conditions.' The large yield gaps between crop yields obtained in National Demonstrations are compared with the much lower yields actually obtained by farmers. Yield gap analysis is then undertaken to identify the relative significance of different constraints which face farmers. This is a long step forward from attributing non-adoption mainly to ignorance.

But the basic model remains the same. Priorities are set by scientists relying on their professional understanding and criteria. Research is conducted in central locations and then extended outwards, tested, and modified. There has, it is true, been increasing emphasis on feedback from the field. There are farmers' melas at Agricultural Universities and Institutes. The T and V system encourages some closer contact between agricultural research scientists and farmers. But throughout, the farmers from whom there is feedback tend to be precisely those best placed to benefit from the technology generated. It is scarcely to be expected that many RPFs, illiterate and powerless as they so often are, will be able to demand the services of agricultural scientists, or will go to melas and speak up about their problems. What feedback comes is mainly from the progressive and better-off farmers, and does not throw into question the basic structure of research activity. RPFs whose needs and resources the technology does not fit are precisely those who do not come and speak up, who are not sought out, and from whom scientists are least able or inclined to learn.

Our conclusion is that for all its manifest power to achieve results on experiment stations and on the fields of RRF farmers, the TOT model of agricultural research does not encourage scientists to learn from RPFs. Even in its modifications it has not shown itself well-suited to generating technology which they can and will adopt.

Model B: Farmer-First-and-Last

The farmer-first-and-last (FFL) model entails fundamental reversals of learning and location. These, we argue, are necessary if research and the technology it generates are better to fit the needs and conditions of RPF families.

FFL differs from TOT in starting not with scientists and their perceptions and priorities, but with RPF families and theirs. It begins with a systematic process of scientists learning from and understanding RPF families, their resources, needs and problems. The main locus of research and learning is the resource-poor farm rather than the research station and the laboratory. Research problems and priorities are identified by the needs and opportunities of the farm family rather than by the professional preferences of the scientist. The research station and the laboratory have a referral and consultancy role, secondary to and serving the RPF family. The criterion of excellence is not the rigour of on-station or in-laboratory research, or yields in research station or resource-rich farmer conditions, but the more rigorous test of whether new practices spread among the resource-poor.

The sharp distinction which we see between TOT and FFL has been blurred by some of the many meanings given to 'farming systems' and 'farming systems research'.[1] Farming systems research sometimes means 'upstream' research, in which elements of a farming system are evolved and investigated on an

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1. For useful reviews see Norman 1980, Gilbert et al 1980, Shaner et al 1982, and Biggs 1983. For salutary cautions not to regard FSR as a panacea, see Nygaard and Rassam 1984.

experiment station. This is a TOT approach. In contrast, there is 'downstream' farming systems research which starts and ends with farmers, beginning with systematic attempts to understand the farm family and farming system. This is an FFL approach.

Four Prototypes and Variants

FFL approaches are not entirely new, but neither have they been fully explored, fitted together, and evolved. Several variants have been described in the literature which we have examined. They are still being developed and so can be considered prototypes. They include CIMMYT's approach to planning technologies appropriate to farmers (Byerlee, Collinson et al 1980; Collinson 1981); the Sondeo method of rapid appraisal (Hildebrand 1981); ICRAF's D and D (diagnosis and design) for agro-forestry (Lundgren and Raintree 1983; Raintree and Young 1983); and the farmer-back-to-farmer methodology of CIP (Rhoades and Booth 1982). These will be briefly described and then compared.

i. CIMMYT. The CIMMYT approach emphasises the farmer as the primary client of agricultural research, and farmer circumstances as the basis for planning research. It pays much attention to the methods whereby farmer circumstances are identified. Farmers are grouped into 'recommendation domains' - groups of farmers for whom more or less the same recommendations can be made. There is a focus on a target crop. Rapid appraisals are conducted by an agronomist and an economist working together. Background information is assembled. An exploratory survey is carried out, using a checklist of farmer circumstances, classified as

natural circumstances

external socio-economic circumstances of markets and institutions

farmers' goals and resources

relevant features of the total farming system

description of production practices for the target crop

(Byerlee and Collinson 1980:13). This is followed by a formal verification survey with a questionnaire (which, however, may well be superfluous after a well-conducted exploratory survey). Analysis of data and prescreening of technological components then lead to the identification of "best bets" and on-farm experiments with these.

ii. Sondeo. The Sondeo approach developed by Hildebrand (1981) in Guatemala is strongest in its technique for the creative combination of disciplines in rapid appraisal to generate new technology. A zone with homogeneous farming practices is identified, in which there are to be farm trials of technologies which are as yet not specified. A team leader and ten team members - five of them agronomists and animal scientists, and five from socio-economics - conduct a very rapid appraisal. They work in pairs - one agronomist or animal scientist with one socio-economist - changing partners each day for five days. They visit the area, and interview farmers and others, attempting to understand the farming system and to identify feasible and suitable improvements, and all brainstorm together each evening. At the end of the five days, many three-cornered discussions - between farmers, social scientists and biological scientists - have contributed to proposals for improved farm practices. A report is written under pressure and provides proposed innovations for the Technology Testing Team which then works in the area with on-farm and with-farmer trials.

iii. ICRAF's D and D. ICRAF's diagnosis and design (D and D) methodology sets out to identify promising candidate agro-forestry technologies. Major emphasis is placed on the farm household management unit and the satisfaction of its needs. The methodology also seeks to address a broader range of production and conservation objectives than most farming systems research, emphasising productivity, sustainability and adoptability. A minimal team includes one or more representatives of agricultural science (general agronomy, horticulture, and livestock sciences), forestry (in the broadest sense), social science (sociology/anthropology, human geography and economics), and natural sciences concerned with land resource survey (ecology, soils science, climatology). The application of D and D procedures by a multidisciplinary team usually entails about two weeks to carry out the diagnostic survey, analyze the results and develop appropriate design concepts for agroforestry interventions to improve the existing land use system. There is a four stage procedure - prediagnostic, diagnostic, design, and follow-up planning. The D and D procedures are seen as part of a continuing learning process and may be repeated.

iv. CIP's farmer-back-to-farmer. The original farmer-back-to-farmer research (Rhoades and Booth 1982, Rhoades 1984) was conducted on potato storage in Peru by biological scientists and an anthropologist following 25 years of failure in potato storage work. The anthropologist learnt about farm families' objectives and their knowledge of and problems with potato storage, and acted as a link between them and the biological scientists, bringing the latter into direct learning contact with the farmers. There were four stages - establishing a common definition of the problem; interdisciplinary team research seeking a solution; testing and adaptation of the proposed technology on-farm, with farmers contributing ideas; and "farmer evaluation: the last judgement". The result was an improved and adoptable technology which met farmers' objectives, used materials to which they had access, fitted in with their traditional house design, and above all was adopted by them. A key element was changes of perception and priority on the part of the scientists. For example, what appeared losses to scientists were not necessarily losses to farmers, who had uses for shrivelled or spoiled potatoes. One biological scientist reflected later:

> "I was not totally convinced of the anthropologists' argument, although he certainly made me think about what I was doing. We (biological scientists) hadn't even really talked to a farmer about the problems we were working on. We were doing research about a problem from a distance, not research to solve a problem. When I finally went with him to visit farmers I could see he was right, but only partially."
>
> (Rhoades and Booth 1982:129).

The Prototypes Analysed

Farming Systems Research (FSR) in its various manifestations is often described in terms of stepwise sequences. Shaner, Philipp and Schmehl (1982) emphasis five activities:

Target and research area selection

Problem identification and development of a research base

Planning on-farm research

On-farm research and analysis

Extension of results

with collaboration between these and extension and the experiment station. Simon Maxwell (1983, with reference to Norman 1978) lists activities slightly differently as classification to identify recommendation domains; diagnosis; the generation of recommendations; implementation; and monitoring and evaluation. He also (1984) has designed a simple algorithm for farming systems research. The CIMMYT and ICRAF approaches to FFL are also set out as logical sequences of activities.

To what extent sequences should be followed will, however, vary by circumstances. The quickest and most cost-effective approach may often be inventive, opportunistic, and iterative, not necessarily following a fixed order of activities. Thus according to Robert Rhoades:

> 'In the farmer-back-to-farmer approach we are more flexible in methodology, using anything that we believe works. Thus, we might even start by conducting experiments with farmers just to learn about a problem. We believe in the rapid appraisal methodology (informal), but we even use the sondeo in evaluating impact. Rigid, step-wise field methodologies have never worked for us. It is more the philosophy that counts.'
>
> (personal communication, 12 March 1984).

Turning now to the four FFL approaches outlined above, some of their main distinguishing features are:

rapid and cost-effective appraisal holistic farming systems analysis, including the farm household and its needs learning from farmers inter-disciplinarity with genuine dialogue	appraisal
on-farm and with-farmer R and D a consultancy and referral role for scientists and experiment stations	R and D
evaluation by farmers' adoption	evaluation

The four have much in common on these lines, but each has its special emphases. These can be presented as follows:

Special Emphases in Different Farmer-First-and-Last Methodologies

	CIMMYT and Collinson	Sondeo	ICRAF D and D	CIP Farmer-back-to-farmer
RPF family focus				
Learning from farmers	x			x
Rapid appraisal methodology	x	x	x	
Combining disciplines	x	x	x	x
On-farm with-farmer experiments	x	x		x
Consultancy and referral role of scientists and research stations				x
Evaluation by farmers' adoption				x

The absence of any x's for 'strongest emphases' against RPF family focus' reflects a lack of explicit priority to RPF families. All four approaches include the definition of a reasonably homogeneous clientele group, often described as a 'recommendation domain'. This may include many RPFs, but in general the smaller and poorer farmers do not appear to have been deliberately sought out in these approaches. It seems quite likely that many of the farmers interviewed and worked with will have been among the somewhat better off. These farmers may be subject to the same physical constraints of soils, and rainfall, but may differ from RPFs in their cash resources, access to inputs and credit, scale of operation, storage facilities, need for subsistence, and so on. Small and marginal farmers face their own specific problems, in resource-poor zones as elsewhere, and these four approaches do not in themselves guarantee that their conditions and needs will be catered for. A deliberate and difficult effort has to be made to include them.

From these examples, the three major components of a farmer-first-and-last model can be identified as:

i. diagnostic procedure, learning from farmers

ii. generating technology on-farm and with-farmer

iii. evaluation of technology by its adoption or non-adoption by farmers.

i. diagnosis. The point about diagnosis preceding the determination of research priorities has been forcefully made by Lundgren and Raintree (1983:43) in justifying ICRAF's D and D methodology:

> "It is a cardinal rule in the medical profession that diagnosis should precede treatment. In practice there are exceptions to this rule, of course, but it would be unthinkable for doctors ever simply to ignore the diagnostic process altogether, and prescribe treatment without due regard for the specific nature of the patient's illness. We would hardly tolerate a haphazard, hit-or-miss approach to treatment from professions dealing with human pathologies. How strange then that we have come to accept such an approach when it comes

> to treating pathologies arising from man's use of the earth. Is this not in fact what happens when a traditional agricultural or forestry research station develops a new technology and recommends it for dissemination? In how many instances is the treatment preceded by adequate diagnosis of the actual and perceived problems which confront the majority of land-users in the recommendation domain? The answer of many researchers, that they 'already know what the problems are' without having to bother with the complications of a formal diagnostic procedure, is analogous to a doctor's making either the patently absurd assumption that all patients are the same, or his claiming arrogantly that a well-trained practitioner is able to treat patients without recourse to an examination.'

There is now a substantial literature on rapid appraisals[1] but much scope for inventiveness remains. The Art of the Informal Agricultural Survey (Rhoades 1982) is one key element. What has formerly been regarded as something anyone can do is now seen as a set of skills which can and should be learnt. Problems are posed where multi-disciplinary teams cannot be assembled, and methods and training are required for agricultural scientists who have perforce to conduct such appraisals on their own.

ii. R and D on-farm and with-farmer. There are tests and experiments which require strictly controlled conditions and precise measurements which are most feasible on research stations, in glasshouses, and in laboratories. But if the R and D process is confined to such conditions, the constraints, resources, complexities and stresses of the farm level, and the criteria and priorities of the farm family, are automatically excluded from the generation and screening of technology. Characteristics of the evolving technology will reflect the objectives and criteria of scientists, the resources of the research station, and the controlled environment. Features of the evolving technology which might better fit farmers' needs and conditions may often not be included. Small

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1. See Agricultural Administration 8, 6, 1981, and for a list of some sources, Chambers 1981.

farmers also have a widespread capacity to experiment and innovate themselves as Brammer (1980) has vividly illustrated from Bangladesh, and can contribute as professional colleagues to the R and D process.

The example of potato storage technology in Peru (Rhoades and Booth 1982; Rhoades 1984) illustrates this point. At first scientists worked on potato storage generally, but farmers defined their problem more precisely as the sprouting of stored seed potatoes. When this became the priority problem, scientists worked on-station on the known scientific principle that natural diffused light reduces sprout growth and generally improves seed quality. At the same time ways of applying the principle were worked out with farmers and in their houses, using materials available to farmers and fitting in with traditional house architecture. Improvements in storage were achieved and the new technology was adopted and spread, with farmers making further adaptations.

Had the locus of application of the principle not been the farmer's houses, the classical problems of trying to transfer a research station technology might well have arisen, and scientists and extension staff might to this day still be struggling to persuade farmers to adopt a technology appropriate for the research station but not for farmers' conditions. As it was, finding out and meeting the farmers' perceived problems, and the joint collaboration of farm family and scientist in the farm environment, ensured that adoptability was built into the technology development process itself.

Another example is of maize on-farm research at Pantnagar (Agrawal 1983). Hybrid maize with a high yield potential was not accepted by the farmers. With maize 'on-farm' research trials a direct and effective dialogue between researchers and farmers was established. One reason for non-adoption that emerged was that the soil and climatic conditions of Pantnagar did not represent those of farmers. Another was that farmers' varieties had better adaptability and grain quality. With a change in breeding priorities resulting from the on-farm work and the dialogue, new varieties could be developed which were acceptable to the farmers.

An even more recent example of promising methodological innovation is reported from Colombia (Personal communication, Jacqueline Ashby, 1984), from a special project on the participation of small farmers in on-farm testing. For fertiliser trials, three methods were distinguished:

Type of Participation of Farmers	Trial Design	Trial Management	
		defined by	implemented by
nominal	research	research	research
consultative	research	research	farmer
decision-making	farmer design and research design	farmer	farmer

These three were in parallel and compared. With consultative participation there were two problems: either farmers were reluctant to manage, wanting research staff to tell them what to do; or they 'ruined' the trial from the researcher's point of view. (In Ashby's words - 'The helpful farmer who top-dresses a few fertilizer treatments or harvests and bags all treatments in a single sack must be familiar to all experienced on-farm researchers'). Ashby concludes that farmer-implemented trials in the consultative mode can seldom be truly representative of what farmers would do on their own, leaving the problem of how much yields should be discounted to reflect that they are still experimental yields and not really farmer yields.

An early step with the third approach, decision-making participation of farmers, was for the scientist researchers to reverse roles and learn from the farmers. Farmers were asked to teach them their local techniques for planting and fertilizing beans.:

> 'In a practical teaching situation, often in the fields with traditional tools, it is soon apparent how clumsy, slow-on-the-uptake, and inexpert researchers can be in terms of the farmers' traditional technology. The agronomist, trained to instruct farmers, suffered in this situation: his automatic reaction as an expert, was to argue with farmers and point out how things should be done, while the methodology...required him to rethink this attitude. The role conflict experienced by the agronomist indicated the effectiveness of the methodology in breaking down the social conventions of farmer-expert interaction'.
>
> (Ashby 1984).

Later, the proposed fertiliser technology was discussed with the farmers. The questions farmers wanted answered were listed and the soils scientist prepared an experimental design for these. The researchers had wanted to evaluate rock phosphate under farmers' conditions and to compare response curves for three different phosphate sources. In contrast farmers wanted to know the potential of mixtures including phosphates with chicken manure.

> 'Whereas soil scientists wanted to avoid testing with mixtures and organic fertilisers because of the difficulties of standardizing the quantity of nutrients applied, and of controlling fertilizer-soil reactions from different nutrient sources, the farmers' point of view was to investigate precisely these unknown factors in an empirical fashion."
>
> (ibid).

The soils scientist still prepared the research design, in consultation with the farmers; but the research agenda, the questions to be answered, were those of the farmers.

iii. evaluation by adoption. The final element in FFL is evaluation by RPFs themselves. The test of a new technology is not yield on a research station or on the land of a resource-rich farmer, or even on an RPF's land, but whether RPFs actually adopt it. For this to occur, the technology must usually entail direct satisfaction of the perceived needs of the family, low risk, and low or no reliance on purchased inputs. These, we argue, are much more likely features of the technology when its generation has been preceded and determined by diagnosis and by on-farm and with-farmer R and D, than with the TOT model.

Reversals of Explanation, Learning and Location

FFL entails reversals of explanation, learning and location.

The reversal of explanation concerns non-adoption. There can be seen to be three levels or stages of explanation of non-adoption of new technology by farmers. These are presented in Table 3.

Table 3. Non-adoption: Changes In Explanation And Prescription

Level or stage of explanation	Model	Period when dominant	Explanation of non-adoption	Prescription
1	TOT	1950s, 1960s	Ignorance of farmer	Agricultural extension to transfer the technology
2	TOT	1970s, 1980s	Farm-level constraints	Ease constraints to enable farmers to adopt the technology
3	FFL	Latter 1980s for RPFs?	The technology does not fit RPF conditions	FFL to generate technology which does fit RPF conditions

The major reversal is that explanation of non-adoption shifts from deficiencies of the farmer and the farm level, to deficiencies in the technology and in the technology-generating process.

The reversal of learning requires that scientists start by systematically learning from farmers, with transfer of technology from farmer to scientist as a basic and continuous process.

The reversal in location requires that R and D take place on-farm and with-farmer, with research stations and laboratories in a referral and consultancy role.

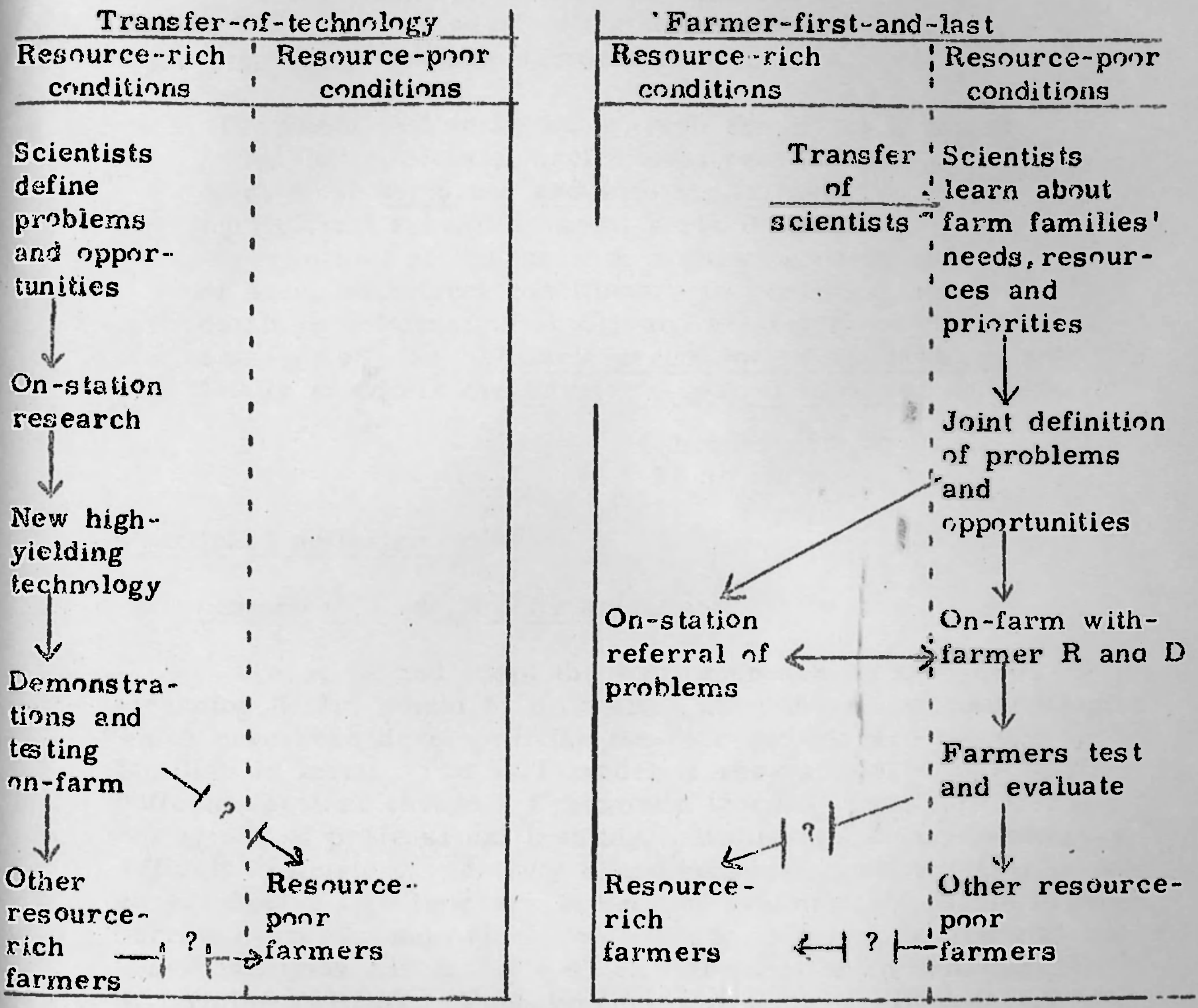
The nature of these reversals are illustrated in Table 4.

Table 4. Contrasts in Learning and Location

	TOT	FFL
Research priorities and conduct determined mainly by	Needs, problems, perceptions and environment of scientists	Needs, problems, perceptions and environment of farmers
Crucial learning is that of	farmers from scientists	scientists from farmers
Role of farmer	'beneficiary'	professional colleague and client
Role of scientist	generator of technology	consultant and collaborator
Main R and D location	experiment station, laboratory, green house	farmers' fields and conditions
Physical features of R and D mainly determined by	scientists' needs and preferences, including statistics and experimental design	farmers' needs and preferences
	research station resources	farm-level resources
Non-adoption of innovations explained by	failure of farmer to learn from scientist	failure of scientist to learn from farmer
	farm-level constraints	research station constraints
Evaluation	by publications	by adoption
	by scientists' peers	by farmers

With FFL for RPFs, the contrast in location and activities can be illustrated diagramatically:

Table 5: Activities and Their Location



Each model has its major problem. That of the first is the transfer of inappropriate technology to resource-poor farmers. That of the second is the transfer of inappropriate scientists to resource-poor conditions. In the first case the technology, and in the second the scientists, bear the deep imprint of resource-rich conditions. For FFL to be feasible requires changes among scientists. These entail a sort of psychological 'flip', seeing the world the other way round, as the RPF family does; or as psychologists sometimes say, 'taking hold of the other end of the stick'.

The mental set for FFL is thus radically different from that of TOT. It has been well stated by Rhoades and Booth in their own farmer-back-to-farmer approach:

> "The basic philosophy upon which the model is based holds that successful agricultural research and development must begin and end with the farmer. Applied agricultural research cannot begin in isolation on an experimental station or with a planning committee out of touch with farm conditions. In practice, this means obtaining information about, and achieving an understanding of, the Farmer's perception of the problem and finally to accept the Farmer's evaluation of the solution...'
>
> (Rhoades and Booth 1982: 132. Their emphases)

Practical Implications

obstacles to adoption by scientists

To adopt and adapt the FFL approach on any scale, stressing RPFs, would be difficult. Even those few methodologies which have been developed, like the four quoted, are not yet familiar in India. The TOT model is very stable, with inbuilt buffering against change. Systematic learning from farmers is not a part of professional training. Multi-disciplinary teams are difficult to muster, and truly interdisciplinary collaboration is not easy. Social scientists are either not available, or liable to have narrow concerns and orientation - costs of cultivation, social cost benefit analysis and so on - which fall short of an understanding of farming systems. Then resources (vehicles, allowances, village-level staff, stores for inputs, etc.) for extended fieldwork in appraisals and work on-farm and with-farmer are often not easily available. Work on research stations or on larger farmers' fields is more easily and conveniently controlled, inspected, measured and shown to others. For some scientists, it may quite simply be uncongenial to spend time with farmers, let alone with those who are resource-poor. On-station work may also more readily and predictably lead to publishable papers which advance a scientist's career and lead in a conventional manner to national and international recognition. Professional values take modern scientific knowledge as superior, advanced and sophisticated, and little appreciate or respect the knowledge of farm families. TOT can, in sum, be convenient and gratifying, allowing scientists to conduct their elite and clean work in controlled quasi-laboratory conditions, and passing to others - extension staff and social scientists - the messy and lower status work of transferring the technology, educating the farmer, and overcoming whatever constraints to diffusion and adoption there may be.

five thrusts

Innovations with parts or variants of FFL have doubtless already been developed in various places in India, and others may be planned, as with the ICRAF D and D methodology in the All-India Coordinated Research Programme for Agro-forestry. Any attempt to develop and introduce the FFL model on a wider scale can be seen to require five complementary thrusts:

i. methodological innovation. Eclectic use of elements of methods already developed elsewhere need to be combined with innovation in and for Indian conditions, with special stress on resource-poor areas and farm families. By analogy with the collection of genetic material, methodological material needs to be collected from different environments. Access is needed to relevant experience in other countries, as well as from within India, and some of this is already available in journals, although some may have only limited distribution in India.

ii. <u>interdisciplinarity</u>. Full interdisciplinarity entails collaboration between farmers, technical scientists and social scientists. In practice, neither technical scientists nor social scientists are properly equipped for this sort of work. Moreover, few social scientists are available. Few institutions can muster a combination of, say, agricultural sciences, farming-systems-oriented agricultural economics, and sociology and social anthropology. The best feasible may often be that farmers and agricultural scientists together do the best they can.

iii. <u>resources</u>. Rapid appraisals require resources for travel and work out of station, as does on-farm and with-farmer R and D. Vehicles and funds for travel do not guarantee it; and vehicles and funds are not always absolutely essential. Nevertheless, to be realistic, their availability will in practical terms often be a precondition for effective FFL work.

iv. <u>rewards</u>. Apart from exceptional individuals, scientists would need to feel that they would be rewarded for behaviour which was both inconvenient and liable to be less productive initially in professional terms, for example publications. One measure would be to encourage self-critical writing about experience with the FFL approach and methodologies such as rapid appraisals. Another would be to recognise through promotions and rewards exceptional work in this field, putting it on a par with high-status genetic and microbiological work. An annual competition might be held with an award for the best FFL R and D.

v. <u>training</u>. How to learn from farmers, like how to manage an organisation, is a set of skills that most people think they have; but like management, learning from farmers has specialised techniques and can be taught and learnt (see for example Rhoades 1982). Techniques for diagnostic survey, analysis and design can also be taught. University curricula can be developed to include farming systems. Attitude changes are more difficult, but simulation games like Green Revolution (Chapman 1983) and Monsoon (Staley 1981) can help, and further simulation games in which scientists play RPFs could be devised. The National Institute of Agricultural Research Management with its mix of important disciplines and experience with techniques of management training, would seem well placed to develop a training programme emphasising a farming systems approach and FFL.

Success will depend critically on the style and quality of the face-to-face relationships of scientists and farmers. For this, there is no substitute for learning by doing. Unless that relationship is truly one of scientists diligently learning from farmers, in a humble role, only the form of farmer-first-and-last might be achieved. and not the substance. For this, the most essential element is learning by doing, with colleagues correcting each other if they slip into the habitual roles of teacher instead of learner.

Conclusion

Among scientists, changes of model or shifts of paradigm are sometimes described as revolutions. They entail seeing the familiar in an entirely new way and they are usually resisted by professional establishments. The five thrusts above also do not fit current staffing, resources, orientation and training. To develop new FFL methodologies requires special institutional conditions. It is striking how strongly the orientation and conditions needed resemble those found in a recent study of America's best-run companies (Peters and Waterman 1982), such as a bias for action, learning from the customer, encouraging risk-taking and tolerating mistakes, and valuing and giving sustained support and resources to innovative individuals. In contrast, in hierarchical organisations with strict norms about resources available, behaviour and conformity, such revolutions in orientation and behaviour are difficult.

If, however, our argument is correct that FFL offers a more cost-effective way of generating technology adoptable by RPFs, then the question is not whether but how it could be developed and introduced. One approach would be to create special multi-disciplinary units for methodological innovation. Another would be to provide additional resources to existing groups which wished to undertake and develop FFL approaches. The professional incentives for far-seeing scientists should be strong. The model challenges them to develop new methodologies. In the longer term there is a promise of professional recognition and rewards for those who pioneer. And above all there should be the profound satisfaction of developing technologies which enable many resource-poor farm families to secure a better livelihood from agriculture.

REFERENCES

Agrawal, B.D. 1983 Maize On-farm Research Project (1982 Report) G.B. Pant Krishi Evam Praudyogik Vishwavidyalaya, Pantnagar 263145.

Ashby, Jacqueline A. 1983 Personal communication based on a study of farmer participation on experimental design - IFDC CIAT Phosphorus Project, A.A. 6713, Cali, Colombia, South America.

Benor, D. and M. Baxter 1984 Training and Visit Extension, The World Bank, 1818 H Street, N.W., Washington, D.C. 20433, USA.

Biggs, Stephen D. 1983 'Monitoring and Control in Agricultural Research Systems Maize in Northern India,' Research Policy, 12, 1, February, pp. 37-59.

Brammer, H. 1980 "Some innovations do not wait for experts: a report on applied research by Bangladesh peasants", Ceres, Vol. 13, No. 2.

Byerlee, Derek, Michael Collinson et al 1980 Planning Technologies Appropriate to Farmers - Concepts and Procedures, CIMMYT, Mexico.

Byerlee, Derek, Larry Harrington and Donald L. Winkelmann 1982 'Farming Systems Research: Issues in Research Strategy and Technology Design', American Journal of Agricultural Economics, December, pp. 897-906.

Catling, H.D. 1983 'How Relevant is Agricultural Research on Conventional Experiment Stations in Developing Countries?", paper read at the Regional Workshop on Research and Technology Transfer for Asian Development, November 1-3, Bangkok, Thailand.

Chambers, Robert 1981 "Rapid Rural Appraisal: Rationale and Repertoire", Public Administration and Development, 1, 2, April-June.

Chambers, Robert 1983 Rural Development: Putting the Last First, Longmans, Harlow, UK.

Collinson, Michael 1981 'A Low Cost Approach to Understanding Small Farmers', Agricultural Administration, 8, 6, November, pp. 433-450.

De Dutta, S.K., K.A. Gomesh, R.W. Herdt and R. Barber 1978 A hand book on the methodology for an integrated experiment - survey on rice yields constraints, International Rice Research Institute, P.O. Box 933, Manila, Philippines.

Gilbert, E.H., D.W. Norman and F.E. Winch 1980 Farming Systems Research: a critical evaluation, MSU Rural Development Paper No. 6. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

GOI-IRRI 1977 Report of Production Oriented Survey on Rice in Problem Areas of Bihar, Orissa and West Bengal, Indian Council of Agricultural Research, Krishi Bhavan, New Delhi.

Hildebrand, Peter 1981 'Combining Disciplines in Rapid Appraisal: the Sondeo Approach', Agricultural Administration, 8, 6, November, pp. 423-432.

ICAR 1983 All India Coordinated Agronomic Research Project, Annual Report 1981-82, Indian Council of Agricultural Research, University of Agricultural Sciences, Bangalore.

Kalra, B.R. 1981 'Size and distribution of operational holdings', Kurukshetra, 29, 23, September 1-15, pp. 4-10.

Lundgren, B. and J.B. Raintree 1983 "Agroforestry" in Barry Nestel, ed. Agricultural Research for Development: Potentials and Challenges in Asia, International Service for National Agricultural Research, The Hague, Netherlands, March, pp. 37-49.

Maxwell, Simon 1983 'Farming Systems Research', Institute of Development Studies, University of Sussex, Brighton, UK, February.

Maxwell, Simon 1984 Personal communication of a one-page chart 'The Farming Systems Research Methodology', Institute of Development Studies, University of Sussex, Brighton, UK, March.

Norman, David 1978 'Farming systems research to improve the livelihood of small farmers', American Journal of Agricultural Economics, 60, 5.

Norman, David 1980 The Farming Systems Approach: Relevancy for the Small Farmer, MSU Rural Development Paper No. 5, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48824, USA.

Nygaard, David F. and Andrée Rassam 1984 "Examples of Farming Systems Research at ICARDA', paper presented at a conference on Intra-household Processes and Farming Systems Analysis, Bellagio, Italy, March 5-9.

Peters, Thomas J. and Robert H. Waterman Jr., 1982 In Search of Excellence: Lessons from America's Best-Run Companies, Harper and Row, New York.

Raintree, J.B. and Anthony Young 1983 Guidelines for Agroforestry Diagnosis and Design, ICRAF Working Paper No. 6, International Council for Research in Agroforestry, P.O. Box 30677, Nairobi, Kenya, November.

Rhoades, Robert E. 1982 The Art of the Informal Agricultural Survey, Social Science Department Training Document 1981 International Potato Center, Aptdo 5969, Lima, Peru; March.

Rhoades, Robert E. and Robert H. Booth 1982 'Farmer-back-to-farmer: a model for generating acceptable agricultural technology', Agricultural Administration, 11, pp. 127-137. (Also available as Social Science Department Working Paper 1982-1, International Potato Center, Aptdo 5969, Lima, Peru).

Rhoades, Robert E. 1984 'Three Models of the Development and Generation of Acceptable Agricultural Technology', typescript, International Potato Center, Aptdo. 5969, Lima, Peru.

Sanghi, N.K. 1982 Operational Research in Dryland Agriculture for Semi-arid Red Soils of Hyderabad, Project Bulletin No. 3, All India Coordinatd Research Project for Dryland Agriculture, Hyderabad 500659.

Sen, Amartya 1981 Poverty and Famines: an essay on entitlement and deprivation, Clarendon Press, Oxford.

Sen, Amartya 1982 "Food Battles - Conflicts in Access to Food", Twelveth Coromandel Lecture, Coromandel Fertilisers Ltd., 10 Parliament Street, New Delhi 110001.

Shaner, W.W., P.E. Philipp and W.R. Schmehl 1982 Farming Systems Research and Development: Guidelines for Developing Countries, Westview Press, Boulder, Colorado.

Staley, John 1981 Monsoon: a Simulation Game, SEARCH, 256 First Block, Jayanagar, Bangalore 560011.

Swaminathan, M.S. 1982 Science and Integrated Rural Development, Concept Publishing Co., New Delhi.

Swaminathan, M.S. 1983 Science and the Conquest of Hunger, Concept Publishing Co., New Delhi.

Appendix I

Rice production in Eastern India - an example

A GOI/IRRI production oriented survey on rice in Eastern India (1977) observed that yields had not increased in kharif rice for two decades. The average yields of rice had remained more or less unchanged at about 0.93 q. per ha., despite a very large increase in yield potential made available with new HYVs. All attempts to transfer the HYV technology had failed to make an impact in kharif. The major problem appeared to be water control. HYVs cannot withstand prolonged water-logging and submergence in low lands or under intermittent flash floods, whereas the local tall varieties possess tolerance to submergence.

Under pressure to increase rice production rapidly for growing demand of ever increasing population, research has been directed towards high potential areas which hold the prospect of most rapid payoff - flat lands with assured irrigation, uplands favoured by rain, low lands with low level of fooding, i.e. in those areas where physiography, climate, institutional and infrastructural conditions are most favourable. The disadvantaged areas have been neglected.

The low coverage under HYV is obviously due to fact that existing HYV can not give reliable performance in these disadvantaged areas and the farmer is reluctant to invest in costly fertilizers and other agricultural inputs. High yielding varieties do very poorly under late transplanting conditions due to delayed onset of monsoon and are affected by diseases and pests. What is needed is to introduce highly stable varieties instead of high yielding varieties and appropriate farming practices that will give reliability and security of profit to the farmer.

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