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On farm research for minimizing risk in rainfed agriculture: Social ecological and institutional perspective.

Context:

On farm research may be considered necessary for development, adaptation, and validation of technology. The on farm research should be distinguished from on farm trials or demonstrations. In case of trial a technological solution to a problem exists, its suitability or adaptability in a given micro-environmental condition is under test. In case of demonstration not only a technological solution exists but even its technical validity in the local conditions has been already confirmed. Only its efficacy needs to be shown to the farmers. It is possible to generate farmers' feedback in on farm research, trial as well as demonstration but the degree, the purpose and the impact may vary depending upon the conceptual approach used. Some of the reasons requiring on farm research may be valid for rainfed as well as irrigated agriculture. But some factors are far more relevant under rainfed conditions only. The paper includes discussion on the problems of on farm research and trials in primarily rainfed regions.

The rainfed environments are characterised by high degree of variability at a short distance. Given the empirical inverse relationship between the quantity of rainfall and the extent of variability one has to appreciate that in western India the ecological variability is much higher over space and time than in Eastern India.

In part one of the paper I present discussion on the rationale for on farm research in risky environment. The methodological implications of incorporating risk in the on farm research approaches are drawn in part two. What issues research managers need to take into account while considering expansion of on farm research programmes or in embedding them in the overall context of research management are given in the last in part three.

Part-One

Why On Farm Research :

On farm research may be necessary because (a) the variable conditions at the farmers field cannot be simulated at the experimental station, (b) there are problems in the development of technology which can be resolved only through close participation of farmers in design and execution of trials, (c) some of the problems at farmers fields can be simulated at a station but there is high risk of these problems affecting other experiments at the station. For instance, nematodes may infect the soils of the farmers but if this problem does not exist at the station, scientists may not like to create it lest the problem may become widespread at station, (d) the feedback of the farmer to certain known and unknown variabilities in input or output of the tech-

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nology may not be easily generated by bringing farmers to the station, (e) the soils of experimental station may have been so heavily pulverized using heavy equipments that these bear no resemblance to the soil structure and texture in the farmers fields, (f) the cost of trial at research station may be very high and by involving farmers in the design, implementation and evaluation of research on their fields, it may be brought down, (g) the interaction of technology with the variable practices of the neighbouring farmers may not be possible to elicit at the station (h) In the farmer managed research, the innovations which farmers may try on their own may more easily be captured than is possible by bringing the farmers to the experiment stations (i) the contingency treatments may not be developed if variability over time is controlled at the experiment stations or if this variability is studied only from technological point of view. The institutional conditions under which farmers work cannot be captured at the research stations, (j) farmers preference for various components of technology to be combined or recombined in a manner that his or her household resources would be adequate cannot be ascertained at the station, (k) the land use choices are also affected by public policy, collective rationality, tennurial conditions and access to factor and product markets. The preferences and skills of women who may travel less frequently and shorter distances may not be captured at the research station (because those who come may not be the most needy ones), and (m) the problems of the post harvest processing, storage, transportation etc.,can be studied better in an interactive environment at the farmers fields.

I must clarify that while on farm research may be able to address various issues raised above I am not arguing that it often does. In fact my argument is that majority of the on farm research programmes world over suffer from basic conceptual and methodological limitations. Thus even if the scientists tried to tackle area specific problems they won't be able to pursue them adequately, given the limitations of the methods.

It is also important to note that conditions at the experimental farm and the farmers field in the low risk irrigated environment may differ less. Therefore, the classical model of developing a technology at the station and transferring it to farmers after trials at various locations may continue to be used with much profit in such environments. In rainfed conditions the characterization of environment and the response to the environmental variability by households individually or collectively has to be studied through on farm research.

Understanding Household Risk Adjustments:

Development of an appropriate conceptual and methodological approach suitable in our institutional environment requires that we carefully understand the household risk adjustment mechanisms. In table 1, I have given a summary of intra-household, inter-household, collective or communal, market or public system based measures that may be generally used. The role of technology has to be seen in combination with the role of other factors. Historically, it has been seen that both the market forces and the public institutions have been quite weak in rainfed environments The obvious reason is the lack of marketable surplus and high degree of socio-economic deprivation. The policy articulation by the households is also quite weak.

It is inevitable that survival strategies of the people should involve experimentation and innovation to manage livelihood given various uncertainties and risks. It is true that experimentation

Table-1

Household Risk adjusment strategies:

Intra-Household:	asset disposal, migration, reduction or modification of consumption, reallocation of resources among diferent enterprises, etc.
Inter- Household	labour, credit, land related bilateral or multilateral contracts, informal sharing, gifts etc.
Group or Communal	reliance on Common property resources, group ploughing, sowing or other farm operations like plant protection, drainage, purity of breed etc., group grain, fuel wood and resource reserves, etc.
Public Interventions	Drought or flood relief, aerial spray for plant protection, distribution od seed or seedlings after natural catastrophies, infrastructural interventions etc.
Cultural artefacts	myths, folkore, religious or other sanctions against private profit from community deprivation or for sustainable resource management, use of lunar calendar to synchronise farm operations etc.

(Based on Gupta, 1984)

and innovation also take place in low risk environments but the ethics of and the knowledge system that governs such trials and innovations by individuals or groups may very significantly in low and high risk environments. On farm research provides one means of linking up such informal experimentation by the farmers with the formal research by the scientists (Verma & Singh, 1969; Biggs, 1980; Chambers, 1983, Gupta, 1980, 1984, 1986).

Given the declining productivity of most of the commercial inputs in the improved agriculture the problem of sustainability is attracting attention of all concerned. On farm research may help in understanding the evolutionary process in which demand for sustainable and perhaps low technology may be generated.

Sustainability requires development of resilience or capacity to cope with the uncertain and unpredictable interactions among various sub-systems of agriculture such as crop, livestock, trees etc. Many of these interactions cannot be studied at the level of an individual farm or sometimes even in the village. One has to study these interactions at the level of niche or ecotones i.e. the intersection of two or more different niches (Rhoades, 1990, Gupta 1990). On farm research can be a useful way of defining and validating the niche boundaries.

On farm research also imposes certain constraints. It requires observance of certain ethical principles under which the collection, processing and interpretation of data is done jointly with the farmers in a mutually accountable manner. Many scientists may not accepts such ethical obligations. With the result the farmers participation in the design as well interpretation of data may be very low. Thus scientists may get very few additional insights primarily because farmers' involvement has been minimal. This is essentially a limitation of approach rather than the concept of on farm research. On the other hand, coefficient of variation in many trials may be more than thirty percent, thus limiting the use of conventional statistical tools.

Part-Two

Methodological implications of risk for on farm research

Various stages involved in designing, implementing and reviewing the experiments after diagnosing farmers' problems, would be affected by planning on farm experiments. We are contrasting the methodology developed by CIMMYT (1980) step by step and illustrating the alternative concepts. The methodology developed by IRRI is relatively less robust and would be referred to wherever necessary.

Planning for on farm research: The definition of "recommendation domain" after selecting the research site is the first building block. In the case of IRRI's methodology the selection of site is common but instead of recommendation domain the concept of extrapolation area is used which is essentially a narrower definition of recommendation domain.

The concept of site is important because scientists are expected to locate all the trials at a given site i.e two or three villages for at least three to five years. For irrigated wheat or paddy, this concept is valid. It is possible to identify representative sites to generalise the results obtained there for larger areas / recommendation domains. In the arid and semi arid regions rainfall variability over time and space even at short distance is very high. The variability in soil mineral properties, drainage, topography, etc., may also be very high. But, the rain fall variability creates extraordinary complexity in the micro environmental conditions as well as in the land use patterns over the years. The integration with livestock and trees is far higher in case of dry regions than sub humid regions. In the sub humid condition the rainfall variability is less over space than over time but the variability in drainage system is very high . Because of natural or man made obstructions, the onset, duration, extent and cessation of floods may vary a great deal in different parts of the same village except in the very heavy rain years. At such time, large stretches in low lying areas would remain under water column even if of varying heights. The difference in the flooding levels have direct implications for variability in the residual moisture regime.

'Niche' compatability and location of trials:

Given such a context whether it is useful to locate experiments on various crops and technologies in the same villages. By definition the recommendation domain of wheat may vary from mustard or groundnut etc. The CIMMYT methodology observes:

> It is true that no two farmers have identical circumstances and therefore identical needs for technology. It is also true that a Research program cannot be established to provide recommendations for each farmer. It is therefore necessary to classify farmers with similar circumstances into recommendation domains-groups of farmers for whom we can make more or less the same recommendations. At least a tentative delineation of these recommendation domains is necessary in planning on-farm experiments since the research priorities and consequent experiments might be different in each domain.

It is recognised in the methodology that the number of recommendation domains depended upon the extent of variation in the circumstances of the farmers. The more the variation, larger the number of domains needed. The availability of resources - man power, material and other - would, of course be a major constraint on the number of domains one can address in on farm research. The interaction between the ecological endowments and socio economic and institutional factors have been incorporated to some extent in the available methodologies. However, what is missed is the concept of niche compatibility. The ideal niches for different crops or combinations thereof would vary within a same agro climatic zone. The niche for say pigeon pea would be different than the niche for rice varieties suitable for medium upland conditions. Within medium upland conditions, the varieties suitable for different growth durations will have varying niches depending upon location specific flooding and drainage attributes.

Therefore, by mapping the varieties of different crops in a rainfed region through impressionistic methods, one can identify the niches for different growing periods as well as crops. The targeting of on farm research or trials can be made far more precise by locating the trials of different crops or enterprises in the most favoured niches within a given agro climatic zone. This also encompasses the concept of 'competing with the local best' while developing solutions to the local problems. Often the trials may be located in convenient villages or sites such that the control conditions are really not comparable with the prevalent practices in the micro region where such a crop or enterprise is most popular. The scientists may find solutions which do not diffuse because the command area or the recommendation domain has characteristics which cannot be captured at the site.

Under the proposed methodology, trials or research experiments on different component technologies or cropping or farming systems would be pursued at different locations. Some of these locations by definition would be outside the site villages. This will help avoid the mistake sometimes observed in Operation Research Project (ORP) villages when experiments on such crops are taken up which are not grown at all by the farmers in those villages. Such a system would be costlier because the scientists would be required to visit locations far apart. However, risk minimization requires recognising the pattern of variability over space, species and time and therefore, greater investment in mobility and man power.

The CIMMYT methodology recognises that recommendation domains need not be continuous geographical areas. It is also noted that two neighboring farmers may belong to different recommendation domains or within a household farm there may be plots belonging to different domains. The major difference that we have with CIMMYT and IRRI methodology is with regard to the concept of site and location of trials there.

Diagnosing farmers' problems and identifying treatments for on farm research:

Variety of constraints limiting the production potential and flow of incomes to the farmers are generally reduced to a short list of solvable, "best-bet" components to be tailored through on farm research or trials. The knowledge of farmers' circumstances is used to "prescreen the treatments or components likely to succeed with the farmers" (CIMMYT,1980).

I have identified two basic limitations of the existing diagnostic methods whether based on surveys or informal interviewing (also called as rapid rural appraisal) with particular reference to rainfed regions. (a) Disentangling of the contribution of socio-economic variables vis-a-vis the agro-ecological (soil, climate, agronomic) variables not done properly, (b) the dynamics of risk adjustment at household, group or community level not built into the design of the treatments.

I suggest following approaches to diagnosis so that the <u>apparent</u> problems are distinguished from the <u>real</u> ones.

Validation of inference ,: Whenever we validate any inference based on a causal model we look for, 'internal' and 'external' validity . The first refers to the condition where a variable measures what is intended to be measured. For instance, cultivation of new varieties is considered a sign of progressive nature of the household. By implication a household which does not grow such varieties at all or does not grow on all plots is considered backward or less progressive. Studies have shown that same farmer in the upland irrigated condition may grow improved varieties of wheat or paddy or other crops whereas in the low land flood plain conditions he may grow local varieties. Thus, the variable measuring progressiveness by the extent of acreage under new varieties is an invalid one.

The external validity implies the generalizability of the inference. Whether the relationship between two or more variables will hold good under other conditions cateris paribus. This is the crux in technological diffusion.

Characterization of the environment:

Every on farm research programme has to be preceded by an in-depth analysis of the climatic, soil, land use variables in addition to the socio-economic ones. As mentioned earlier, the ecological variables have been found to explain far greater variance in the choice of certain technologies in rainfed regions than the socio economic variables.

Compared to other developing countries India has a much better data base on rain fall, land use, soil fertility and other characteristics. But, at the same time, utilization of this data for identifying patterns in the climatic and edaphic variables has been very little. The status reports prepared under National Agriculture Research Project (NARP) did provide a basic information about the broad patterns in land use and micro environment characteristics. However, the characterization for the purposes of developing on farm research programme must provide for a decision tree analysis for various farmer groups. Such an analysis would help understand the range of available risk adjustment options all of which are not available simultaneously. Some of these options can be analysed only in a sequence where the choice exercised in the beginning influences significantly the choices available later on.

Several features may have to be included in the understanding of risk adjustment. For example, are there some niches problems of which do not figure in our current research programme at all? The methods of identifying research priorities often overemphasized the interest of the articulated sections of the peasantry. The studies have shown that articulation of the grievances or complaints or demands from backward high risk environments is far lesser than the developed regions per unit of area. (Gupta, Patel, and Singh, 1990). There is no better way of addressing the problems of disadvantaged social groups than giving greater importance to the easily identifiable disadvantaged areas, pockets or niches. To what extent, the household risk adjustment options depend upon public policies or group action ? Can such a group be involved in designing of on farm research programme ? To what extent the options given in table-one have been studied before designing various experiments?

Trade off under Risk:

The risk adjustment strategies include intra household, household, group and group level alternatives, besides, the public interventions. The sequence in which one option is preferred over another has to be documented but in dynamic manner. In Bangladesh almost all the on farm research programmes based primarily on IRRI's methodology began with survey of the existing cropping patterns. The trials were started to substitute crops varieties or component technologies in the most prevalent patterns. It was ignored that relative weightage of different patterns changed drastically in different years (Hossian 1987, Gupta 1987), given the changes in the location and time specific interaction between climate and soil, such mistakes will have to be avoided. In the short run the component technology trials can be appraised on the bais of cropping patterns. Research on developing ideal cropping patterns in rainfed regions does not seem promising at all.

The patterns of risk adjustments whether pre-sowing or during the crop cultivation should be incorporated in the component technology trials. For instance, in some parts of Eastern India and Basngladesh, in areas where water level is very high during the sowing period of monsoon paddy, farmers sow mix the paddy seeds of aus (April to July) and aman (July to October) varieties. Sometimes, when early floods damage the aman paddy the surviving plants are selected and replanted after cutting the tillers into sets, just like in sugarcane and sown afresh. A conventional research programme may ignore such practices for improving productivity. In specific niches where there is a good probability of such contingencies taking place, trials to add value to the farmers practices will have to be taken up in the years in which the situation so demands.

In certain places, if kharif crop has been sown late and good showers are received during September or October, farmers may like to harvest the crop as fodder and instead use the residual moisture for taking rabi crop (which may be more remunerative and better user of the available moisture). Such trade offs have to be monitored, inventorised, prioritized and incorporated into the design of on farm research programme.

Transferring Science rather than just the technology:

The characterization of environment would continue to be refined as the knowledge about the risk adjustment systems of the farmers is accumulated. In some of the cases where farmers have gained considerable experience, for example, in adapting sowing dates or fertilizer rates to local conditions scientists should merely make available the basic principles or the scientific propositions to the farmers. The design of the experiments and its implementation would be better done by the farmers and scientists would monitor the results, search for the patterns and feed it back to the farmers.

The characterisation of environment can be very helpful not only in targeting the technological trials, but also in disseminating the results. Thus, the extension messages would be tailored in some areas in the form of scientific propositions and in other areas as general rules. For instance, if sowing is delayed the number of paddy seedlings per hill and number of hills per square meter should be increased in the regions where paddy is grown on the receding moisture or where irrigation is provided by tidal waves. This is a general rule but it will have to be converted into a set of specific coefficients through on farm trials by farmers themselves or in consultation with the scientists. Extension messages will not be based on the coefficience developed at a particular site or at a station because such recommendations may not be applicable. With how much delay, how much increase in the number of hills and seedlings is optimal could also be deduced by monitoring farmers practices and deriving inferences through rigorous analysis.

Identifying problems for designing trials:

There has been considerable upsurge in the interest in rapid appraisal methodology for identifying farmers problems. Many-times research programmes in which one spent or planned to spend decades, "experts" advise spending only a few days or weeks for analysing the farmers problems and designing the treatments. There is nothing more unscientific and unethical than resorting to such methods or approaches for defining farmers' problems. The cost of errors in such quick diagnosis may be very high. Therefore, iterative and interactive methods of documenting resource use planning and management by the farming households through process learning case studies are recommended in this paper (Gupta 1981,'83, '86). By incorporating the conflictive or dialectical dimensions, we may even generate a healthy competition amongst the farmers and scientists in certain situations for identifying solutions. It is well known that many times farmers compete with the scientists and try to add extra inputs whether labour or material in the control plots to prove that they can achieve higher yields than the scientists. Rather than treating this as a case of wasted control one can through repeated dialogues identify the basic divergence in the hypothesis of farmers and scientists and pursue a competition in a sporting spirit.

Action learning or action research approach:

Researchers have also found that farmers some times may convey one set of problems while in essence they may be facing a set of totally different constraints. They either demand what they think scientists can supply or provide indifferent suggestions assuming that scientists were not serious either. Central Research Institute of Dryland Agriculture, Hyderabad tried an innovative way of sifting apparent from the real constraints (Sanghi,1987, Gupta, Singh, Sanghi and Nadarajan, 1989). They relaxed one by one each of the constraints that farmers mentioned as responsible for not trying a particular technology. They provided a tractor when farmers complained about draft power. They brought seeds when farmers complained about that as a major constraint. Scientists closely monitored the use of these additional resources and learned that farmers actually had totally different constraints which they were hesitating in sharing lest the scientists felt offended. Their problem was that the income they got from off farm work was more attractive than the increased income they could get by using the improved technology involving additional time, cost and labour.

The action research approach for defining farmers' problems with periodic feedback to the farmers about the inferences that scientists drew from the analysis of their behaviour could provide an operational framework in rainfed environments. Farmers should also be encouraged to provide feed back about the scientists behaviour. In an experimental watershed project, in Medak district of Andhra Pradesh, the farmers' response was poorer in the village the scientists spent more time than the village where they spent much lesser time. One of the reasons for scientists spending less time in that village was the demanding and argumentative nature of the people. The culture of complaince is often given more weightage by the scientists- belonging themselves to hierarchical and authoritarian organizations. The farmers who were not easily satisfied and also who asked many questions were generally shunned.

The institutional variables may be more important than socioeconomic variables in some cases. The process of acquiring data for defining farmers' problems is as important, if not more, as the technological trial itself.

Contrast analysis or manual discriminant analysis:

Manual discriminant analysis or contrast analysis (Gupta 1987. 1990) has been found to be an effective way of generating hypothesis for on farm research by comparing and contrasting the farming practices of the ouliers. After surveying the resource use practices in a given region one identifies the farmers with highest and the lowest ranking on a particular variable. Those who get highest yield or sow last or use minimum seed rate or apply fertilizer by only top dressing fertilizer are contrasted with those who do the opposite. One goes to the farmer who let us say get highest yield in a particular crop and ask questions about the farmers who get lowest yields. Once the higher achievers explain or hypothesise the reasons for low performers of other extreme group they are asked about their own practices. Such a dialogue provides a list of ecological, agronomic, economic or management related hypothesis. These hypothesis can be short listed and universe of each of these can be ascertained by a quick survey. The most important ones then could be taken up for trial along with appropriate contingency treatments.

It may be added here that same farmers some times may follow very different set of practices in the same crop on one set of plot vis-a-vis another. Therefore, a very common error in most household surveys of asking details of the practices crop wise rather than plot wise should be avoided, A farmer does not apply inputs to a crop but to a particular plot having that crop. In the same crop but in a different plot, having variable residual moisture and fertility conditions farmers may use a very different set of practices. The conditions of internal validity are violated in the case of trials based on crop wise surveys rather plot wise surveys.

Developing technological recommendations also depends upon the analytical approach used in designing and implementing on farm research. For instance, if the impact of micro environmental variables is ignored it is unlikely that recommendations would be made in such a manner that farmers could tailor them to such environmental niches.

After pursuing the first Ph.D thesis on farmers indigenous innovations in dryland regions, Hira Nand (1979) suggested that fertilizer recommendations should be made with the help of a ready reckoner. Farmers could locate major determinants on X and Y axis and identify the range or the combination of different inputs suitable for their conditions. For instance, our studies have shown that in some of the rainfed regions farmers make a trade off between two poor crops and one good crop by keeping the other season fallow. The fertilizer recommendation which would be economically profitable and scientifically judicious would vary a great deal for both these conditions. However, if the fertilizer trials were performed and evaluated on the basis of single season and single crop the faulty recommendations would continue to be made. The appraisal of the trials should be on system basis even if experiments are based on a single season basis.

Incoporating gender concerns :

The identification of farmers' priorities also depends upon the socio-cultural conditions and the gender dimensions of survival systems. In large parts of drought prone regions and hill areas, male workers migrate away for part or full season or year.

In such cases the choice of technology may considerably be influenced by the resources, capabilities and status of the women or the old people left behind in the region. While the role of women is important, it is certainly more important in some regions than others. On farm researchers have often underplayed location specific differences in the contribution of women to farming or cropping systems.

The role of women as an intellectual or as a knowledge worker has not been appreciated adequately. The studies on time task allocation to find out the importance of womens' contribution were useful in 70s but have no place now. The important contribution that can be made by incorporating gender dimension is to look at the knowledge which is unique to women workers. In bangladesh it was found that sweet potato was a class specific commodity in uplands and eco specific in the riverine/char lands (Alam et al 1986, Gupta 1986). In the upland homestead conditions large number of poor families could not afford to consume paddy. Sweet potato was a staple food for part of the year. Women grew the nursery of sweet potato vines on small patches of land available near their huts. If the land on tenancy was available, the vines were cut and transplanted but in case such lands were not available, the nursery became the small crop. It was observed that women practiced derooting of the wines at the nodes. When we asked ~~the~~ women about the reason, we were told that fewer roots meant that tuber was round and thick skinned. The round shape improved the consumer preference when women brought such tubers to the market. And the thickness of the skin influenced the storage life improving thereby bargaining power of the seller in the market. This knowledge we could not have obtained by talking to the man farmers. At the same time the formal research programme on sweet potato at CIP and local research institute in Bangaladesh had no mechanism for acknowledging and incorporating such knowledge peculiar to women in their on station and on farm research programme.

Likewise, in a study by the women scientists pursued by more than two dozen lady scientists from different disciplines at that Bangaladesh Agriculture Research Institute, a large number of innovative practices developed by the women were identified. (Gupta 1987; Gupta, Abedin, Haque, Dilruba, Nadira and others 1986). Unfortunately the analysis of these practices was done only by the male scientists. In rainfed regions gender issues can be better appreciated if the scientific and technical knowledge unique to women is made the first building block.

The priority of research may also vary depending upon who are consulted and with what understanding. For example in above study on homestead utilization, it was noted that water was very scarce in the winter. The scientists thought this water could be utilized for growing vegetables and fruit trees. Women considered alternative use of this water for drinking and bathing of the animals and other domestic purposes more important than for growing vegetables. In any case, both men and women among the poor families had to go out to the irrigated farms in winter for doing wage labour. The protection of vegetables thus became difficult. In addition a conflict could arise when the poultry birds maintained by the well off families intruded in the homestead of the poor families and damaged whatever little vegetable cultivation existed. The context in which poor women lived was in this case quite different from the context of rich women.

Validation of Research Programme and getting farmers involved:

The perception of the scientists and that of the farmers - man and woman - may vary. Sensitivity to variation of this kind can be developed if research programme for any on farm research unit is validated separately with male and female farmer groups. In some cases differences can arise if the validation is done with the old and the young farm workers as well.

It is possible that the priorities of well endowed rich farm families may vary from the priorities of the disadvantaged groups. However, this would not be the case by definition in all situations. Nevertheless, scientists should ensure that the experimental programme gives weightage to the conditions and constraints under which disadvantaged groups work. Inter-household disparities in the arid and semi arid dry villages may be lesser than the irrigated households, other things being equal.

There would be little purpose served by sharing research program with the farmers if the results of the previous experiments are not shared. Scientists complain that the farmers may not be able to understand the complexity of the experimental design. They often fail to show empirically to the farmers what they have learnt from the previous experiments in the farmers fields. When the scientists show to the farmers how they have modified the research programme in the light of farmers' feedback as well as the results of previous experiments, the farmers begin to appreciate the sincerity of the scientists' purpose and participate more actively.

It should also be explained to the farmers that what scientists were trying was something <u>different</u> not necessarily <u>better.</u> The possibility of failure should be made explicit. Studies have shown that farmers do realize that experiments even when pursued by them in their own conditions can fail (Richards, 1985).

Several ethical and value dilemma become apparent in the process of validating research programme. Scientists have to sometime make judgment about the interest they have to serve and espouse. Like any other sub system of society, scientists also are conflict-ridden. Some would concentrate their on farm research and trials programmes on the fields of well endowed farmers. At the same time there would be others who would do the opposite. The peer culture of the scientists can generate pluralism if some of the less likely biases are monitored at the higher level.The presence of contingency treatments may also demonstrate whether or not the biases exist in the programme toward disadvantaged households and the regions.

Evaluation of on farm research programmes:

Collinson (1987) has discussed several problems faced in this regard. For instance, scientists have to decide at what level of significance should the statistical results be accepted? Whether marginal analysis should be used exclusively to make recommendations? How should the institutional and policy variables be included in the analysis of experimental results and generation of technological recommendations? Answer to these questions is not easy. However, we list below some of the additional factors that can be kept in view while evaluating trials/research experiments or research programmes:

a. There are several channels through which the communication takes place between scientists and farmers (See Annexure 1). The scientists do not learn about the farmers' problems only through on farm research. The contradictions between the priorities emerging through different channels should be discussed in the research priortitization meetings of the scientists. For instance, the articulate farmers may demand similar solutions whether at the on farm research site or through letters/personal contacts. On the other hand, the illiterate disadvantaged tenants or small farmers may not always visit the university or research centres. On farm research may be a more effective means of reaching and hearing them. The results of on farm experiments should include evidence on (i) the feedback received from different socio-economic groups (ii) the feedback received from and given to the on station research scientists and (iii) the bearing of the results on the design of future on farm and on station research programmes.

b. To what extent the design of experiments was modified in the light of environmental variations. Also whether coping strategies of the farmers with the unexpected environmental contingencies were recorded by visiting the experiments during or soon after such contingencies. The absence of such data is one of the most conspicuous weakness of the on farm research programme in most countries. Part of the problem arises from the lack of involvement of the scientists themselves and greater reliance on field assistants for collecting data. To some extent this also happens because the work load is too heavy or the conceptual framework for collection of data does not provide for monitoring farmers' coping strategies. Sometimes the results are extremely flawed because the 'treatment' a farmer provided after hailstorm, strong winds, snap floods, etc., may remain unrecorded. In a few cases the farmers' practices are recorded in isolation of the on going research programme. Not all contingency treatments can be experimented at the farmers'fields. The close linkage with on station research programme is thus very vital.

c. The reactions of the farmers should be collected not merely after the harvest of the experimental plots but also at various critical growth stages. The variance in the outcome may be explained by some of the changes noted at the earlier stages.

d. The results of the experimental plots are sometimes compared with the average of farmers' yields at a larger number of plots. The control yield thus are by design lesser than the experimental yields. The selection of controls, variation within the controls across replications (each farmer often is one replication) and the difference between each replication and its corresponding control have to be looked into in addition to the usual variance analysis. More than the hard data the farmers' hypothesis about various sources of variability are the more important gains of on farm research.

e. Very often more time is spent in collecting data on variables which are usually monitored in on station research. The results is that the time available for collecting any other data is very limited. The research programme should include clear statement about the data not to be collected just the way the data to be collected has to be specified.

f. In most of the on station as well as on farm experiments in rainfed regions data are collected about the entire biomass. However, the results are interpreted generally in terms of only grain yield. The information on fodder yield and quality as well as other residues is not taken into account. While it may take time for an on farm crop research programme to evolve into farming systems programme, the evaluation of experimental results according to the farmers' criteria could certainly be incorporated. In my view , the first step for transition of a cropping systems programme into a farming systems programme is the evaluation of cropping systems results according to the linkages with the entire farming and sometimes the livelihood systems.

g. On farm research programmes in the villages located near cities have suffered because the gains from the technology for rainfed regions are many times far lesser than the gains from operations in urban labour market. Under such circumstances, little purpose is served by concentrating one's efforts on on-farm research.

h. Farmers' own innovations can form a useful building block of on farm research programmes. If the reports of the research on farmers' fields do not include any reference to farmers' own innovations or experiments, it is unlikely that the programmes would become sustainable in the long run. Because such programmes would not evoke durable farmers participation.

Part-Three

Summing up

On farm research programmes involve very heavy manpower and material cost. Given the precarious situation on balance of payment front in most developing countries, a judicious appraisal is called for before starting or expanding any new programme. Donor agencies often encourage fast expansion so as to show higher achievements. It is ignored that the staff hired on such projects may have to be absorbed in the public systems after the termination of the aid. The result is the poorly funded programmes become more and more starved of incremental funds. In any inflationary environment increase in the public expenditure makes the conditions of the poor farmers and labourers even worse.

It is necessary that host agencies recognise the pitfalls of falling prey to easy aid for poorly conceptualized on farm research programmes.

Thanks to a strong academic base in India such dangers are less serious. But, one cannot totally ignore this fear. I, therefore, suggest that before starting or expanding any new on farm research programme, the leader of the research management systems must answer following questions:

a. Whether the feedback being received from the farmers directly at farmers fairs, field days, scientists visit to the farmers' fields or farmers visit to the research station, etc., is properly catalogued and made use of? Likewise, whether the data on farmers' communications through indirect routes are made use of adequately? If the questions asked by the extension workers at the training programmes are not documented and forwarded to the respective research teams, there is hardly any justification for collection of new data from the farmers about their problems or possible solutions.

b, Whether the data of the ongoing on farm trials or demonstrations is fed back to the farmer groups and to what extent the feed back of such groups is available in documented form?

c. To what extent the design of research programmes at regional research stations is linked with the characterization of the environment available in status reports prepared under Nationala Agricultural Research Project? Whether on station research programme has been modified, stopped or started on the basis of the feed back from extension workers, on farm research programmes and scientists own judgment in the matter? If the experimental programmes continue to have **additions without subtraction**, the quality of the programme is bound to decline.

d. Whether existing extension messages incorporate the contingency measures for risky conditions available from prior on station research? Sometimes, the less fashionable but more effective non-monetory technological messages are given less importance by the extension workers. If on farm research is aimed at generating such low cost and low external input solutions, the results are unlikely to be used if existing knowledge in this regard is discounted.

e. To what extent the senior scientists send feed back on the research reports prepared by the junior scientists located in regional stations or in the farmers' fields under operation research projects? Further, whether junior scientists are encouraged to critisise the research progrmmes developed by the senior scientists at the research station or in on farm research programmes? If the vertical accountability within the formal research system among different levels and constituents is weak, there is no way in which horizontal accountability between farmers and scientists would ever evolve (Gupta, 1987).

f. To what extent the linkages between research and extension are tailored to the various socio-ecological conditions? As illustrated in annexure 2, different strategies would work under low and high risk environments. If such a contextualization has not taken place, it is unlikely that future on farm research programme would be linked with extension system any differently. The research in building these linkages unfortunately has not progressed much. Before new solutions to the existing problems are generated the research on disseminating after adaptation the existing solutions should be evaluated.

Once these questions have been answered, the content, scope, scale, cost, etc., of the future on farm research programme can be more realistically estimated.

I have suggested that the methodology for on farm research programme should be modified to accommodate the perception of and response to the risks by the farmers. Since risks do not arise only because of environmental conditions, but also emerge from market and policy interventions, the research programmes should include a systematic appraisal of these risks. It should be clearly stated that certain types of policy risks cannot be faced through technological solutions. Also scientists should not always take the institutions as given because in the process one may reinforce them. The on farm researchers thus have to raise issues about the institutional conditions which would favour development and dissemination of low risk technologies.

It would be useful to recognise that the advantage of clustering of experiments at a site (Collinson, 1987) are far lesser in rainfed regions where the ideal niches for different technologies would vary. Identifying such niches through ecological mapping may be one useful way. The agro-eco system analysis (Conway,

1987) can be pursued along with many other complementary approaches.

The design, monitoring and evaluation of experiments on farmers' fields in rainfed environments require modification of basic conceptual approach developed by international centres. The rich experience of various programmes in the country involving experiments on the cultivators' fields, lab to land, operation research project etc., should be drawn upon.

Farmers' own innovations and indigenous knowledge systems offer a challenging opportunity for collaborative research to extend the frontier of science and develop sustainable technologies. In this regard the pioneering work started by Dr.Y.P.Singh, way back in mid sixties provides a useful starting point (Verma and Singh, 1969) . The term 'resource poor farmer' should be avoided so that knowledge as a resource is not discounted while designing on farm research programmes.

The targeting of trials and emerging analysis requires understanding the socio-cultural and institutional context of household decision making in rainfed regions. I have argued elsewhere that portfolio approach should be used to analyse the interactions between different economic and non-economic activities of disadvantaged households (Gupta 1990). The risk adjustment strategies vary systematically over space, season, and sector. The social stratification and gender aspects also are modified considerably by the interactions between ecological, edaphic and economic conditions (Gupta 1990).

The ethical basis of building mutually accountable relationships between farmers and scientists should be made explicit. The on farm research in Indian context can be strengthened only if it is seen as a part of overall research management systems. Any attempt to make it a departmental activity would marginalize its' scope. It should be realized that not all solutions to farmers' problems can be generated through farmers' participation or research on farmers' fields. On farm research has to complement the on station research.

The problems of rainfed regions require massive investments in strengthening well dispersed regional research facilities. A net work of on farm research experiments around these stations needs to be built up. Since most of the problems in rainfed regions require coordination among larger number of farmers, a group based experimental approach should be developed. This will require identifying farmers associations wherever they exist and building experimenter's groups wherever association do not exist. The teams of the farmer should visit and audit experimental designs and results in close consultation with the scientists.

Wherever possible the on farm research should be based on micro watershed planning so that inter linkages between different sub systems of a watershed could be eventually forged and strengthened.

The on farm research like any other research should be pursued rigourously if useful results have to be obtained. The experience of international centres in dealing with the problems of high risk environments is extremely limited, notwithstanding the claims of donor agencies. There is a need for eminent scientists from various disciplines to review the lessons both conceptual and operationally learnt from earlier programmes in the country. Sustainable technologies cannot be built without having a sustainable institutional frame work. Sustainability of institutions depends upon the ability of the society or a professional group to build upon indigenous knowledge system and provide for debate and discussion on various conflicts that would emerge in any process of change. K.M.Munshi had spoken about the relationship between the spirit and soil while enunciating his concept of 'land transformation'. The on farm researchers would benefit if they would pursue "The Gospel of Dirty Hand" that he put forward 40 years ago. It was much before the interest in on farm or farming systems research had even began to be taken in western countries. Can the development and dissemination of sustainable approaches for on farm research in rainfed regions begin with a proper understanding of historical experience?

The answer would depend upon the determination of the scientific community,research managers and policy makers who will then have to start listening downwards and practice The Gospel of Dirty Hand.