TRANSFERRING SCIENCE FOR DEVELOPMENT AND DIFFUSION OF TECHNOLOGY: AGENDA FOR RECASTING EXTENSION SCIENCE RESEARCH FOR DRYLANDS/RAINFED REGIONS

By

Anil K Gupta

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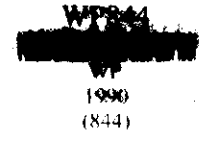

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380 056
INDIA

ABSTRACT

We argue that both, the system of technology generation as also transfer in dry regions/rainfed high risk environments have to be differently designed than the systems suitable for irrigated regions.

In Part-I, we discuss the characteristics of dry region and implications for participative organizational design. Various dimensions discussed include: ecological diversity; low population density and poor demand system; lack of timeliness in operations; inability of markets to act as monitors of farmers' needs; rainfed economy is not just crop centered; survival through commons; need for research on group based technologies as against individual based technologies etc.

Part-II includes the concept of horizontal diffusion and a brief review of literature on the subject. Part-III provides socio-ecological implications for institutional restructing such as, (a) need for on-farm research, (b) concept of ecological mapping, (c) method of manual discriminant analysis, (d) building upon local knowledge, (e) ethics of knowledge transfer, (f) agro-industrial watershed, (g) sustainable institutional design through linkage between communication and power etc.

Need for incorporating concerns of women and poor multi-enterprise rural households is highlighted. It is suggested that instead of technology transfer, emphasis in future will have to be on science transfer. This will help people develop technologies by linking formal and informal knowledge system.

Draft

TRANSFERRING SCIENCE FOR DEVELOPMENT AND DIFFUSION OF TECHNOLOGY: AGENDA FOR RECASTING EXTENSION SCIENCE RESEARCH FOR DRYLANDS/RAINFED REGIONS

It is well known that top-down bureaucratic means of transferring technology do work in irrigated areas. Even without Training and Visit system the traditional extension machinery had succeeded in very wide diffusion of new varieties of wheat within two years in mid Sixties such that the production had increased by more than 30 million tonnes in this period. One factor, other than administrative support, responsible for the diffusion was the suitability and adaptability of the technology over large areas in Indo-Gangetic plains. A lesson was learned. If technology is good and provides spectacular results, Indian farmers do not lag behind in its adoption and adaptation. Why does the problem arise when this model of technology transfer is used in rainfed/dry regions? The earlier success can be a reason for our failure. Particularly, if we learn all the wrong lessons from it.

It should not be disputed that infrastructure, population density, market forces and assurance of returns were all far higher in

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I am grateful to Dr.R.P. Singh, Director, CRIDA, Hyderabad and his colleagues for very helpful comments on the earlier draft. This is a considerably modified and expanded version of an earlier paper entitled 'Transferring Dryland Technology' serialised in "Intensive Farming - a journal of Ministry of Agriculture, New Delhi,1989. Dr. R.P. Singh has suggested setting up a working group to further analyse the implications for extension science research in drylands. Dr. J. Venkateswaralu, Director, CAZRI and his colleagues have already started discussion on strengthening research and extension system in arid regions.

the regions where the irrigated varieties of wheat and paddy diffused. Thus if farmers -small or big - have access to resources and institutions, have ability (skills) to use new technology and have assurance of future returns from present investments and do not have to worry about others' behaviour vis-a-vis one's own, the technological diffusion does not pose much problems. One does not have to mention the role price and procurement support besides input subsidies have played in diffusion of technology in irrigated areas. The interest of the market forces and the administrative systems coalesced. The participation of people therefore was essentially a process of technology transfer from "lab to land". The conditions at irrigated farms were not too different from that of the research station. The private sector recognised tremendous scope of gains in participating and accelerating technology transfer.

Both the crops - wheat and paddy - were primarily self-pollinated in nature. The seed thus could be recycled by the farmers themselves. Many of the crops in rainfed regions are cross pollinated. The seed production particularly of hybrids is more complex and difficult to deliver given poor infrastructure.Why then do we need a different strategy for dry regions or rainfed regions? And are the contrasts between the policy imperatives for dry regions vis-a-vis irrigated regions being recognized by the planners and senior administrators? Our contention is that the process of technology diffusion for dry regions will require reconceptualisation of the process of technology generation itself. Simple solutions by way of early success of some of the

hybrids in case of bajra, sorghum and improved varieties in groundnut have not proved sustainable in all the regions. The alternative approach to technology transfer is presented in three parts. In part I we identify characteristic conditions of Dry Regions and their implications for designing organizations for transferring technology. Part - 2 includes brief literature review on horizontal diffusion of technology and Part - 3 deals with the Socio-Ecological implications for institutional restructuring.

Part 1 : The Characteristics of Dry Regions and Implications for Participative Organizational Design

1. Ecological Diversity : No two Fields are Alike

It may be an exaggeration to state that no two fields are really alike. But the reality is not too different. The rainfall variability both over time and space has been known to be extremely high. Within a village it may rain on one side and not on other. The mean (average) rainfall is inversely correlated with the variability (coefficient of variation) in rainfall. It is for this reason that farmers very rightly and intelligently have persisted with fragmented and scattered landholdings. There is perhaps, no better way of diffusing the risk of rain not falling on any of the plot of the farmer at all. Given the variability in rainfall the soil, topography, fertility and quality also therefore varies a great deal. This is also the reason why land consolidation has never been preferred by dry farmers.

Another view is that inheritance patterns (in which each plot is sub-divided among all the heirs) has contributed to this situation. Our reaction to this is that (a) the consolidation has indeed been accepted in irrigated regions despite the same socio-cultural practices and (b) the average plot size is much larger in dry regions and swapping rather than sub-division might be more preferred. In the dry regions, as Dr. Singh puts it, one has to deal with widely diverse and heterogeneous crop and livestock growing environments.

2. Low Population Density: Costly Delivery and Poor Demand System

The irony of equity is manifested more strikingly in no other case than in dry regions. The allocation of equal resources whether manpower or finance or mobility to extension people in a region where population density may be 30 to 50 persons per Sq. k.m. compared to a region where it is as high as 500 to 1000 persons per Sq. Km. implies error magnified by 100 times. There is no scope for people to even interact with, much less influence, the administrative functionaries in such a context. If a village level worker takes say two weeks to cover 800 families in irrigated region how long would it take to cover the same number of families in a dry region? The cost of transportation, storage and distribution of inputs further makes it well nigh impossible for any sustainable relationship to emerge between extension workers, input delivery system and the

farmers. The poor people here are much less articulated than the farmers in irrigated regions. When have we heard about farmers' agitation in rainfed/dry regions. Thus the demand and delivery system don't match.

3. **Timeliness and Precision of Operations Often not Possible!**

Given the dependence on soil moisture within a small period of time the farming operations have to be extremely time-bound. Historically people had evolved systems like "irjik" i.e. pooling of bullocks to plough a whole series of plots in such a manner that large number of people could sow atleast some part of their land. The severe constraint of draft power results in a situation where even land fit for cultivation remains fallow in some year. The cash compulsive economy also forces some people to work on others' land for ready cash rather than invest labour on own farm. In context of the modern input-responsive-technology it will be expected that the institutions in such regions will work more efficiently than in irrigated regions where some delay can be tolerated. Scientists also maintain that unfortunately, we do not have any dependable technology for late sowing conditions in dry lands (Singh, 1988). The experience about efficiency has been the opposite. The frequent stock out in a cooperative fertilizer stores or seed stores is not an uncommon sight in dry/rainfed regions. The absence of any specialized monitoring system which can take care of location specific timely need of inputs reinforces

an institutional apathy in the mind of public officials.

Another area of technological thrust to deal with this issue has been popularization of mechanization. In the absence of custom hiring centres, the tractors were owned largely by only the very resourceful farmer. In some areas, the competition amongst the tractor owners did bring the hiring rates to quite a competitive level. However, in other areas, decline in availability of bullocks (due to fodder stress and disposal triggered by drought induced deficit) and lack of tractors has affected the timely operations adversely. There is one more effect of mechanization which has remained rather less noted. While ploughing the fields by tractors, it is very difficult to leave tree/shrub saplings intact. The tree density on cultivated fields has been noted to be extremely low in mechanized and irrigated fields (Gupta 1984). The lack of research on farm implements for these regions has also compounded the problem.

4. Will Markets Act as Monitors of Farmers' Needs?

The absence of any incentives with public, cooperative or private input agencies for absorbing losses in the short run makes it very difficult for them to open large number of distribution outlets. It is a pity that government would spend millions on trying to make people viable through subsidised credit but would not consider making institutions or their outlets in such regions viable through managerial and infrastructural subsidies and innovative inter-organiza-

tional networks in the short run. Only recently smaller bags of fertilizer have started coming in the market although demand for such packages had been voiced by the people for more than a decade.

Another implication of weak market forces is the absence of coordination by commercial agencies in rainfed regions. Market forces coordinate the expectations of large number of individual producers, and through demand pull, influence the design and efficiency of supply systems. The markets monitor the needs of surplus consumers through various signals. In rainfed regions majority of the farmers have chronic deficit in their household budgets due to repeated droughts and occasional floods. The characteristic of deficit budget farmers and their risk bearing abilities are obviously very different from that of the subsistence budget and surplus budget farmers. The weak articulation by majority of deficit budget farmers and labourers does not produce signals which can be perceived and responded to by the market forces.

The small, scattered, seasonally erratic demand for inputs or supply of outputs is not conducive for emergence of strong market forces unless these goods are in great demand. Supply of cheap wheat through Public Distribution Systems (PDS) and food for work programmes in dry/rainfed regions has further suppressed the demand for locally produced grains from outside. Lack of value addition technologies has affected the demand from Agro-industrial sector.

The decline in prices in years of good production thus neutralizes any gain possible through market. Resources for self provisioning further make the markets for rainfed commodities very complex. The short table life of hybrid sorghum made it less useful for Employment Guarantee Schemes in Maharashtra. Breeders' criteria may have to be modified in the light of feedback from various user systems. The important issue is to get this feedback. If markets and public systems fail to generate the right type of feedback, would not the scientists have to generate this feedback directly?

5. Rainfed Economy is not Crop Centered

Even though all the factors mentioned above primarily relate to crops it is important to note that it is not the crop but the livestock which is the main anchor of household survival system in dry regions. Within livestock the small ruminants i.e. sheep and goat are owned by more vulnerable groups compared to the rest. Once this is recognised the primacy of fodder whether from grass lands, trees or crop residues vis-a- vis grain becomes clear. The extra-ordinary increase in the price of fodder during the last decade has made it quite 'rational' for dry farmers to switch from cattle to small ruminants. The degradation of grasslands has only reinforced this shift. It is not without significance that we do not have any worthwhile system of transferring of technology for animal husbandry management. It is not a

paradox that National Dairy Development Programmes are far more "successful" in regions where livestock is a subsidiary means of income and not a primary means of survival (with only a few exception). The cropping patterns and the plant types and technologies which will suite livestock predominant farming systems have to be quite different. If people do not cooperate with an extension system that does not recognize this reality of dry regions, they hardly need to be blamed.

The neglect of livestock based craft activities by way of market and technological support is even more serious. Demand for livestock technology can hardly improve if the economy of livestock products does not become more remunerative. The land degradation through large herd size of less productive animals is inevitable when investments in highly productive animals are not possible, by majority of poor pastoralists.

6. Survival through Commons : Transferring Group-based Technologies Through Instruments Suitable for Individual Technologies!

Numerous studies have shown that livestock is far less skewed in its distribution than land. Within livestock the sheep and goat are primarily owned by the landless and the marginal farmers. It does not require a great deal of logic to understand that these people would not be able to manage these livestock unless they allowed the animals to graze on private fallow lands, common grazing lands, government

wastelands and forest areas besides road and railway sides. We have practically no capability in the official system to deal with transfer of group-based technology whether for watershed development, pasture or rangeland development. Exceptions are the efforts of Dryland Development Board in Karnataka and Operation Research Projects of All India Coordinated Research Project for Dryland Agriculture (AICRP-DA) in different parts of the country. Even in these projects there is practically no research or action in terms of building people's organization for managing watersheds (after the project teams withdraw) or for influencing the design of the project itself.

Even the pest and diseases which are major source of crop and animal losses cannot be controlled without involvement of groups of people. However, most of the efforts in technology transfer continued to be individual based.

Extension science should attach considerable importance to research on this issue. The public administration has also to recognize the limits of 'contact farmer' and 'adoption ladder' approach in dry regions. It is pity that excessive influence of World Bank and other aid agencies perhaps has made the task of searching alternative group and class based technology transfer approaches very difficult. The instruments and approaches evolved to deal with individuals will not help while dealing with the issues of 'collective rationality' and group action.

7. Transferring Technology for Primary, Secondary and Tertiary Sector Together

The District Industries Centre may have nothing to with Agricultural Technology Transfer System in the normal course of work. The transfer of agro-industrial technologies or services like repair of pumpsets or sprayers or other tools require different approaches to transfer of technology.

The linkage between Council of Scientific and Industrial Research (CSIR) and Indian Council of Agricultural Research (ICAR) at higher level and coordination between district level delivery system for agricultural, industrial, cottage and craft goods and services is quite weak. There are a few examples of very innovative inter-organizational linkages have been attempted. For instance in Faizabad, NDUAT has established technologies for reclaiming usar' (alkaline) lands through the financial and administrative support of District Rural Development Agency.

The linkage between rural employment resources and technology development and demonstration has also been tried very effectively in Karnataka by Dryland Development Board. The watersheds developed in each district of the state show how collective action around development of private and non-arable public/revenue lands could be achieved through technological tie up with inputs and administrative support. There is a need for experiments to link services, industry, craft activities, crop, livestock and tree technology in rainfed region because none in isolation may be viable in

the short term. The activities of the technology mission on Wasteland Development, National Watershed Project, National Research Development Corporation, CSIR, Krishi Vigyan Kendras set up by SAU and ICAR are not connected at all. We do not argue for an utopian integration at organizational level. 'Mutual Monitoring' may generate programmatic correspondence better than organizational integration in the short run. The 'portfolio' i.e,, multi-enterprise approach to monitoring the trials and demonstration of component technologies may help in advancing the concept of "Tiers of Technology" developed by Krishnamurthy (1972, AICRPDA, Hyderabad). Improving information environment of clients may create demand faster for portfolios of technology than integrating the supply side delivery system.

As Singh (1988) observes, five main factors affect the process of technology transfer: (i) availability of location specific technology, (ii) ability to understand risk and uncertainty in environmental factors including climate and soil, (iii) lack of support systems including shortage of draft power, (iv) weak economic base of the households and (v) weak market forces. The system of technology transfer has to deal with each one of these factors while designing delivery system. Socio-ecological perspective provides options of designing resource delivery system[1]

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1. Gupta, 1989, Design of Resource Delivery Systems, International Studies of Management and Organization, Vol. XVIII, No.4, pp. 64-82)

Part Two : Concept of Horizontal Diffusion

The tradition of studies on diffusion of innovation in India dates back to 1957 (or perhaps even earlier). A seminal review of all the post graduate thesis on the subject upto 1974 (Singh, Pareek, Arora; 1974) and (Singh and Jhamtani, 1978) brought out the excessive emphasis placed on Rogerian model of Diffusion of Innovation. The preponderance of sociological factors in the variables which impede the transfer of technology was noted but its limited role in facilitating the adoption was found intriguing (Singh 1979). We argue that most studies failed to identify the contribution of relevant factors in diffusion of technology because of three assumptions:

a) the adoption was rational and non - adoption non rational ;

b) non-adoption was a sign of backwardness or inertia on the part of the farmer and

c) the factors which affected the adoption were mainly either economic or socio-psychological.

The contributions of ecological variables has remained neglected in most studies on diffusion of innovation (Gupta ,1981 ,Rhoades 1982, Ashby, 1981) For a recent example of this neglect see Feder (1985).

Further, the potential of farmer to farmer diffusion as a method of appraising the potential of a new technology would have remained limited had not the importance of discontinuance

analysis and role of risk in modifying farmers expectation been properly appreciated (Gupta, 1986).

Dimensions of horizontal diffusion are:

1. The farmers may try a particular line in a given plot depending upon the way the scientist matched it with the corresponding local land race . This plot may or may not turn out to be ideal for manifesting the full potential of this line . In that case the farmer may shift it to another plot similar (if the earlier experience was good) or dissimilar (if the experience was bad). This idea was discussed by the author first in Bangladesh in 1986 while assisting On-farm Research System there. If tried, the method will reveal the dynamics of the niche identification of a new line through plot-to-plot shift. As mentioned earlier, if by chance the plot on which it was grown first year was indeed ideal, the expansion may take place on the similar plots instead of shift to dissimilar ones.

2. The expansion will depend upon the availability of suitable plots with the farmers . This indicates another major limitation of the studies on diffusion . The adoption rate has often been calculated for the total area under a crop . The micro-ecological variabilities have not been given due importance .We had suggested use of Diffusion Index as a ratio of number of plots (or area) on which a line was grown with number of plots having potential for the particular line (Gupta, 1987). It was also noted that two farmers

may do the same thing for different reasons and hence the precise reasons for diffusion or discontinuance will have to be found out. Again, some farmer may have tried and then rejected a line as against another who did not try but rejected it on a priori basis. Both the cases when asked may report that they were not growing a particular line. But for different reasons. The extension research has often clubbed such dissimilar respondents under a common category of non-adoptors.

3. Given the fact that there is a limit of the extent to which a farmer may expand his area under a line or a variety, other farmers who have seen the potential of this line or variety may like to exchange, borrow or buy the new seed from this farmer. This will be inter-farmer diffusion as different from the inter- plot discussed above. Maurya (1985-86) and Richards (1985) have used this approach independently as an intuitive method of appraising the worth of an advanced line of rice given to rainfed farmers.

In a study on 'Matching Farmers' Concerns with The Technologists Objectives : A study of scientific goal setting (Gupta, Patel and Shah, 1985 revised in 1987) it has been demonstrated using discriminant analysis technique that soil fertility index, residual fertility and moisture from previous crop were better determinant of use of certain technologies than either of the economic variables like land size or access to credit etc. in semi-arid regions of western Haryana.

Differences in inter-plot topography, fertility and vulnerability to floods have been found to give rise to more than hundred cropping patterns among different plots of about 150 farmers in a study in Bangladesh (Gupta et al ,1986)

In another study Hossain et al (1986) showed that dominance of cropping patterns changed over years in the same village depending upon climate-soil interactions.

We do not know of studies which have tried to look at the concept of actual and potential diffusion in rainfed regions except to a limited extent in Richards (1985).

Scholars have wondered as to why farmers who adopt new technology so well in winter' Rabi season turn into 'laggards' in aus or aman season (Nag, 1983 in Gupta et al 1988). So much for the claim that "Only 20-25 per cent of the farmers are receptive to new ideas " (Prasad, Choudhary and Nayar : 1987 : 60) rest being different shades of laggards. It is obviously an inadequate formulation of the problem. Twenty or twentyfive per cent farmers are not the ones who are more receptive to new technology but perhaps have more appropriate ecological or economic wherewithal necessary for new technology. Otherwise, how could same farmer be early adopter in one season, say Rabi or winter and laggard in monsoon or Kharif. Description in this case is being used for an invalid socio-psychological derivation (Sen, 1981). The incorporation of ecological variables will help circumscribe the descriptive and predictive power of socio-psychological and economic variables in terms of adoption or adaptation behaviour of

farmers.

We have studied how different social classes of rural households have chosen different combination of crop, livestock, tree and other enterprises in different ecological regions. The historical experience, accumulated debts/deficits or surplus in the household budgets, immediate past experience vis-a-vis distant experience with the technology, successive or alternate losses or gains besides future expectation are some of the major factors which affect household perception of high risk environment (Gupta; 1981, 1984). Access to factor and product markets, kinship networks, intra and inter household risk adjustment options, public and common property survival systems help in defining micro limits of the niches of technological suitability. Socio-ecological perspective helps in relating ecological, institutional and technological dimensions. Extension workers have to be enabled to get over the mind set created by decades of inappropriate indoctrination that social-psychological variables by themselves explain the differential choice of technology. The resultant emphasis on training for motivation, learning through demonstration and targetting at so called opinion leaders will then become misplaced.

The extension workers realise the need for proper market segmentation, identification of niches for locating trials in proper habitats through ecological mapping and manual discriminant analysis (Gupta; 1987) and thus recognise the rational limits of available technologies. They would also see the need for linking institutional systems with technological ones - assumed to be

independent under training and visit systems of extension

We thus agree with the contention of Prasad, Chaudhary and Nayar; 1987 that extension workers must not be blamed entirely for lack of diffusion of new technology in rain fed regions. But we agree for a different reason. We submit that the inability of extension workers in being more successful in these regions is because they still are using techniques of knowledge transfer suitable for irrigated regions.

We believe that both on account of inappropriate targeting of trials under CIMMYT and IRRI on-farm research methodologies and inappropriate conceptualization of diffusion potential in high risk environment the problem of trials on the fields of poor farmers and its impact assessment has remained intractable. We address the issue of operationalising these concerns in next section.

Part 3 : The Socio-Ecological Implications for Institutional Restructuring

1. On-Farm Research For Generating Technologies Which can Diffuse Widely

The possibility of developing technologies at research station which can diffuse widely in dry regions are remote. One has to recognize the need for high correspondence between technological requirements and socio-ecological conditions. The fact that majority of the Kharif crops which are rainfed are also cross pollinated makes the task more complex. Not many multi-lines are being developed and hybrids require availability of seed afresh every year. National Seeds Corporation and State Seeds Corporation do not produce even a fraction of the total requirement of seeds of rainfed crops (Maurya, Bottrall and Farrington, 1988). The agronomic practices have to be adapted to highly diversified ecological conditions.

The preponderance of land races and local livestock breeds in such regions prove that farmers have been engaged in selection and improvement of genotypes in crops , livestock and tree species (Vishwanath, 1938; Richaria, 1986; Munshi, 1964; ICAR, 1964; Richards, 1985; Verma and Singh, 1969; Gupta, 1980,1987 [2], 1988). However, the selection criteria of the farmers and techniques of plant improvement did not

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2. It is a pity that most Western and recent Indian publications on the local technical knowledge of farmers continue to ignore the pioneering work done by Indian scholars and farmers.

incoporate many of the alternatives which have become availd only recently with the help of modern science and technology and for obvious reasons.

Thus given (a) the variance in the conditions of the research stations and that of the farmers, (b) the need for building upon local knowledge of different classes of rural households, a close interaction between scientists and farmer is called for. This will imply institutionalization of on-farm research and extension system (Kimowitz and Sands ,1989). Farmers would participate not only in implementing the ideas of the scientists but scientists would also participate in implementing the ideas of the farmers. The transfer of science and development of technology will become much faster and sustainable in this process. Swaminathan (1989) has also realized the importance of science transfer when he argued that technology is actually developed in the farmers' fields. We however, do not agree entirely with this formulation because when conditions at station and farmers' fields match or compare well, the technology can indeed be developed at experimental station and then transferred to the farmers in 'lab to land' fashion.

In rainfed regions, since large number of stresses can't be simulated at experimentation station, the need for making selection at advanced level in farmers fields may have merit. Scientific problems associated with determination of heritability under farmers' condition are very difficult and

complex to resolve at present.Not only the selections can be made by the farmers in the advanced generations but even attempt for such selection can be made in segregating populations processed in parallel, that is at the station and the farmers' fields after sufficient seed is accumulated. Scientists can perform experiments (formal and informal) to generate various types of information which will make technology development more precise and specific. Farmers can be brought to the station to evaluate or rank the lines so that the scientists can compare their assessment with that of the farmers (Gupta, Patel and Shah, 1985).

The crops which are essentially grown as inter or mixed crops need not be selected as sole crop in the breeding process, and then adapted for agronomic practices (Gupta, 1984, 1987, Haque, Gupta and Abedin, 1986).

2. Ecological Mapping

Targeting of technology like marketing of a commodity requires understanding of different consumer classes and niches. A method of mapping impressionistically, the pockets of different rainfed crops and their varieties has been developed by the author. This relies upon the extremely rich insights that village level workers have in their mind about the agro-climatic combinations or niches in which different land races have been favoured by the farmers. Since crop and climate are strongly correlated, by mapping crops and pockets of their varieties on village/block/dis;

trict-wise maps, one can almost map the agro-climatic regions and sub-regions. Once this has been done, a very effective alternative has been found for locating the trials and demonstrations of potential technologies. Not everything is tried everywhere in a random fashion. If a technology performs better against the local best it has greater chance of diffusion. However, while participating in on-farm research one has to underline that the trial is of a different technology but not necessarily a better technology (Gupta, Alam, Abedin and Rahman, 1986).

3. Manual Descriminant Analysis

This is a method which draws upon farmers' own innovative genius. The basic assumption is that by comparing and contrasting farmers' own practices we can develop hypothesis for technology development and transfer. For instance in any given technology within a village, a large number of practices whether in agronomic or plant protection or other parameters can be easily identified. If we concentrate on both the ends of the distribution of any parameter say for instance, seed rate or sowing time of the crop, we can identify the outliners i.e., farmers who apply very high or low seed rate or sow very early or late. Having done that we should ask each group of farmers individually as well as collectively the reasons they think are responsible for the contrasting practice by the other group of farmers. Having calibrated their frame of reference we should then ask them

about their own practice. This will help us in generating hypotheses responsible for the variability in farming practices in the same micro- ecological region. This will also help in isolating the contribution of ecological factors from that of the socio- economic factors. As mentioned earlier, we strongly dispute the utility of using the worn-out classification of farmers into early adopters, late adopters and the laggards. Same farmer who is an early adapter for one practice cannot become laggard in rainfed crops for another due to some innate inertia, exceptions apart.

The farmers' participation in generation of hypotheses as well as in development of technologies for diffusion in different regions can also facilitated by the use of marketing research strategies (Epstein, 1988). The market researchers have known for long the techniques for market segmentation based on assessment of consumer needs and the nature of product. The segmentation can better be done by identifying the underlying reasons responsible for differences in consumer preference and ecological endowments as distinct from the assumed differences in their socio-economic characteristics.

4. Building upon Local Knowledge

In several workshops of extension workers in India and Bangladesh , the author has found a tremendously rich knowledge that grass root extension workers of public and NGO

systems have about farmers' own innovations. Unfortunately many of these practices are never transferred back to the scientists for experimental validation , modification and eventual diffusion. (Richards, 1985; Chambers, 1985; Verma and Singh, 1969; ICAR, 1964; Basant, 1988; Warren, 1988). In the process the tendency continues to be from "lab to land" rather than land-to-lab-to-land. This is not to argue that all technologies can be developed in the same fashion. A considerable scope exists for developing technologies which farmers may never have been able to imagine in a particular region. After all no farmer in India had demanded a dwarf wheat variety. It was primarily a supply side intervention. One should, as mentioned earlier be cautious in asking for farmers' participation in technology development. One should not argue for reducing the zone of responsibility of scientists. Farmers don't always know what the scientists can deliver. Thus should scientists not work on such problems?

5. Ethics of Knowledge Transfer

Argument for giving importance to farmers' innovations also rests on the efficiency and ethical ground. If extension workers reinforce farmers' own experimental ethic it is possible that farmers may participate more actively in redesigning technology generation and transfer process. Also, by acknowledging that ideas of many experiments were derived from farmers' practices reported by extension work-

ers, the scientists would enlarge the ethical boundaries of their profession [Gupta, 1987 (b)].

The feed back has been one of the major weaknesses of extension programme in the recent past. The World Bank specialists responsible for pushing training and visit system have failed to provide many examples of the on-station experiments started on the basis of feedback generated in the programme.

World Bank specialists have also violated the professional ethics while explaining development or diffusion of technologies in developing countries. Greenfield (1988) recently failed to acknowledge the contribution of public officials, extension workers and farmers in Karnataka while describing the case of Khus (Veti Ver) grass in watershed development.

Greenfield referred to a visit to a village Gundelpet in Karnataka where farmers had been practicing use of Khus grass on bunds for several decades much before World Bank discovered the utility of this grass in soil conservation. He did not acknowledge the extension workers and executives of Dryland Development Board, Karnataka who discovered the existing farmers' practice and took World Bank expert to the site. Such behaviour by international 'experts' or national scientists have not helped in redefining the relations between (a) those who develop scientific principles (b) those who adapt these principles into technological practices and (c) those who adapt or diffuse these princi-

ples/practices in the farmers' fields.

Aid agencies have also been known to reinforce mediocrity at times to break local teams and thus weaken local peer culture .

Lest one assumes that such violations take place only at the level of international experts we are aware of many examples of violation by national scientists as well (e.g., a veterinary medicine developed on the basis of a herbal indigenous practice discovered by Verma and Singh (1969) using a herb viz., Khartumba was never sourced to the extension scientists who documented the practice in the first place; Singh, 1989 - personal communication).

We have not come across many examples in India or abroad where biological scientists have acknowledged explicitly the contribution by extension workers (or even farmers) in modification of an existing technology or generation of new one.

It may be added here that innovations for survival may not necessarily be similar to the innovations for accumulation. In any case research on poor man's crops and livestock species has remained neglected and therefore, the technology transfer system has suffered. (See a review of post-graduate thesis abstracts during 1973-1984 for further validation of these biases, Gupta, Patel and Shah, 1985, 1989).

Another ethical aspect is the sharing of knowledge with those from whom we collect information (Gupta, 1987). It is important that farmers are told about the contributions they make to the theory or practice of science. Also, they should have a right to invalidate our inferences if the same are based on false theorizing.

6. Agro-Industrial Watershed

As suggested by Bali (1980) the concept of involving farmers in setting up value adding enterprise by combining farm and non-farm aspects of watershed development has to be given due importance. We have to recognize that unless we add value to the skills and resources of disadvantaged households incentives for them to cooperate and collectively manage resources may not exist. The emphasis on individual oriented technological transfer system must be tempered as said earlier, in favour of group and/or watershed based technology transfer system.

It is also obvious that in a system's perspective the uniform fertilizer recommendations for different crops in a sequence will no more remain rational. The residual effect of the fertilizer will be taken into account to move from crop based to cropping system based technology transfer system and eventually the whole farming system or portfolio of enterprises may be taken into account on the watershed basis. When farmers find extension workers transferring illogical technologies they justifiably choose not to coop-

erate.

The advantage of 'agro-industrial watershed' is that scientists would, by improving post-harvest technologies and pre-harvest practices make adoption of systems approach more profitable for the farmers. For instance as Dr. Rangnekar (1989) mentioned, if a dual purpose crop (i.e., for grain and fodder) is harvested just a few days before the total dryness i.e., at physiological maturity stage (or soon after), the quality of fodder may go up considerably.

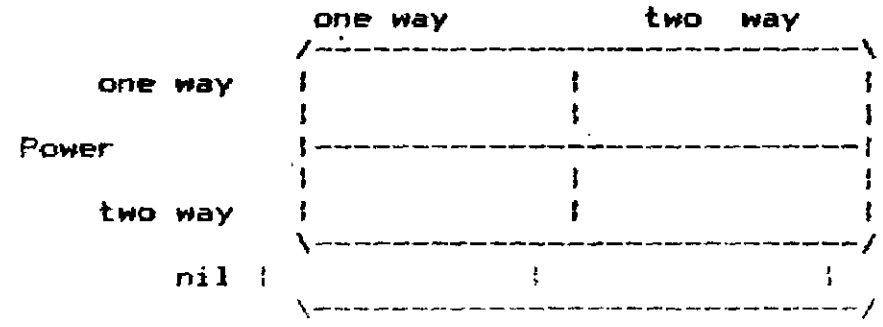
If better processing of grain or fodder is made possible, the incentives for improving crop management through better soil and water conservation, pest and weed control etc may become more remunerative.

The farmers may go for cultivating medicinal plants and shrubs in watershed if processing facilities are developed. The research and technology transfer system can not limit itself to the primary production alone.

7. Sustainable Science & Technology Transfer Institutions

There are several approaches to build sustainable institutional linkages between different social groups and the centres of expertise. Conceptually , the relations between deamd and supply system can be seen through a matrix of 'communication and power (Gupta ,1980)'

Communication



The subset **:one-way communication and one-way power** implies authoritarian system in which only the top down flow of information takes place . Such systems are least sustainable .They get very quickly isolated from their clients . By the time notice may be taken the system may lose its capacity of self-correction . The **one-way-communication and two-way power** is almost an impossible set . Power can not exist without ability to communicate in some form . The organizations showing **two-way communication but one-way power** are characterized by a very high level of employee remotivation at the cutting edge . The staff of the organizations feel that they have ability to feedback the ideas to the top but have no capacity or power to change content, style or form of the information or services . The clients also get frustrated when they find that their feedback is received but not acted upon . In systems where one finds **two-way communication and no power either way** .one can see organizational decline (Weitzel & Jonsson ,1989) setting in .The client satisfaction is aimed at but not monitored and if monitored ,not responded to through restructuring of the organization . Leaders emphasize redoubling of the efforts

in the same direction because they had been part of deciding those dierection in the past . **One -way communication with no power either way** is a case of drum beater who announces given message without any authority or capacity to change it .In this case the client feedback has marginal impact only on the frequency of message .

The ideal system is **two-way communication and two-way power** also compared with the mass line concept of China or decentralised system of Gandhi. Here the people have the **ability** to communicate their reactions to the messages given from the top but also have the **capacity** to design and execute their own ideas in collaboration with the supply system . People can persuade the supply system to change its priorities and incorporate new issues for research or trials .

Institutionally there are several ways in which many of these ideas can be experimented upon . Three conditions have to be kept in view :

(a) The pride of the people in their knowledge has to be preserved but not in all cases .Verma and Singh (1969).Nand and Kumar (1980) and Selvanayagam (1986) have shown the merit of some of the beliefs that scientists acknowledge to be well placed . However , they also show examples of the cases where the farmers' beliefs may be misplaced.In the process of science transfer or upgradation , it may be easier for extension workers to attempt modification in the beliefs of the farmers if they began with what **farmers already knew and without their or scientists telling them .**

(b) Variability in economic and ecological endowments and historical experiences does create social stratification .Technologists can not be insensitive to the conflicts inherent in the on going developmental processes. While it is desirable to emphasize ecological and common property basis of the technological interdependence , one must underscore the need for aiming at the disadvantaged social groups through transfer pricing or wider options of experimental options .

(c) Learning is an essential element of sustainability .It requires discrediting or self criticism , accountability at all levels and explicit acknowledgement of ideas that one learns from others . Scientists while modifying ,stopping or initiating experiments on the basis of the feedback from farmers directly or through extension workers should acknowledge their learning .
Sustainable interface with farmers may be attempted through

several routes such as :

(1) Farmers could be enabled to explore the potential of local lines/varieties of different crops collected from neighboring regions under different management conditions . It should not be assumed that the historical process of farmer-to-farmer diffusion of viable technologies would have exhausted all possibilities of further exploration or diffusion. The social and cultural networks through which the diffusion of information about outlier technology takes place keep getting forged and also dissolved. Excessive reliance on public delivery system has certainly weakened the experimental ethic of the farmers.

(2) Systematic analysis of various questions posed by the farmers at Kisan Melas /Farmers' fairs or sent to the question-answer column of farm magazines may bring out the nature of problems that bother certain classes of farmers . Farmers problems are also ascertained by the scientists during their visit to the villages , dealers of inputs and some times directly through letters or the visit of the farmers. It is very important to note that research priorities should not be based on articulation through any one channel . Gupta,Patel and Shah (1985) analysed all the questions posed by the farmers of Haryana during 1973-1984 to the journal of Haryana Agricultural University viz:Haryana Kheti . It was found that there were only 30/290 questions which pertained to dry regions though one fourth to one third of Haryana has dry farming conditions .Horticulture , Livestock (excluding small ruminants) and cash crops were the major categories of farmers' concerns articulated through this medium .

Sustainability will require that analysis of this kind is fedback to the farmers and their groups regularly so that they learn to make demands on the system better and differently .

(3) An innovative attempt has been made at Central Sheep and Wool Research Institute . Good sheep herds are identified on the basis of certain indicators and then rams of these herds are exchanged with the rams of the herds of poor performance .Inferior rams so collected are culled . This is perhaps the only case of organized transfer of knowledge from one group of herdsman to another (Acharya, 1988).

(4) Breeders have tried giving extra seed of the advanced lines (and not F-5 as claimed in this case) left after trails at the station for another trial at the farmers fields . The care is taken that the lines say of rice for upland conditions are given to farmers to match with their own upland varieties. After next year the farmer to farmer diffusion is monitored to ascertain the performance of these lines . At times lines which should have not gone on farmers conditions are also given but that is a problem which can be corrected with better care . The advantage of this system is that the lines get additional opportunity to b e tried under the soil and tilth conditions of the farmers . It was proposed that the seed given once may be collected next year so that it may be pooled in the village and distributed to others next year depending upon the interest of the farmers . System was tried with temporary staff and crude data collection methods at NDUAT (Maurya,1985-1988). Attempt to strengthen the system have not been very successful due to various institutional and methodological conflicts . However , the fact remains that with proper care in location of trials through ecological mapping and better farmer participation , selection of advanced lines carefully rather than taking all the left over seed to farmers' fields , pursuing certain lines for few years at both farmers' and station conditions so that lines once rejected could be taken forward in the formal breeding system (a process suggested but not yet pursued at NDUAT) etc., a sustainable system can indeed be built . It has to be realised that ultimate test of such method will be revision in the screening criteria of plant breeders -an act of which not many examples are available as yet . One will have to also overcome the temptation of making claims which scientifically or professionally are not tenable . Institutionally , such claims encourage others to a step forward . A colleague in the same department where this trial is going on asserted that he had taken segregating population to the farmers condition in another crop . Farmers can participate in influencing the research directions if they are explained the science underlying various interventions .Regret is that in most cases including the above case farmers participate merely in carrying out the scientists' ideas .

(5) Sustainability requires building teams which many innovators abhor. The result is that are able to generate ideas but fail to see them through '. Extension workers and the scientists should have some joint experiments in which ideas and method should be the outcome of what outputs are expected and what methodological rigour is required . It may start a new tradition of valid research .Undoubtedly in such cases the extension system has both up stream (i.e. towards the on-station scientists colleague) and down stream responsibilty (i.e. towards farmers colleagues). communication system is truly of two-way-communication-two-way-power type .

(6) 'Lateral Learning '(Gupta,1986 ,Singh et al,1988) i.e. learning from each other has been found to be an age old but very effective organizational means of generating options for sustainability . In these workshops various teams of the scientists and extension workers having dealings with the farmers (at the main research station or regional research station) share in self critical manner the methodological and conceptual innovations as well as inadequacies.Joint strategies are worked out for initiating experiments .Mutual Monitoring and reinforcements generate a peer culture which is necessary for any program to renew itself from time to time .

There are many more strategies which can help build sustainable linkages between farmers , extension workers and the scientists (at lower and higher level) not without tensions . However, minimum amount of tension is necessary without which howsoever good a sitar or a violin may be, no music can ever be produced . Trick is to recognise the point where and when the wire will break !

Summary and Conclusion

1. More resources for dryland research and transfer

As a part of a survey done to prepare for a national workshop on Management of Research for Rainfed Regions being organised by the Indian Institute of Management, Ahmedabad in collaboration with Central Research Institute of Dryland Agriculture, Hyderabad and National Academy of Agricultural Research Management, Hyderabad we have learned about extremely serious resource constraints under which dry farming scientists are required to work. In some of the universities hardly 2.5 percent of the total budget is available for experimentation and mobility of the scientists. The scientists can not be expected under such resource constrained

environment to work with the extension workers and farmers to develop location specific technologies. We do not know what gives the hope to the planners that doing more of the same will improve the situation in 8th Five Year Plan. The allocation of the funds for research both on station and on farmers' field even under the technology mission for oil seeds is negligible.

There is a need for reconceptualising both the institutional environment and its resource requirement for making dry farming technology generation and transfer system for dry farming/rainfed farming viable (Jodha, 1984; Gupta, 1984).

7. **Need for greater number of trials and demonstrations in ecological diverse regions**

It is obvious that higher the heterogeneity in the population greater will have to be the sample size to achieve a reliable estimation of the problem. Number of trials in rainfed regions and demonstrations of technology will have to be far more per unit of area than in irrigated units. People participate more when they see realism in our approach. Half-hearted approach seldom wins converts. Given the emphasis on agro-climatic zoning, Planning Commission should specifically earmark funds for developing many more multi-location testing facilities in rainfed regions.

Transfer Pricing for Technology Transfer System

There is a case for withdrawal of the subsidy from technolo-

gy transfer system in irrigated areas (Shingi, 1988; Gupta, 1985). There is no reason why farmers who can be served by the market forces in their own individual interest need to be subsidised by the state. Thus, in all the cash crop irrigated regions the extension services must be owned by the farmers' own organization through their cooperatives or other such systems. Government should help in the development of such institutions but withdraw the village level extension infrastructure. Given high population density and much better transport network, farmers can come to Krishi Vigyan Kendras and get their problem resolved. The extension should essentially become a demand based system. There can be information bulletins in case of any unforeseen pest problem or other such contingencies publicized through trade and other channels. Private sector would perforce allocate resources to strengthen the technology development and transfer system in well endowed low risk regions.

Money and man-power so saved should be deployed in dry regions if we really want second Green Revolution. Let it be clearly understood that soft options of continuing attention on low risk-better-endowed regions will not help the developing countries in the next decade. We need combination of different strategies and structures for different ecological regions.

4. **Farmers cooperate best when their own wisdom and experience in managing their resources and risks is built upon through collective institutions**

At no point in future will scientists be able to develop and the extension workers be able to deliver the technological solutions for each micro niche of highly diverse, spatial, seasonal, sectoral complex of rainfed regions. Therefore, need for building up capacity in the groups of farmers to experiment and adapt the modern concepts as well as indigenous ideas and innovations has to be recognized. Action research projects on building farmers' institutions have to be urgently initiated. Unfortunately most of the watershed projects have neglected this dimension. Not to mention the social scientists and management scientists have also not given it due attention. Research on institution building for group action is an urgent area of concern needing support.

5. Banks have to be involved in the process of technology generation itself so that their ability to adapt their institutional system in line with the requirements of rainfed technology can be increased. Slowly the banks are recognizing that **individual crop** and **single season** oriented financing will not generate sustainable demand for the credit nor would it lead to viable investments. The concept of portfolio financing i.e. multi-enterprise financing and built-in rescheduling and rehabilitation or cyclical credit systems (Gupta, 1983; NABARD, 1988) have to be given proper attention. Action research on credit-technology in two of the drought prone districts of Karnataka is under way in collaboration with DLDB, commercial and cooperative banks

and State Agricultural University.

6. **Technology for Women**

In view of the fact that large number of households are headed or managed by the women in dry regions (because males have to migrate away for part or whole of the year in search of employment) the extension system has to generate capacity to deal with such clients. Intuitive faculty of women to see things, perhaps, more holistically than men has to be built upon.

7. It is well-known that any credit based technology transfer system relies upon the land records as a basic document of entitlement. However, the dry regions have a chronic problem of land records which have not been updated. Government must organize mutation camps on warfooting to ensure that up-to-date land records are available to everybody. This is particularly true for watershed development projects.

8. The fact that large number of loans could not be paid back in these regions due to persistent drought (Western India) or frequent floods (Eastern India), has led to a situation of widespread default. Farmers thus are ineligible to borrow. On one hand the banking infrastructure is itself very weak and on the other hand the demand for credit is

very low given such disabilities. For all those farmers who have worked on National Rural Employment Programme (now merged into Jawahar Rojgar Yojana) (NREP) or Employment Guarantee Scheme (EGS) and have only unirrigated holdings must be allowed to borrow again. Their old loans may even be converted into interest free loans to be paid back in 15 to 20 years time. As far as the Tacawi and land development loans are concerned they should even be written off given the above conditions. There is no reason why when Government could not recover and does not want to recover development levy from the irrigated farmers, it should insist on recovering the land development loans from farmers relying on rainfed agriculture. In principle, we are against writing off of the loans. But when these are given for inappropriate technology, or are insufficient for investment or have led to failed investment, we have to realize the need for writing off.

9. The individual oriented subsidy schemes of the Government such as IRDP must be urgently reviewed. In all those 100 and odd districts which have benefited from the Green Revolution and where the growth rate as well as base level of production and productivity is fairly high, the trickle down process should be allowed to take care of the poverty problem. The resources so saved should be deployed in the bottom 100 and odd districts where not only growth rate is near zero or negative but even the base level of productivity is very low. It is in these regions that the wage rates

are very low, employment is limited, pulses, oil seeds and millets are predominant, there is a preponderance of sheep, goat, camel and cattle (and not buffalo) and where there is nothing to trickle down. The 'irony of equity' is that equal resources are allocated to situation unequal in their endowment or historical experience. When differences are indeed brought into play, the weight is assigned to such criteria which lead to greater resource transfer to developed regions.

We should realize that social tensions on account of stagnant nature of technological and economic development will not remain subdued for too long. Considerable rural violence was observed in late sixties in high growth regions due to sudden spurt in social disparities. Next round of such tensions could as well be in rainfed regions if technologies continued to be tied to water and capital inputs. The pressure for privatisation of CPRs like ground water will increase and extension workers, under pressure to show results, will also focus only on such better endowed 'twenty per cent' farmers in dry regions. Given ecological incompatibility between these and the rest of the regions, horizontal diffusion of low risk technology from better to worse endowed regions is ruled out.

Lack of results due to inappropriate methods of work could further demotivate the extension workers. Science transfer to farmers whose information processing capacity have been

increasing over time (in some regions and need to be improved in other) must form the basis of new paradigm of knowledge generation and utilization system. The transfer of scientific principles and thumb rules will help the farmers to develop technologies for their non micro-watersheds. Hira Nand (1979) had suggested a ready reckoner for working out fertilizer combinations keeping in view of the soil fertility, moisture etc. Institutional context for socio-ecological determinants of choice of technology can not be neglected if sustainable system have to be built. It is a pity that we have still not learned to deal organizationally with the diversity, complexity and simultaneity underlying ecological systems (Gupta, 1989). Recognizing limits of what disadvantaged farmers can not demand and better endowed can, we have to appreciate that responsibility of designers of supply side is enormous. Delivering just what people demand can put such people at a great disadvantage who have not experienced or seen what delivery systems are capable of delivery (Gupta, 1987). Ethical obligations must be carefully weighed while structuring the relationships between scientists, extension workers and the farmers.

Institutional aspects of sustainability requires that the role of status vis-a-vis skills , lateral learning ,mutual monitoring , self renewal strategies etc., is recognised by the organizational designers. they should also take note of the fact different designs of delivery system can become accessible and accountable to poor and rich clients .

Reliance on just the experience of 'Green Revolution' could be like driving on the basis of only a 'rear view' mirror, it shows the road travelled but does not tell anything about where to go; let us remove the tint from the front glass created by experience with irrigated, concentrated and articulated farmers. We could then realize that the path ahead calls for redesigning the vehicle itself and not just recalibrating the rout map.

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