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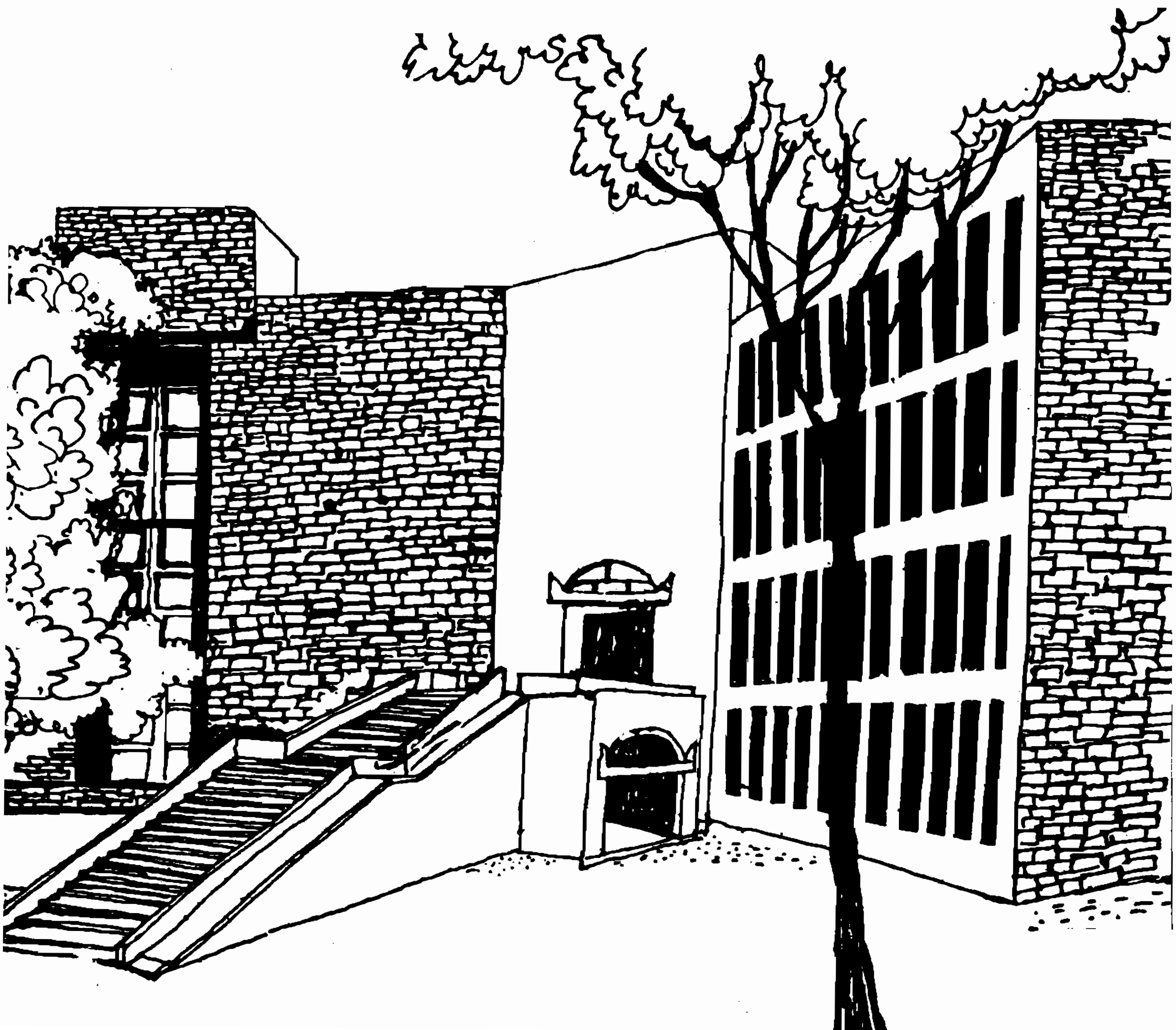

TECHNOLOGY DEVELOPMENT AND DIFFUSION IN TREE GROWERS' COOPERATIVES IN A COASTAL SALINE REGION OF GUJARAT: A LEARNING ENVIRONMENTAL APPROACH

By

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ABSTRACT

Technology Development and Diffusion in Tree Growers' Cooperatives in a Coastal Saline Region of Gujarat: a Learning Environmental Approach

This paper examines the nexus between new technology for an open access land resource and an institutional set-up for establishing and managing tree plantations as a common pool resource.

The Vankars, a scheduled caste of a coastal saline region of Gujarat, combined their knowledge of local resources with the techno-managerial inputs of an external non-government organisation* to evolve a new technology for making these lands productive. Some land was acquired on long lease from the government on an individual basis and also on a group basis. In either case they soon realised that reclamation and management of such degraded lands called for the pooling together of land as well as other resources. This in turn demanded simultaneous investment in human resource development and institution-building at the grass root level.

The setting up of a chain of cooperatives in different villages in this region from 1979 onwards and their subsequent federation into a cooperative union in 1989 is the realisation of a dream shared by the leaders of an oppressed community and their conterparts in the external agency.

This paper highlights the informal networking system between cooperatives which provided multiple points for experimentation, trial and validation of new techniques and ideas. It describes the methodology used by the BSC in promoting technological innovation of both types (a) local knowledge & initiative based (b) supply induced.

The paper examines the evolution of rules for using usufruct, providing labour and protection, processing wood into charcoal and marketing; in three cooperatives selected on the basis of land productivity as a criterion. The mechanisms for sharing set-up costs and maintenance of plantations, the problems of fostering unity and the perceived stream of benefits realised by the members vis-a-vis the NGO are summarised. Implications are drawn for building institutions around common pool resources.

Paper Presented at the 10th Annual Symposium of Association for Farming Systems Research - Extension (AFSRE) held during October 14 - 17, 1990 at Michigan State University, E. Lansing.

This paper was prepared by Mr. A.R. Pastakia during his work at IIM-A as part time assistance to Prof. Anil K. Gupta in a project on Sustainable Development of High Risk Environment.

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INTRODUCTION

So called "resource-poor families" of the complex, diverse and risk prone farming system have not been benefitted or have not benefitted as much as the industrial and green revolution types of agriculture (terminology : Bruntland Commission WCED 1987, 120-2).

The reason for this state of affairs could well be the very way we define the problem. The term "resource-poor" signifies an attempt to consider disadvantaged households in high-risk environs, devoid of any resources. However, we are convinced that such households are rich in at least one resource, i.e., knowledge. Is knowledge not a resource then? (Gupta 1987, 1989). The Bruntland Commission missed this dimension of people's knowledge-richness altogether.

In this paper an attempt is made to describe a process of technological development and diffusion which has sought to build upon this critical resource. At the same time, it should be clarified that those who argue for technological search only in response to articulated needs of farmers, circumscribe the possibilities of supply-induced innovation. Articulation by rural disadvantaged households is restricted by the range of their experiences. If people have not been exposed to a particular scientific possibility available elsewhere, will they ever demand it ? The responsibility of the supply side making choices available has to be equally emphasised while building upon people's prior knowledge (Gupta, 1987).

If development could be defined as the process of widening the decision-making horizon of such farmers and extending their time-frame, then the role of developmental agencies should be to facilitate this process by broadening the range of choices before them (Gupta, 1981).

In this paper I present a case of tree farming in a coastal saline region where the Vankars, a scheduled caste of a backward region in Gujarat organise themselves to use this open-access land as a common pool resource (CPR).

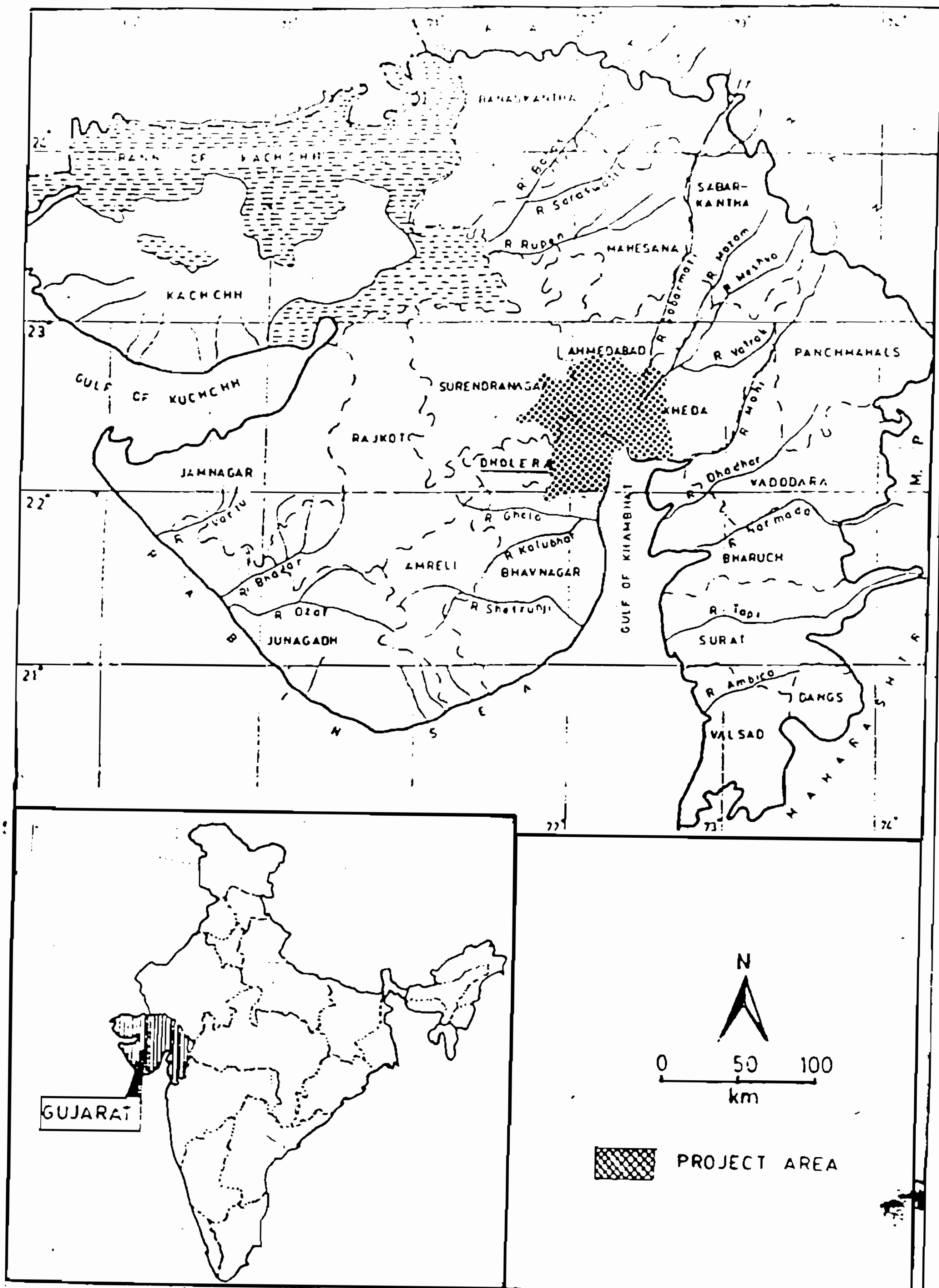
It has been recognised (Gupta, 1989) that in high-risk environments technology for individual resource management does not offer much hope. At the same time there are not many examples of technological development using open-access land and CPR institutions (Abstracts of paper presented at FSR conference, Kansas, 1987). To that extent this paper fills an important gap in literature.

The Vankars combined their knowledge of local resources with the techno-managerial inputs of a city-based developmental and educational agency called the Behavioural Science Centre (BSC), to evolve a new technology for making these lands productive.

Efforts in farming systems research in general seem to have ignored this blending of indigenous knowledge and external knowhow in an institutional and common pool resource context.

Foot note : The author is grateful to Prof. Anil Gupta for his valuable comments and guidance in preparing this paper.

GEOGRAPHICAL LOCATION OF PROJECT AREA



This paper is divided into five parts. The first describes the setting, including natural endowments and pattern of control over available resources. The second focuses on the precursors for community action; this includes assessment of enterprise risks and their negotiation.

Part three lists some of the technological innovations of the collaborating farmers and describes the institutional arrangements that made these innovations possible.

Part four examines the management systems, evolved over time to manage the community plantations as a common pool resource.

In part five implications are drawn for promotion of technology for a particular "recomendation domain", in the institutional context.

Part 1. THE SETTING

Framework for Analysis :

Underutilised natural resources offer the biggest challenge and opportunity to marginal producers in degraded environments.

The quality and relative abundance of a resource has a direct bearing on access to such resources, control over such resources and skills to convert such resources into investments. Skills are an outcome of use of resources over time and can undergo changes with changes in technology, public policy and resource use. With the necessary internal and external assurances such producers can set up their own institutions which would enable them to improve their access to resources as well as the skills.

Hence the nature of local resources, the rules which governed their utilisation and the skills available to convert them into assets are described below :

A) Local Resources :

The "Bhal" region of Gujarat covers the low-lying coastal area around the Gulf of Cambay (fig. one). The region suffers from a hostile geo-climatic environment comprising highly saline soils, erratic rains, monsoon inundation, temperature extremes, coastal cyclones etc. All these have rendered life conditions very difficult (refer Appendix 2).

Saline wastelands occupying more than 50% of the land represents the single largest underutilised resource. The halophytic bio-mass produced on this land together with the agricultural waste supports a fairly large animal population -- mainly cows, buffaloes & bullocks with a few goats.

The remaining land comprising alluvial soils is used for dry-land farming - the main crops being, wheat and cotton. Yields are low and uncertain owing to erratic rainfall.

Over the last ten years, with the advent of the Mahi Canal

System some villages have started cultivating irrigated paddy. However, the risk involved is quite high for many of the tail-end villages as timely water-supply is not guaranteed.

B) Pattern of Control over Resources :

Much of the agricultural land is privately-owned by the farmers, while most of the saline wastes are the property of the revenue department of the state government. For the utilisation of bio-mass these are open-access lands mainly due to low productivity and relative abundancy. In keeping with the stated government policy, part of this land has been privatised by alloting small plots of 1-2 ha. to individuals of the scheduled and backward castes. Such land has also been leased out to cooperatives of the same target groups. In most of these cases the state of the land has remained the same. Often the cooperatives are declared defunct and liquidated after a few years and the land restored to the government, to complete the cycle (<u>Appendix 3</u>).

The village panchayat (which is an elected body) also owns some land in the village -- mainly the settlement land and village commons such as village tank and <u>gaucher</u> (or grazing lands). The panchayat exercises control over these lands.

The traditional dominance of the upper caste had given it a head start in the race for political power. The Sarpanch (head of the village panchayat) in most of the villages was an upper caste person. The local MLA was also a Rajput. Control over these channels made the government delivery system more accessible to the upper caste than to the backward or scheduled castes. For a diagrammatic representation of this relationship see <u>Appendix 3, figure 1</u>.

C) Local Skills :

Caste as an institution plays a dominant role in segregating people into different groups based on professions/skills. It also provides an identity which defines the range of inter-caste interactions.

Most of the Bhal villages are multi-caste in nature. Traditionally the Rajputs represent the erstwhile ruling class and continue to behave as such. The Brahmins are the priests while the Bharwads are the traditional shepherds. The Patels are agriculturists while the Vaghris are usually landless and have a diverse portfolio comprising hunting, fishing etc.

The most despised lot are the out-castes comprising the traditional weavers (Vankars), sweepers (Bhangis) and flayers (Chamars).

Traditionally the upper caste tended to specialise in managerial, supervisory and arbitration skills. Hence the formation of multi-caste institutions without generating a parity in managerial skills between different caste groups resulted in the continued dominance of the upper caste in such institutions.

The Vankars who have undergone a change of occupation from weaving to farming in the recent past (last quarter century) have a good understanding of saline soils and their own nomenclature for differentiating alkaline patches from saline lands. While ordinary "khar" could be washed off with sweet water "Telio (oily) khar" (alkaline patches) could not. The sense of taste and indication plants were used to assess the extent of salinity and degradation of land (Appendix 4). They believed that saline lands could be reclaimed through a process of bunding, ploughing and leaching of salts with rain-water. However, in the participative planning process all alternatives considered were related to agriculture and pastoralism. Their conditioning with these activities may have been the reason for foreclosing other options.

Institutions, formal or informal, provide legitimacy for a given world view or exercise of occupationary option. It is necessary to intervene at an institutional level in a traditional caste-ridden society if these options have to be modified in a sustained manner.

Part 2. PRECURSORS OF COMMUNITY ACTION

A) Investment in Pre-cooperative Education

"Implanting of Institutions" on an unwitting and unprepared group of beneficiaries is not uncommon among development agencies as well as aid agencies.

In institutions where community leaders take the initiative in the mobilisation of community members they have to bear the set-up costs. They also have to take care of the assurance problem (Tushar Shah, 1989).

In institutions induced by an external agency much of the set-up cost and responsibility of resolving the assurance problem can be taken up by the agency. The BSC was fully aware of this responsibility while promoting cooperatives in the Bhal, and made a considerable investment in pre-cooperative education.

What did the cooperative offer the Vankars?

The cooperative (registered either as a primary agricultural cooperative or as a tree growers' cooperative) promised to serve the following purposes:

1) To reduce the economic risk by diversification of portfolio.
2) To improve access to resources and technology (Appendix 2, Table 2).
3) To increase staying power in the village by cutting down on migration.
4) To enable individuals to create a new legal personality with credit-worthiness.
5) To enable individuals to extend their time-frame.(Most individual families would not be in a position to withstand a gestation period of 5-6 years for returns on investments.)

6) To redefine social relations both within caste and between caste groups.
7) To move towards a life of self-reliance and self-respect.

Most aid agencies in their urgency to reach out to the poor overlook the fact that education and institution-building are slow processes. The BSC as a rule would spend at least one year "preparing the ground" for the acceptance of a cooperative in a given village -- although after several years now, there is evidence of being able to telescope the phase to a considerable extent.

The preparatory phase was essentially used to raise awareness about social conditions ,to bring to the surface the perceived risks, and to work out the necessary assurance mechanisms.

B) Assessment of Risks :

In starting a new enterprise the Vankars found themselves faced with a whole range of risks - social, political and economic in nature - both at the individual level and at the group level.

The perceived risks as indicated in Table 1 varied from village to village depending upon the nature of the resource at their disposal, the nature of leadership within the community and social relations with other castes in the village.

Table 1
Village -vise assement of Enterprise Risks

	Particulars	Vadgam	Pandad	Golana
A	Economic (Vertical)			
	1) Technological viability	++	+++	+
	2) Future returns on investment	++	+++	+
	3) Doubts about managerial skills	+++	+	+++
	4) Doubts about adequacy of employment generation	+	-	+
B	Environmental(Social\Political)			
	1) Threats from Upper caste			
	- withrawal of employment and credit.	+++	++	+++
	- blockage of government scheme benefits	+	+	+
	- Denial of services in the village	++	+	++
	- Manipulation to divide Vankars	+++	++	+++
	- Harrassment(false implications, abuse,theft etc.)	++	+	++
	- Physical assault on life\ property.	-	-	+
	2) Sabotage by other stake-holders mainly Bharwads.	+++	+	+
	3) Cooperative legal system: fear of losing land to government on failure of enterprise	++	+++	+++
C	Social (Horizontal)			
	1) Uncertainty in behaviour of other members:			
	- Factional fights	+++	++	+++
	- Dysfunctional leaders	+++	+++	++
	- Inequality in distribution of benifits and contributions			
	(i) between individuals	+++	+++	+++
	(ii) between factions	+++	++	+++
	- Unequal opportunities for growth; resultant jealousies and fights	+++	+	+++
	2) Sabotage by disgruntled elements	+++	+++	+
	3) Competition, healthy or otherwise, from parellel social organisations	+++	+++	++

The economic risks were mostly related to the quality and quantity of land. While Pandad had a vast tract of land of very poor quality, Golana had relatively better land.

Pandad shows a significantly lower score on horizontal and environmental risks as compared to Vadgam and Golana, both of which had a history of factionalism with strong traditional leadership. In Pandad the factions were more diffuse and unstable - realignments taking place from time to time. Pandad also had a strong youth leadership which could keep in check the traditional leaders whenever they tended to be dysfunctional.

It is significant that Pandad which has a lower score on environmental risks had, in the past, successfully negotiated with the upper caste around issues of unjust treatment\harrassment on the basis of caste.

C) Pre-cooperative Negotiations :

In 1979 when the idea of such a cooperative was mooted in Vadgam, several types of negotiations preceeded community action:

a) Between factions within the Vankar community
b) Between the Vankars and the upper castes of the village
c) Between the Vankars and the cooperative legal system
d) Between the Vankars and the facilitating agency(BSC).

Negotiations between Vadgam (the first cooperative) and the BSC led to the signing of a ten-year contract.

(i) The BSC provided the following assurances :

- to play the role of facilitator and supporter for a minimum period of ten years and to provide necessary training at various levels in the cooperative.

- to appoint a secretary to the cooperative from its staff who would ensure clean administration until such time as the Vankars developed sufficient faith in their own people to assume this responsibility.

- to ensure that information of the working of the cooperative was made available to all members.

- to provide the cooperative with an interest-free loan which could be written off in the event of failure due to technical reasons or due to lack of proper management

(ii) The assurances sought by the BSC in return were :

- to ensure that all Vankars were made members with equal share holding and equal say in the working of the cooperative
- to repay the loan in the event that the project became viable; in order to enable the BSC to set up a revolving capital for the purpose of promoting similar cooperatives in the area.

D) Preparation for the Sangh

The idea of the apex cooperative was introduced to the villages by the BSC almost five to six years before it came into existence.

The rationale for a federation of scheduled caste cooperatives of the region (BSC Annual Report, 1988) included :

(i) better articulation of needs.

(ii) greater bargaining power with external forces and agencies such as, market, bureaucracy, upper caste, politicians etc.. Greater access to resources and technology.

(iii) realising economics in scale and sharing overheads.

(iv) facilitating development of managerial skills through a system of mutual monitoring and support.

(v) facilitating the process of disengagement - since the Sangh would be staffed by trained manpower and would be expected to take over the role of the BSC.

At the end of its first year of existence the Sangh appears to have achieved institutional equilibrium. It has successfully replaced the BSC in several functions and established a credibility of its own. Particular mention could be made of its success in dealing with external threats and external agencies. Its efforts at mediation in the internal problems of the cooperatives have met with partial success. It has successfully initiated the move to integrate women into the cooperative movement by initiating activities to be run exclusively by women in order to give them the much-required self-confidence. Sericulture has been one such activity.

For the BSC the entire work with the cooperative was in the nature of an action-research, which was making discoveries both on the technical and the institutional sides.

Part 3. TECHNOLOGICAL CHANGE, ACTION RESEARCH AND INSTITUTIONAL ARRANGEMENTS

A. Organisational context of Action Research

Techno-managerial institutions which have tried the development of technology on the farmer's field have often failed to make a distinction between **trial** and **demonstration**. It is necessary to carry out on-farm trials with the knowledge that the new idea is **different** though not **better** (Gupta, 1987). The consequence of a failed demonstration could be reduced confidence in certain types of learning approaches.

Experimentation and trial in the Bhal cooperatives went through two stages - one prior to and the other after the setting up of the Sangh (the apex body).

Phase I - In this stage experimentation took place on the cooperative fields. Considerable progress with the main tree species viz. *Prosopis juliflora* (mesquite), was made - in method of planting, silvicultural practices and design of water harvesting and drainage systems. However, trials aimed at introduction of new species suffered setbacks. The major difficulties were :

(i) problems in protecting experimental plots.
(ii) difficulty in monitoring experiments because of dispersed locations.
(iii) large overheads and costs of experimentation.
(iv) conflict in management between normal production activity and trials.

Phase 2 : The need for a sub-centre to carry out costly trials and generate more systematic data on experiments was clearly felt. At the same time the need for a central facility to provide common services to cooperatives such as storage, accounting and training was also realised by the BSC. This led to the setting up of a sub-centre in village Daheda, in 1984, on fifty acres of typically saline wasteland. This was also to be the headquarters of the Sangh.

The two-tier structure of cooperatives now offered multiple points for technological experimentation upgradation, validation and diffusion.

Figure 1

```
 ------                                -----------------
 | BSC  |<------------------>| BSC  sub-centre  |
 ------                       |  and HQ of Sangh |
                                -----------------
                                        |
          -----------------------------------------------------
          :                 :                 :           :             :
    Cooperative
```

The sub-centre served the purpose of screening new techniques and germplasm before offering it to cooperatives for trial, thereby, reducing the cost of experimentation.

Assimilation of knowledge, its diffusion and cost of learning :

The sub-centre served to facilitate group discussions and analysis of the technical problems faced by the managers of different cooperatives. Sharing of experiences in this informal network reduced greatly the cost of learning for individual cooperatives. Two examples are given to illustrate the point.

At one time the group meeting identified the possibility of using drainage to irrigate the plantation during the summer months. Based on his experience Bhikabhai, the manager of the cooperative at Valli, cautioned the others about irrigating plots which had trenches dug in them for the purpose of rain water harvesting. Bhavanbhai, the manager at Pandad decided to validate the finding by irrigating in two small plots - one with the trenches and one without. It was clear that the flooding of plots without trenches was beneficial while the former resulted in high mortality of plants. The underlying principle in water management was to ensure a root zone free of salt. This had been violated in the plots with the trenches - where salt got translocated to the root zone during post irrigation evaporation (see diagram).

On another occasion the use of sandy loam soil in raising saplings coupled with poor quality of polythene bags resulted in heavy losses during transportation of saplings. One of the managers decided to wet the saplings before loading them onto the tractor and also before planting them out. It took a little time for the rest to follow suit. However, the nursey manager was warned not to use sandy loam soil alone in future.

B. Technological Innovation

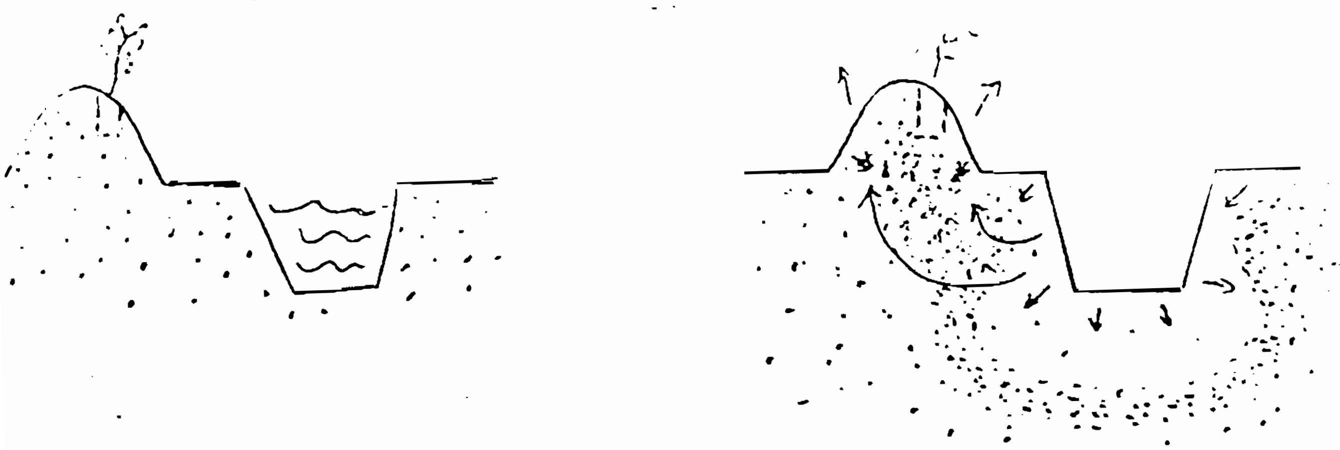
1) **Local Innovation :**

The decentralised structure with informal network resulted in a number of "incremental innovations" during the course of work in the field. A few examples are listed :

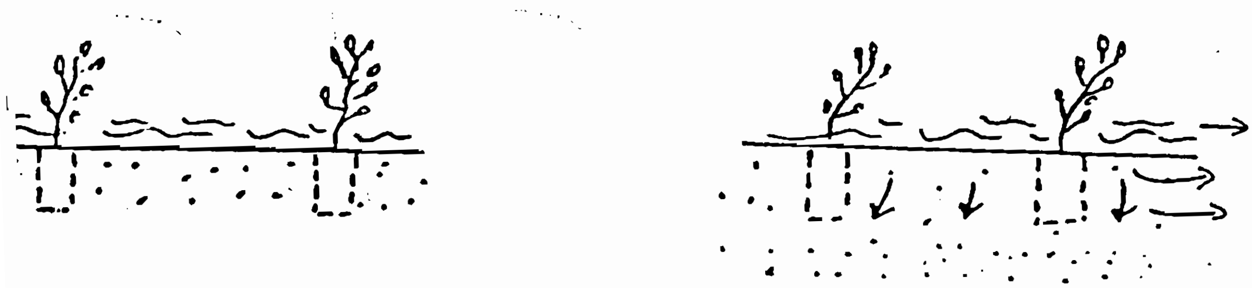
(a) Can traditional be modern ?

In Golana the cost of transporting saplings across the river to the planting site was causing concern to Bhikabhai,

Figure 1 (Part 3 - A)

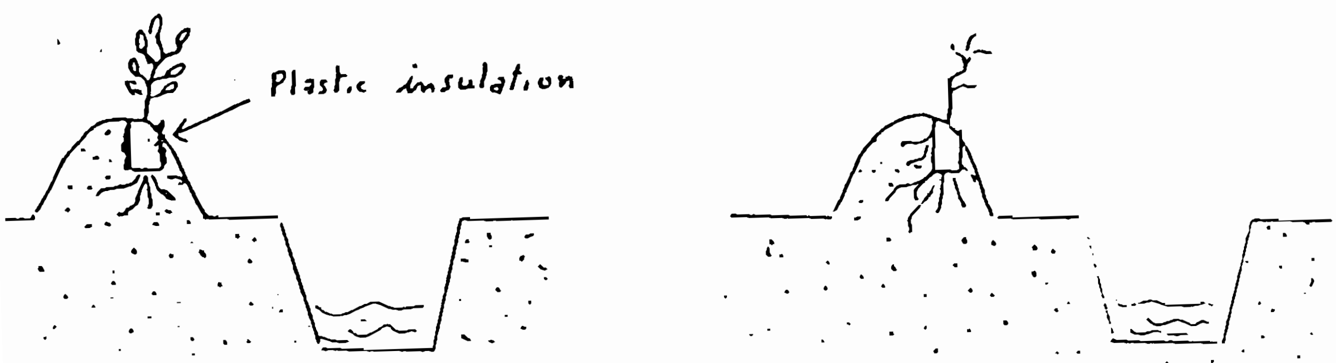


Trench Irrigation and resultant high mortality



Control : Flooding followed by mulching in Trench less ploi

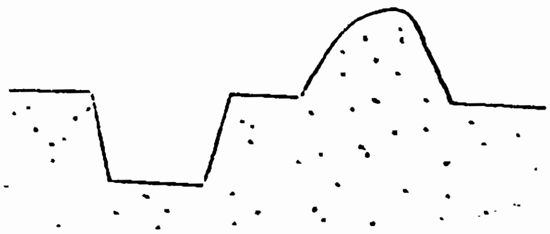
Figure 2 (Part 3 - B, C)



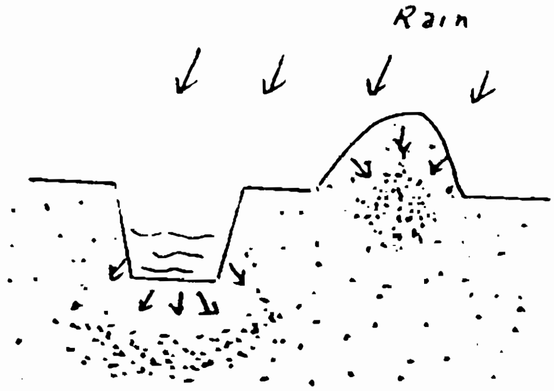
Planting with side covers on

b) Control : Planting
removal of entire P
bag

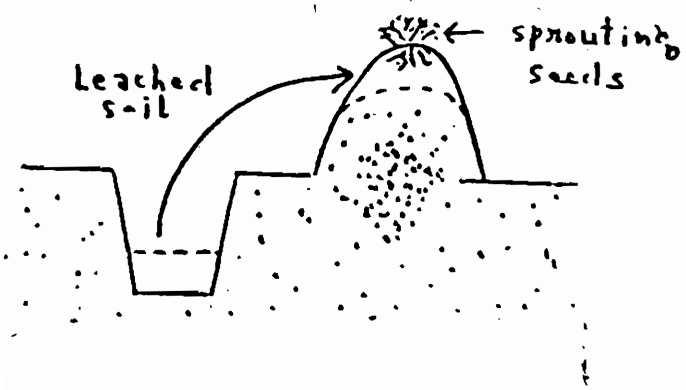
Figure 3 (Part 3 - B, c)



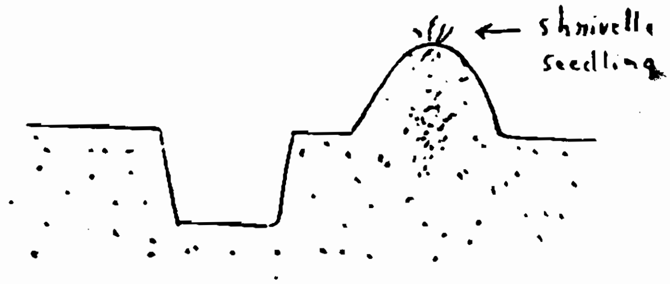
a) Initial position of salts in profile



b) Position of salts after first monsoon season



) Direct sowing after repairs of bund – Second season.



d) Control: direct sowing un-repaired bun the manager. He then suggested direct sowing. One member suggested use of excreta of donkeys fed with pods of Prosopis as ideal material for direct sowing. In this way not only did the seed treatment take place in stomach of the animals, but the seed also got pelleted in collected and the idea put into practice.

(b) Can outside disturbance have positive effects ?

In Pandad there were several plots of stagnated plantation owing to adverse sub-soil conditions. When a row of such plants was cleared by the ONGC* for the purpose of oil prospecting, everyone was concerned about compensation. The critical observation by one member was that harvesting of stagnated plants was actually helpful since the vigorous coppicing power was used to overcome the adverse sub-soil conditions. This led to a practice of harvesting mature plants irrespective of their first growth.

(c) Can mistakes be productive ?

Yet, another technique was evolved from a critical observation by Bhikabhai - this time as manager of a different cooperative. Saplings in which only the bottom part of the plastic covering was removed by some workers were in fact doing better than those planted after removing the entire covering. The covering on the sides helped to lessen the shock experienced by the plant when planted in a highly saline environment (see diagram).

(d) Can ordinary workers be teachers?

In 1984 Shantibhai, the manager at Daheda sub-station was supervising the work of dibbling seeds of Prosopis juliflora on the external bund of the farm for purposes of live fencing. Instead of putting 3-4 seeds per dibble as instructed, some workers were putting a handful (20-30 seeds) per dibble - much to the chargin of the manager and the technical officer of the BSC who happened to be present. A few days later the manager found on inspecting the site that the seeds sown in clusters had survived the adverse soil conditions better than the others.

(e) Can discovery be made by chance?

The following year, a related observation in direct sowing was equally revealing. Shantibhai at Daheda noticed that seeds had sprouted only on that portion of the bund which had been strengthened the previous summer. It was realised that the leached soil from the adjacent drain was now on top of the bund. It was this soil that had supported the seedlings. Both these experiences were later converted into techniques (see diagram).

(f) Can the people's experience match the expert's power ?

In Vadgam after the first major harvest of wood in 1984, the cooperative supervisors and the BSC technical staff were inspecting the coppice growth from time to time. It became evident after 3 months that about 15% of the plants had failed to coppice. The BSC staff was worried as it had implications for economic viability. The following possible causes were identified after consultation with an eminent forester :

(i) improper cutting - i.e either razing of stumps to the ground or splitting of stumps during harvesting which could have resulted in rain-water entering the stumps and causing pest attack.
(ii) inappropriate harvesting time - not harvesting in summer months may have affected the coppicing shoots.

The people accepted the first as a valid reason but regretted that they did not have proper equipment for harvesting.

Blunted axes and sickles might have led to injury to the stumps. The cooperative therefore decided to invest in axes with sharpened edges. In future harvesting operations, care was taken to leave a stump of 4" off the ground and with a sloping edge (see diagram).

The second suggestion was not acceptable to the people as their experience with the species suggested otherwise. The following year harvesting was allowed to continue during summer. Care was taken not to harvest the border plots so that coppicing shoots might be protected from descicating winds during summer. The coppicing rate this time was over 95%.

2. Supply-induced Innovation

a) Locating appropriate technologies

Appendix-5 provides a summary of the BSC's understanding of the technical problem and its search for technical solutions along with outcomes.

The major contribution has been to expose the collaboration to the concepts of tree farming and micro-water harvesting systems.

Subsequent diversification into reservoir fisheries and sericulture were also a direct outcome of the continued search to locate technological options that could fit into the socio-ecological context of the Bhal, with necessary modifications.

In the area of wasteland development, introduction of germplasm of Salvadora persica from natural coastal plantations of the adjacent Dholera region was made possible. Salvadora is a halophytic oil-seed producing bush well adapted to the area. However, there were no examples of man-made plantations to learn from. The economics of cultivation of Salvadora were established in a five-year trial at the Daheda sub-centre before the cooperatives decided to diversify their plantations.

Scope for Agro-forestry :

Recent trials have yielded two more species, for future intercultivation in the existing plantation of mesquite:

(a) Argeria speciosa (local name : Hawara Hawri) is a halophytic creeper with medicinal properties. Its leaves are used in some parts of Gujarat to treat boils and other skin ailments. During the first year of trial the prolific growth impressed everyone. As news of the effectiveness of the leaves in the treatment of skin diseases spread through the cooperative network, a number of people began to try it out. By the end of the second year more than two hundred and fifty people had used it at least once.*

(b) Eclipta alba (local name : Bhangro) - is a small herb with mild salt tolerance. It was identified during the course of a succession study of grasses and herbs at the sub-centre. The extract from the vegetative portion of the herb can be used to produce hair oil which can find a ready local market.

Serendipits and Innovation.
The succession study itself revealed that with complete protection from interference of man and animal, and treatment of micro-water harvesting system consisting of pits (dim. 4' x 4' x 4') the full potential of the land to support grasses and herbs could be realised in five years during which time twenty-two species had come up covering 95% of the land. As the top few inches of soil began to improve year after year, less and less salt tolerant species became dominant. Cooperative plantations which are semi-protected have also shown an improved grass cover. The understanding of succession patterns may help in inducing better grass cover through a dispersal of seeds.

b) Failed attempts and lessons learnt

The attrition rate of supply-induced technologies was expectedly higher than that of local ideas.

The use of gypsum advocated by the CSSRI, Karnal on saline soils was found to produce no significant advantage to the tree species being planted out. It was only a few years later that the institute began to advocate use of gypsum exclusively for alkaline soils and not for alkaline-saline soils. The effectiveness of gypsum also depended on thorough mixing with soil. This was not found cost effective.

Another technology which involved making pits of 4ft.x 1ft. diameter with the help of a tractor-driven post-hole digger, was recommended by the CSSRI in the early eighties, for tree planting in saline and alkaline soils. The recommendation was based on its experience with the saline soils of Haryana and U.P. This induced the BSC to invest in a tractor as well as a post-hole digger.

Trials were made at Gudel and Pandad villages in twenty five acres and one acre, respectively. While in Gudel the plants died out after initial establishment, at Pandad the advantage in growth was only temporary. The failure at Gudel was later analysed to have been caused by seepage of saline ground water into the pits.

Drip irrigation is known to be advantageous to plants under saline soil conditions. A drip system using earthen pitchers was an indigenous technology finding favour with the scientists at Karnal also. On-station trials at Daheda revealed that salinity caused the pores of the earthen pitcher to clog quickly thereby drastically reducing the efficiency as well as life of the pitcher.

On-station, trials with a number of exotic species which are well-known for salt tolerance failed in the Bhal. This was because the salinity coupled with poor drainage as well as the brackish, high water-table created conditions which were perhaps twice as difficult as the salinity in well-drained, low water-table soils. Examples of such species include Prosopis tamarugo and Tamarisk aphylla

The above lsit is by no means an exhaustive one. This once again highlights the savings in cost of learning effected due to the existence of a sub-centre which effectively represented the field conditions in the cooperatives.

Part 4. MANAGEMENT SYSTEM AND INSTITUTIONAL ARRANGEMENTS

Facilitating technical innovation is one way by which developmental agencies can help in reducing the vertical risks of grass-root institutions.

Evolution of a proper management system is a necessary complement to the technical effort of the CPR user-institution. Negotiating horizontal and environmental risks requires fostering of suitable leadership and evolution of rules/norms mainly for pooling of resources and sharing of benefits.

A) Leadership :

The leadership needs of the cooperatives were different from those of the community. The cooperatives needed a new functional leadership to run the new enterprises. New skills in the areas of technology development and diffusion, group decision-making, administration, mobilisation and public relations were required. These were the skills hardest to learn given the history of caste-based dependence.

Most of the key positions in the cooperative were occupied by the youth, who in general were more open to experiment with new forms of organisation and new technological options, than the traditional leaders.

B) Pooling of Resources :

The three main resources pooled were land, labour and knowledge. While sharing of knowledge came naturally to farmers in high-risk environments, pooling of land required extensive negotiations between non-land contributors and land contributors in order to arrive at a compensation formula. Wherever government land was available on lease, individuals were free from the pressure to pool their land for collective action.

Pooling of labour became necessary only when the peak tree planting operations coincided with the peak paddy season. Group sanctions in combination with partially raised wages were used to safeguard the work of the cooperative.

Defence as a Common Good :

Defence is crucial in the successful completion of trials. Informal flow of information among members is the only way of protecting the plantation and its trials in a cost-effective manner.

In Pandad for example, a single watchman takes care of 575 acres of land. This seemingly impossible task is performed effectively mainly because of support provided through informal flow of information to the watchman.

In Vadgam, a breach in the protective bunds would mean serious damage to the plantation due to tidal sea water intrusion. Timely reporting by alert members has been instrumental in averting such losses.

Again in Vadgam, doors and windows stolen from the farm house of the cooperative were traced by an alert member despite the fact that the offender had fixed them onto his own house and applied a thick coat of fresh paint of a different colour.

Two cooperatives profitably used the principle of "making the naughty boy monitor" in approaching the protection problem. In Vadgam a Bharwad was appointed to keep the Bharwads in check, while in Golana a Rajput known for his honesty and poverty was identified to dissuade the Rajputs.

C) Sharing of Benefits :

The major benefit so far has been labour. Not surprisingly the cooperatives have expended considerable attention on evolving norms for equity in labour opportunities among members and among factions.

Norms for supevision were affected by (a) task : delicate tasks requiring more supervision (b) the associated technology e.g. tractor putting a constraint on number of workers per supervisor and (c) compensation : linking of compensation (see Appendix 6).

Norms for distribution of surplus are yet to evolve. The management system devised by the cooperative network, provided for mutual monitoring and an atmosphere for learning. Technical failures and collective post-mortems were considered indispensible for learning. One of the managerial dilemmas which remained unresolved was whether to reward success or to reward experiment.

Part 5. CONCLUSIONS

The experience of the Bhal cooperatives in evolving a technology that met the requirements of the members, indicates that normative criteria for analysing choice and experiment do not always hold good. Rationality in technological innovations could even be post-facto as shown in numerous examples given in the past. The sources/basis of innovation could vary from application of formal R & D at one end to serendipity or even mere intrigue at the other. Table 2 below attempts to capture this range.

Table - 2

Sources	Supply driven	Demand driven	Interacti
1) Indigeneous knowledge	Algeria speciosa – medicinal uses Pitcher method of drip irrigation	donkey excreta as pelleted seed summer harvesting of Prosopis	succession of grasses
2) Formal R & D	Post hole digger method; use of gypsum etc.		
3) Serendipity		harnessing copp-icing power for vigorous growth in adverse conditions	planting saplings with side cover of plastic bag intact
4) Compare and contrast		proper harvesting method; exotic tree species	direct sowing in clusters. direct sowing in leached soil in bund
5) Inter nische exchange	Salvadora persica Eclipta alba		
6) Widening horizon	Brackish Water Aquaculture Sericulture	tree farming	
7) Fun & Intrigue			"Kabristan method" – water harvesting
8) Exchange of skills		charcoal making by people of Kutch	

Some of the important conclusions from this experiences are listed below :

1) It is provision of a learning environment rather than learning approach which facilitates technological innovation/change in an institutional context.

2) Normative criteris of analysing choice and experiment do not always hold good. Serendipity (i.e.discovery by chance) can be equally valid source of technological change as long as eyes are trained and line of communication are strong.

3) The two tier structure adopted by the cooperatives in Bhal provided multiple points for technological experimentation, upgradation, validation and diffusion.

   The cost of learning can be greatly reduced in such an informal network by learning from other's mistakes. On station trials also contribute towards reduction in overall cost of experimentation.

4) Technological search when restricted only to articulated needs of farmers in high risks environments, greatly circumscribe the possibilities of supply induced innovation.

5) Failed attempts can greatly reduce the confidence in certain types of learning approaches. Hence experiment should be treated as trials rather than demonstrations.

NOTES

1. The term "Scheduled Caste" was first adopted in 1935 when the lowest ranking Hindu castes were listed in a "schedule" appended to the Government of India Act for purposes of statutory safeguards and other benefits. The Constitution of India followed a similar procedure.

2. Provision for registration as Tree Growers' Cooperatives became available only after 1985 in the wake of a government initiative to address the problem of wasteland.

3. The Oil & Natural Gas Commision (ONGC) is a public sector undertaking active in the area for prospecting and tapping of oil and gas resources.

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APPENDIX - 1

GROWTH OF COOPERATIVE MOVEMENT IN BHAL (March 1990)

Year	Village	Members	Total Acerage
A. FORESTRY ON WASTELANDS:			
1979	Vadgam	67	232
1982	Pandad	90	578
1982	Golana	100	147
1982	Gudel	46	85
1984	Valli	17	34
1984	Vainej	42	83
1986	Rohini	40	100
1987	Tamsa	28	50*
1988	Mithli	66	140*
1989	Golana (Harijan)	22	44
	Sub-Total	518	1493
B. SWEET WATER FISHERIES:			
1988	Varsada	112	1200
1988	Indranej	52	192
	Sub-Total	164	1392
C. SERICULTURE:			
1990	Valli	52 @	4
1990	Khaksar	52 @	4
1990	Golana	116 @	4
		220	12

* The land has not yet been given officially by the Government

@ Valli it has a mixed cooperative, Khaksar has a men's cooperative and Golana has a women's cooperative.

APPENDIX - 2

Characteristics of natural hazards in Bhal area

Sr. No.	Geo-Climatic Environments	Characters and Hazards
1.	Land salinity and ground water	Inherent salinity of sediments and ground water and surface ingress by tides and winds constantly degrade the land and water resources.
2.	Flooding and Inundation	Lack of drainage and low permeability of soils cause longer flood coverage. During monsoon high sea tides and upland river discharge result large scale inundation and water-logging.
3.	Land erosion and river migration	The habitation sites and agricultural lands are subjected to erosion by river chanel shifts, cyclonic winds and frequent high intensity rains.
4.	Sedimentation	The lowlying areas and stream channels getting silted by sediments causing threat of flooding further severe.
5.	Cyclones and storms	Extremes of coastal weather conditions very frequently hit the area resulting damage to property and life.
6.	Climate extremes	Temperature, wind, humidity etc. render the area with most oppresive living conditions.
7.	Evaporation	High evaporation rate result in loss of sweet water and increase of airidity.
8.	Environmental Health	Poor quality of drinking water and agricultural soil affect the regional health adversely.

APPENDIX - 3

Pattern of Ownership & Control of Natural Resources

Party	Resource	Ownership	Control
1. Individual farmers	Agricultural land	Private	Private; land tax paid to Govt. & Village Panchayat.
	Wasteland	Private; given to SC and BC under New Tenure, which disallows selling mortgaging or leasing out.	
2. Farmer cooperatives	mostly wasteland	State Govt. Cooperatives by Revenue Dept.	cooperative; lease tax amount collected by revenue department (Govt.)
3. Village Panchayat	Common grazing land (Gaucher) village settlement land, village pond, temple etc.	State Govt.	Panchayat, Govt. may exercise control in exceptional cases.
4. State Govt.			
a) Revenue Dept.	wastelands (tidal and raised mud flats)	State Govt.	Open access at village level.
b) Irrigation Dept.	Mahi canal system	State Govt.	Department controls release and flow of water; Nominal rent collected from farmers.
c) Forest Dept.	Road side plantations	State Govt.	Harvesting of trees organised by Dept. and wood is auctioned.
	All trees in the District	Private, Govt. or Panchayat	Harvesting of immature trees controlled by department. Also controls transit of wood/charcoal across districts through a system of transit pass.

APPENDIX - 4

Understanding of Saline Soils : Fusion of Local and Text Book Knowledge

Local Understanding	Text Book Understanding
Salinity is caused, by presence of salts in the roots zone. The source of salts could be brackish ground water or tidal ingress.	Salts identified as chloridea and sulphates of sodium and potassium.
Ordinary "khar" (saline soils) can be washed (leached) out with sweet water unlike "Telio (oily) khar" (alkaline patches)	Alkalinity in patches confirmed by high pH and sodium absorption ratio.
Measurement of salinity by testing soil and observing texture (compaction) and nature of vegetation (use of indicator plants such as "morad", "del", "dilo", "lano")	Precise measurement possible. Range from 2 - 100 milli mhos./cm. Halophytic species identified as Suaeda maritama,Aleurops ligopoides Scirpus maritimus and Cressa Critica
Bunding, ploughing of soil and providing surface drainage can help to leach salts out of root zone with the help of rain water. A salt tolerant nullet called "Banti" can be sown for first few years, followed by cotton or sorghum. In case of alkaline soils there is no solution except physical removal. Paddy can be grown in soils which bear "dilo", after proper leaching and addition of 25 cartloads of Farm Yard manure.	Leaching of soils from root zone for saline soils. Treatment with gypsum for alkaline soils. Most agricultural crops cannot do well in salinity > 4 milli mhos/cm. Some varieties of cotton and paddy can perform reasonably at 4 - 5 milli mhos/cm.
Salt loving plants can improve the soil by removing salts from it. Not sure whether soil improvement by <u>Prosopis juliflora</u> is due to the same reason.	Certain halophytes like <u>Suaeda</u> sp. absorb salts into the system and isolate them in vaccoules or in specialised cells. Salt tolerant species such as <u>Prosopis juliflora</u> exert considerable metabolic energy to keep the salts out of the system. Soil is improved because of better aeration, drainage, organic matter and because of nitrogen fixing from the atmosphere.

APPENDIX – 5 (A)

A. Characteristics of the Problem :

The saline soils of the Bhal are non-productive because of the following combination of factors :

1) High salinity (E.C. ranging from 2-235) in m mhos/cm
2) High alkalinity (S.A.R. ranging from 10-70 per cent)
3) High and brackish ground water table (< 3m)
4) Poor water infiltration rates
5) Poor drainage conditions during the monsoon.
   (Factors 4 and 5 are the result of heavy texture of soil as well as shattering of soil structure caused by alkalinity.)
6) Occurence of hard pan formation (Calcium carbonate deposits) in some places, in the sub-soil region.
7) Salinity increases with depth due to marine origin of soils.

APPENDIX - 5 (B)

B. Search for Technology to tackle Saline Wastelands of BHAL

Technology Attempted	Source of Technology	Year	Result	Present Status
1) Chemical amendments to reclaim for agriculture	G.A.U. Anand	1979	Total	Abandoned
2) Forestry with P. Juliflora using standard techniques	F.D.	1980	35 percent survival rate	Abandoned
3) Screw Auger Technique to afforest saline land	C.S.S.R.I. Karnal	1982	Total failure in low lying area; no significant advantage in upland area	Abandoned
4) Bunding and leaching with rain water	Local	1980	Beneficial	In use since 1980
5) Rain water harvesting through pits	Based on micro catchment water harvesting system	1982	Beneficial survival rates 80 per cent	In use since 1982 except in high water table areas
6) Bunds for planting; gutters for water harvesting	Fusion of outside and local knowledge	1984	Found most suitable for establishment as well as subsequent growth	In use only since 1986
7) Use of Gypsum to tackle alkalinity	C.S.S.R.I. Karnal	1982	Suitable	Used in patches

Activity	Mode of Payment	Norms for Participation	Supervisio Level
1. All earth work bunding, water harvesting system, drainage system, tanks, land levelling	Piece rate basis, Formula for incremental wages depending on lift and lead of earth work.	Usually work pairs of one male and one female. During drought labour shared with other backward communities.	One per 50 workers
2. Nursery Raising	Daily wages	System of rotation from house to house. Women's participation high.	1:25
3. Transport of saplings by Tractor earth or FYM	daily wages or fixed rate per trip.	Rotation not always possible	1:7
4. All planting, digging pits, spot watering, mulching, etc.	daily wages	participation of women, aged and adolocent youth high.	1:15
5. Harvesting wood and billeting	piece rat[illegible]	predetermined [illegible]s who [illegible] to meet [illegible]ting [illegible]ule - m[illegible]nly.	1:30
6. Charcoal making	piece rate basis	on [illegible]ontract, mo[illegible]ly to ou[illegible]ders. Differential ra[illegible] used to encourage members.	1:30
7. Loading & unloading of wood charcoal, grain etc.	fixed [illegible]e per truck f[illegible] wood Piece [illegible]e in case of Bag	[illegible] only. No s[illegible]em of F[illegible]tion	maximum one per truck.