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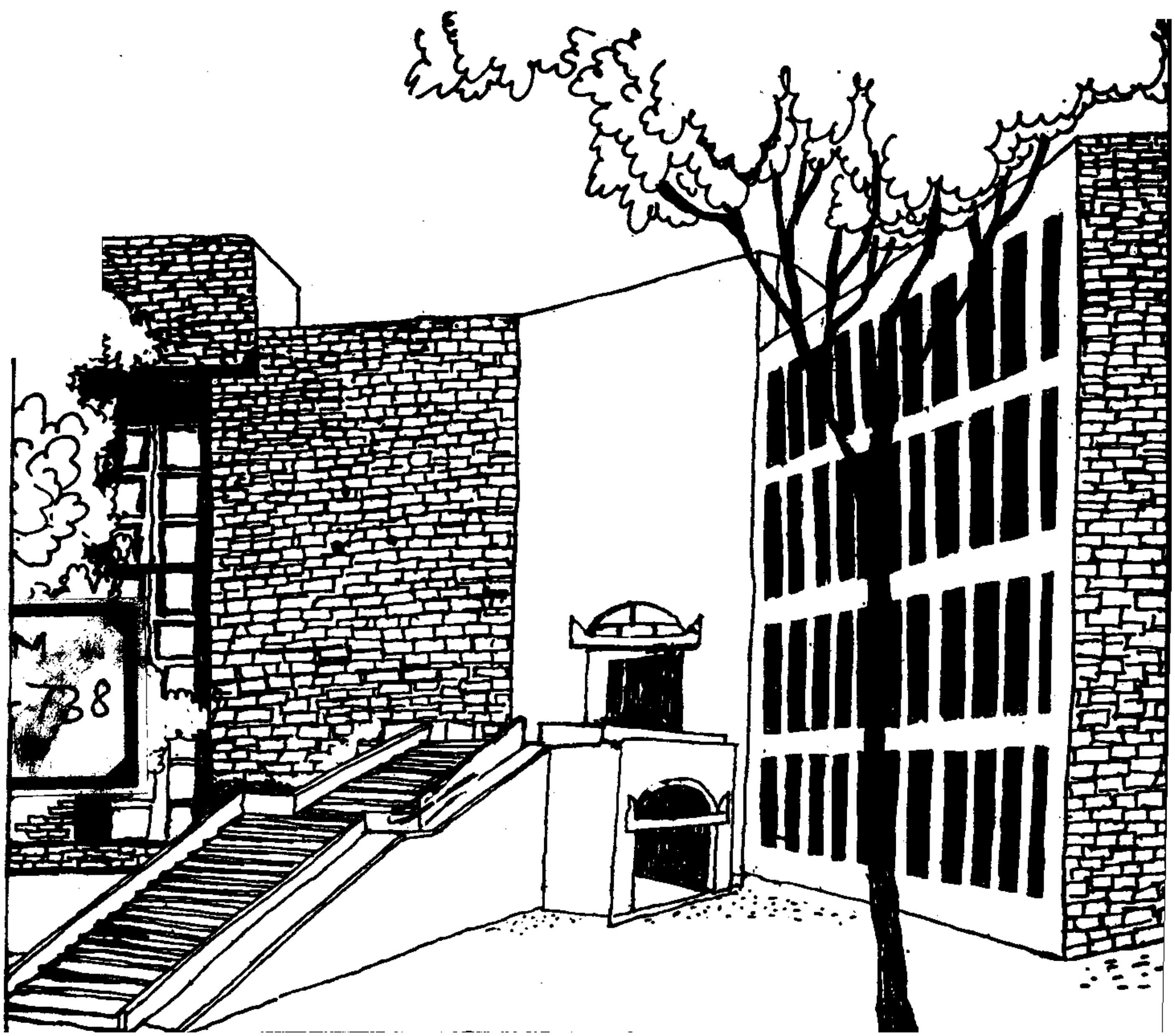

# SURVIVAL UNDER STRESS: SOCIO ECOLOGICAL PERSPECTIVE ON FARMERS' INNOVATION AND RISK ADJUSTMENTS

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Preliminary Draft

# SURVIVAL UNDER STRESS: SOCIO ECOLOGICAL PERSPECTIVE ON INNOVATION AND RISK ADJUSTMENTS

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# Survival Under Stress :Socio-Ecological perspective on farmers' innovations and risk adjustments


## Abstract

Need for closer interactions between natural scientists and farmers to generate relevant technologies is being increasingly recognised . The uniformity of ecological endowment and its correspondence with conditions at research station did not call for reorientation of research strategy for irrigated regions However, in rainfed regions ,we argue in this paper ,there is a need to understand farmers' adjustment with risks as well as their experimental ethic.

Drawing upon Chinese knowledge dating back to First century B.C.,recent evidence from Bangladesh and India ,it is suggested that natural scientists should initiate systematic documentation and experimentation on farmers' oen knowledge system . It might on one hand expand the frontier of natural sciences and on the other make value addition in local knowledge possible .
Knowledge generating systems in high risk rural areas should not be converted into just knowledge receiving systems .
Further ,transfer of science rather than only technology to people should be emphasized in future so that formal and informal R&D can reinforce each other

# SURVIVAL UNDER STRESS: SOCIO-ECOLOGICAL PERSPECTIVE ON FARMERS' INNOVATION AND RISK ADJUSTMENTS

It has been well recognised that it did not matter much if the natural scientists did not interact with the farmers as long as they were developing technologies relevant for ecologically more uniform and well endowed conditions such as irrigated plain areas. However, it is obvious that simulating on research stations conditions akin to wide variety of production environments under which people try to survive in high risk environments is extremely difficult. As a result, most national and international centres of agricultural research recognise the need for on-farm research. Linking the context in which farmers work and the context in which scientists work at station or at farmers' field requires precise understanding of (a) the risk adjustment (RA) mechanisms evolved by different classes of rural producers historically in a given socio-ecological context and (b) the repertoire of experimental ethic existing amongst the farmers and their groups.

In this paper we first present the socio-ecological paradigm in which household adjustment with risks can be studied in a multi enterprise, multi market context. In part two we *discuss the institutional aspect of research on farmers' R A mechanisms. In part three we have presented a framework in which* the local/indigenous technical knowledge and the experiemental process of generating this knowledge can be linked with the formal research processes. Empirical examples drawn from historical studies in India, China and other parts of the world dating back to second century B.C. are presented. Finally a case is made for natural scientists to consider research on indigenous knowledge systems as a necessary compliment of the formal laboratory research. It is hoped that plant physiologists would find the innovations evolved by the farmers with regard to survival of crops/trees in high risk conditions worthy of formal testing before rejecting or accepting any innovation.

At the outset, we must state our assumption that the farmers' experimentation cannot be the only prime precursor of generating new technologies. The role of scientists in anticipating future needs of marginal farmers and generating technological options will always remain. What we must add however, is the extraordinary contributions that indigenous knowledge of the peasants can make in generating atleast a few <u>new</u> relationships amongst <u>old</u> variables. Some contend that if there was all the alleged strength in farmers' own experimental repertoire, why would these have been so many famines in olden times. Our reply to such a comment is two fold;

(a) famine induced distress was not always caused due to net decline in food availability, a thesis quite popular now; the political economy of 'entitlements' that people lose may make all the difference;

(b) over the years, the excessive emphasis on 'lab-to-land' approach has reduced the appreciation in the minds of the scientists about farmers' own risk adjustment strategies involving combination of efforts in relation to crop, livestock, craft etc. Moreover, massive relief-oriented policy of providing succour to drought affected people also weakened their self/reliant potential. Instead of strengthening markets, public delivery systems and local R & D in such regions, we have relied on using such regions as a cheap source of labour (NCDBA, 1981).

We thus hope that arguments in this paper would be seen in the light of mutual learning that is possible by linking formal and informal R & D (Biggs, 1981) rather than one substituting another.

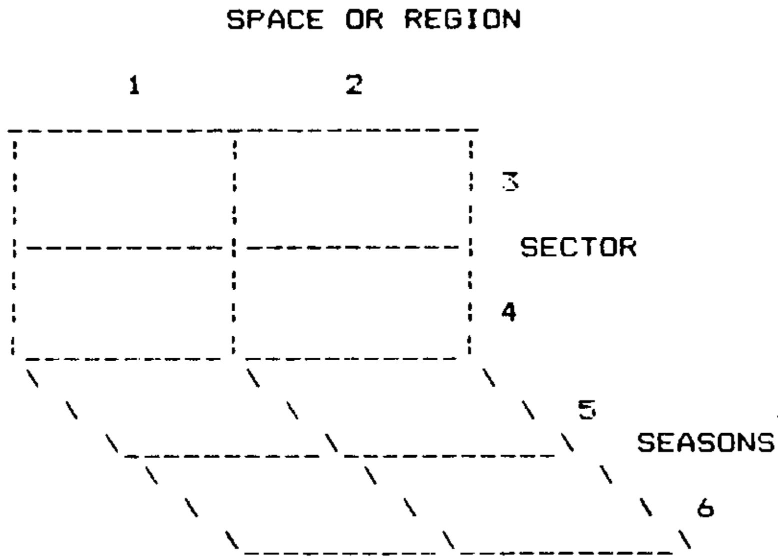
Part I: Socio-ecological paradigm for household survival under risk.

Several studies on the subject of farmers' adjustments with risks have shown a multi market multi enterprise approach to survival (Jodha 1975, 1979, 1985, Gupta 1981, 1986, 1987, Spitz 1979, Wisner 1986, Torry 1986, Turton 1985). A review of several of these studies is presented elsewhere (Gupta 1984, 1987). Here we first define the terms that we are using and then discuss the socio-ecological perspective.

The multi market approach implies that farmers tried to adjust with the risks through simultaenous operations in factor and product markets. The factor markets imply land, labour, capital, information etc., the product markets imply crop, livestock, tree etc., including various technologies of land water use. Higher the amount of risk in the environment greater is the dependence between the decisions made in one resource market with the other. This is not to say that these links are not important in developed regions. The difference is that many imperfections in respective markets in the developed regions can be ofsetted through market mechanisms.

The multi enterprise framework implies that farmers adjustments with risks cannot be understood by concentrating on any one enterprise such as crop, livestock or tree at a time. The four S model linking Space, Season, Sector and Social stratificiation given below will further clarify the multi enterprise focus.

Each dimension can be dichotomized for ideal typing purposes. For instance, a "space" can be dichotomized in terms of population density, or low lands and high lands, or undulated and plain topography, etc. "Sector" can be dichotomized as agriculture or industry; public or private; specialized or diversified; single crop or diversified crop region; cash crop or food crop dominated asset portfolio, etc.




"Season" can be dichotomized into unimodal or bi-modal rainfall regions, arid or humid, low rainfall or high rainfall, low seasonality or high seasonality region, etc.

Given any two parameters the third can be anticipated. For instance in a region with low population density and high seasonality (ie., low rainfall) the sectoral characteristics are expected to be highly diversified. Instead of single crop farmers may prefer next or inter crops. Likewise households rather than being depended on any one enterprise such as crop, livestock, trees or labour etc., may simultaneously pursue many of these activities at the same time. The social stratification in such regions is expected to be quite different compared to the regions with high population density, low seasonality and specialised sectoral activities involving only one or very few enterprises. In the former case households to hadge risks may draw assurances from kinship and extended family networks. Thus we may find in high risk environments preponderance of non-monetary exchanges, pooling of bullocks, implements etc. In this manner the farmers try to deal with differential demand for draft power or inputs in different villages or plots at different points of time due to erratic nature of rainfall through informal social and economic networks.

As we will see with the help of socio-ecological paradigm illustrated in Fig.2 the interactions between space, season and sector generate range of choices which are not equally available to rich and poor farming households. Understanding of these differences may help the natural scientists in developing technologies which will either be amenable to easy adaptation by the farmers or will make minimum demands on the system in the short run. In developed region no such constraint is needed to be taken into account because of strong market forces. Therefore, if a technology required several inputs simultaenously and in a particular proportion, it would not be difficult to organise that

The plant architecture cannot be divorced from social and institutional architecture evolved in a given region in a historical context.

The socio-ecological paradigm involves essentially two assumptions: (i) ecology defines the range of economic enterprises that can be sustained in a given region. (ii) the scale however, at which different classes of rural producers managed each enterprise depended upon the access of the households to factor and product markets, kinship networks, public and other relief mechanisms, common property resources (such as common grazing land, water tank, tree groves etc).

The portfolio/bundle are mix of enterprises which so evolved in a given ecological region resulted in specific production conditions. These conditions could be understood with the help of mean and variance matrix as shown below:

Mean Return

| Variance | Low | High |
| --- | --- | --- |
| Low | Low varieties of Millets, Cattles, long gestation multi-purpose Tree species etc. | Maxican varieties of Wheat, well adopted small scale vegetable cultivation. |
| High | Pulses, Oilseed crops, sheep herd etc. | Crossbred cattle, Hybrid varieties of Millets, Cotton, other cash crops etc. |

It is obvious that household having portfolios with low mean productivity with high variance in output would be most vulnerable. Historically the extent of poverty has often been most intense and deprivating in such regions where low mean high variance is the dominant characteristics of the portfolio. We will discuss later in third section how the survival under such conditions of high risk involved experimentation and innovations by the farmers.

Reverting back to the S-E paradigm we noticed that the time frame and the discount rate chosen to appraise the investment choices depends upon a) the portfolio characteristics, b) the access to kinship networks c) access to intra and inter-household risk adjustements d) communal and public R A options. The time frame has a bearing on the sustainability of a technological choice. Shorter the time frame in which households or even the scientists appraise their choices less likely it is for technology to be sustainable. The discount rate indicates the way future returns from present investments would be converted into a net present value. The more uncertain the outcome higher may be the discount rate. The certainty itself may depend upon a) the previous experience with a particular enterprise/crop b) immediate past experience c) successive losses or gains d) accumulated deficit or surplus in the household cashflow e) future expectations of returns f) the complementarity between other assets/enterprises and the proposed investment etc.

The intra-household RAs include asset disposal, migration and modified consumption. Inter-household imply tenancy, credit, and labour contracts. For further details see Jodha and Mascarenhas (1983). The communal RAs include reliance on common property resources. The public relief mechanisms include employment programmes as well as aerial pesticides spray against pest or disease epidemics.

The result of various RA strategies available to different classes of households may reflect in some households having deficit/subsistence in the budget while others having surplus in the budget. This would have a bearing on the stakes different classes have in the sustainable ecological balance in the given region. This would finally feedback as shown in Fig.2 into the portfolios of economic enterprises evolved by different classes.

The purpose of above discussion is to understand the macro (4-S model) and micro (S-E paradigm) context of household decision making in high risk environments. This will provide us basis for analysing the institutional contexts in which research on peasant innovation may or may not be done. This will also help us relate the principles of homeostasis as evolved in plant physiology and the S-E systems.

Homeostasis:

The plant physiologists generally define homeostasis at two levels: a) developmental and b) physiological. The former deals with adjustments made by plants at different stages of growth while the latter refer to the concurrent adjustments at any particular stage of growth. Likewise farming households can make adjustments concurrently or overtime depending upon the nature of contingency and their repertoire of risk adjustments.

Institutional Context of Research on Farmers' Risk Adjustments:

The detailed evidence with regard to this aspect is presented elsewhere (Gupta 1987a, b). We summarize here some of the most important findings which may be of interest to the natural scientists in so far as these may influence the future resource allocation in this direction.

Way back in 1941 Dr. Saver recommended, "that the improvement of the genetic base of agricultural crops be predicated on an understanding of the relation of such work to the poorer segments of the society" (Dasa and Jennings 1983:34). In India more than two decades ago Dr. Y.P. Singh pioneered two of the earliest studies aimed at unravelling the traditional farming wisdom in context of animal husbandry practices. A decade later another study was initiated to understand the indigenous dry farming practices. Review of post-graduate thesis in five disciplines from more than two dozen universities and colleges during 1973 to 1983 did not reveal any other research on similar subject. Perhaps the contempt for farmers' knowledge is far too deeply embedded in the very structure of formal research institutions. Some of the important factors influencing perception of farmers' practices may be summarized here:

a) Eventhough considerable body of knowledge has accumulated on link between formal and informal R&D (Biggs and Clay 1981, Gupta 1980, 1981 Richards 1982 Rhoades 1984, Chambers 1985, 1987, Verma and Singh 1967, Hiranand 1979, Bush 1984, Collinson 1985 etc). Still the formal scientific institutions consider research on farmers' practices/survival strategies as something non-glamourous. Perhaps the peer pressure, the monitoring system in the research bureaucracies, the norms of accountability of the scientists towards various constituent and inability of majority of social scientists to act as bridge between farmers and the natural scientists may all contribute towards this problem.

(b) There has been an excessive bias in the technology generation process towards individual household oriented alternatives. The common property resource oriented solutions have generally been negelected. For instance if cooperation in terms of sowing time of a crop could influence the pest build up and eventual intensity of crop damage then research on such alternatives could take precedence over individual level pest control. Even otherwise pest cannot be controlled at individual level efficiently in the long term. Likewise soil and water conservation and consequent availability of moisture at critical stages of crop through common property resources such as farm, ponds or other means of watershed management call for collective choice alternatives. Historically there are examples of such cooperation amongst farmers for a specific technological alternative (also see Swaminathan, 1973, 1976).

(c) It has been shown that single disciplinary research could deliver some results when technologies for low risk and well endowed irrigated regions were to be developed. However, the need for inter and cross disciplinary research for dry-farming areas does not need to be emphasised. The management principles which determined or influenced the formation of teams around riskier problems may not be same as would be the case for easily predictable or less risky problems. How do we build teams to work on farmers' problems when division of responsibility cannot be very precise along disciplinary or functional boundaries ?

(d) Another implication of crop-livestock-tree interactions is not only to have convergence in the breeding and other technological objectives but also to take into account the farmers' survival options while giving primacy to one or the other consideration. For instance studies have shown that. "present trends in plant selection may be by-passing two important trade off in the objectives of the farmers i.e., fodder content or cereals or millets and lignin content of cereal stalkes which, affects biodegradation in the soil and has implications for soil fertility" (McDowell Robert, 1986). Likewise recent studies have shown that most of the technologies even in dry-farming areas are appraised only on the basis of grain yield rather than on the basis of both grain and fodder yield and quality. The data is indeed collected on the entire biomass but is not used for the purposes of screening the lines.

(e) The purpose of extension in most agricultural universities has become merely to extend knowledge from lab to land rather than vice-versa. Our contention is that given the weak social science departments in most agricultural research institutions there is no substitute to the direct interactions between natural scientists and the farmers. We also believe that biological scientists can learn the social science concepts far more easily than otherwise.

(f) It has been found that the socio-economic class background of the scientists has some bearing on their perception of the farmers' problems. Our contention is not to suggest that scientists with well endowed low risk backgrounds would not be competent to do research on problems of small farmers in high risk environments. However, what we are suggesting is that tendency on the part of such scientists is to consider basic problem lying with the farmers, banks, extension systems rather than with the technology itself. The implication is that reorientation of research priorities would require taking note of these word views so that alternative perspectives can be better argued. In general, for more scientists perceive farmers' innovations than the ones who decide to work on them.

The scientific context of research on farmers' innovations as demonstrated by several colleagues in different parts of the world somehow is considerably biased towards certain tools and techniques. As Richards suggests scholars sometimes are guilty of presenting peasant knowledge as practice without theory (1983:15). In a historical account of Indian Science and Technology in eighteenth century it was noted that many of the scientific discoveries being made in Europe were preceded by the actual farming practices based on the same principles in India. (Walker, 1820 in Dharam Pal 1983). What are the processes which snapped the link between technologies evolved by the farmers and the researchers who tried to derive scientific basis of the same? Why did the formal research systems in developing countries neglect their own reserve of ancient peasant knowledge? Is it not possible that farmers sometimes may do right things for the wrong reasons? If so, how do we discriminate ritual from rationality? Is there no comparative advantage in tropical countries with so-called backward agriculture in high risk spaces?

In the next section we review some of the contemporary as well as ancient practices evolved by the farmers in high risk environents. This may help us in re-initiating a process of reverse transfer of knowledge and concepts. This may also help in building bridges between what farmers know and so demand and what they do not know and therefore cannot demand. We have argued elsewhere (Gupta 1987a) that no farmer had demanded dwarf wheat simply because they never knew that such a plant type was possible. The role for supply side interventions by the scientists cannot therefore be ignored or under-played. At the same time what we are suggesting is that in high risk environments because of complexity inherent in the farming systems the close interaction between scientists and farmers may be far more productive and efficient.

Perception of Peasant Innovations:

In a recent paper (Gupta 1987c) we have tried to understand the barriers to scientific curiosity with regard to perceiving the peasant innovations but not subjecting them to scientiic/formal scrutiny. While arguing for transferring science and not just the technology to the farmers we have suggested the need for abstracting science underlying farmers' practices. Any value added to such knowledge when transferred back would have far greater diffusion potential. The problems of classifying the peasant innovations and building a theory of innovations for survival vis-a-vis innovations for accumulations are beyond the scope of this paper. We, however, review some of the practices which to our mind hold the key to the issue of survival under risk through experimentation and innovation.

Chinese knowledge in first century B.C. and the sixth century:

Extremely rich account of farmers' knowledge existing in the first century BC (Sheng-han, 1963) and sixth century (1982) provide instances where research on peasant innovations may extend the frontiers of science if pursued properly. We summarize some of these practices derived from these two sources without detailed comments hoping that readers would consider this evidence worth reflection and pursual.

1. To get drought tolerant plants the seeds of the cereals could be mixed with a paste of excrement of polyvoltine silkworms with melted snow. "after five or six days when the excrement becomes well softened rub it between hands." (1963:13).

2. The treatment of seeds in extract of certain types of bones from which a decoction is obtained helps the seeds withstand stresses better. In case the described bones are not available the boiled steep of silk reeling basins may be used. When the rains fail in the sowing season of wheat, treatment with sour rice drink (lactic fermentation of cooked rice steep) may help the wheat become drought resistant while bombyxine excrement may help in the wheat cold tolerance.

   While commenting upon practices of these types Sheng-Han (1963:59) suggests that high content of calcium carbonate in bombyxine experiments is mixed with lactic and acitic acids produced in the process of fermentation of sour rice - grain. These acids dissolve the calcium carbonate forming solution of calcium salts of organic acids. Drawing upon the work of Prof. Henckel (of the Timiriazeff Institute of Moskow) it was found that wheat corn treated with a solution of CaCl2 enhanced the drought resistence of wheat seedlings. The author has suggested that prescription by Sheng-Chih of treating wheat corn with organic calcium salts given in first century B.C. might have the same effect.

Further the seed treatment rather than the soil treatment has been analysed from another angle also. It is noted that excrement of silkworm was very hygroscopic. While sowing the seeds of millets side by side with excrement of silk-worms it was thought that soil in the immediate vicinity of the seed might get enriched by moisture through vapour condensation from atmospheric air. This might improve germination ability. Further it is added that bombyxine excrement contained quite a good amount of easily available potassium, nitorgen and phospherous together with auxins and vitamins derived from mulberry tree leaves and a host of microbial action. Perhaps under suboptimal temperature and humidity such an inoculation of microbes and the nutrients in the darkness triggered the physiological activities. Perhaps the temperature and the moisture would then rise to the optimal level. The soil surrounding the seeds is expected to undergo changes favourable to the growth of the young radicula.

The author has critically analysed the significance of melted snow as a substitute of bone decoction while treating the seed. It is noted that in the arid north-western China, water from the river and particularly from the well was heavily charged by soluable salts present in the soils. Perhaps the Sodium and Magnesium salts available there might have some undesirable effect on the soil macrobes and the seeds. The melted snow would obviously have far lower content of salts and thus be devoid of harmful ions. The author has strongly recommended further experimental tests of these speculations.

3. The bombyxine excrement when mixed with seeds of spiked millet is assumed to protect the millets from insects and pests.

4. To prevent the frost injuries in spiked millet it is advised to look at the night temperature 80-90 days after the sowing. If frost or white dew was suspected, two persons facing each other could drag a rope horizontally right through the crop to remove frost or dew. This should be stopped only after the Sun rise.

Interestingly precisely this practice of taking a rope or even a bamboo pole through the nursery of paddy in the early hours of the day was noted in Bangladesh. And the explanation offered were both to protect from the frost but more importantly to provide dew so harvested to the roots of the plant. It does not need to be mentioned that formal research on physiological aspects of such a practice had not been initiated in Bangladesh and for that matter in other countries as well.

5. Drawing upon the work of Yao Shu compiling a sort of agricultural encyclopaedia as of sixth century several suggestions have been given for linking the type of bone decoction to be used for treating the seeds vis-a-vis the type of soil. For instance for red hard soil the bone decoction of oxen has been suggested, whereas the decoction of the bones of hogs has been suggested for sowing in the clay soil. Research on the effect of gelatenous coats and the salts on moisture adsorption and microbial activity perhaps remains to be seriously pursued.

6. Extremely meticulous recipes have been given for preparing the shallow pit manure for growing melons and other crops.

   In a study on indigenous knowledge of women around homestead production in Bangladesh we had found similarly rich variety of manure compositions.

It is interesting to note that the Chinese philosophical thinking very strongly underlined harmony of three cardinal factors ie., proper season, proper ground, and proper human effort similar to our 4-S model developed independently. While much more work remains to be done on the subject we will now review some of the practices noted in our own work in India.

The contemporary Indian experience:

We may add here that we have a very vast inventory of practices recorded from different parts of the country including both drought and flood prone regions. What we are mentioning are just few random examples to underline the importance of generating hypothesis from farmers' practices for formal research.

a) Early planting of gram:

During our field work in 1985 in collaboration with Dr.Hiranand and Mandavkar as a part of in our study on Matching Farmers' Concerns with Technologists, Objectives in Dry Regions we had studied the issue of farmers' innovations and their recognition or lack of it by the scientists. In some cases we took example of so-called irrational practice of the farmer from the interview with the scientists. And we pursued with farmers the more indepth explanation of their rationality.

Early planting of gram was reported to make it more vulnerable to wilt attack. It was learnt that sowing was begun in the month of October and the main factor taken into account was soil temperature. The method of taking soil temperature varied in different villages at a small distance in the area of the study in Western Haryana. Soils in village Kasoli were predominantly loam rather than sandy loam. The soil temperature was noted either walking by bare foot at noon time or by smelling the order which amenated when water was dropped on the ground while drinking. In some other villages another indicator ie., rising of dust in the evening when animals returned after grazing was questioned. Some other farmers felt that blooming of some other plants or sighting of certain birds could also indicate the appropriateness of the temperature. A farmer proposed a counter hypothesis about wilt attack and early sowing of gram. He felt that grams sown early might yield higher despite higher vulnerability to wilt attack because grain setting got completed by mid February. By this time the strong winds or increase in temperature might affect the crop adversely perhaps the damage by this problem was more serious than from other problems.

It is possible that none of the hypothesis mentioned above may be valid even if practice was still considered to be useful. The issue is not whether hypothesis derived by the farmers would prove superior to the ones generated by the scientists. The issue is, are there some relationships between biotic, edaphic, climatic and human factors important for survival of crops and the cultivators which people have derived intutively even if not systematically. And to what extent this intutive hypothesis deserve to be scientifically probed.

b) PPST (Patriotic and People oriented Science and Technology Foundation, Madras) recently brought out a bibliography on Indian Agriculture and Plant Sciences (April 1987) which is a very rich source of references on the subject in the country. Perhaps the issue of linking formal and informal research cannot be delayed or ignored any further. Academy of Development Science, Karjat, Maharashtra; Academy of Young Scientists, Chandigarh are some other groups which are engaged in research on indigenous knowledge systems including plant sciences. If the community of plant physiologists considers some of these issues worthy of attention it is hoped that they would consider initiating not only a formal dialogue but also institutional innovation that can link knowledge that people have with the knowledge that they need to have to improve their livelihoods systems.

Innovations from Humid Tropics: Bangladesh

Author had recently an opportunity of spending a year with agricultural scientists in Bangladesh with specific reference to the development of methodologies and systems for on-farm research. One of the important sub-objective was to draw upon peasant innovations while developing formal research agenda.

Some of the examples which might interest plant physiologists are mentioned here.

a) When it was found that farmers were able to market tomatoes kept quite fresh even in the off seasons the agricultural administrators were quite keen to find out the reasons. Dr. Abedin and his colleagues were confronted with this problem. It was thought that best way to understand it would be to ask the farmers themselves. It turned out that farmers uprooted the whole tomato plant before tomatoes were riped and hung the same upside down in the well aired but shaddy place. It appears that flow of chemicals responsible for ripening was impeded in this process. If indeed such a method has some validity by adding modern scientific knowledge a useful technology could be developed as was done in the case of diffused light potato storage system.

b) In case cucurbits a widely found problem is of delayed transformation from vegetative to reproductive stage or sometimes excessive flowering without culmination into fruiting. Farmers in Bangladesh tried different methods to overcome this problem. They provided a vertical incision in the vine and inserted opium (Subash 1986 p.c.), tobacco (Rafique 1986 p.c.) or just left it like that (Feroz 1986 p.c.) and found onset of fruiting.

c) The jute capsularis seed abstract was used for controlling stem borer in paddy (Hoque 1986 p.c.). The planking and laddering after 30-45 days in paddy and 20-25 days in wheat was found to have positive effect on tillering of the crop (Murshid and Alam, 1986 p.c.).

d) Women scientists who tried to study the homested practices discovered several innovative strategies of risk adjustments which deserve further study. For instance it was noted that a banana plant grown in between four betelnut trees in north-west Bangladesh held in moisture availability to the betelnut roots through banana suckers in stress period.

There could be large number of other practices which deserve to be studied systematically if for no other reason than just to extend the frontiers of science.

Conclusion:

We have suggested in this paper that in the process of adjusting with risks various classes of households devise numerous risk adjustment strategies. At macro level these could be studied with the help of 4-S model which includes interaction between space-sector-season-social stratification. At micro level socio-ecological paradigm could be of some help. It essentially builds upon Access of households to factor and product markets, ecological and other resources: Assurances available regarding risks (climatic, social ie., how would others behave given one's own behaviour, temporal ie., future returns from present investments etc.) and abilities (ie., skills) of the households to convert Access into investments given various assurances.

We have reviewed some of the institutional factors which influence perception of peasant innovations. Later we have drawn upon some of the specific examples of farmer experimentation in high risk environments in China, India and Bangladesh. We have a far richer inventory of such practices than what has been presented in this paper.

Our contention is that while in some cases rituals might dominate the rationality of peasant survival mechanisms. But there are certainly many cases where peasant knowledge deserves to be systematically understood, analysed and built upon while generating new alternatives for technological development. In this process we would have to not merely start the process of transferring science instead of only technologies to the farmers but also generate an alternative college of peers involving poor farmers, pastoralists, tenants etc., who would collaborate in research and also invalidating knowledge so produced. We do concede the fact that there would remain a case for some research purely guided by scientists own vision and imagination. What we are submitting is a small step. Linking peasant science with so-called modern science and technology in a manner that the knowledge generating systems in the rural areas are not converted into just the knowledge receiving systems.

And we believe that this is possible and would perhaps be pursued by even those who wonder whether we aren't moving the wheel backwards!

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