Cradle of Creativity:
Strategies for in-situ Conservation of Agro Biodiversity

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Abstract

Given the inter-relationship of different agro ecological sub-systems in any country, success of the strategy of diffusion of varieties invariably adversely affects the conservation of agro biodiversity. At the same time, given the climate change and other fluctuations in the environment, *in-situ* conservation of agro biodiversity is most essential for future survival of the society. This study is a part of a long term investigation being pursued by the first author about the micro level changes at plot level in the farmers' fields and their implications for micro policy at national and international level. Same villages were studied in 1988-89 and 2000-02 to look at the degree of erosion of agro biodiversity. In addition, a survey on preferred incentives for *in-situ* conservation was also conducted among the local communities. The implications of the study for monetary and non-monetary incentives for conservation have been drawn. Different models of incentives for possible action research have been described. There are not too many studies that provide micro level evidence over a decade on the subject. The findings were presented to the national policy makers though actual response in practice so far has been limited.

INTRODUCTION:

Cradle of Creativity

The case for *in situ* conservation of agro biodiversity

Agro biodiversity in any specific ecological context emerges through the interaction among human preferences, natural selection pressures and larger social and institutional considerations. There are major catastrophic events such as droughts, severe floods and other natural calamities which might lead to not only extraordinary changes in the agro biodiversity conditions or the local agro ecological characteristics but also to major migrations. The inter mingling of agricultural biodiversity from different regions has gone on for millennia. Human preferences have played a prominent role in selection but many times in highly ecologically stressed regions, the selection was made by nature and human beings adapted to whatever seeds or plants which survived. It will be useful therefore in any study of agro biodiversity to look at the pattern in the use of agro biodiversity within the variable field conditions as influenced by medium or long term agro ecological changes. Such studies would require a longitudinal or a long term monitoring of agro biodiversity for which we have not had any institutional infrastructure created in the country. This is perhaps the only study where we had the opportunity to revisit the same region after an interval of 10 years to see the changes at plot and sub plot level in the preferences of farmers as influenced by agro project conditions.

Agro biodiversity is influenced by several factors operating at different levels- social, cultural and institutional. It is well understood that taste is a major driver of human choice in some of the crops more than in others. But taste itself evolved out of social cultural practices influenced by the survival strategies. For instance in high altitude Himalayan regions, most Buddhist communities eat meat though Buddhism is one of the most devoted religion to non-violence and preservation of life. Social institutions have emerged which permit vis-à-vis eating of meat but not hunting of animals. Special social groups are allowed to hunt or rear animals for meat purposes. The selection of crop varieties in such regions is obviously influenced by the agro ecological conditions but also by the compatibility between food of crop or tree origin vis-à-vis that of animal origin. Need for high calories in a cold temperate environment further influences the human preferences. Just as lack of preference for milk influences the selection of varieties in which fodder may not be an important concern in some of the South Indian regions. The coastal communities relying on fish express different preferences for plant and animal origin food because of obvious compatibility implications. Therefore social factors are also shaped differently in various geo physical and agro ecological conditions. The coastal community on Western coast of India vis-à-vis eastern coast of India has contrasting practices and preferences in many regards.

Ecological Factors:

Micro agro ecological factors: The agro climatic and micro ecological factors are influenced by natural or human made infrastructural modifications in the physical conditions. For instance making a road without culverts for cross drainage may influence the water holding capacity of a specific niche and thereby change the local ecological conditions. Similarly the changes in the drainage profile because of construction within the village or around it may change the area and velocity with which water may drain. I remember an example in an East Indian village where a particular variety of rice was grown in a specific low line pocket because water drained at high speed from this region. Only a variety with the strong root system capable of withstanding high speed water would have survived in this pocket. There was no choice but to grow such a variety.

Modification of cultivation conditions:

Conservation through modification of agronomic practices: However, one should get an impression that farmers only cope and adjust with the environmental constraints. So created in the environment. They constantly modify the environment, itself to making possible the cultivation possible of different kinds of varieties. One of the most famous examples is ridge and furrow system in Central India where there are heavy clay soils. Given the high rainfall in the region, without providing for drainage, cultivation would not be easily possible. Likewise in Saurashtra, a dry land region with light soils and low rainfall, permanent set and furrow system has been developed for groundnut in which the moisture retained in the furrows and crop is cultivated on the slightly raised beds. Similar physical arrangement with characteristics variations in different kinds of agro ecological conditions provides a rich understanding of the context in which agro biodiversity has evolved.

Modification of Soil Properties: The modification of the soil topography and other properties due to various natural and other human induced factors also influence the micro ecological conditions for conservation. These modifications can take place through public policy for land leveling or watershed development or through natural factors such as land slide, siltation through flooding or tidal waves or erosion. In Southern Bangladesh, in Barisal region it was observed by the author during 1986 and that due to siltation, the flooding level had changed. The rice varieties requiring higher level of inundation could no more be cultivated. Similarly, the tidal waves influenced the movement of water during day and night as well as during different phases of lunar cycles and accordingly interacted with the soil level and other properties. In some of the eastern Indian plains large scale deposition of sand and or silt through flooding or changing of the course of the river as also influenced the conditions for conservation of germ plasm.

Socio-economic and cultural factors:

Dis-entangling the class and eco-specific factors in choice of technology: Modification of human preferences can take place sometimes according to class and at other times ecological considerations. In a study (Gupta 1985) an effort was made to disentangle the class and eco specific factors in the choice of technology in this case of crop varieties by different social groups. Cultivation of sweet potato on rivarine lands, *chaur* lands (small islands in the river) was eco specific. That is rich or poor both would cultivate the same crop given the agro ecological suitability for the given conditions. However, in the upland conditions around the homesteads, it was generally cultivated only by the most poor people. In fact the nursery for sweet potato was grown on the homestead often less than 20 or 30 cents with the understanding that if land on lease became available, it will be cut and transplanted in the given plot or else one would try to get some food out of the vines in the homestead. For such poor people in Bangladesh who could not afford even rice in the lean season, sweet potato was the only food they could afford.

Social status of low economic value dry land crops: The conservation of agro biodiversity is also influenced by the mindsets, values and socio psychological context of the self-esteem. Some of the local crops and varieties (for instance minor millets, also called as inferior millets) are going down in consumer preference because these are not the foods, the rich and better off people in society consume. Dr. Geerwani, an eminent nutritionist and home science scholar once mentioned that only way one could conserve many of the local varieties of dry land crops was by putting these crops and their products on the table of the elite. There may be some truth in it. The curriculum in primary and secondary education also includes references to such crops in a manner that generates disdain towards them. The lower status of a crop or a variety may have nothing to do with its nutritive quality, fit with the agro ecological condition or its role in overcoming hunger and conserving environment.

Paying attention to etymological roots of the local name of varieties: As mentioned elsewhere local names provide useful clues in some cases to the most important characteristics of the farmers variety which may have led local committees to select that variety. For instance *'sathiya'* variety of paddy indicates a maturity period of 60 days. Similarly tolerance to flooding level, colour of the grain, storability, tolerance to floods or drought or salt etc. suitability for early sowing or late sowing or for poor or rich fertility conditions, mixability with the other crops for growing as inter or mixed crops, vulnerability to birds being high or low etc. or some of the characteristics which may be indicated by the local names. While systematic studies of such names have been done for fish biodiversity, author is not aware of many studies for agro biodiversity. Lack of attention to such selection criteria may prevent breeders from improving the suitability of local germ plasm through improvement for modern market needs. It is not that breeders have not paid attention at all. The important characteristics such as high salt tolerance, flooding, level or drought tolerance etc., are indeed taken into account while developing breeding programmes. However, some of the final characteristics which may have much more important role in developing niche markets have not been given enough attention.

Cultural mechanisms for conservation: Certain rituals, festivals and traditions play an important role in conservation of agro biodiversity. For e.g. the tradition of eating echnocloa culonun (popularly known as *sama* or *samo*) on a particular day of fast in North Western India has generated an institutionalized demand for a grain of this plant. It grows as a weed in rice crop but in some areas it is grown as a crop also. Likewise, there are several other similar rituals which require specific varieties of crops for specific functions or on particular days. During various shodh yatras we have discovered many uncultivable plants which are used by women in various recipes. These crops also serve as source of stress foods i.e. food during stress periods when other grain or vegetable crops are not available. Sometimes there are grains required for ceremonial purposes or for health reasons.

Consumer preferences:

Consumer preference and crop characteristics: It is interesting to see how sometimes farmers are unable to modify the genetic characteristics of a land race but they modify the cultural practices to generate the output needed by them. Once while walking through farmers homestead in Tangail region of Bangladesh during 1985-86 along with a young bright researcher viz. Nurul Alam, we observed a lady (unfortunately I don't recall her name) who was de-rooting the vines of sweet potato before readying them for transplantation. When asked, why was she doing it, she provided a very interesting insight, which plant breeders and agronomists have persistently ignored. She said that if all the rootlets at each node of the vine cuttings were allowed to stay and grow into sweet potatoes after transplantation, the sweet potatoes would be long, thin and have thinner skin. The consumers in the market preferred round potatoes which would be the case if she left only a few rootlets in place. Further the round tubers would have thicker skin, increasing in the process, storability of the tubers. She did not have to sell these faster and even at low prices. Also she could store these for longer period for self consumption. The factoring of consumer feedback takes place even by the poorest agro biodiversity conservators but only when consumer demand and preference is a motivator for the same. There are many cases in which absence of consumer demand acts as a great disincentive for conservation.

Consumer demand for bio diverse crops: In an earlier paper exploring the question 'why regions of high biodiversity have high poverty?' (Gupta 1990), I had pursued this issue. Among various reasons for high poverty in such regions, the fact that consumer demand for irregularly shaped, variously colored fruits and vegetables was much lower than the uniformly shaped and colored fruits and vegetables made a difference to the incentives farmers had to cultivate diverse land races. There were also structural reasons behind the consumer demand. How many different kinds of tomatoes or gourds would a vegetable vendor be able to display on a small vending lorry or roadside shack. Of course if there was a strong consumer demand, vendors with different kinds of tomatoes would find it profitable to specialize. Such a demand has unfortunately been going down with increasing popularization of aesthetically pleasing, even if taste-wise poorer, high yielding varieties of fruits and vegetables. There are other reasons for consumer lack of preference for diverse agro biodiversity products. The improved varieties are often grown in better endowed agro climatic conditions. These are provided chemical inputs particularly pesticides. Consumers apparently prefer pest free products though the ones eaten by the pest are likely to have no pesticides residues or low residues.

Suitability for food processing: It is well known that taste and preliminary characteristics of food have been a major influence on the evolution of selection criteria of particularly women who often select and store the seed. Sometimes even the local names of variety signify suitability for such purposes. However, gene banks generally do not record the local food processing properties for which a particular farmer's variety is preferred or known for. In the absence of such characterization the ability of food processing industries to generate demand for specific varieties is very limited. The lack of demand, as is obvious, acts as disincentive for conservation.

POLICY INDUCED DISINCENTIVES FOR CONSERVATION:

Implications of Price, Procurement and distribution support: Public policy for food procurement and distribution is another factor that contributes to the erosion of agro biodiversity. The public requirement has mainly proposed on wheat and rice in India and accordingly the public distribution system (on which many poor people rely) has also provided only these grains for consumption. Under food for work programme for generating employment in lean season wheat and rice are mainly has been given as wages in coin. For last almost thirty years distribution of wheat and rice, has generated demand and taste for wheat and in some cases for rice. The market for local grains gets suppressed particularly in rainfed regions which is where the agro biodiversity is found in abundance. Improved varieties of sorghum though yield higher, yet do not have enough storability and thus are not suitable for procurement. Government has not developed procurement system to other local crops and their varieties. Thus on one hand taste for wheat and rice has been developed even in the regions where these crops are not grown at all or enough and on the other, lack of procurement support depresses the demand for local grains. In some of the states such as Andhra Pradesh where rice distribution at Rs. 2 per kg has seriously depressed the demand for sorghum and many other millets. Once the demand goes down the erosion of agro biodiversity inevitably follows.

Neglect of storability criteria: The crop breeders have also neglected storability has a selection criteria or one of the breeding objective in crops. Some years ago in a meeting on conservation on agro biodiversity I had asked Dr. Mangesha, then chief of Germplasm Conservation, ICIR, Hyderabad, whether they had characterized their germplasm on storability criteria. He replied that storability was not an issue in sorghum. However, earlier studies in Maharashtra had shown that hybrid sorghum grains when distributed under employment guarantee scheme has part wages for work, this was rejected by the farmers because of quality deterioration during storage. At the same time some other participants in that meeting in Chennai informed that one of the local varieties of sorghum had a name called as Irangu Chollam. I had asked a question as to whether there was any Sorghum variety known for its storability. I was informed that '*Irangu*' is derived from '*Erumbu*', a Tamil word which means iron. This variety is known for its storability and supposed to last long as an iron piece does and is red in colour similar to the rust on the iron. Such gaps between the objectives of the breeders and public policymakers on one hand and farmers on the other who have to survive in these difficult regions illustrate an institutional impediment for conservation of agro biodiversity.

Organic agriculture as a means of promoting agro biodiversity condition: Much of the cultivation an extreme arid or semi arid some of the high altitude mountain regions or deep flooding regions is organic. Certification of these regions and crops growing therein as organic would help in getting the producers and conservators of agro biodiversity, incentive in the emerging market place. The constraint of these producers in affording inputs or in having input responsive varieties will in fact become an opportunity for conservation as well as income generation. Lack of certification facilities is a serious disincentive for such producers in marginal environments.

Incentive for agro biodiversity enhancers: The Role of Farmer Breeders: Honeybee network has documented large number of examples of farmer breeders who have made selections, in natural diversity or artificially introduced diversity through crossing and developed new varieties. Protection of intellectual property rights of farmer breeders either as defensive protection or as an aid to potential commercialization, can be an important incentive. The fast track testing of such varieties at no cost to the farmer breeders in the countrywide varietal testing programme can be another incentive. Venture capital support to such farmers or licensees of their varieties for setting up seed companies could also help in dissemination of these varieties and thereby enrichment of agro biodiversity. In some cases farmers' varieties can be an important source of genetic traits. For instance a groundnut variety earlier called as *Morla* (peacock beak like) was developed by Thakershibhai in Saurashtra. It had two unique properties, namely strong peg and lack of ridges on the groundnut pod. Because of this, the general problem faced by the farmers at the time of groundnut digging of several pods remaining in the ground while uprooting the plants became less severe in the improved variety. The scientist of the National Research Centre of groundnut rejected the variety on account of lower yield but failed to use it as germ plasm for the two characteristics mentioned above. In an International Crop Science Congress held in 1996 at Delhi, ICRISAT scientists had acknowledged that they did not have good germ plasm for these two characteristics. Because of lack of ridges the soil did not get attached to the pod and thus digging of groundnut was facilitated. In another case, Dhulabhai had developed a pigeon pea variety which had a red or pink flowers, apart from high yield and early maturity. Unlike the conventional varieties with yellow colour flowers, this new variety did not attract many pests. And thus saved the cost of pesticides. Likewise there are large numbers of other varieties developed by the farmers reviewed in Chapter III which indicate the potential farmer breeders have for enhancing agro biodiversity. It may be added that farmers' varieties are not always based on improvement in land races. Many times they select mutants from improved variety population also.

Monetary incentive model for *in situ* conservation:

Many of the local varieties have high micro ecological fit and yet lose out in the market place because of low consumer demand, poor public policy support, low prices and of course low yield. The result is the farmers grow this variety generally out of compulsion and shift to modern varieties as soon as viable alternatives become available. There are several monetary or non monetary incentive for individual or communities which can be envisaged for the purpose. In this section we deal with various models that we have developed for monetary incentives for *in situ* conservation. These are speculative models and we need to be experimentally validated to find out institutional conditions under which the different models have highest fit.

The conditions of in situ conservation can be classified as follows:

Diversity

	High Crop level	**High Variety level**	**Low Crop level**	**Low Variety level**
High Diffusion Crop	1	2	3	4
High diffusion variety	5	6	7	8
Low diffusion crop	9	10	11	12
Low diffusion variety	13	14	15	16

As is apparent from the table, two dimensions of agro biodiversity i.e. diffusion and diversity can be studied at the crop and varietal level. One can thus have high crop diversity with high diffusion of each of the crop, likewise one could have high diversity of varieties within a crop and the same could have high or low diffusion in a given region. The implications for policy as well as institutional conditions of diversity and diffusion will be different for inter species diversity vis-à-vis intra species diversity.

The incentives for conservation of varieties which are widely diffused within a region may be less selective than for the varieties which are scattered, localized and grown on only few plots with a very few farmers. If the threatened pr designated varieties are only available in one or two villages, the targeting of incentives may become much easier but conservation may become very uncertain. The uncertainty in this case may arise because of the natural hazards or climatic variabilities. Since certain genes can be conserved only or mainly in *in situ* conditions, the conservation design or plan should provide safeguards as much as possible against too narrow base of conservation area.

The monetary incentives are intended to not only provide insurance against uncertainty but also ensure that (a) incentive is not too small per person so that it fails to provide right kind of motivation (b) it is targeted in a sufficiently focused manner to avoid leakages (c) it is amenable to decentralized implementation and monitoring (d) it is complemented with such non monetary incentives that enhance effectiveness, compensate for its lack of consequences and generate sufficient pride among all the conservators. It is possible that no one incentive would fulfill all the objectives of conservation. It is therefore necessary that portfolio approach is used including monetary and non monetary incentives targeted at individuals as well as communities. Each kind of incentive would however, need to be parameterized.

Incentive Models for *in situ* conservation:

Model - 1: Incentive through lottery system:

In this scheme, all the farmers who have grown a land race/farmers variety would be eligible to participate in the lottery. The yield into price product of local variety will be subtracted from the yield into price produce of the high yield variety of the substitute crop hat is potentially possible in the given region. The idea is that if farmer had replaced the local variety with the improved one people would have got some additional income. This income is assured to the winner of the lottery. There are two ways in which the lottery can operate. The first approach is to put the names of all the people who have grown local varieties which are aimed to be conserved on separate chits or lots. If the number is very small then of course there is no need for lottery and everyone is given the differential income. However, if the number is large and amount is limited, in that case ten per cent of the total eligible farmers would get the differential income through the lottery. Next year or next season a lottery can be operated again and once again 10% people should be given incentives. The second approach within the lottery system could be to pick the lots for 10 years or 10 seasons. So that every individual in the village would know as to which year would he/she get incentive payment for conservation. This will reduce the uncertainty and ensure that those whose term is year marked would at least grow designated variety to be conserved, in that year. The weakness of this approach is that area under conservation may be equal to or less than the number of people getting incentive. The possible advantage of the first model is that larger number of people grow the designated varieties to be eligible to participate in the lottery.

Model - 2: Segmenting the conservation area into different niches for different varieties:

The assumption here is that given the high fit between the variety and the condition of the specific plots located in different parts of the watershed, only those people should be given incentives to provide the most favourable niche for the conservation of the particular variety. In this model subsequent segmentation of both the approaches of the lottery discussed in model 1 can be tried.

Model - 3: Fixed area incentive to everybody growing local varieties:

Approach here is to maximize the diversity of conditions under which a crop or a variety or set of varieties that are conserved to preserve the maximum gene pool. Therefore farmers who may be able to take more risk or/are able to grow various eligible varieties in sufficient area at their own larger farm should not corner all the conservation benefits. In this model attempt is to provide some compensation to everybody who grows varieties designated for conservation. The difference in the yield between local and improved varieties is given for 10 or 20 cents area to everybody which means that in 10 hectares under a particular variety distributed over 100 plots of 100 farmers, the benefits can be shared by that many people. It is possible that some of the larger farmers may opt out of this model because of the smallness of incentive. In dryland regions these plots may be spread over large area and some plots may have no yield at all. In flood plain regions these plots may be concentrated in a smaller area. Modifications will have to be done in respective locations. It is also important that every eligible farmer is also covered by insurance scheme to cover the absolute loss, where as the only the differential income is given under the conservation scheme. The reference yield of high yield varieties will be calculated in all the cases by averaging the yields of five fields having such varieties in the comparable region. Therefore if natural calamities have affected the high yielding varieties also, the difference may get reduced but if these varieties are irrigated, grown on better plots and are managed better, the difference may amplified.

Model 4: Conservation through elected champions:

The village community elects or selects three to five farmers either on voluntary basis or through lottery for each crop varieties to be conserved in different ecological niches. Here instead of maximizing the conservation of diversity of the same variety over large locations, effort is to maximize the conservation of number of varieties or crops at fewer locations each.

Model 5: Community level conservation on earmarked common property areas:

The village community or village council takes on lease, a specified area for conserving different varieties of various crops to be conserved. Here, the land owner gets only the lease price prevalent in the region. The scheme provides meeting the entire cost of cultivation to selected farmers or landless laborers who cultivate the leased-in plot and if they make profit after deducting the costs, they retain it. However, if they make losses, then they would be compensated by this scheme.

Model 6: Community level incentive for conserving diversity regardless of area under each crop:

Here, the incentives are given to the village communities for conserving maximum number of varieties and crops regardless of area under each crop or variety. There can be two variants. First in which the award money or incentive is given to he village council to use in which ever way they like, so long as the conservation continues. In the second variant, the awards were given to those farmers who grow maximum number of varieties/crops designated for conservation or to obtain the maximum yield of grains and fodder for respective variety. In the second phase some part of the award may go to the village community also.

Model 7: Travel grants to conservation champions:

In this scheme champions for conservation are selected on the basis of past record and are given responsibility for conserving one or more variety each. They are given travel grants to visit other areas across the country where similar varieties of crops are grown so as to collect germplasm and grow it at their farm. These champions therefore get incentives not only for conservation but also for introduction of local varieties from other regions into their region. The introductions has to be carefully managed in case of cross pollinated crops to avoid genetic mixtures.

Model 8: Incentives through procurement support for designated local varieties:

Procurement support is given to the growers of designated varieties in the specific regions after confirming the characteristics of these varieties. Later the varieties may be distributed under the employment programmes in the same region or may be merged and distributed as food grain under public distribution system.

Many more models can be developed to provide various kinds of monetary incentives tailored to local conditions in such a way that the conservation would be maximized under different combinations of diversity and diffusion of local varieties. The transaction cost of implementing different models will have to be kept in view while selecting them for a specific context. The monetary incentives can include direct payments as mentioned above or through awards to individuals or communities. In addition, **monetary incentives** can also be provided through the following instruments:

a) Traveling grants or fellowships: selected conservators can be provided opportunity to visit research institutions, gene banks, other farmers in different regions to compare notes and select material. They could also use these grants for doing market research in different regions for their varieties.

b) Creating awareness: Festivals can be organized where different farmers (men and women) can be invited to show case the food preparations, varieties for sale and other products to generate awareness, create demand and to promote lateral learning.

c) Mobile exhibitions of agro biodiversity, its preparations, unique properties small samples of seed and folk lore about these varieties, are shared through mobile exhibitions Profiles of the conservators are displayed in the form of posters. For individuals conserving diversity, this is a non monetary incentive but for those promoting conservation, it may be a monetary incentive.

d) Insurance funds can be set up either to pay the premia on behalf of the conservator of designated biodiversity to existing insurance companies or new insurance fund may be created specifically for this purpose.

e) Venture capital funds for investing in getting new product developed through partnership between public and private sector on one hand and farmers whether individuals or groups on the other. The venture of the risk capital would support enterprises at different scales which add value to local germplasm and thereby generated demand locally, nationally or globally. For instance, buck wheat grown in Bhutan has demand in Japan.

f) A small cess or tax be imposed on market arrivals of high yielding varieties in marketing committees or market yards to generate funds for providing incentives for conservation in non green revolution regions. Greatest erosion of agro biodiversity has taken place through pubic interventions through promotion of modern varieties. Given the low seed replacement ratios in most developing countries, a tax on seed may further affect the seed replacement ratio adversely. In any case the volume of seed sale is much lesser in most crops then the volume of crop harvest sold. Therefore the tax on seed will have to be much higher than the tax on market arrivals of high yielding varieties to get the same amount of revenue.

Non monetary incentives for conservation:

a) The recognition of champions of conservation as well as farmer breeders at local, regional, national and international level may provide considerable motivation to those who conserve agro biodiversity. The experience of Honeybee network in this regard has been exemplary. In many cases media took special note of the farmers who were honoured by SRISTI or NIF.

b) The portraits of extraordinary champions of conservation can be hung in public buildings as a mark of respect towards such conservators.

c) Public and private media can highlight the contribution of individuals or communities thereby inspire others to emulate the conservators.

d) Incorporation of lessons in the text books at different levels of education can help in changing the social esteem towards the minor crops and also towards growers and conservators of this crop. The lessons could include information about the nutritive and conservation values of local crops and varieties. For example, most of the minor millets have six to eight times more fibre than wheat, maize, rice, etc. This might enhance the awareness and the demand for these varieties.

e) Some of the outstanding conservators can be invited to educational institutions as well as research institutions for sharing their experiences and thus generating better understanding of their contribution.

f) Public gardens, streets and other places can be named after such conservators to remind the larger society about the subject.

g) Food festivals can be organized in elite hotels and other such places to generate demand among the elite for the products made out of the endangered or threatened agro biodiversity. This is likely to stimulate demand and thus help in generation of market based incentives for conservation. In the case of wines, cheese, honey and many other such products, widespread consumer preference has generated incentives for localized conservation. Geographical indications can also be used for such products to ensure that incentives flow back to those conserving *in situ diversity*.

h) The provisions like gene fund made under Plant Variety Protection and Farmers Rights act should be operationalised aggressively so that users of farmers' varieties for developing commercialized seeds, share the profits with the providers of the breeding material.

i) The cost of generating data to extend the benefits of Plant Varieties and Farmers Act should be borne by the plant variety authority so that economically poor but knowledge rich conservators of agro biodiversity are not deprived of this benefit.

j) The local communities cannot monitor as to which of their land races have been utilized by which seed company for developing new varieties or hybrids. Therefore, they would not be able to submit claims to the National Plant Variety Protection and Farmers' Rights Authority for due compensation. A facility can be created for tracking the pedigree of the new varieties and informing the communities about relevant cases from time to time. This should be done for varieties developed within the country to begin with but internationally in due course.

k) Due to climate change, micro ecological variations caused by localized infrastructure development (such as raised roads without culverts, bunds, dams, etc.) and other factors, farmers may find that their traditional varieties might not be appropriate for the new agro ecological conditions. In such cases, farmers should be able to send a requisition for varieties that might suit their conditions. The agricultural staff from rainfed regions should be advised to monitor such cases, document the description of agro ecological conditions and submit request to NBPGR for appropriate varieties.

l) Under the food for work programme, the workers may be given a choice of buying the local varieties through the food coupons so that demand for the same may increase.

m) Media portrayal of good healthy food should include local varieties so that popular consciousness on the subject gets modified. Film, theatre and print media may be educated on the subject and persuaded to pay attention to this goal.

In this study we pursue following objectives:

i. To understand the changes in the *in situ* agro biodiversity in a few rainfed villages of eastern India over a decade.

ii. To identify the factors responsible for decline or increase in the diversity.

iii. To explore the incentives required for conservation of agro biodiversity using monetary, non-monetary means aimed at individuals as well as groups.

iv. To discuss policy options with various stakeholders at micro and macro level so that the status of agro biodiversity improves in the coming decades despite socio economic and cultural pressures against it.

Chapter 2

Review of literature

Agro-biodiversity – factors and preferences

The taste, texture and diversity of food we eat, as well as its nutritional qualities, depends on the genetic pattern of the local plants and animals. These plants and animals have a symbiotic relationship with their environment and comprise the agro-biodiversity which is the subset of biodiversity.

Brush (1991) defines agro-biodiversity as the interdependent life-support system that helps sustain local eco-systems, that provide, not just food to eat, but also clean water, healthy top-soils, living landscapes, clean air, and even a sink for excess carbon dioxide. Brush adds that it is the product of the application of knowledge and skills used by women and men to develop agriculture, livestock production and aquaculture.

The consumption patterns across the world reveal that only three to four crops (maize, potato, rice and wheat) provide more than half of the dietary energy required by the population. Such dependence is dangerous, since it can lead to pest or disease epidemic, the emergence of new pests and also has implications on the climate and ecology.

United Nations Food and Agriculture Organization (FAO, 1996) estimates show that more than 90 per cent of crop varieties have disappeared from the farmers' fields in the past 100 years. Agricultural plants are continuing to disappear at two per cent a year. Livestock breeds are being lost at five per cent annually. The current extinction rate of species range from approximately 1,000 to 10,000 times higher than natural extinction rates. As a result of these rates of decline, over 50 pollinator species are listed as threatened or endangered and wild honeybee populations have dropped 25 per cent since 1990. Pollinators, including bees, provide free services that have been valued at more than $50 billion annually. The popular reason cited by governments for the decrease in biodiversity is the increase in breed and varietal replacement on farm and the threat presented by the adoption of the genetic engineered varieties (Brush, 1991).

Experiments in Sustainable agro ecology (the option that sustains agricultural biodiversity and food production) have been tried in the more degraded production systems of more than 10 million hectare of land, spread over 51 countries. The increase in yield has been 200-300 percent. There has been a increase of around 10% with reduced use of fertilizers, even in smallholder production systems or fragmented systems. (Brush, 1991).

Scientific plant breeding has definitely been successful as can be seen by the increased production and productivity over the last few decades. But a primary concern has been that this success has contributed to the erosion of the valuable genetic resources. This concern led to the establishment of worldwide system for conservation, consisting of national and international gene banks, where these resources are maintained in *ex situ* conditions. Although the *in situ*[1] approach towards the

[1] On-farm conservation is the continued cultivation and management by farmers of a diverse set of crop populations in the agroecosystem where the crop has evolved or in secondary centre of diversity (Bellon *et al.,* 1997a).

conservation of germplasm was discussed, it was not pursued. Frankel (1970) observed no “steady state” is possible in the population of the primitive cultivars because of the technological change in the farming system that once produced them. This observation errs in two ways, first, it suggests that some sort of steady state existed before the advent of fertilizers, mechanization, irrigation, pest control and crop improvement programs and second, it assumes that landraces are mutually exclusive with new cultivars and fertilizers. Frankel’s conclusion that “farm cannot be simply conserved” laid the foundation for dismissal of *in situ* conservation.

Some other reasons for which *in situ* conservation has been neglected for several years are

- primary reason for neglecting *in situ* conservation was concern over genetic erosion in traditional farming systems (Harlan and Martini, 1936) and the belief that replacement of landraces by modern cultivars is inevitable
- if genetic erosion is novel, inevitable and inexorable, then the only means of preserving crop germplasm would be in gene bank
- farmers cannot be trusted to maintain such valuable resources
- long and tortuous road that germplasm must travel between the field and the breeding station
- there is rapid and uncontrolled loss of germplasm from traditional agriculture due to replacement of traditional varieties by the modern varieties.
- farmer’s conservation methods are rejected because of the assumption that they would condemn certain areas to perpetual poverty for the benefit of others
- *in situ* conservation may prove to be expensive as it requires subsides to make farmer do something that otherwise he wouldn’t have done.
- finally, as long as the short term and immediate benefits are the focus of the scientist in situ conservation approaches will be rejected.

The reasons for lacks of popularity or not adopting on site conservation are several but going by the experience of decades of off-site conservation the advantages from *in situ* conservation of landraces[2] cannot be ignored. Recently, greater attention and advocacy for on site conservation may be due to the realization of the facts that,

- collection of germplasm is a continuous process for evaluation trial. There is loss of collections due to genetic drift (sampling error)
- research in centers of crop diversity has shown that the adoption of improved varieties does not necessarily lead to the abandonment of local, farmer varieties (Brush, 1995),
- diffusion of modern varieties is not uniform, and many areas that are rich in crop genetic resources are bypassed by crop improvement programs (Cleveland *et. al.*,1994). Moreover, the international community has emphasized the need to achieve an equitable balance in the provision for genetic resources and benefits from using them.
- participation by farmers in conservation is part of achieving such equity (Esquinas Alcazar, 1998).

A dynamic form of conservation it allow crop populations potentially to continue their evolution in response to natural and human selection (Jackson, 1995; Pham *et al*., 1996).

[2] The term landrace has been used as a label for local crop varieties that are named and maintained by farmers (Harlan, 1992)

- crop scientists have begun to recognize that the conservation of knowledge systems and evolutionary processes for crop require *in situ* conservation (Frankel et. al., 1996)
- there is a continuous need to collect the germplasm for off-farm conservation and collections inevitably experience loss due to genetic drift and other causes (Wilkes, 1985)
- commonness and rarity are not very well understood for any crop population and so there are all chances of negligence of certain valuable resources.
- evolutionary processes are halted as a result of off farm conservation.
- *in situ* method may be less expensive if methods other than direct subsides are devised.
- on site conservation may compliment for off site conservation especially, for wide range of characters that are outside the breeders current interest.

The value of landraces to the farmers in the developing countries lies in their utility as a dependable source of planting and breeding material. It is, therefore important that locally adapted/enhanced seeds are multiplied for distribution to farmers whose requirements have not been adequately met by modern, high-input cultivars. It may otherwise make very little sense to conserve landraces or may even be difficult to convince farmers to do so unless the landrace conservation activity is oriented towards supporting sustainable production.

Contribution of N. Vavilov and his successors like Harlan and Frankel has to greater extent explained the processes like crop domestication and evolution and their work is essential in identifying the places where, the in situ conservation can be attempted and what evolutionary processes might be included.

Some indigenous people have developed many varieties of every crop, live stock breeds, fish and other aquatic organisms. These provide for every possible social, cultural and economic need and are suited to different ecosystems, climates and pest and disease threats. The biodiversity has remained persistent over generations as a result of selection and improvement in local varieties and livestock breeds, swapping seeds and animals amongst themselves and sharing these with neighbors, etc. The exchange of seeds and breeds across the world has resulted in the vast number of locally adopted varieties and breeds. Maize, which originated in what is now Oaxaca, Mexico, is a staple crop in Africa and Asia, as well as of the America and much of Europe. Apples, which originated in Himalayas now has varieties suited to every community in all temperate regions of the world. Rice came from S E Asia, wheat from the Fertile Crescent, potatoes from Peru, and the humble lettuce has its origin in Slovenia.

Futher, researchers have also documented that small-scale farmers in areas of crop diversity often plant several crop varieties in one season (Brush *et al.*, 1981; Richards, 1986; Dennis, 1987). These farmers have multiple interests or concerns and are confronted with numerous problems in attempting to fulfill them. A single variety cannot have all of the traits demanded by the farm household. Thus, the choice of varieties can be seen as a process by which farmers assemble various traits to fulfill his specific production conditions, consumption preferences, or marketing requirements (Bellon, 1996). There is always a trade-offs in the selection of varieties, and the farmer can change the preference for the traits by changing the allocation of crop area among varieties.

One thus needs to look into the management of crop genetic resources by the farmers through social science research on farming system.

Components of on-farm diversity of crops

Crop genetic components	Environmental components	Management components
Reproductive system Gene flow Genome size	Environmental heterogeneity Risk Isolation	Crop and variety selection Exchange

(Brush, 1991)

All three components entails large amounts of information, different type of analysis and their own research program-theoretical framework and method –to elicit and analyze information pertaining to *in situ* conservation. Selection and crop exchange are the important components of on-farm crop diversity and are the product of the complex factors that combines concerns of the farmer viz., social, economic, ecological and technical. Social research in regions where crop diversity is found indicates that a large number of farmers concerns needs to be considered while understanding selection decisions. "Use of conventional objectives such as maximization to analyze and predict the performance of farmers in centers of traditional agriculture and agrobiodiversity has led to unrealistic expectations of the rapid diffusion of modern varieties and the replacement of local varieties (Frankel, 1970.)". The most common approach to study long-term changes is cross sectional analysis using inter-household comparison. These helps to understand changes under increased commercialization or, the diffusion of technology across heterogeneous social and natural environments. Ideally, time series data can also be used to analyze long-term changes such as population increase, technology diffusion and market integration.

Table: Management of on-farm diversity

Factors in crop and variety selection	Social context of crop management
Production factors Expected yield Input demands **Consumption factors** Cuisine Storage Non-food use Market demand and value **Risk factors** Yield variability Susceptibility to disease Susceptibility to physical stress	**Household context** Labour availability Wealth Farm size Education Market context **Information** Seeds Inputs Insurance Consumer goods Commodity market Policy context Credit Research and extension Price support Market regulation

Bellon (1996) classified concern in crop selection and intraspecific diversity management in to five general categories 1) environmental heterogeneity of the farm, 2) pests and pathogen, 3) risk management, 4) culture and ritual, and 5) diet. These factors are given greater or lesser emphasis based on the influence of social, cultural and environmental factors, government policies and farmers' knowledge.

Study of Andean potato farmers in Peru (Brush, 1991), Mexican maize farmers (Bellon, 1996 and Perales, 1998) and Anatolian wheat farmers in Turkey (Meng, 1997) have highlighted that, environmental heterogeneity is directly linked to the maintenance of the local varieties. In spite of better performances by improved varieties it was observed that farmers still continue to maintain local varieties because of their good performance on marginal lands and may be that the yield advantage of the improved varieties that is observed on marginal lands with few inputs is not great enough to impress the farmers of their higher performances. Moreover, modern varieties may not compete with local varieties under poor input regimes.

Anthropologists and economists have observed that farm management in subsistence economics is affected by the fact that household is the primary unit of production and consumption (Netting, 1993). Households vary in terms of labor availability, wealth, farm size, and education, etc. Differences in each of these characteristics can affect the way that a farmer responds to production, consumption and risk factors. "Thus, a household with abundant labour may accept the demands for prompt weeding associated with short statured, improved varieties; while a household with limited labour may reject them and choose a local variety (Bellon & Brush, 1994)". Farmers who have limited labour and credit prefer landraces of maize against modern varieties which requires weeding and fertilizer in timely fashion.

Production for home consumption (quality or taste) is also one of the key factors in selection. Home consumption takes into account good storage qualities of local varieties that are absent in modern varieties.

Non-food use like animal fodder also plays a vital role in selection decisions, modern varieties are normally bred for short stature to enable then to be responsive to input, in turn they have less biomass and are not fit for animal fodder. Thus, farmers who need to feed livestock on the stubble and straw of harvested grain crops may select local varieties, at least for part of their crop.

Perales (1998) reported demand for blue maize for tortillas by urban tourists or special parching maize in Mexico. In Peru, for instance, farmers continue to grow local potato varieties as part of wages that can be offered to workers and as special gifts (Brush, 1992). Risk avoidance is also one of the major factor that farmer consider while making selection. Stability of the performance as far as mean yield is concerned also plays on the back of farmers mind while selecting the material to be grown. Studies on risk associated with local varieties versus modern varieties have suggested that local varieties may be more stable, especially in marginal and heterogeneous farming conditions (Clawson, 1985; Meng, 1997), but this findings may not hold true for other crops and regions (Anderson & Hazell, 1989).

Markets can alter the context of farm management by allowing the farmer to purchase substitutes for factor of production, to purchase inputs, and to avoid risk. Thus a farmer faced with marginal and heterogeneous land may be able to purchase fertilizer and irrigation or crop insurance to overcome adverse conditions. Decline in subsistence production and on-farm diversity has been accompanied by the development of market information, seeds, farm inputs, and commodities in the industrialized countries. Lack of market for specific variety may encourage *in situ* conservation.

On-farm selection accounts for an important segment of diversity in a particular farming system, but exchange between farmers and between farming regions is also important. Studies on cereals in Southeast Asia, maize in Mexico and potato in Peru, indicate that the respective crop populations are characterized by a small number of varieties that are both abundant and widespread than a larger number of minor varieties that are rare and local. The pattern of dominance by a few varieties derives from a pattern of selection and exchange among farmers and has important implications for the diversity of crops and for *in situ* conservation. Further, research on the maintenance and production of landraces in cradle areas of diversity has consistently showed that farmers exchange seed within and between villages. The amount of seed exchanges may be relatively small but can accumulate to a complete mixing of the stock of varieties and their genetic material. To farmers, exchange within and between villages is a part of the conscious (artificial) selection of varieties that leads to the dominance of relatively widely adapted landrace varieties, not only in the inventory of a single farm but also within villages and across regions. This picture of landrace population's contrasts with an earlier view that landraces are stable and narrowly adapted to local conditions (Harlan, 1992)".

Need for *in situ* conservation

One of the characteristics of modern agriculture has been the planting of large areas with uniform cultivars. This makes the system vulnerable to sudden yield limiting factors like a disease epidemic. For instance the leaf blight epidemic in southern corn in the US in 1969-70, Irish famine in due to late blight of potato in 1845-49, etc. The new varieties may not be as dependable as the ones that have been replaced by them as it has been greatly appreciated that the in the traditional varieties, the genes to provide resistance to the host against the biotic and abiotic stresses are usually present. *Ex situ* conservation removes crops from their cultural-ecological context and cannot conserve the sources of crop genetic resources

Further, several research studies have shown that the distribution of the improved varieties is uneven and it has been slowed by the environmental factors that are not easily overcome by the centralized breeding programs. Moreover, socio-economic factors such as decreased availability of farm labour due to migration and off-farm employment have also contributed to the uneven distribution. A study of Andean potato diversity in Peru shows that farmers don't conceive of simply replacing native types with improved ones. Rather, the common strategy is to grow both native and modern types and to keep as much diversity in the native category as possible. The study on *in situ* conservation also shows that adoption of modern varieties has not displaced local/traditional varieties. On site conservation of traditional varieties occur even as the farming system changes and modern varieties are adopted. These may be primarily due to the high association of the landraces with the ecology and environment where they are grown. If the adaptability is taken into consideration, on site conservation of landraces cannot be accomplished in isolation in biological reserves; rather it will only be accomplished by encouraging farmers to continue planting landraces and giving them as much importance in conservation program as scientists and bureaucrats .

Incentive models

Iltis (1974) proposed a model of *in situ* conservation "reserve in which neither changes in cultural practices nor introduction of foreign material is permitted" i.e., fixing the genetic structures and the growing environment as the case in *ex situ* conservation.

In situ conservation relies on the continued maintenance of germplasm resources by the farmers in agricultural habitats. For successful implementation of *in situ* conservation complete understanding of both crop populations and the farming system that produces it, is needed. These require stimulating active cooperation between the farmers and the conservationists. Moreover, it should be complimentary to the prevailing conservation strategy and should not compete with it. It also should share the common institutional framework and must be politically viable (i. e. it must satisfy broadly set development goals and this depends on the acceptance by several interest groups besides geneticists and conservationist: farmers, consumers and government officials).

The Ethiopian study on *in situ* conservation suggests that, the best way to achieve this is probably through community based seed production or marketing and distribution systems operating in networks. Enhancing or further organizing the traditional networks could possibly develop them. Through this approach, the farmers will be able to control the choice of crop types and cultivars and also have ready access to the planting material adapted to their local growing conditions. They will also be able to evaluate on their own the relative merits of a wide range of cultivars, thereby limiting the undue spread of the exotic cultivars that are costly and have poor adaptability. The example of such a network that has been developed in Ethiopia is provided:

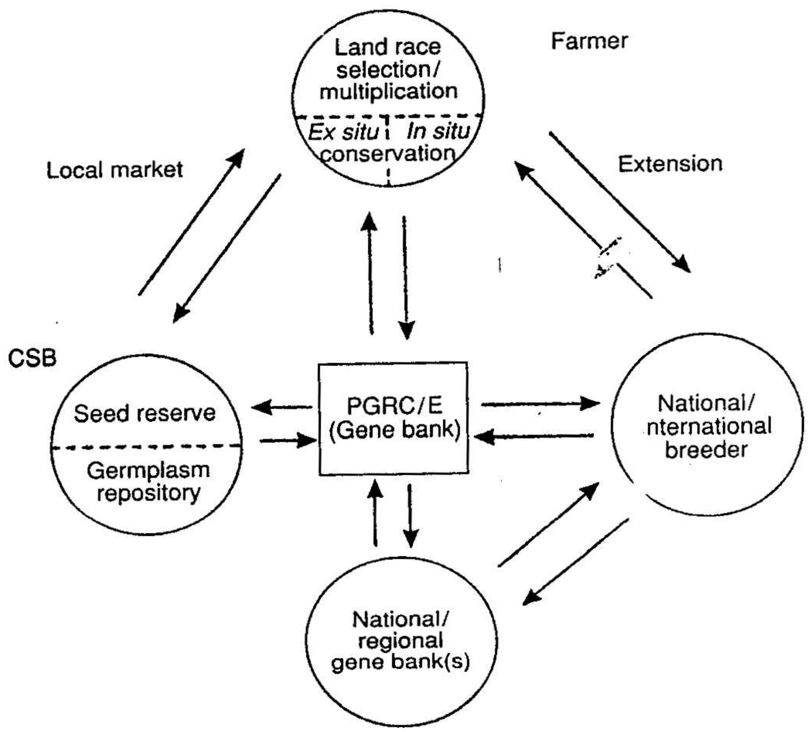


Figure: A network of seed conservation, selection (enhancement), multiplication and utilization activities in Ethiopia. CSB = Community Seed Bank; PGRC/E = Plant Genetic Resources Centre/ Ethiopia.

The community seed Bank is a low cost and low technology system that will be owned and managed by local communities involving existing community service cooperatives. It comprises two major components – a seed store and a germplasm repository – for local crop improvement, complementing the gene bank at PGRC/E. The seed store represents a seed reserve system (largely represented by land race materials developed or multiplied contractually by the farmer) that will provide back up to the local (informal) market network, where farmers traditionally exchange seeds and information. The seed reserve that the CSBs maintain becomes crucial to ensuring a sustained supply of adapted seeds to farmers, channeled through the informal market system, thereby averting the risk of losing diversity. The detailed case study is presented at the end of this chapter

Based on the various studies on farming systems where *de facto* on site conservation is occurring **five guiding principles** that can be drawn are:

- **Complementarity:** *In situ* conservation should enhance the sustainability of *ex-situ* storage by preserving germplasm and habitat that generate new germplasm. On site conservation should not be treated as an alternative or competitor to off-site methods, but rather a back up to the existing gene bank strategy.
- **Minimalism:** *In situ* conservation strategies should encourage activities that are already found in farming systems but which may fade under changing social, economic and environmental conditions.
- **Continuity:** Existing institutions and incentives should be reinforced, rather than create new ones.
- **Development goal:** Conservation of farmers must be strengthened by agricultural development policies that enhance incentives to continue to maintain germplasm resources.
- **Internationalism:** Crop germplasm is an international public good hence its conservation should be supported through international means (i.e. collaborative approach of international, national and regional programs).

Components that are of prime importance is implementing in situ conservation are

Institutional framework: *In situ* conservation is dependent on farmer's participation and, therefore, must rely principally on national agencies. "An obstacle in involving national agencies has been the assumption that *in situ* conservation is antithetical to their primary development goals. Financially strapped national agencies in LDCs are likely to see *in situ* conservation as a luxury that they cannot afford or as a benefit for other countries. Steps towards development of institutional framework as suggested by Brush in his study during 1991 are:

- **Developing institutional framework for *on-site* conservation** to establish a clear international mandate to specific institution to serve as international centers for crop germplasm conservation. Conservation agencies like IUCN and IARCs of CGIAR need to rise above their basic goals in conservation and expand their conservation role to include such things as monitoring wild and landrace population besides working collections. "IBPGR recognized the need for the expanded role in their call for eco-geographic monitoring (IBPGR, 1985) but, they have not moved aggressively to fill the need for data and analysis"

- **Designating an international institution with the responsibility of monitoring world collections**. Because of the international, public good nature of germplasm resources, an international agency are more appropriate than the national agencies are as national agencies lack incentives and means to conserve collections and may lead to moves that nationalize germplasm to restrict other nations. IARCs are seen as the logical candidates for the role but, they do not have sufficient scientific and financial resources to undertake this new role. IARCs taking up this role have to assets firstly, "it will increase their potential for sustainable agricultural research through maintenance of exotic germplasm that may have future value, and secondly, it may enhance their applied breeding program by providing information on agro-ecological zones or crop habitats".
- **Engage national and regional agencies in *on farm* conservation activities** as these are necessarily to be implemented at the local levels. The task of designing and implementing policies to stimulate conservation by farmers and monitoring crop populations and agro ecosystems logically falls to National Research Programs (NARs). NAR scientists are having the clear knowledge of genetic resources, the factors that affect them locally, and with the needs of farming system where they are produced. NARs also maintain regional germplasm collection and data bank on agriculture, and these are very important in the view of where to implement the in situ conservation program. " In addition to international and national agencies, Non Governmental Organizations (NGOs) and Private Voluntary Organizations (PVOs) are also essential to the success of *in situ* conservation. Local organizations may include marketing co-operatives for traditional varieties or cultural heritage groups as these groups have closer association,much greater ties and better access with farmers who, produce traditional varieties. They are likely to need some extramural support, perhaps channeled through national commodity programs. Linkage of these groups to National Commodity Programs concerned with policy and international centers is also extremely essential. International development assistance to link conservation minded NGOs in less developed countries with their counterparts (e.g., seed savers/SEARCH) in developed countries would also be beneficial. Two institutional levels are necessary for building and maintaining an information base for *in situ* conservation. (1) Existing international research programs, such as IARCs of the CGIAR, might take the lead in designing data bases and their information processing methodology. (2) National agricultural universities and commodity programs in areas of crop germplasm richness should be supported through international development assistance to assemble and maintain the database that is specific to a crop and its farming system. These two levels are necessary because of international public good nature of crop germplasm resources and because of the localized nature of the necessary data.

Concept of on farm conservation can be examined

- **Market incentive** for conservation can be strengthened by improving market system for local varieties like transportation, wholesale marketing at low interest loans, education and public relation campaigns aimed at retailers and consumers, etc. and through lowering the unit cost of production of traditional varieties through research on fertilizer use, tillage and phytopathology can be reoriented to deal with mixed seed lots rather than uniform ones.
- **Removing disincentives** created by national agricultural and food policies, This may include tying agricultural credit to use of modern varieties, the provision of subsidies etc. For instance, in Peru, rice is subsidized while potato is not.

- **Support for** grassroots organizations and support for events like agricultural fairs and expositions that award farmers for production and display of diversity in traditional crops can be encouraged. Model gardens and farms at agricultural colleges and schools and in could be supported in part by tourism to "historic farms". In North America and Europe, local "seed savers network" have been organized to preserve heirloom and locally important varieties. This effort has been mostly done without public support. In less developed countries in areas of diversity, seed savers networks might be organized through non-governmental organizations such as farmer production cooperatives and cultural preservation organizations. Private interests in LDCs, such as speciality produce wholesalers might also take an active interest in organizing or supporting seed saving and exchange programs.

Case Studies
CASE:ONE ⟶ ETHIOPIAN AGRICULTURE

The indigenous land races of the various crop plant species, their wild relatives and the wild and weedy species that form the basis of Ethiopia's plant genetic resources are highly prized for their potential value as sources of important variations for crop improvement programmes. Among the most valuable traits that are believed to exist in these materials by the cultivators of this diversity are earliness, disease and pest resistance, nutritional quality, resistance to drought and other environmental stresses, and various other characteristics. The cultivators believe that these are the attributes which make this diversity special for use in low input agriculture and under marginal and diverse growing conditions. Besides this, such diversity also provides the farmers an opportunity to exploit the full range of country's highly varied microenvironments, differing in characteristics such as soil, water, temperature, altitude, slope and fertility. The wide variety of plant and animal species provides material for food, fibre, medicine and socio-economic uses : thus this diversity is also crucial to sustain current production systems, improve human diets and maintain life support systems, essential for the livelihood of local communities. In Ethiopia, peasant farmers always retain some seed stock of numerous crops, using safe storage mechanisms, for security reasons unless unavoidable circumstances prevent them from doing so. "Individual farmers often store seeds in clay pots and rock-hewn mortars or underground pits which are sealed, buried or stored in other secure places" (Worede and Hailu, 1993). The length of storage may vary based on the need or circumstances (like unanticipated social events like a daughter's wedding). It can go up to seven years. In times of famine, farmers even bury their seed in some secured place within farm premises (communally or at the household level) before they migrate to other regions, returning to reclaim and plant the seed after the drought is over. Ethiopian farmers have been instrumental in creating, maintaining and promoting crop genetic diversity through a series of other longstanding activities which include intercropping and cropping with varietal mixtures which result in rapid diversification due to introgression from accidental crosses (e.g. *Brassicas*); promoting the intercrossing of cultivated crops with wild or weedy relatives, which results in new characteristics (e.g. *Guizotia abyssinica*); identifying and propagating new, mutant types which occur in their fields, or hybridization between wild and/or cultivated types, or cultivars obtained from exchange; diffusing both crop varieties and knowledge through local seed exchange networks; growing a diversity of local varieties of crops (e.g. *Coffea arabica*) preserved in small areas alongside new, improved/introduced varieties; making available their knowledge and skills in identifying, collecting/rescuing and utilizing plants which they have helped to develop and maintain for generations (Worede, 1992). This valuable wealth of Ethiopia is now being subjected to serious genetic erosion and irreversible losses.

The threat involves the interaction of several factors like displacement of indigenous landraces by new, genetically uniform crop cultivars, changes and development in agriculture or land use, destruction of habitat and ecosystems, and drought and famine, which has forced farmers to eat their own seed in order to survive or sell the seed as the food commodity.(This often resulted in the displacement of the local varieties by the exotic stock provided by the relief agencies). While in few crop species like sorghum, legumes and oil crops where displacement does not plays the major role in erosion of the native stocks, genetic erosion is progressive on account of extensive use of this wealth in breeding programs. There is a need for research to conserve this valuable wealth, to sustain the evolutionary systems (environmental stresses) that are responsible for generation of genetic variability. Under the extreme environmental conditions landraces provide suitable base material for crop improvement programs.

Work has recently begun in Ethiopia to develop farmer based conservation activities through two major approaches: Conservation and enhancement of land races on farm and maintaining elite indigenous land race selections on peasant farm (Worede, 1992).

Conservation and enhancement of land races on farm: This approach has the active participation of the farmers, scientist and the extension workers and was started in 1988. The approach is aimed at conservation measures designed, primarily, to maintain on-farm diversity of crop in areas where they are widely grown and also improving their genetic performance. Material collected during drought in the area is included in the program. The land races are maintained on each peasant farm, exclusively following the traditional practices of selection, production (including weed management), storage and utilization. The particular site would vary each season based on the traditional cropping pattern, which involves the various crops grown in rotation on the farm. The plot size and seed rates employed are those already established by the farmers over centuries of planting of their land races. For each crop, the farmer, depending on need, amount of seed and labour available, and method of seeding and soil type, determines this. The rationale for this is the fact that this is how the farmers have maintained diversity of land races as they exist now, thus providing the basis for a sound and viable approach to conservation. Farmers involved in this, simultaneously, also carry out the crop improvement using traditional approaches like mass selection. This also provides an opportunity for transferring genes that control characters of interest (e.g. disease/pest resistance, high lysine in sorghum, and drought tolerance) from existing selections or from external sources, to enhance the elite populations. Farmers are paid on a contractual basis for conserving and multiplying land race materials, and elite land races are distributed to local farmers in the region. The rates are determined on the basis of additional input (labour and various costs) incurred.

Maintaining elite indigenous land race selections on peasant farm: This approach aims at restoring land races to regions where they were once widely grown and have been now displaced by new varieties following traditional low-input farming practices. These populations are subjected to modification by mass selection based on performance in yield tests under different conditions of environmental stresses. Samples of these elite lines are sent for the long-term storage at the gene bank. This encourages farmers to make continued and effective use of superior germplasm and avoids the treat of losing unexplored germplasm.

Future perspectives in *in situ* conservation is considered a viable and vital component of the nationals overall conservation strategy, complementing the existing off farm *(ex situ)* conservation practice;

- it is participatory, involving farmers and their long-established skills and knowledge of land races;
- it is dynamic, allowing continual evolution and generation of useful germplasm;
- it is relatively inexpensive considering the amount of potentially useful material preserved; and, together with *ex situ* conservation,
- it would provide a mechanism by which germplasm resources are protected and more effectively utilized on a long term basis.

With each crop species farmers spread their risk across time, space and the diversity of the material they grow and this occurs at the levels of the farm household, communities and regions where they exchange or diffuse their material and information about their seed, which may account for the wide range of adaptability as well as the plasticity inherent in these material.

It was essential to plan a correspondingly wide network of *in situ* conservation sites, taking all these factors into consideration. This needs to be supported by more extensive research relating to the genetic, ecological and social dynamics of land races.

CASE: TWO ⟶ MARAGWA SEED SHOW

Drawn from: http://www.ukabc.org/abc.pdf

Maragwa is an isolated place with no road network and the only mode of transportation is by foot. The Maragwa Seed show is the part of the farmer to farmer extension activities, within the framework of the Participatory Technology Development (PTD) approach, of the on-going Marginal Farmers' Project, supported by Intermediate Technology, Kenya. IT Kenya has been supporting the Locational Development Committee (LDC) of Maragwa location to host these show to strengthen the existing systems used by farmers to save, acquire and exchange seeds and also share information and their experiences on farming in local conditions. Farmers not only display their seeds, indigenous foods and farming implements, but also a cultural show, where there are performances of traditional songs and dances promoting seed security and crop diversity. The farmers come to the seed show from as far as 20 Km in search of the varieties they desire (early maturing, high yielding, resistant/tolerant to biotic and abiotic stresses and many other characteristics). They find this type of village level or ward level seed shows held within the boundaries of the communities with the similar climatic conditions, culture, vegetation and soil type to be useful for acquiring useful crops seeds. There is a belief amidst the farming community that the farmers who regularly participate in the seeds shows not only acquire new and better crop varieties but also become committed to the process of community-capacity building, like Manduru and Maudumu self-help groups in Maragawa location, which initiate seed banking activities. The members of the Maragwa LDC feel that as a result of the interest of the outsiders in the seed show there is an addition of value to their traditional crop varieties.

To list one of the many success stories, Elizabeth, one of the visiting farmers, had obtained the varieties of the crop in the seed show which outstripped the yield of the traditional varieties by two to three times. Asked if she would discontinue the cultivation of the same she responded that she will still persist on the old varieties under some stretch of land as they possessed some desirable qualities such as good storage and taste, which is lacking in the new varieties. Also by cultivating both the varieties she can enjoy comparative advantage. There are certain varieties that were given to her by her grandmother on the occasion of her wedding and by discontinuing them she will be cursed as she had learnt all the skills from her grandmother and would like to pass on the same to her children.

At the seed show, stands are setup for exhibition. These stands are judged on the basis of general quality and diversity of seeds (stands with highest diversity between and within crops scoring highest), diversity in cereals and diversity in pulses and also on general presentation and arrangement of seeds and prizes are awarded. The show is open for the public once the judges have gone around the stands. The judges comprise of 4 agricultural officers, 3 farmers from outside Maragwa community and 3 project staff of ITDG – Kenya's Marginal Farmers' Project. At the

Maragwa seed show in 1999 there were 47 exhibitors, a decrease from the 56 that participated in 1998. But there was significant increase in between and within diversity of the crops.

In the Maragwa Seed Show held in 1998, displays were mounted by 29 women and 47 men as well as some community groups. Women farmers had more seed varieties than men and the grand prize for the best quality of seeds and stand with the highest number of crop varieties was won by Gakia Seed Banking Group. The total number of crop varieties displayed increased in 1998 to 149 from 134 in 1997. More varieties of sorghum and cowpeas were recorded in 1998 than in 1997 on more than 35 stands. KARl's Mtama 1, a sorghum variety introduced about three years ago, featured in all stands in 1998, compared with only two in 1997 and 1996. Also in 1998, the Atilano variety of cowpeas was displayed by 22 farmers compared with only 2 the previous year. The more traditional and popular cowpeas varieties of mugeta, kaguru and itune were displayed on all stands. There were more displays in 1998 of yellow and black grams.

CASE: THREE ⟶ SEED FAIRS IN ZIMBABWE AND KENYA
Drawn From: Conserving And Promoting Agricultural Diversity
http://www.ukabc.org/itdg_weboflife.pdf

Seed fairs are increasingly popular events for promoting diversity. African interest in these was rekindled by exchange visits in the 1990s between Zimbabwe and Peru, where seed fairs are a traditional, spiritual and cultural mechanism for keeping seed diversity alive. Zimbabwean Seed Fairs are now annual events in many villages and the word spread to many countries throughout the continent. This has been achieved by informal information exchange, publications and through some formal NGO networks, such as PELUM. In Tharaka, Kenya, for example, they are called Seed Shows and have been held annually since 1996, when they were initiated by ITDG. In 2001, 46 farmers displayed 206 varieties. Participants like seed shows for many reasons: farmers can obtain rare crop varieties; they identify seed sources; it is a good forum for exchange of ideas on farming and exchange of seeds; farmers are exposed to national agricultural research work; the spirit of competition boosts farmers' morale and motivates farmers to diversify their crops, indirectly enhancing food security; and it is a venue for interaction between farmers, students, researchers, extension staff and other development agents..

CASE: FOUR ⟶ MAIZE IN VALLEY OF CUZALAPA

The study by Louette (1994) in valley of Cuzalapa was basically aimed at finding the extent of genetic diversity as a result of management of materials strictly of local origin in maize, and the association between introduction of varieties with the loss of genetic diversity over a period of three years consisting of six cropping cycle of maize. The variety was considered 'local' if it was in cultivation for at least one farmer generation (more than 30 yrs of if farmer maintains that "my father used to sow it", 'foreign' refers to recent introduction or by episodic sowing in the valley and 'landraces' as farmers varieties which have not been improved by formal breeding schemes. Of the total 26 varieties, 6 were local and occupied 80 % of the total study area and remaining 20 were classified as foreign (farmers (15); farmers advanced generation of improved varieties (4); and recent generations of improved varieties (1)) and most of the foreign variety accounted for less than five per cent of the total maize area planted in each season. Moreover, only three foreign varieties were cultivated regularly in the previous four or five years by significant number of farmers i.e. 10

–12 %. The selection of the planted material over all cropping seasons indicated that the farmers selected nearly half (45%) of their seeds from their own harvest; 40% of the seed lot from other farmers in Cuzalapa and 15 % were introduced from other regions. The study also identified three categories of farmers: farmers who use only their own seed lot and modify the proportion of area planted under each variety, called as *suppliers of local seeds*; farmers who use their own seed lots as well as seed acquired in the community or introduced material, and proportion of seed vary from season to season depending on the objectives and constraints of the farmer and farmers who never used seed from their own harvest and recourse to seed acquired within and outside the Cuzalapa community. Another interesting outcome of the study was that there was correlation coefficient of 0.5 between number of varieties per cycle and proportion of farmer's seed stock from their own harvest. In general, farmers who have more recourse to seed produced by other farmers appear to plant fewer varieties per cycle. The group of farmers who sowed more than 90 % of their crop with seed from their own harvest planted an average of 2.6 varieties per cycle, while those who used no seed from their own harvests planted an average of only 1.3 varieties per cycle. This finding may reflect either a greater reliance on diverse maize types by more conservative farmers or it may reflect that searching for seeds from other farmers require more effort and is therefore associated with fewer varieties sown.

The study also identified some factors for seed exchange and these included traditional methods of seed storage that does not permit longer storage due to pest attack, socio-economic status of the household, custom of Cuzalapa region of producing maize under sharecropping arrangements, (under this arrangements, the partner generally supplies labour while, the field owner supplies the inputs). Generally the partner does not choose which variety to plant, and at harvest time acquires seed from the owner. The study also strongly indicates that a small group of local varieties are continuously grown by the farmers, while the varieties with diverse origin, morphological differences and different from the local varieties succeed each other over time. Foreign varieties are taken for testing by the farmers and may at time be incorporated in to the group of local varieties if they satisfy the needs of the farmer that are not at present satisfied by the local varieties and rather than replacing local varieties they occupy small portion of the planted area. The study suggests that the traditional systems are not close and isolated with respect to flow of genetic material. The study shows that over three years alone, in a traditional farming system located in what some regard as the geographical center of origin for maize, introduced materials represent a substantial proportion of the maize seed planted. The study further shows that local varieties are not generally the product of exclusively local seed selection and management, because farmers exchange seed of local varieties with other farmers within and outside the region.

Chapter 3

Area of study and methodology:

In view of the existing benchmark data of a few villages in Faizabad district of eastern Uttar Pradesh, it was decided to revisit the same villages after a decade. The earlier study was done in collaboration with Acharya Narendradev University of Agriculture Technology (NDUAT) during 1988-89. Village maps were prepared documenting the nature of diversity as well as some other agro ecological features. Five villages had been selected for sample study on the basis of diversity of land types and agricultural varieties. Three of these five villages were studied during earlier research in 1988-89 viz., Isoulibhari, Kharella, Shivnathpur. The older village Shivnathpur is situated adjacent to the university farm and has majority of the medium upland fields. One of the new villages viz., Bhogai Tiwari Ka Purva is also medium upland village located adjoining the university. The other three villages, Isoulibhari, Kharella (older villages) and Pithla (new village), or medium low land villages.

The villages Shivnathpur and Kharella are combined under Shivnathpur group panchayat. Likewise, Pithla and Bhogai Tiwari Ka Purva are combined under Pithla group panchayat. Most of the villages are located within 2 – 4 kms. of the Agricultural University campus. In fact, land of Shivanathpur and Pithla are partly covered under the university campus. All these are very small villages with area ranging from 25 – 75 hectares except Bhogai Tiwari Ka Purva which has only about 17 hectares. Except Isoulibhari and Pithla where Yadhavs and Thakurs are dominant, other villages are dominated by Bhramins. Only in Pithla and Isoulibhari have significant population of SC, ST and OBCs.

Literacy levels are quite high ranging from 62 – 84 per cent among males and 34 – 75 per cent among women. Shivnathpur has the highest literacy level.

Crop diversity:

The predominant soil types in all the five villages are sandy loam, loam, clay, and alkaline wasteland. The land use pattern indicates very small area as uncultivated and the average size holding also very small. The cropping diversity is given in table – for rabi, kharif and summer season. The village Isoulibhari has the maximum diversity with almost similar pattern in other villages. Wheat, sugarcane, mustard, pigeon pea, lantil, potatao, barley, berseenm are the most common crops. It is obvious that social and cultural diversity of these villages has had less to do with the agrobiodiversity. It is essentially, the ecological characteristics which have defined the contours of agrobiodiveristy.

Characteristics of sample:

We had selected 123 farmers from five villages as given in table 2.1 with land holding pattern given in table 2.2, livestock ownership in table 2.3, family size variation in table 2.4, educational profile in table 2.5, irrigation endowment in table 2.6, and diversity in other sources of income in table 2.7. Majority of the farmers have less than one hectare land, three to five animals, five to eight family members and have studied only up to primary class. Given the uncertainty in electric supply, most

FIGURE 1: LOCATION MAP OF VILLAGES SHIVNATHPUR

Village: Shivnathpur
Block: Milkipur
Tehsil: Bikapur
District: Faizabad (U. P.)

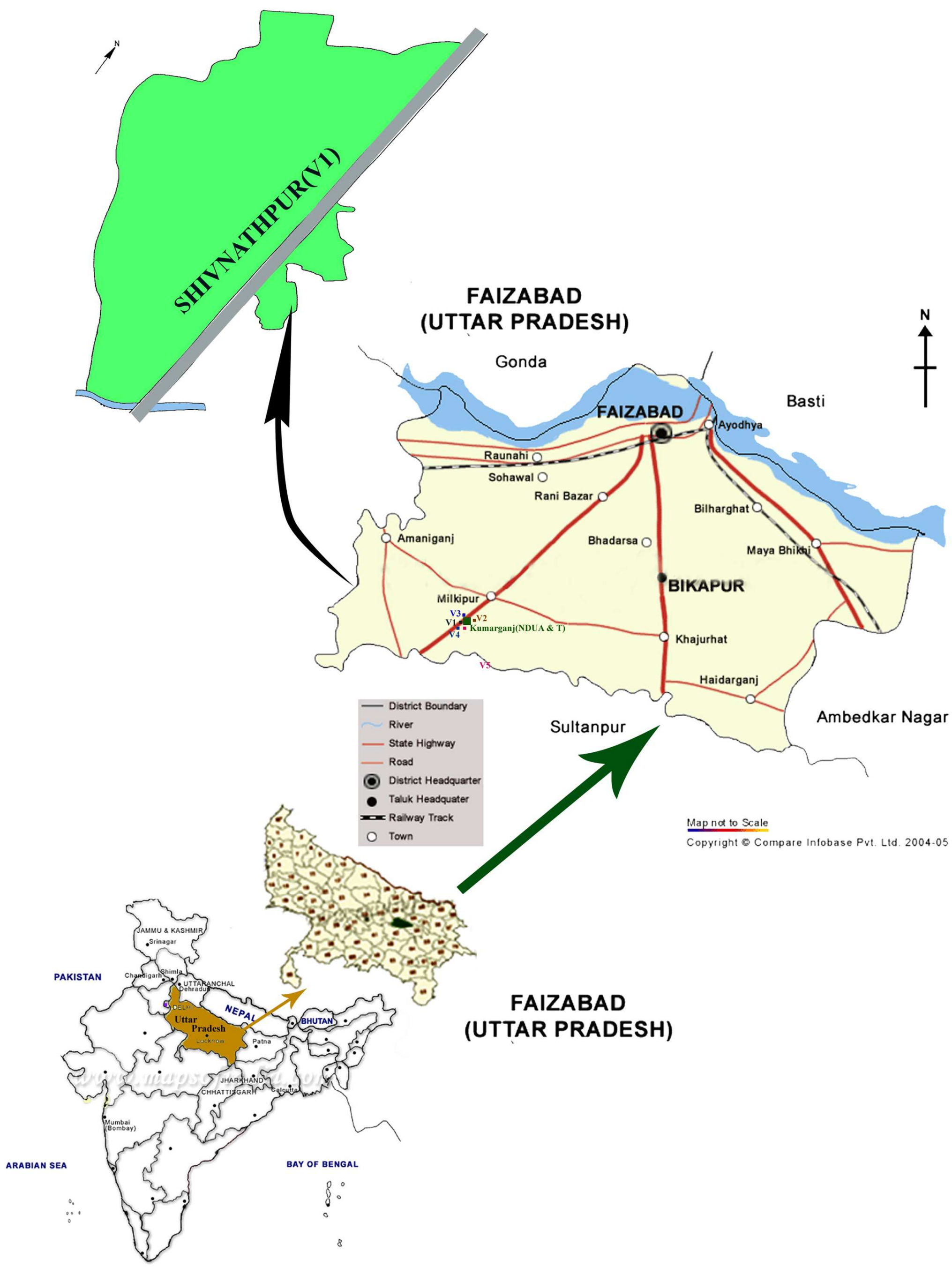
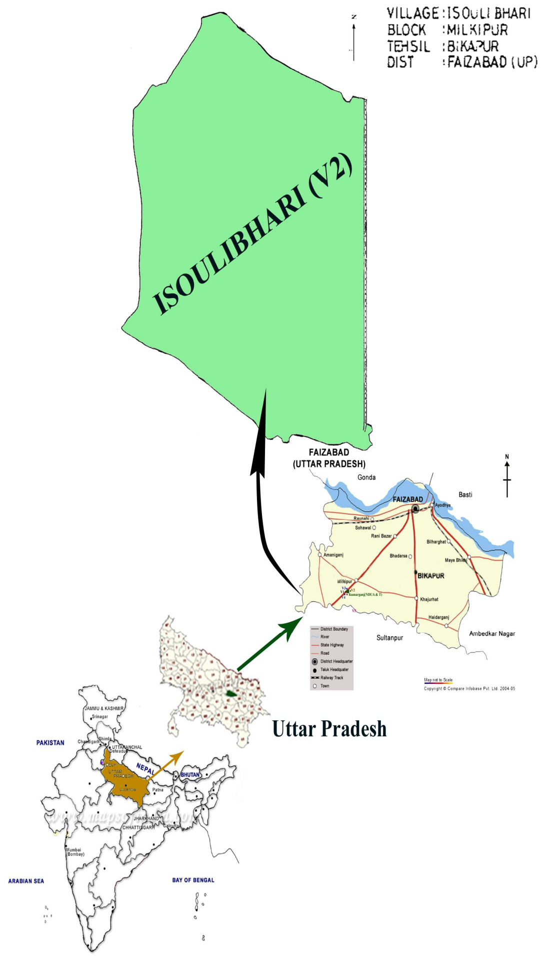
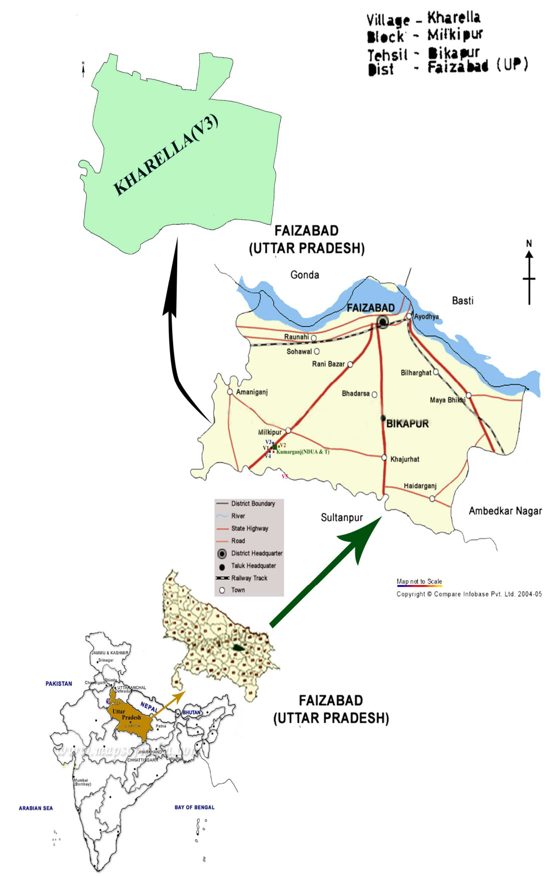


FIGURE 2 & 3 : LOCATION MAP OF VILLAGES ISOULIBHARI AND KHARELLA





people either rent the irrigation facility or use diesel engines except in Isoulibhari and Bhogai Tiwari ka Purva. Since perception of uncertainty and consequent choice of technology in agriculture is influenced considerably by the regularity in income, it is important to note that majority of farmers in the sample do not have any regular source of inward remittance and rely primarily on labour. If there was a similar ecological endowment and only parameters of this variable were to change, we could expect significant difference in the outcomes.

TABLE 2.1: VILLAGE WISE NUMBER OF HOUSEBOLD SURVEYED

Sr. no.	**Name of the village**	**Household surveyed**
1.	Isoulibhari	31
2.	Kharella	21
3.	Shivnathpur	23
4.	Pithla	25
5.	Bhogai tiwari ka purva	23
	Total households surveyed	**123**

TABLE 2.2: DISTRIBUTION OF LAND HOLDING UNDER FOR THE SAMPLE UNDER STUDY IN VARIOUS VILLAGES (2002-03)

Sr.	Size of holding	Village (No. of Households)				
		Isoulibhari	Kharella	Shivathpur	Pithla	Bhogai tiwari ka purva
1.	< 0.25 ha.	7	3	7	4	10
2.	0.25 – 1.00 ha.	20	13	11	17	7
3.	> 1.00 ha.	4	5	5	4	6
	Total households	31	21	23	25	23
	Mean	0.56	0.68	0.73	0.72	0.72
	Standard Deviation	0.45	0.36	0.59	0.64	0.66
	CV %	79.82	53.42	81.23	88.67	92.61

TABLE 2.3: DISTRIBUTION OF ANIMAL HOLDING UNDER FOR THE SAMPLE UNDER STUDY IN VARIOUS VILLAGES (2002-03)

Sr.	Animal holding	Village (No. of Households)				
		Isoulibhari	Kharella	Shivathpur	Pithla	Bhogai tiwari ka purva
1.	2 Animals	15	3	8	1	5
2.	3 – 5 Animals	10	9	11	16	13
3.	> 5 Animals	6	9	4	7	5
	Total	31	21	23	25	23
	Mean	2.90	4.48	3.74	5.00	3.83
	Standard Deviation	2.15	2.04	1.98	1.50	1.87
	CV %	74.14	45.54	52.94	30.00	48.83

TABLE 2.4: DISTRIBUTION OF FAMILY SIZE UNDER VARIOUS VILLAGES (2002-03)

Sr.	Size of Family	Village (No. of Households)				
		Isoulibhari	Kharella	Shivathpur	Pithla	Bhogai tiwari ka purva
1	Upto 4 members	3	2	2	2	1
2	5 – 8 members	19	17	15	19	16
3	More than 8 members	9	2	6	4	6
	Total	31	21	31	25	23
	Mean	7.77	6.76	7.65	6.88	7.04
	Standard Deviation	2.94	1.70	3.51	1.86	1.97
	CV %	37.84	25.15	45.88	27.03	27.98

TABLE 2.5: EDUCATIONAL PROFILE OF FARMERS UNDER SURVEY IN DIFFERENT VILLAGES (2002-03)

Sr.	Education	Village (No. of Households)				
		Isoulibhari	Kharella	Shivathpur	Pithla	Bhogai tiwari ka purva
1	Illiterate	12	7	8	8	8
2	Primary	13	6	7	11	7
3	Matriculation	5	4	5	5	6
4	Above matriculation	1	4	3	1	2
	Mean	1.84	2.24	2.13	1.96	2.09
	Standard Deviation	0.82	1.14	1.06	0.84	1.00
	CV %	44.57	50.89	49.77	42.86	47.85

TABLE 2.6: IRRIGATION TYPE PROFILE OF FARMERS UNDER SURVEY IN DIFFERENT VILLAGES (2002-03)

Sr.	Irrigation	Village (No. of Households)				
		Isoulibhari	Kharella	Shivathpur	Pithla	Bhogai tiwari ka purva
1	**NOT OWNED**					
	Rented	7	4	4	5	3
2	**OWNED**					
	Diesel	5	12	18	9	4
	Tube well	18	5	1	9	14
	Missing	0	0	0	2	2

TABLE 2.7: SOURCES OF OTHER INCOME TO FARMERS UNDER SURVEY IN DIFFERENT VILLAGES (2002-03)

Sr.	Income Source	Village (No. of Households)				
		Isoulibhari	Kharella	Shivathpur	Pithla	Bhogai tiwari ka purva
1.	Daily labour (Casual)	10	13	4	10	4
2.	Milk Sale	0	0	1	1	2
3.	Job (Permanent)	1	1	4	0	2
4.	Milk sale + Job	4	1	2	5	1
5.	Milk Sale + Job	2	0	0	0	2
6.	No other source	10	13	4	10	4
	Missing	1	0	0	1	1

Chapter 4
Summary of findings

The loss of agrobiodiversity over time and space is well known. What is less well understood is the degree and direction. For instance, what are the characteristics of the varieties which disappear or continue in different contexts. To what extent, can public policy be tailored to encourage conservation of those land races which might not find favour on their own. Some which are surviving may also disappear if the factors in their favour disappear in future. For instance, if good varieties are developed for low lying conditions, then local varieties from such conditions may disappear. Likewise, due to late withdrawal of flood waters in eastern India, if the late sown local varieties are replaced by modern varieties, then also these will disappear. Unless there are food processing or nutraceutical properties in some of the varieties, the market based incentives may be difficult to generate. The cultural reasons have had limited effect in sustaining these local varieties.

Decadal variation in agrobiodiversity:

Over a decade during 1988-89 and 2002-03, as shown in table 3.1, out of 14 local rice varieties, only four were still under cultivation in three villages. Among the improved varieties of rice, out of 16 released varieties, only eight had survived. Of these, sarjoo 52 and masuri are two of the oldest released varieties still doing quite fine. The maps are given in figure (annexure).

When we compare the percentage change in the area and number of plots under different varieties in the three villages of Faizabad during 1989 – 1999-2000 (table No. 3.2), we notice decline of plots ranging from 22 per cent in mustard to 100 per cent in Foxtail millet and 30 – 37 per cent in pea, gram, *Vicia faba* and sunhemp. In minor millet, the decline is more than 78 per cent in terms of plot. When we look at area, the trend is similar except that in gram the decline in total area is more than 50 per cent as against 38 per cent in number of plots. In most crops, percentage decline in area is more than percentage decline in plots because of varying size of plots. It is obvious that in some

TABLE 3.1: LOSS OF VARIETAL DIVERSITY OF RICE IN THREE VILLAGES
BETWEEN 1988-89 AND 2002-03

SR.	VARIETIES UNDER CULTIVATION IN 1988-89	VARIETIES UNDER CULTIVATION IN 2002-03
DESI/LOCAL/FARMER DEVELOPED VARIETIES		
1.	Lalmati	Lalmati
2.	Muthmuri	Muthmuri
3.	Dehula	Dehula
4.	Bahgari	Baghari
5.	Jarhan	
6.	Gajraj	
7.	Bashawa	
8.	Dhaneshwar	
9.	Kala namak	
10.	Dudhiya	
11.	Hiramali	
12.	Nebui	

13.	Vishnu Parag	
14.	Samari	
IMPROVED/HYBRID VARIETIES		
1.	Sarjoo-52	Sarjoo-52
2.	Saket – 4	NDR-359
3.	Pant-4	Pant-10
4.	China-4	Pant-12
5.	NDR-80	NDR-90
6.	Kaveri	NDR-118
7.	Jaya	HY. Rice
8.	IR-8	Masuri
9.	IR-36	
10.	Nahar Punjab	
11.	Usha	
12.	NDR-118	
13.	Mansuri	
14.	Sita	
15.	Madhukar	
16.	Prasad	
Total	30	12

TABLE No. 3.2: PER CENT CHANGE IN AREA AND PLOTS UNDER VARIOUS INDIGENOUS VARIETIES IN THREE VILLAGES OF FAIZABAD DISTRICT (U.P.) FROM 1989 TO 1999-2000

SR.	VARIETY (CROP)	PLOTS		AREA	
		1988-89	1999-2000	1988-89	1999-2000
1.	Desi Pea (Desi & Rachna) (Pea) *(Pisum sativum*)	219	138 (-36.99)	125.53	69.92 (-44.30)
2.	Desi Chana (Gram, pulse) (*Cicer arietinum*)	173	109 (-36.99)	93.04	44.33 (-52.35)
3.	Kodo millet (Minor millet) (*Paspalum scorbiculam*)	37	8 (-78.38)	10.62	2.61 (-75.42)
4.	Kakoon (Minor millet) (*Setaria italica*)	35	0 (-100.00)	7.98	0.00 (-100.00)
5.	Bakada (Pulse) (*Vicia faba*)	43	30 (-30.23)	10.10	6.09 (-39.70)
6.	Desi Jau (Barley) (*Avena sativa*)	155	107 (-30.97)	43.01	26.54 (-38.29)
7.	Patua (Sanhemp) (*Crotalaria juncea*)	86	59 (-31.40)	18.72	12.59 (-32.75)
8.	Peeli Sarson (Mustard) (*Brassica juncea*)	131	102 (-22.14)	77.77	56.42 (-27.45)
	Total	879	553 (-37.09)	386.77	218.50 (-43.51)

** Note: Value in parenthesis indicate the decline in plots and area under respective varieties in percentage*

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TABLE 3.3: PER CENT CHANGE IN AREA AND NUMBER OF PLOTS UNDER VARIOUS INDIGENOUS VARIETIES IN THREE VILLAGES OF FAIZABAD DISTRICT (U.P.) FROM 1989 TO 1999-00 TO 2003

SR.	VARIETY (CROP)	PLOTS			AREA		
		1989-89	1999-2000	2002-03	1989-89	1999-2000	2002-03
1.	Lalmati (Paddy)	41	15(-63.42)	17(-58.54)	61.66	14.59(-76.34)	3.70(-94.00)
2.	Baghari (Paddy)	49	16(-67.35)	13(-73.47)	19.58	3.52(-82.02)	2.30(-88.25)
3.	Muthmuri (Paddy)	39	13(-66.67)	6 (-84.62)	26.23	3.92(-85.06)	1.00(-96.19)
4.	Dehula (Paddy)	38	2(-94.74)	11(-71.05)	7.04	0.96(-86.36)	1.30(-81.53)
5.	Hiramati (Paddy)	30	0(-100.00)	0(-100.00)	36.92	0.00(-100.00)	0.00(-100.00)
6.	Samari (Paddy)	25	0(-100.00)	0(-100.00)	38.34	0.00(-100.00)	0.00(-100.00)
7.	Dudhiya (Paddy)	36	3(-91.67)	0(-100.00)	31.59	2.5(-92.09)	0.00(-100.00)
8.	Vishnu parag (Paddy)	45	0(-100.00)	0(-100.00)	37.90	0.00(-100.00)	0.00(-100.00)
9.	Jonhari (Maize)	159	92(-42.14)	37(-76.73)	96.25	46.07(-52.14)	17.07(-82.27)
10.	Lenhari + Desi chari (Sorghum)	157	63(-59.87)	57(-63.69)	64.32	27.44(-57.34)	12.82(-80.07)
11.	Desi Arhar (Pigeon pea)	156	43(-72.34)	53(-66.03)	53.73	20.86(-61.18)	10.07(-81.26)
12.	Saurauti (Sugar cane)	55	12(-78.18)	15(-72.73)	38.07	6.13(-83.90)	3.50(-90.81)
13.	Nadsari (Sugar cane)	44	8(-81.18)	12(-72.73)	43.19	3.72(-91.37)	2.40(-94.44)
14.	Aghani Gobhi (Cauliflower)	40	49(11.37)	17(-57.50)	27.06	21.20(-21.66)	5.20(-80.78)
15.	Karti Gobhi	38	25(-34.21)	15(-60.53)	26.00	15.50(-40.39)	3.57(-86.27)
16.	Desi Ganji	137	76(-44.53)	27(-80.29)	71.77	43.92(-38.81)	10.20(-85.79)
17.	Desi Sava (Jethau & Badhela)	130	87(-33.08)	35(-73.08)	65.83	30.37(-53.87)	7.10(-89.22)
18.	Desi Udad	91	60(-34.07)	23(-74.72)	23.91	13.33(-44.25)	5.60(-76.58)
	Total	1310	564(-56.95)	338(-74.20)	769.39	254.03(-66.98)	85.83(-88.84)

** Note: Value in parenthesis indicate the decline or increase in plots & area under the respective variety in percentage*

Villages Surveyed: Shivnathpur, Isoulibhari and Kharella, Tehsil: Milkipur, District: Faizabad, Uttar Pradesh.

crops the decline is much more significant. We tracked this decline in the previous three years, i.e., during 1999-2003. Compared to 1988-89, the decline was much higher during 1999-2000 in most crops though in some cases, the number of plots were higher in 2002-2003 but the area declined in almost all the cases as in table 3.3. There is only one exception in Dehula variety of paddy in which area declined in 1999-2000 was about 86 per cent whereas in 2002-2003 was marginally lesser at around 82 per cent. Surely, this secular trend indicates that the problem of erosion of diversity is quite serious. What should cause even more concern is that within three years many varieties almost disappeared. The rate at which this erosion is taking place should require a much more serious policy action but that seems to be absent today. The decline in paddy is much more than in some of the minor crops though even in those area decline is significant.

When we look at erosion of agrobiodiversity in the mixed stand (i.e., when crops are grown mixed in the same field) or when another crop is grown as a border crop for the main crop. There were 51 plots (table 3.4) in which different varieties of rice were mixed together (almost 25 per cent of the plots having mixed crops or varieties). Sorghum-maize was the next most popular mixture. The nature of mixture i.e., whether in the field or through border crop is described in table 3.5. Border crops could be taken for home consumption and sometimes for pest control. They are given less economic importance. As is apparent from table 3.6, the crop mixture whether in the main field or in the border, is practiced in not only local varieties but also improved varieties. There are many reasons for this practice, important among these is the risk. Given the uncertainty of rainfall (quantity, onset, cessation, duration of floods, height of floods, height of standing water in the field, time taken for drainage from uplands, etc.), the farmers try to cope with the risk by combining different crops and varieties. The combination of local varieties with the improved varieties provides a very rich insight about how conservation of agrobiodiverity in future could be contemplated.

One of the approaches for conservation could be to identify agronomic or plant protection or risk hedging advantage of the local varieties in the cropping systems. Apart from nutritional and nutraceutical properties of some of the local varieties, their agro ecological properties thus could become an added reason for their continued cultivation. But, the modern scientific research on agricultural research stations does not, as yet, pay much attention to this direction of research.

Another implication of the analysis of crop mixtures is that not only majority of the local varieties are grown in mixture in case of paddy but even many modern varieties are preferred to be so cultivated. However, this pattern changes in different crops. In the case of sugar cane in the area of study no crop mixtures were noticed. Though sugar cane and potato are mixed together in some of the rainfed regions. In crops like pigeon pea and maize and some other minor crops, the area under mixture was significantly higher than the sole crop. In sorghum and black gram (udad), there was no sole crop plot. Similarly in local carrot and sawa (scientific name – vikas to put English and scientific name of sawa, gajjar, udad, ganji, gobhi, and others).

TABLE No. 3.4: FREQUENCY DISTRIBUTION OF CROPS IN MIXED STAND DURING 2002-03

Sr. No.	Crop combination	Number of plots
1.	Rice – Rice	51
2.	Pigeon Pea – Sweet Potato	17
3.	Pigeon Pea – Sorghum	13
4.	Pigeon Pea – Carrot	10
5.	Pigeon Pea – Maize – Sorghum	8
6.	Pigeon Pea – Maize	8
7.	Pigeon Pea – Lady's finger	4
8.	Pigeon Pea – Chilli	3
9.	Pigeon Pea – Cauliflower	1
10.	Sorghum - Maize	37
11.	Sorghum – Cauliflower	9
12.	Maize – Sawa	10
13.	Maize – Udad – Sawa	10
14.	Maize – Sawa – Sweet Potato	4
15.	Udad – Sawa	12
16.	Udad – Cauliflower	6
	Total Plots	***203***

TABLE 3.5: FREQUENCY DISTRIBUTION OF IMPROVED AND LOCAL CROPS IN MIXED CROP/BORDER CROP FOR YEAR 2002-03

Sr. No.	Crop	Mixed/ Border crop	No. of plots
RICE			
1	Improved Rice – Improved Rice	Border	28
2	Improved Rice – Local Rice	Mixed	18
3	Local rice – Local Rice	Mixed	5
PIGEON PEA			
4	Improved Pigeon Pea – Local Maize	Mixed	8
5	Improved Pigeon Pea – Local Sorghum	Mixed	6
6	Improved Pigeon Pea – Local Sweet Potato	Border	3
7	Improved Pigeon Pea – Local Chilli	Border	1
8	Improved Pigeon Pea – Local Cauliflower	Border	1
9	Improved Pigeon Pea – Improved Maize – Local Sorghum	Mixed	3
10	Local Pigeon Pea – Local Sweet Potato	Border	14
11	Local Pigeon Pea – Local Carrot	Border	10
12	Local Pigeon Pea – Local Sorghum	Mixed	7
13	Local Pigeon Pea – Local Lady's finger	Border	4
14	Local Pigeon Pea – Local Chilli	Border	2
15	Local Pigeon Pea – Local Maize – Local Sorghum	Mixed	5
SORGUM			
16	Improved Sorghum – Improved Maize	Mixed	9
17	Local Sorghum – Local Maize	Mixed	22
18	Local Sorghum – Improved Maize	Mixed	8
19	Local Sorghum – Local Cauliflower	Border	9
MAIZE			
20	Improved Maize – Local Sawa	Border	9
21	Improved Maize – Local Udad – Local Sawa	Mixed	5
22	Local Maize – Local Sawa	Border	1
23	Local Maize – Local Udad – Local Sawa	Mixed/Border	5
24	Local Maize – Local Sawa – Local Sweet Potato	Mixed	4
OTHERS			
25	Improved Udad – Local Cauliflower	Border	5
26	Local Udad – Local Sawa	Mixed	12
27	Local Udad – Local Cauliflower	Border	1

TABLE No. 3.6: FREQUENCY DISTRIBUTION OF IMPROVED AND LOCAL VARIETIES IN MIXED & BORDER STAND DURING 2002-03

Sr. No.	Varieties	Type of mixture	Mixed/ Border	Plots
		RICE		
1	Pant 10 – Pant 12	Improved – Improved	Border	11
2	NDR 118 – Sarjoo 52	Improved – Improved	Border	9
3	Pant 10 – Sarjoo 52	Improved – Improved	Border	4
4	Pant 10 – Pant 12 – Sarjoo 52	Improved – Improved - Improved	Border	4
5	Baghari – Sarjoo 52	Local - Improved	Mixed	9
6	Dehula – Sarjoo 52	Local - Improved	Mixed	9
7	Lalmati –Baghari	Local - Local	Mixed	5
		PIGEON PEA		
8	Bahar (Arhar, Pigeon pea)– Jonhari (Maize)	Improved – Local	Mixed	8
9	Bahar – Lenhari (Sorghum)	Improved – Local	Mixed	6
10	Bahar – Ganji (Sweet Potato)	Improved – Local	Border	3
11	Bahar – Aghani (Cauliflower)	Improved – Local	Mixed	1
12	Bahar – Desi Chilli	Improved – Local	Border	1
13	Bahar – Vikram (Maize) - Lenhari	Improved – Improved – Local	Mixed	3
14	Desi Arhar – Ganji	Local - Local	Border	14
15	Desi Arhar – Desi gajar	Local – Local	Border	10
16	Desi Arhar – Lenhari	Local – Local	Mixed	7
17	Desi Arhar – Desi Bhindi	Local – Local	Border	4
18	Desi Arhar – Desi Chilli	Local – Local	Border	2
19	Desi Arhar – Jonhari- Lenhari	Local – Local - Local	Mixed	5
		SORGHUM		
20	Lenhari – Vikram	Local - Improved	Mixed	5
21	Lenhari – Jonhari (Maize)	Local – Local	Mixed	11
22	Lenhari – Karti (Cauliflower)	Local – Local	Border	5
23	Lenhari – Aghani	Local – Local	Border	4
24	Sudan chari (Sorghum) – Shankar (Maize)	Local – Improved	Mixed	7
25	Desi Chari – Vikram	Local – Improved	Mixed	3
26	Desi chari– Jonhari	Local – Local	Mixed	11
		MAIZE		
27	Shankar – Desi sawa	Local – Local	Mixed	5
28	Vikram– Desi udad – Desi sawa	Improved - Local – Local	Mixed	5
29	Vikram – Desi sawa	Improved - Local	Mixed	4
30	Jonhari – Desi Sawa	Local – Local	Mixed	1
31	Jonhari – Sawa – Ganji	Local – Local - Local	Border	4
32	Jonhari – Desi udad – Desi sawa	Local – Local - Local	Mixed	5
		OTHER COMBINATIONS		
33	Desi udad – Desi sawa	Local – Local	Mixed	12
34	Aghani – Improved Udad	Local – Improved	Border	5
35	Aghani– Desi udad	Local – Local	Mixed	1

Reasons for cultivating local varieties:

There were four categories of reasons, consumption, managerial, technological and economic. Most farmers indicated more than one reason for cultivating local varieties (table No.4). Large number of them grew local varieties because these were required for home consumption and were preferred for their taste. Some found their fodder very good for the animals. Hardly 10 per cent grew the local varieties for religious or cultural reasons. For many small and marginal farmers, requirement of less care and management and easy availability of seed were important criteria for cultivating these varieties. The topographical features and the consequent micro ecological conditions of different plots influenced the choice of local varieties in 40 per cent of the cases followed by lack of irrigation facility in one third cases. The turnaround time also was a factor in the choice of local varieties. Many modern varieties are far more specific in terms of time of sowing than the local varieties. Since the time of flood recession cannot be predicted easily, farmers have to be ready to use the residual moisture for second crop in whatever contingency they have to make decision. The fact that local varieties require less inputs was also a significant reason for their cultivation.

TABLE No. 4: REASONS FOR CULTIVATING LOCAL VARIETIES

Sr. no.	*ISSUE*	*Frequency*
1	*CONSUMPTION ISSUES*	
	• *Required for home consumption*	*63 (63.34 %)*
	• *Taste Preference*	*60 (60.61 %)*
	• *For Animal Fodder*	*28 (28.28 %)*
	• *Religious/cultural significance*	*09 (09.09 %)*
2.	*MANAGERIAL ISSUES*	
	• *Requires less care and management*	*56 (56.57 %)*
	• *Local variety seed is easily available with farmer*	*45 (45.46 %)*
	• *Less labour intensive*	*42 (42.42 %)*
	• *Farm leased out (Rented)*	*16 (16.16 %)*
3.	*TECHNOLOGY ISSUES*	
	• *Difference in plots*	*40 (40.40 %)*
	• *Lack if irrigation facility*	*30 (30.30 %)*
	• *Early harvesting of previous crop*	*23 (23.23 %)*
4.	*ECONOMIC ISSUES*	
	• *Requires less inputs*	*50 (50.51 %)*
	• *Poor standard of living*	*25 (25.25 %)*

****** Values in parenthesis indicate number of respondents in per cent.***

Number of respondents: 99 ***Number of villages surveyed: 5***

The agronomic characteristic of improved varieties under cultivation and the ones which have been replaced are given in table 5.1. It seems that tillering, number of ear bearing tillers per hill and consequent yield advantage are the more important reasons for replacement of modern varieties. Among the local varieties (table 5.2), the reasons the

TABLE No. 5.1: CHARACTERISTICS OF VARIOUS IMPROVED VARIETIES UNDER CULTIVATION (2002-03) AND THOSE WHICH HAVE BEEN REPLACED OVER YEARS

	Variety	Days to 50 % flowering	Days to maturity	Plant height (cm.)	Panicle length	Total number of tillers	EBT/hill	Grain colour	Yield Quintals
IMPROVED VARIETIES UNDER CULTIVATION									
	Mahsuri	108-115	138-145	97-110	23.8-24.2	6.4-6.6	5.0-6.6	YW/R/LR	65-70
	NDR-118 ®	72	85-90	95	21	11	8	W	40-45
	NDR-359	96	130-135	104-110	21-24	11-15	11-15	W	65-70
	Pant 10	95	115-120	95	20-23	11	10-12	W	50-55
	Pant 12	97	115-128	93-98	21-23	11	10-12	W	50-55
	Hybrid	90	125	90-92	22-26	12-16	12-16	W	70
	Sarjoo 52	99	125-135	98	26	5.8	5.0	W	60
REPLACED IMPROVED VARIETIES									
	Kaveri ®	76	96	83.3	20.6	9.3	4.6	R	30-35
	Chaina 4	81	103	133.3	22.0	16.6	10.6	LY	40-45
	Madhukar*	118	145	134.3	22.6	6.3	5.0	R	40
	Prasad	82	105	99	23.6	8.0	8.0	W	40-45
	Krishna	88	112	127.6	25.6	8.6	8.6	LY	40-45
	Saket 4 (I)	86-90	110-115	97.3	25.3	11.6	8.0	W	40-42
	Narendra 80	93	115	119-124	27	4-8	4-8	W	45-50
	Usha	88	117	130.3	22.6	13.0	8.0	LY	40
	IR 36 (I)	89	118	102-108	25-27	7-11	7-11	W	40
	Jaya (I)	102	130-135	80.4	25.6	7.4	7.0	W	45-50
	Pant 4	94	135	98.4	26.0	6.8	6.8	W	50-55
	IR 8 (I)	98	135	88	25.8	6.2	6.2	W	50-55
	Sita (I)	99	135	95-105	22.3	6.3	4.0	W	45-50

* can sustain water logging for 10 days during floods

TABLE No. 5.2: CHARACTERISTICS OF VARIOUS LOCAL VARIETIES UNDER CULTIVATION (2002-03)AND THOSE WHICH HAVE BEEN REPLACED OVER YEARS

	Variety	Days to 50 % flowering	Days to maturity	Plant height (cm.)	Panicle length	Total number of tillers	EBT/hill	Grain colour	Yield Quintals
LOCAL VARIETIES UNDER CULTIVATION									
	Baghari ®	71-74	90-100	101.0-112	15.3-23.3	11.6-13.3	2.0-3.3	B	25-30
	Dehula	65-75	90-105	119-127.0	22.6-25.6	6.3-9.0	4.0-5.0	R	30-35
	Muthmuri	55	85	90-100	20-22	6	4.0 -4.5	W/LY	25-30
	Lalmati	75	95	143.3	23.6	6.3	3.3	R	35-40
REPLACED LOCAL VARIETIES									
	Kalanamak	127	155	76.0-135.3	17.6-23.6	8.0	6.0	B	30-42
	Heeramali	59	84	79.0	23.0	11.0	8.0	W	30-35
	Dhansawar	97	121	80.0	23.6	12.6	8.3	W	30-35
	Dudhiya/Duddhi	71	95	119.6	21.6	10.3	4.0	Y	30
	Nebui/Nibbu	73	94	121.6	22.6	12.0	7.3	R	25-30
	Jarhan	115	142	139.6	26.0	6.3	4.3	R	25-32
	Gajraj	78-121	100-140	132.6-147	19.3-25	6-7.6	3.36.0	R/LY/W	30-35
	Vishnu Parag	95	120	80-95	20.0	7.0	5.0	W/LY	30
	Samari	84	125	100	22	10	7	W	30-35
	Bashawa	88	116	142.6	26.6	11.3	6.3	LY	30-32

® Rainfed

Vishnu Parag is a scented variety
Samari has very low water requirement and
Muthmuri is a short duration, rainfed variety with very small grain size and sweet in taste with very low yield

varieties which survived seemed to have done primarily for their plot specific fit rather than any specific agronomic feature. For instance, dehula, muthmuri and lalmati do not have higher number of tillers or higher number of ear bearing tillers. Their yield also compares well with many of the replaced local varieties. And yet these have been preferred because of taste and local fit and duration.

When we tried to analyze the pedigree of modern varieties (table 5.3), some of the successful surviving varieties had very adapted local parent.

TABLE 5.3: PEDIGREE OF VARIOUS IMPROVED VARIETY OF RICE

No	Variety	Parents	Duration	Type	Year of release
1	Narendra 118	Hansraj x IR 64	Early	Rainfed	1987
2	Kaveri	TKM 6 x Tai chung native 1	Early	Rainfed	1970
3	Narendra 80	Nagina 22 x IR 36	Early	Irrigated	1986
4	IR 36	Niwara wild x CR 94 –3	Early	Irrigated	1981
5	Saket 4	TKM 6 x IR 8	Early	Irrigated	1971
6	Pant 10	IR 32 x Masuri x IR 8	Med- early	Irrigated	NA
7	Sarjoo 52	TN 1 x Kashi	Medium	Irrigated	1980
8	Narendra 359	BJ 90-2-4 x OI 667	Medium	Irrigated	1993
9	Jaya	TN 1 x Type 141	Medium	Irrigated	1968
10	IR 8	Dee Jee Woo Jan x Peta	Medium	Irrigated	1966
11	Pant 4	IR 262 x Rema duja	Medium	Irrigated	1984
12	Sita	IR 12-178-2-3 x IR 8	Medium	Irrigated	1972
13	Masuri (Flooding 30 cm)	Taichung 65 x Mayang Easab 80-2	Late	Irrigated	1971
14	Madhukar	Selection from Gonda	Late	Irrigated	1969

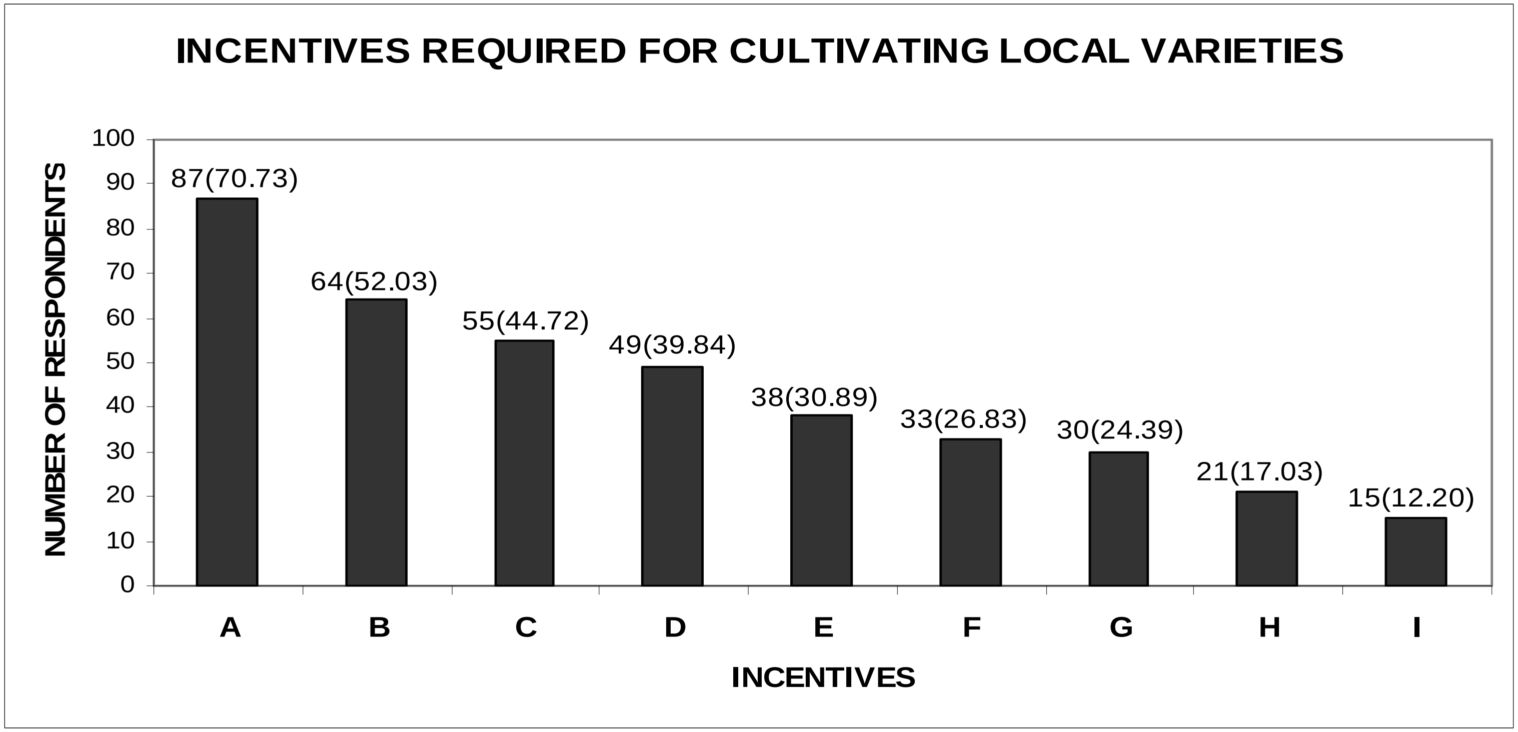
Note: Hansraj is one of the parents in the variety Narendra 118.
**parents mentioned above are the ones used in the development of the end variety.*

Incentives for conservation of local varieties

More than 70 per cent farmers (Table No.6, fig 3) across different size holdings preferred that government should take some initiative such as creating market for local varieties, purchase of the same, support price, making seed available and explaining their technical advantages. Sixty five per cent felt that in case there is any loss caused by the cultivation of local varieties, they should be compensated for the same. About 40 per cent of the respondents wanted either all the inputs or some land on lease for cultivating local varieties.

One of the very interesting suggestions expressed by one third of the respondents was that village council (panchayat) should decide which farmers will allocate how much land for cultivating local varieties. Such a system should involve rotation so that every year, some or the other farmers will allocate a small part of their land for cultivation of local varieties. Some felt that the best way to conserve local varieties would be to select the best among them and then circulate the same to the

FIGURE 3: INCENTIVES FOR CULTIVATION OF LOCAL VARIETIES



Number of Respondents : 120 **Number of Villages surveyed : 5**

A : Government should take some initiative like creating market for the local varieties, purchase of the produce, etc.
B : Farmer should be compensated for the loss incurred in income from cultivation of local variety as against improved cultivars.
C : Farmer should be provided with all the inputs required for cultivating local varieties.
D : Farmer should be provided with some piece of land for cultivating local varieties.
E : Village panchayat should decide that some farmers should allot a part of their holding for cultivating local varieties and there should be a rotation.
F : Best variety among the local variety should be selected and provided to the farmer for cultivation.
G : Progressive and rich farmers who have large land holdings should be asked to cultivate local varieties on their small plots.
H : Farmer should be provided with some sort of insurance cover.
I : Some improvements should be made in local varieties so that their cultivation becomes more beneficial and economical**.**

*********Values in parenthesis indicate number of respondents in per cent***

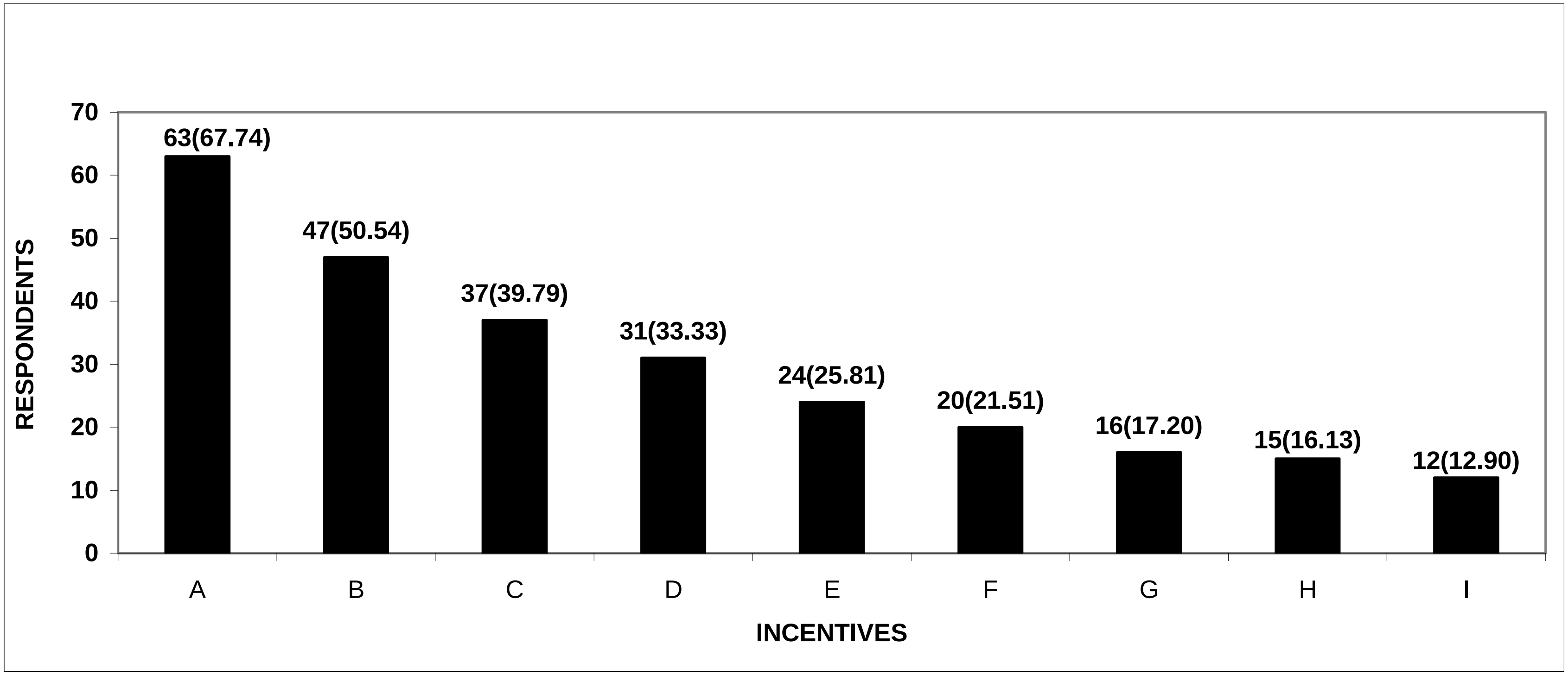
TABLE No. 6: FREQUENCY DISTRIBUTION OF INCENTIVES REQUIRED BY FARMERS WITH DIFFERENT SIZE OF LAND HOLDING TO FACILITATE *IN SITU* CONSERVATION OF LOCAL VARIETIES

Incentives	**Frequency of various incentives under different size of holdings**			**Total freq.**
	<.25 ha.	0.25 – 1.00 ha.	.1.00 ha.	
Government should take some initiative like creating markets for local varieties, buy back of produce, support price mechanism, make seeds available to the farmers, provide technical know how, etc .	20 (66.67)	49 (74.24)	17 (70.83)	86 (71.67)
Farmers should be compensated for the loss in income incurred from cultivation of local varieties as against improved cultivars.	15 (50.00)	37 (56.06)	13 (54.17)	65 (54.17)
Farmers should be provided with all the inputs required and technical knowledge for the cultivation of the local varieties.	9 (30.00)	30 (45.46)	9 (37.50)	48 (40.00)
Farmers should be provided with some piece of land of cultivation local varieties.	16 (53.33)	25 (37.88)	10 (41.67)	51 (42.50)
Village panchayat should decide that come farmers should allot a part of their holding for cultivating local varieties and there should be a rotation.	10 (33.33)	22 (33.33)	8 (33.33)	40 (33.33)
Best variety among the local varieties should be selected and the seeds of the same should be provided to the farmers for cultivation.	16 (53.33)	18 (27.27)	10 (41.67)	44 (36.67)
Progressive and rich farmers who have large land holdings should be asked to cultivate local varieties on their small plots.	7 (23.33)	14 (21.21)	5 (20.83)	26 (21.67)
Farmers should be provided with some sort of insurance cover.	4 (13.33)	12 (18.18)	1 (4.17)	17 (14.17)
Some improvements should be made in the local varieties so that their cultivation becomes more economical and beneficial	8 (26.66)	8 (12.12)	4 (16.67)	20 (16.67)
Total Respondents	**30**	**66**	**24**	**120**

farmers. A small section (about 22 per cent) felt that larger farmers should take more responsibility in this regard. Other suggestions were need for insurance cover and improvement in local varieties to make them more economical. The preferred incentives by those who grew both local and improved varieties and those who grew only improved varieties were not very different (figure 3.1 & 3.2) except that those growing improved varieties did not suggest the improvement be made in local varieties to make them economical. Also, much higher proportion wanted subsidies and support.

The factor analysis of the ground of the farmers and the incentive preferences revealed some interesting patterns. Those who preferred government to take initiative also preferred panchayat to take initiative as distinct from those who wanted a small piece of land to be available for cultivating

FIGURE 3.1: INCENTIVES REQUIRED FOR CULTIVATING LOCAL VARIETIES BY FARMERS CULTIVATING BOTH LOCAL AND IMPROVED VARIETIES

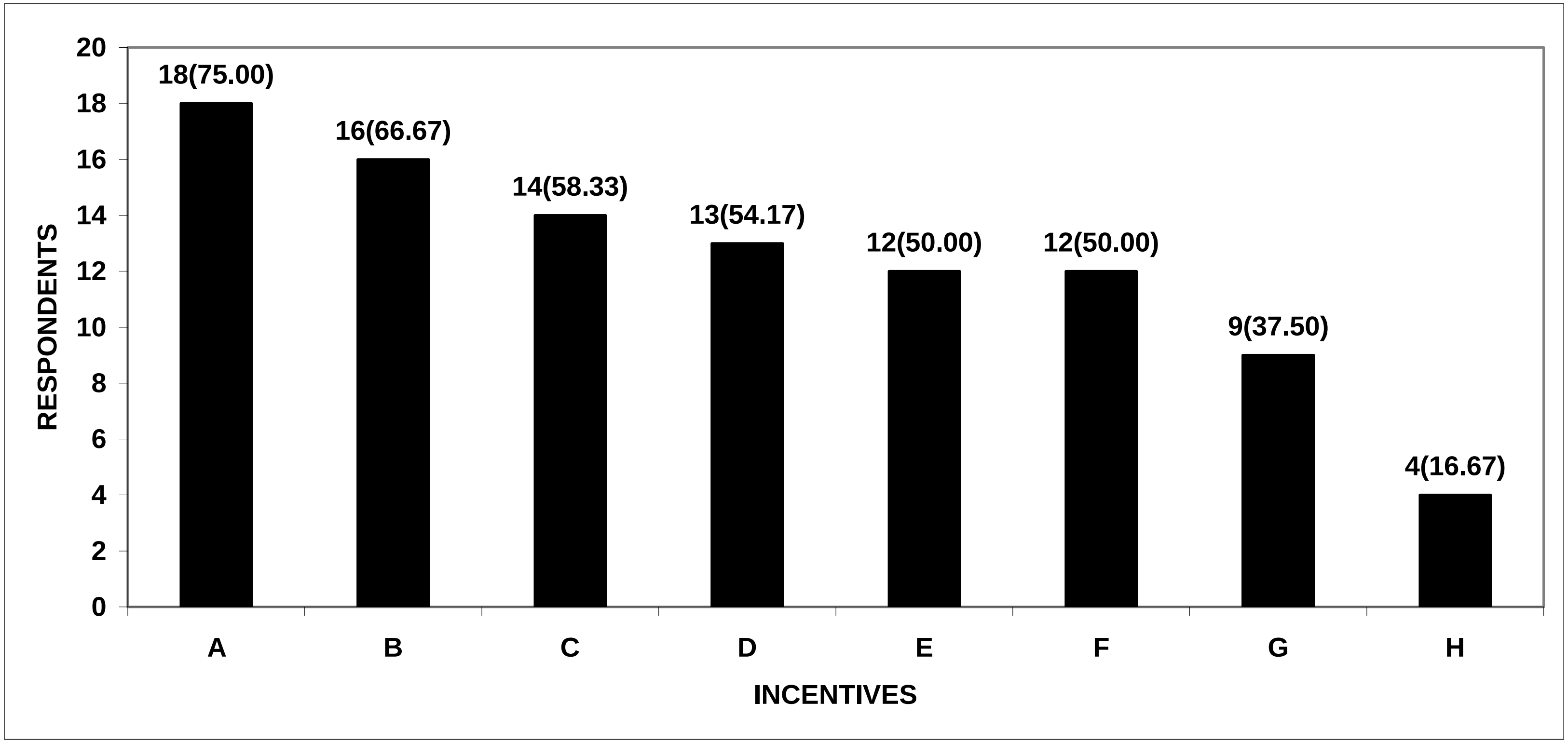


Number of Respondents : 93 **Number of Villages surveyed : 5**

A: Government should take some initiative like creating market for the local varieties, purchase of the produce, etc.
B: Farmer should be compensated for the loss incurred in income from cultivation of local variety as against improved cultivars.
C: Farmer should be provided with all the inputs required for cultivating local varieties.
D: Farmer should be provided with some piece of land for cultivating local varieties.
E: Village panchayat should decide that some farmers should allot a part of their holding for cultivating local varieties and there should be a rotation.
F: Progressive and rich farmers who have large land holdings should be asked to cultivate local varieties on their small plots.
G: Best variety among the local variety should be selected and provided to the farmer for cultivation.
H: Farmer should be provided with some sort of insurance cover.
I: Some improvements should be made in local varieties so that their cultivation becomes more beneficial and economical**.**

***Values in parenthesis indicate number of respondents in per cent*

FIGURE 3.2: INCENTIVES REQUIRED FOR CULTIVATING LOCAL VARIETIES BY FARMERS WHO CULTIVATE ONLY IMPROVED VARIETIES



Number of Respondents: 24 **Number of Villages surveyed: 5**

A: Government should take some initiative like creating market for the local varieties, purchase of the produce, etc.
B: Farmer should be provided with some piece of land for cultivating local varieties.
C: Farmer should be provided with all the inputs required for cultivating local varieties.
D: Farmer should be compensated for the loss incurred in income from cultivation of local variety as against improved cultivars.
E: Village panchayat should decide that some farmers should allot a part of their holding for cultivating local varieties and there should be a rotation.
F: Best variety among the local variety should be selected and provided to the farmer for cultivation.
G: Progressive and rich farmers who have large land holdings should be asked to cultivate local varieties on their small plots.
H: Farmer should be provided with some sort of insurance cover.

******Values in parenthesis indicate number of respondents in per cent local varieties, also preferring improvement in the same. The ones who preferred that the conservation be the responsibility of the rich farmers did not have much remittances (i.e., had to face much more risk) and had majority of the low lying plots (further evidence of their higher risk vulnerability). The farmers who had larger holding, higher education did not prefer somebody else selecting the best local varieties to be cultivated by them and wanted them to take steps for cultivation of local varieties. Those who did not have much remittance preferred government's initiative and some insurance cover.

Reasons for not cultivating local varieties (Fig. 4):

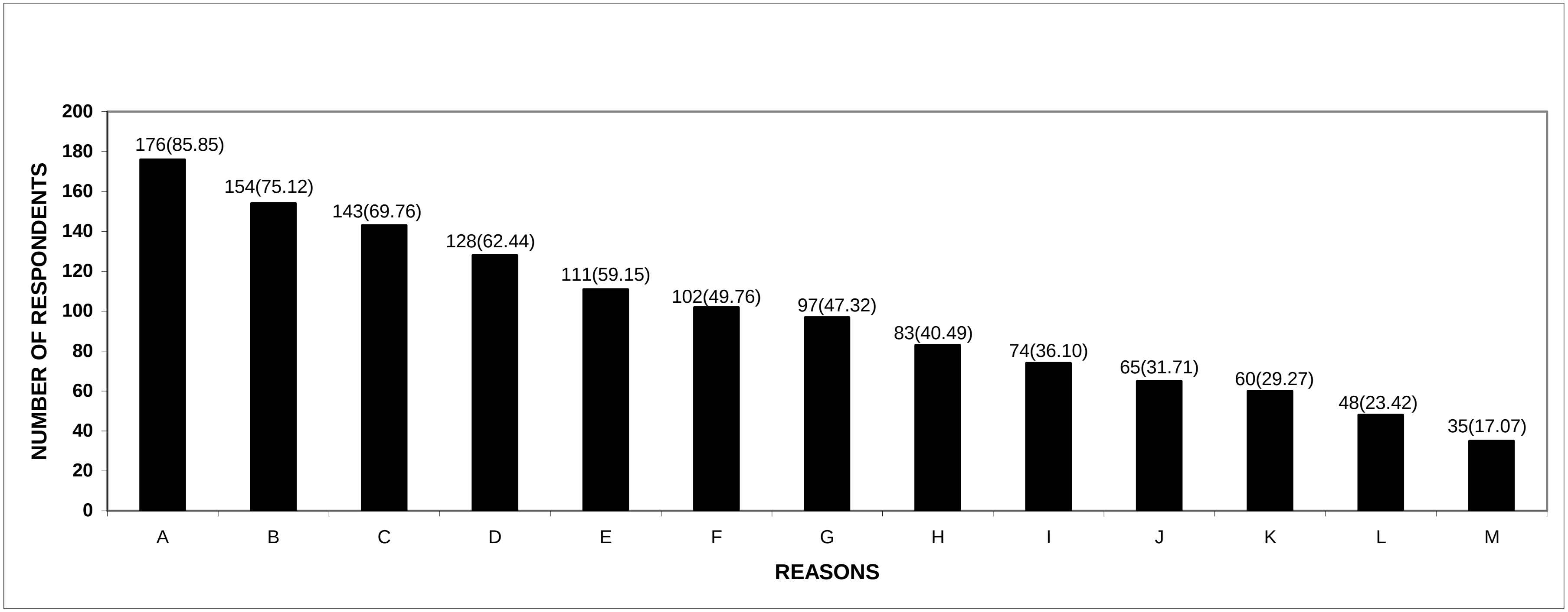
Almost double the number of respondents (205) as against (112 reporting reasons for cultivating local varieties) reported the reasons for not cultivating local varieties. The most important reason obviously was the low yield followed by lower market price and preference, advice from extension department of state government and agricultural university. There were obvious other factors such as availability of irrigation, responsiveness of modern varieties to external inputs, easy availability of inputs, availability of modern varieties suitable for different sowing times, etc. On the other hand, lack of availability of seeds of local varieties was a reason for not cultivating varieties by as many as 23 per cent. The local varieties were apparently liked more by the wildlife such as blue bull which caused lot of damage.

Therefore, just one intervention i.e., making available the seeds of local varieties could enhance the chances of *in situ* conservation.

Women's reasons for cultivating local varieties (Fig 5)

Quite understandably, women gave first preference to taste followed by less care and management, less labour requirement, availability of green fodder and easiness in cooking. The availability of seed at home and religious significance were also important reasons for 39 and 24 per cent respondents. The factor of cooking ease did not figure at all among the reasons by men farmers. The plant breeders also seldom take into account the cooking and taste as important breeding objectives.

FIGURE 4: REASONS FOR NOT CULTIVATING LOCAL VARIETIES

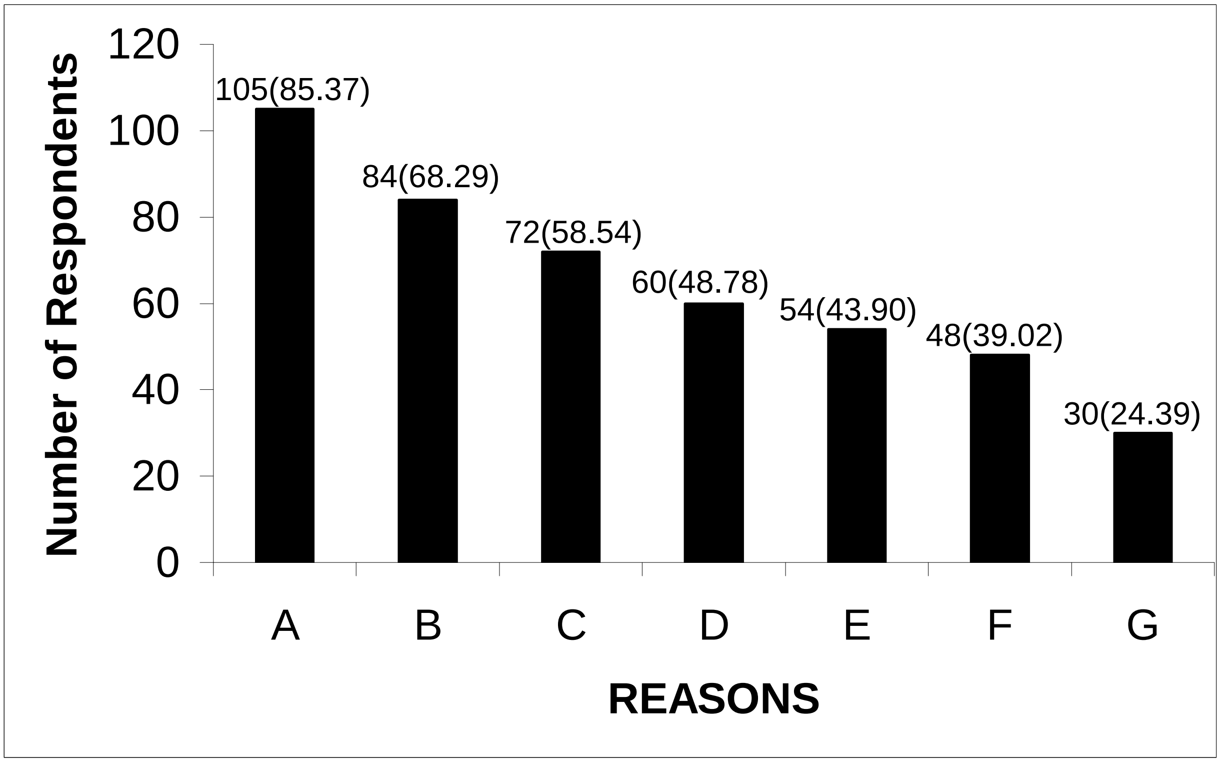


Number of Respondents : 205 **Number of villages surveyed : 5**

A : Low yield of local varieties.
B : Low market price/preference for local varieties.
C : Advised to grow improved varieties by agricultural information center and sources like seed seller, gram sevaks, VLWs, etc. .
D : Advised/recommended to grow improved varieties by agricultural university and also information of package and practices is made available.
E : Varieties required for different sowing times are easily available in case of improved varieties.
F : Inputs easily available.
G : Irrigation facility is available with the farmer.
H : Input irresponsiveness of local varieties.
I : Poor economic condition of the household and thus preference for improved variety to meet their daily requirements.
J : Good economic condition/larger holding of the farmer.
K : Difference in plot.
L : Lack of availability of seeds of local variety in the market.
M : Damage of crop like pigeon pea, maize and to some extent rice by animals like *neel guy*, etc. .

****Values in parenthesis indicate number of respondents in percent*

FIGURE 5: WOMENS OPINION FOR CULTIVATING LOCAL VARIETIES



A : Taste Preference
B : Less care and management
C : Less labour intensive
D : Green fodder
E : Easiness in cooking
F : Seeds available at home
G : Religious Importance

** *Value in parenthesis indicate number of respondents in per cent*

Chapter 5:
Conclusions and policy implications:

There are very few studies on *in situ* conservation from the farmers' perspective. In India, we did not find any study referring to the overtime variation in the agrobiodiversity and systematic assessment of farmers preferences in this regard. There are studies which have looked at cultural and other factors taken into account while preferring the varieties developed by scientists. But our purpose in this study was to explore the variation in agrobiodiversity in the same villages over a decade and then identify the possible incentives which can stem the erosion. The evidence presented in this study clearly indicates that situation is very grim. Once we recognize that many important genes responsible for stress tolerance, disease and pest resistance, unique taste and food processing properties, etc., will not be conserved only by ex situ conservation, it will become obvious that the institutional conditions for in situ conservation will have to be strengthened.

We followed up the study of decadal variation with the help of plot by plot mapping to understand whether there were specific factors that varied among different locations within the village. Subsequently, variation was studied between 2000 – 2003. The trend for erosion became even more stronger than before. Delay in providing incentives will only lead to significant loss of agrobiodiversity. Since many of the germ plasm collections made decades ago have not been maintained in similar risk prone environments, unavailable at national gene bank, many of the important genes may already have been lost. Therefore, reversing the erosion of in situ diversity by providing germ plasm from ex situ banks is definitely a possibility as attempted in Cambodia and few other countries. This may not be a complete answer to reverse the erosion.

What are the key policy choices that can be attempted in this regard. In part one of the study we mention various incentive models which need to be experimented with.

a. An All India Coordinated Action Research Project on incentives for in situ conservation needs to be developed so that a systematic monitoring is done of the process of erosion and at the same time location specific interventions for reversal are made.

b. Availability of the seeds alone can motivate about 25 per cent of the farmers in high risk environment to put some area under local varieties. In a separate study, we have found this to be quite true (Gupta, Patel, Vikas, 2005). The seeds could be made available by encouraging village councils (Panchayats) to procure 20 – 50 kg of seeds of each of the local variety which is under threat of extinction or which has already disappeared from the village but is demanded by the local farmers. These seeds could be distributed through lottery or by rotation or first come first served basis or any other method chosen by the village council.

c. Those village councils which succeed in conserving the maximum agrobiodiveity should be given award of best conservator community at block, district, state and national level. The award could be in the form of trust fund for making small piece of land available for growing those local varieties for which there is no demand but which have historically been grown up in that region. This will institutionalize the long term conservation of diversity and thus help future generations in not only accessing these varieties for emerging changes in the cultural taste preferences, but also for breeding purposes. Farmers may be encouraged to cross these varieties with the local germ plasm to adapt even the modern varieties.

d. An innovative insurance cover may be provided to ten per cent of farmers growing 5 to 10 per cent of the area under local varieties if their average yield falls below the modal value of those varieties in that region.

e. Culinary competitions may be organized among women as a part of traditional food festivals such as the ones orgnised by SRISTI, NIF, GIAN in IIMA campus during 2004.

f. One of the achievements of the traditional food festival has been the much wider awareness among the urban consumers about the taste of local crops and varieties than was the case so far. Further, the demand generated for such varieties may stimulate their conservation.

g. The hotel industry may be encouraged to introduce the menu cards using various local varieties and crops for specific target clients affected by either cardiac or arthritic or other ailments. The nutraceutical uses of local varieties may become one of the most potentially demanding uses of local varieties.

h. Food processing is one of the most buoyant sectors of Indian economy. The characteristics of local varieties for different food processing purposes may be studied and database of this kind could be offered to the food processing industry for exploiting marketing opportunities. The demands so generated may provide incentives for conserving agro biodiversity.

i. Conservation cannot only on utilitarian ground. As mentioned earlier, even if there is no local demand of the agrobiodivesity, we may still have to identify interventions that make their conservation possible. It is this area where much more research is required in future. It is very obvious that we cannot conserve agrobiodiversity by keeping people poor (Gupta, 2003, 2005). If conservation does not make an ecological, economic, ethical and cultural sense, then this must be encouraged as a national task of equal importance as the sanctuaries for wildlife are. We may have to create specific macro zone for different kinds of varieties and compensate farmers for the foregone loss if they had shifted to modern varieties. The agrobiodiveristy parks and sanctuaries will need to take into account not only crops but their companion plants (also called as weeds). Many of these so called weeds today may become crops tomorrow once we identify their importance either as nutraceutical or as drugs, dyes or other derivatives.

There are many more questions this study opens up which remain unanswered. But we believe that policy makers and science leaders would find this study as a good reminder to an urgent concern for conservation which so far has not received adequate attention.

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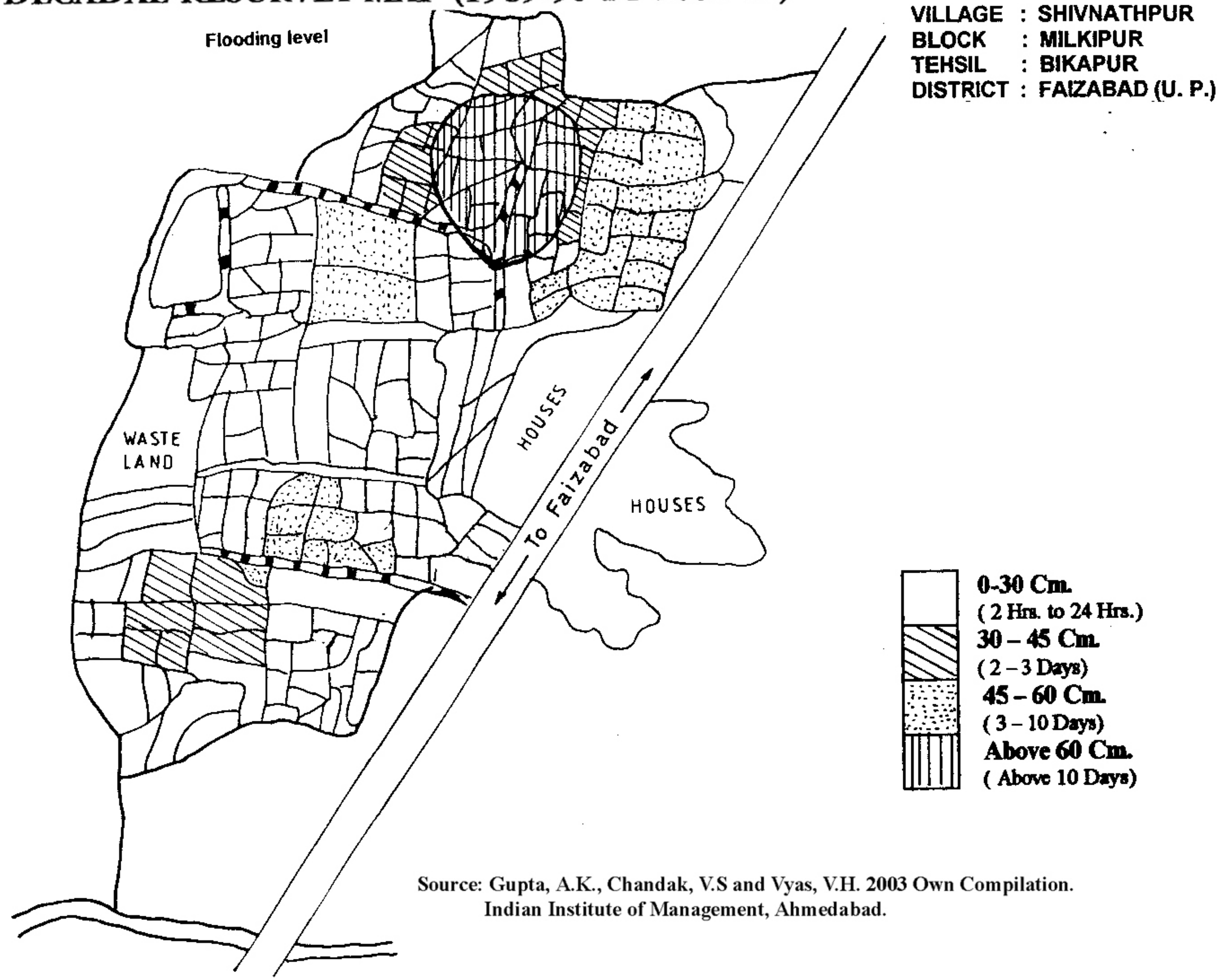
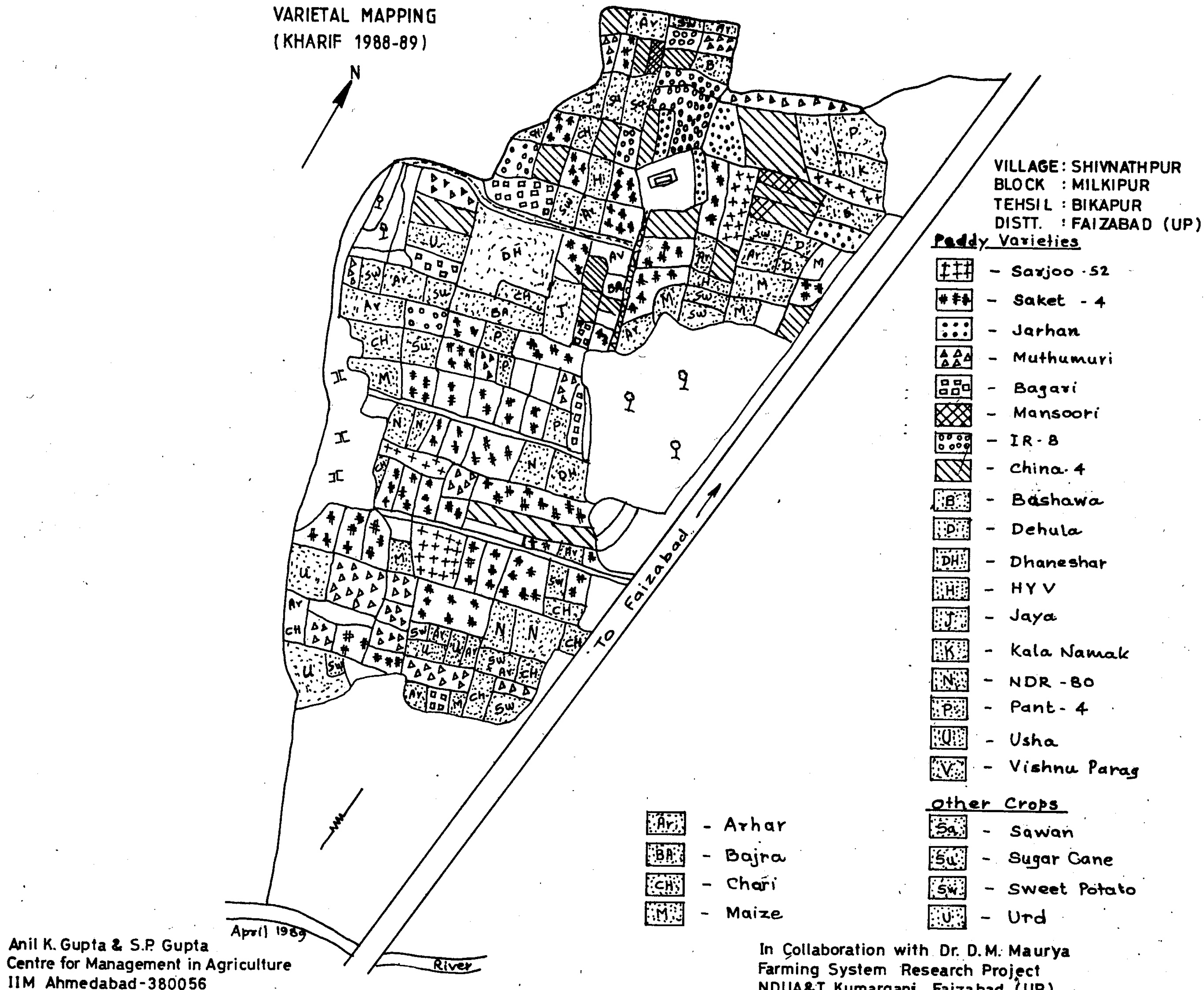
ANNEXURE

DECADAL RESURVEY MAP (1989-90 TO 2002-03)



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.


VARIETAL MAPPING
(KHARIF 1988-89)
N
VILLAGE : SHIVNATHPUR
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTT. : FAIZABAD (UP)
Paddy Varieties
Sarjoo - 52
Saket - 4
Jarhan
Muthumuri
Bagari
Mansoori
IR - 8
China - 4
B - Bashawa
D - Dehula
DH - Dhaneshar
H - HYV
J - Jaya
K - Kala Namak
N - NDR - 80
P - Pant - 4
U - Usha
V - Vishnu Parag
Other Crops
Sa - Sawan
Su - Sugar Cane
Sw - Sweet Potato
U - Urd
Ar - Arhar
BA - Bajra
CH - Chari
M - Maize
To Faizabad
River
April 1989
Anil K. Gupta & S.P. Gupta
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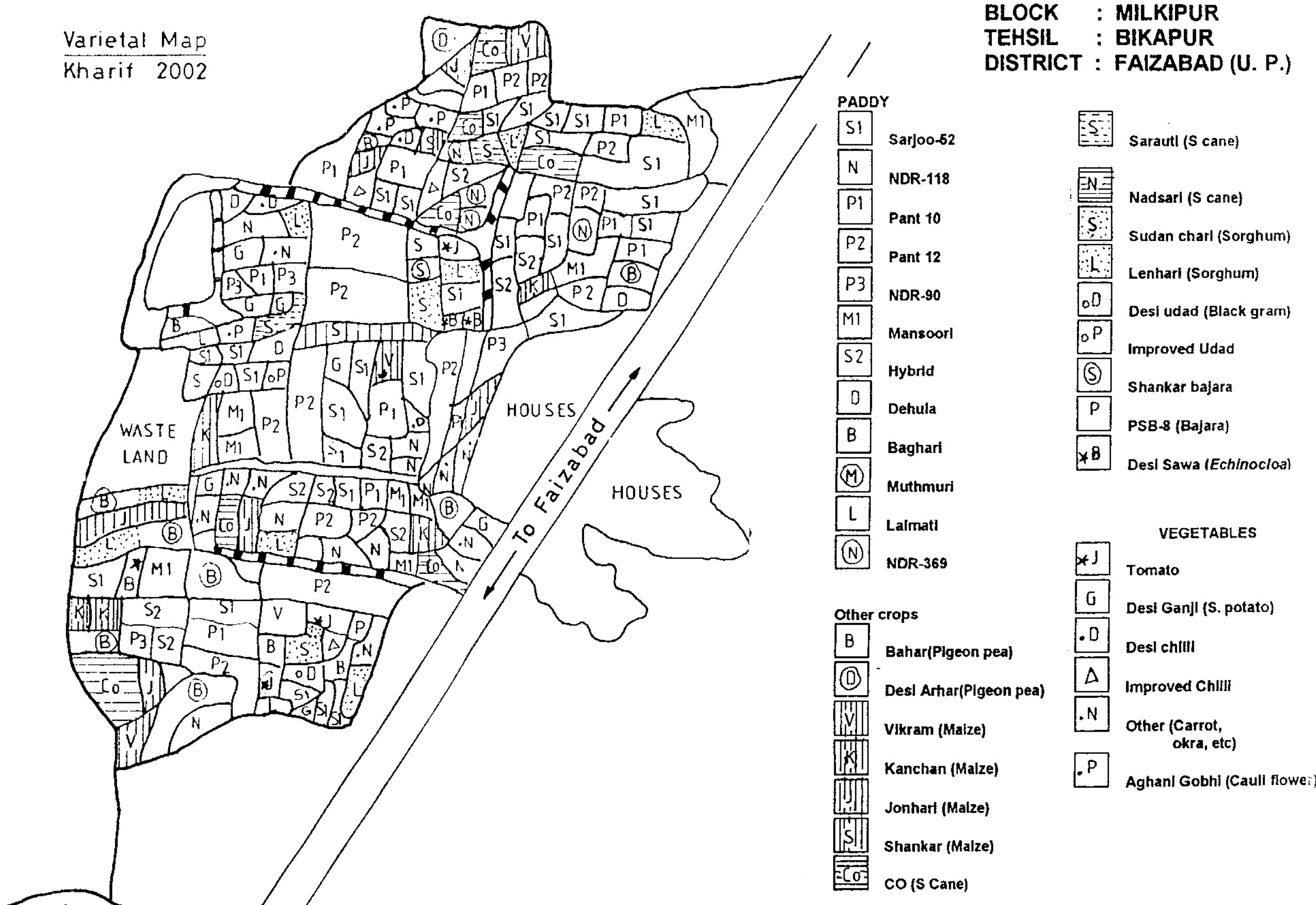
In Collaboration with Dr. D.M. Maurya
Farming System Research Project
NDUA&T, Kumarganj, Faizabad (UP)

DECADAL RESURVEY MAP (1989-90 TO 2002-03)

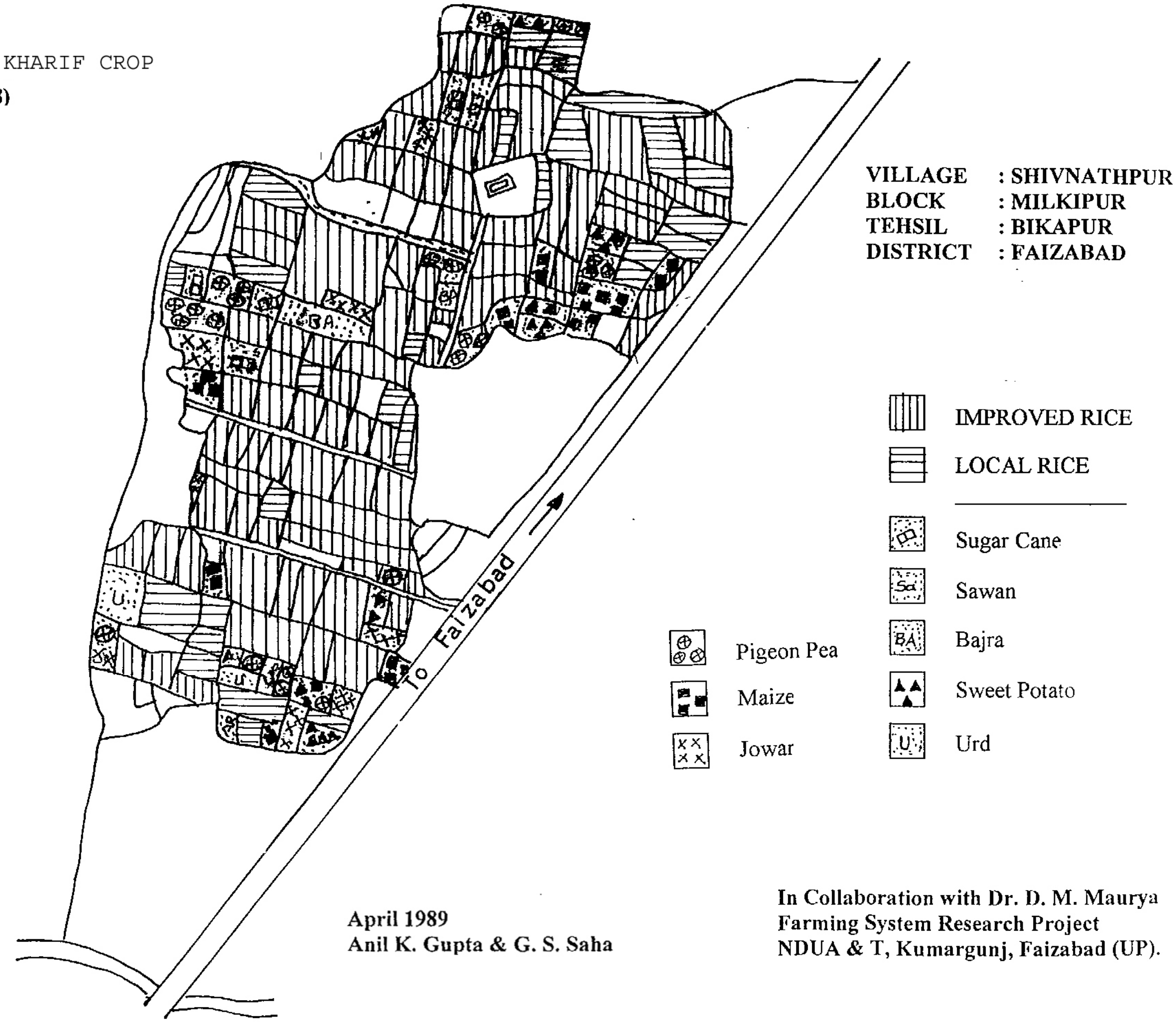
VILLAGE : SHIVNATHPUR
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.

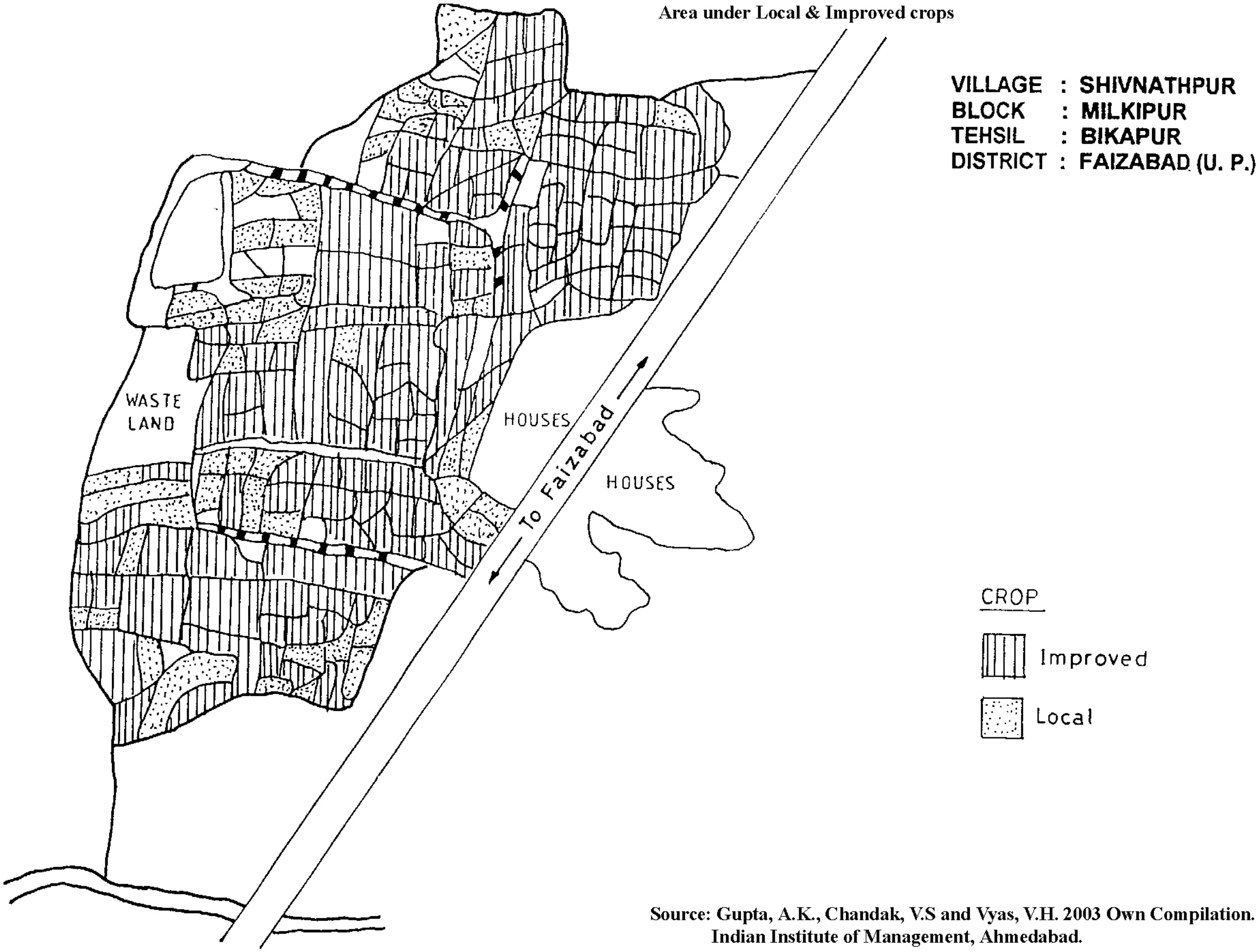
AREA UNDER KHARIF CROP

(Kharif 1988-98)



DECADAL RESURVEY MAP (1989-90 TO 2002-03)

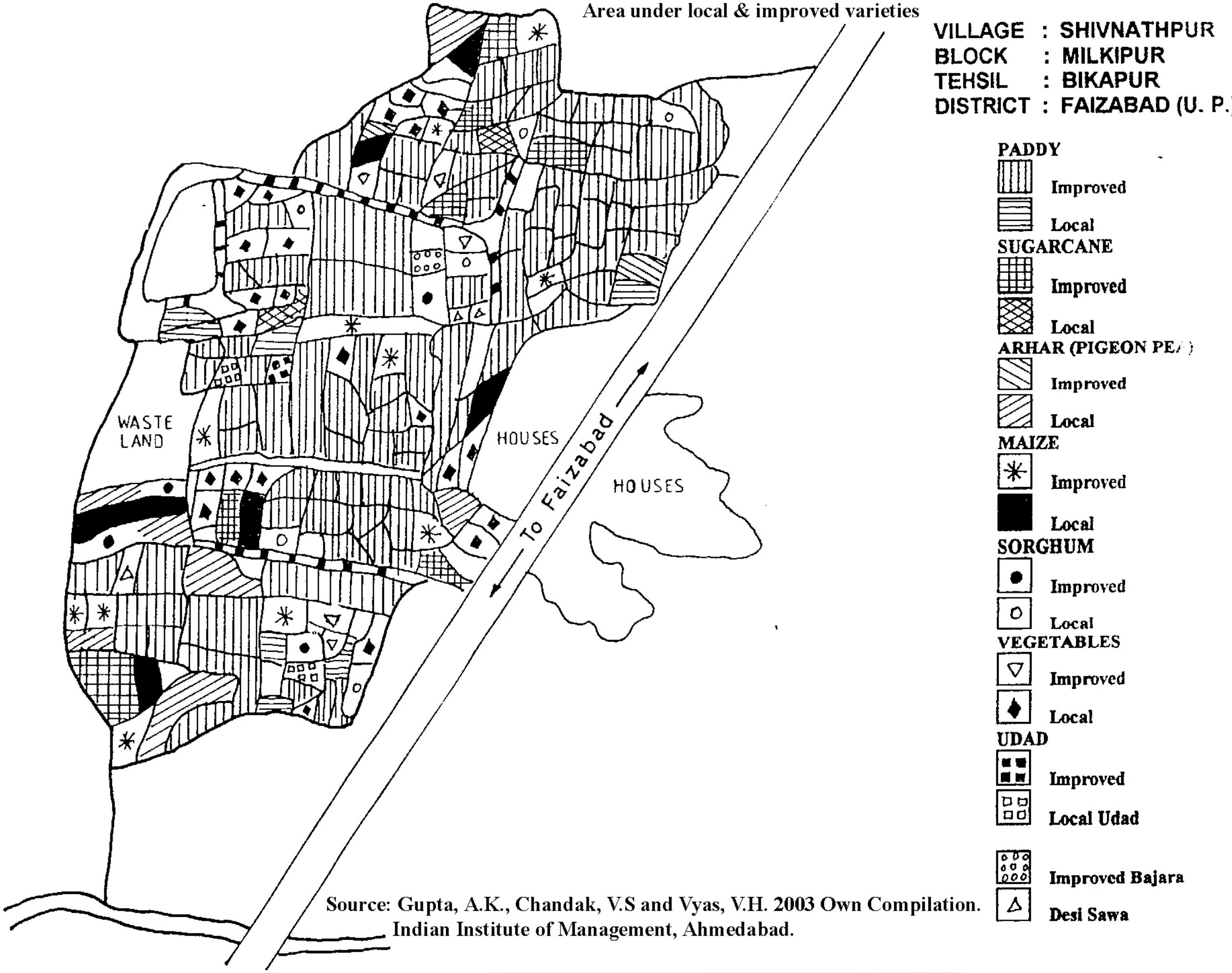
Area under Local & Improved crops



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation. Indian Institute of Management, Ahmedabad.

DECADAL RESURVEY MAP (1989-90 TO 2002-03)

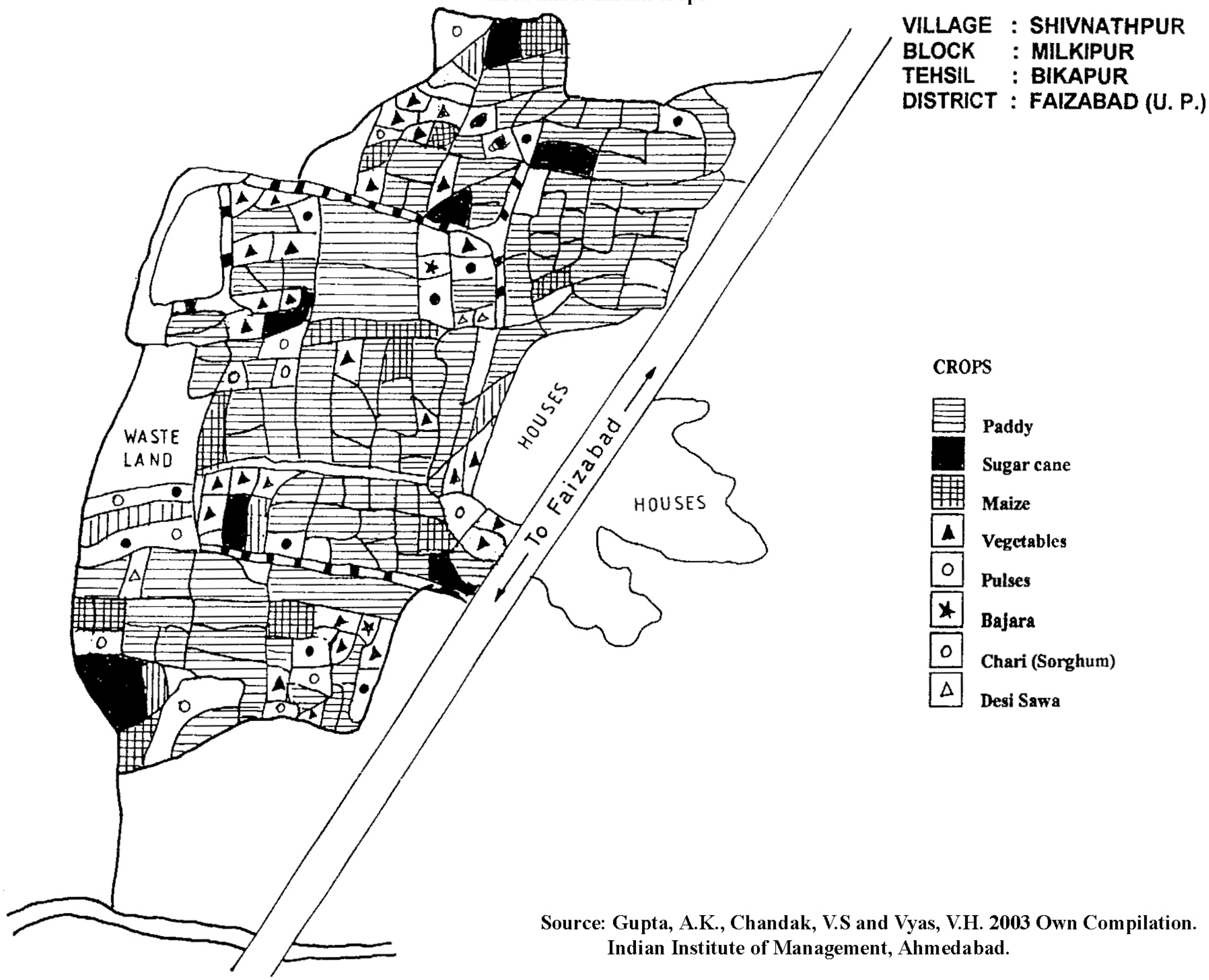
Area under local & improved varieties



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation. Indian Institute of Management, Ahmedabad.

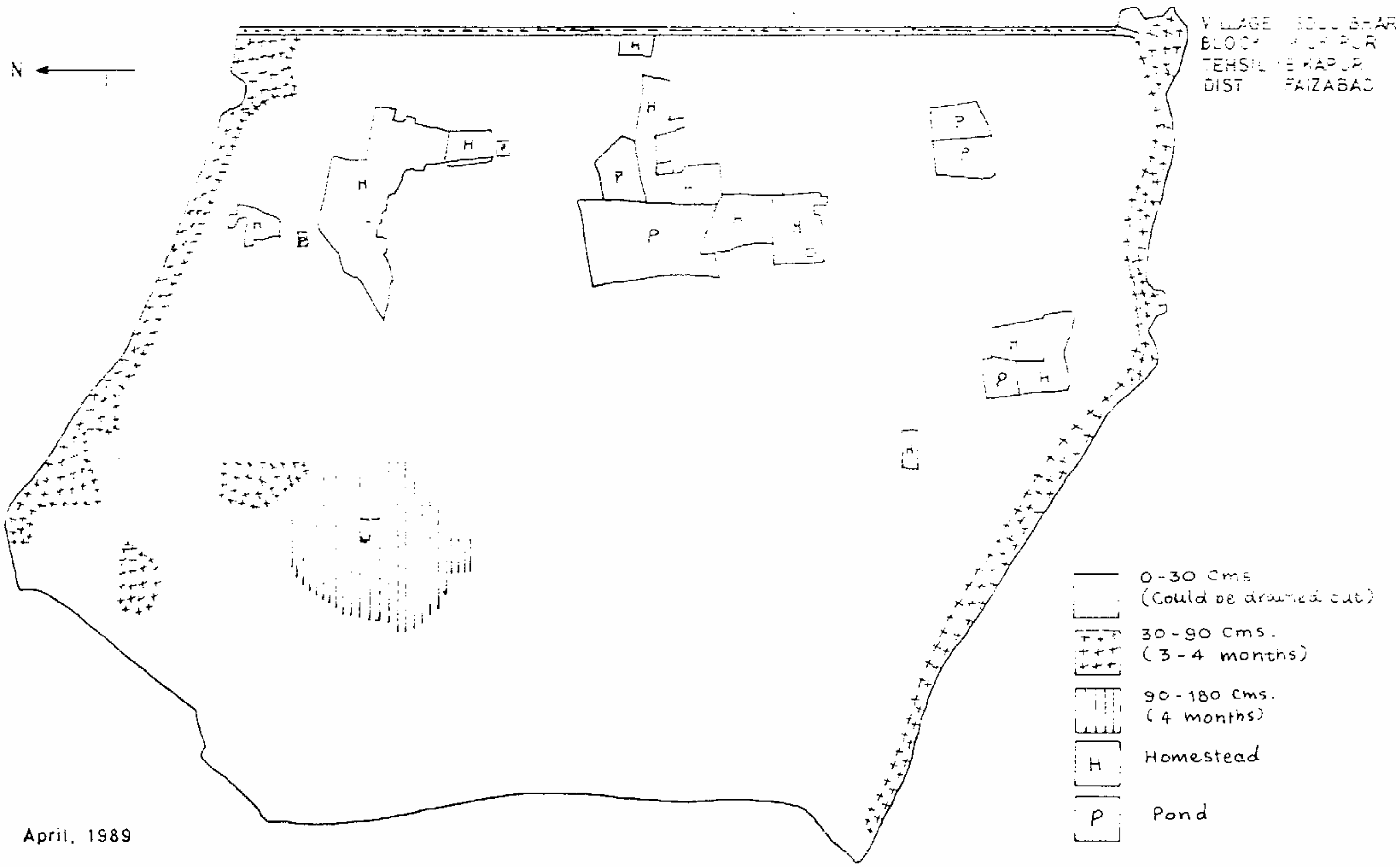
DECADAL RESURVEY MAP (1989-90 TO 2002-03)

Area under Kharif crops



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation. Indian Institute of Management, Ahmedabad.

FLOODING LEVEL MAP 88-89



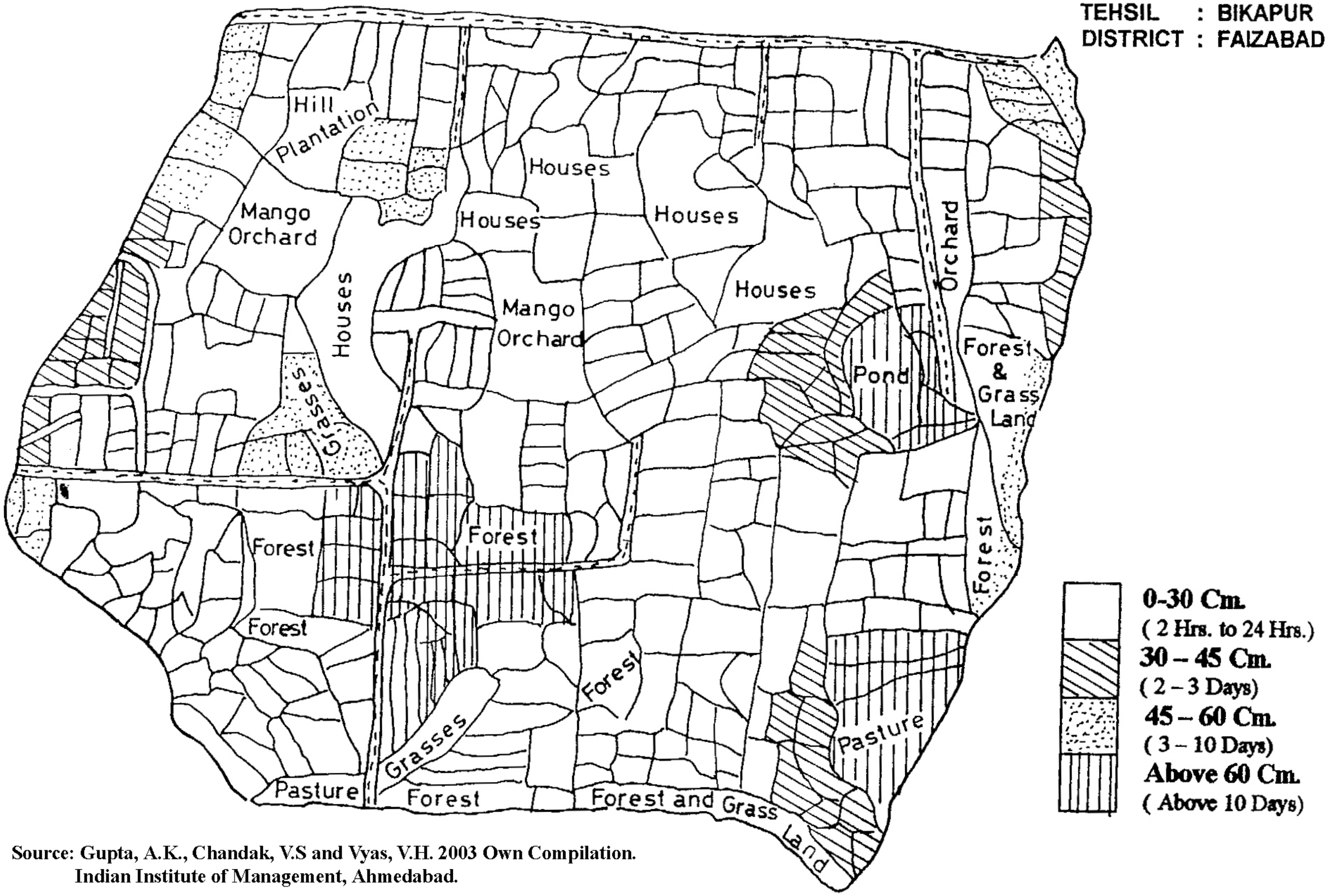
April, 1989

Anil K. Gupta & G.S. Saha
Centre for Management in Agriculture
IIM, Ahmedabad -380056

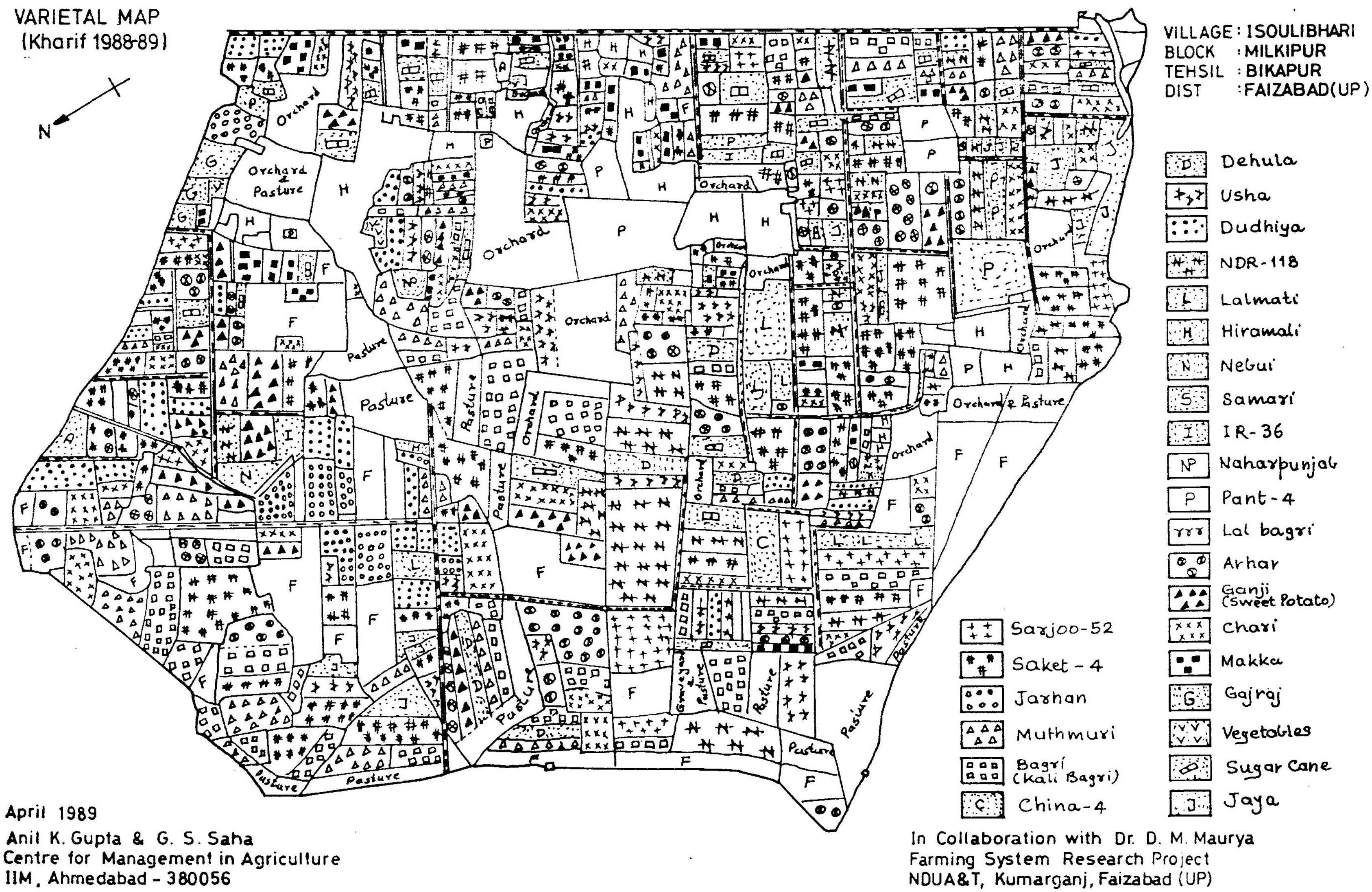
In Collaboration with Dr. D. M. Maurya
Farming System Research Project
NDUA&T, Kumargan,. Faizabad (UP)

DECADAL RESURVEY MAP (1989-90 TO 2002-03)
Flooding level

VILLAGE : ISOULIBHARI
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.


VARIETAL MAP
(Kharif 1988-89)
N
VILLAGE: ISOULIBHARI
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DIST : FAIZABAD(UP)
Dehula
Usha
Dudhiya
NDR-118
Lalmati
Hiramali
Nebui
Samari
IR-36
Naharpunjab
Pant-4
Lal bagri
Arhar
Ganji (Sweet Potato)
Chari
Makka
Gajraj
Vegetables
Sugar Cane
Jaya
Sarjoo-52
Saket-4
Jarhan
Muthmuri
Bagri (Kali Bagri)
China-4
Orchard
Pasture
Orchard & Pasture
April 1989
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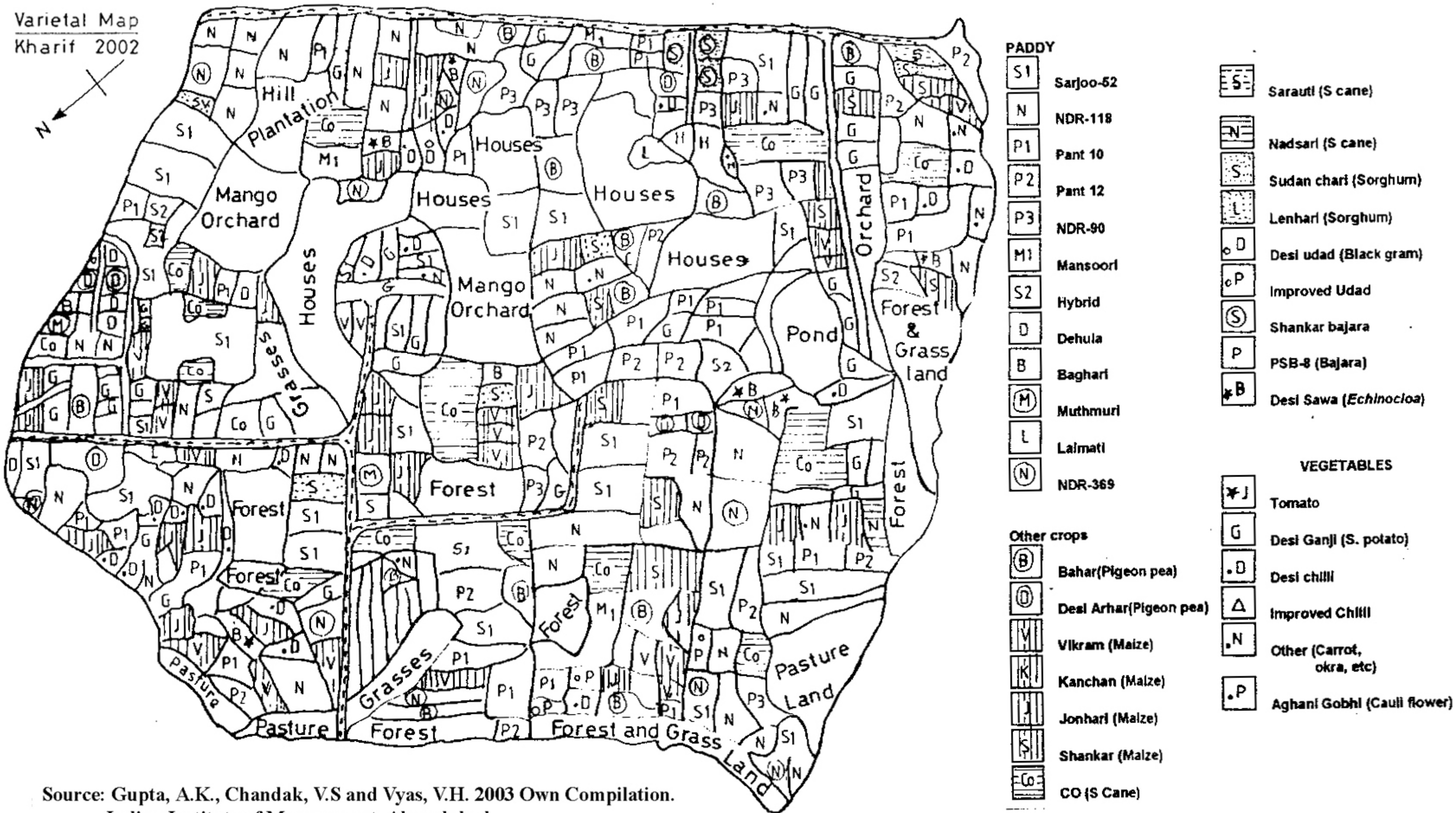
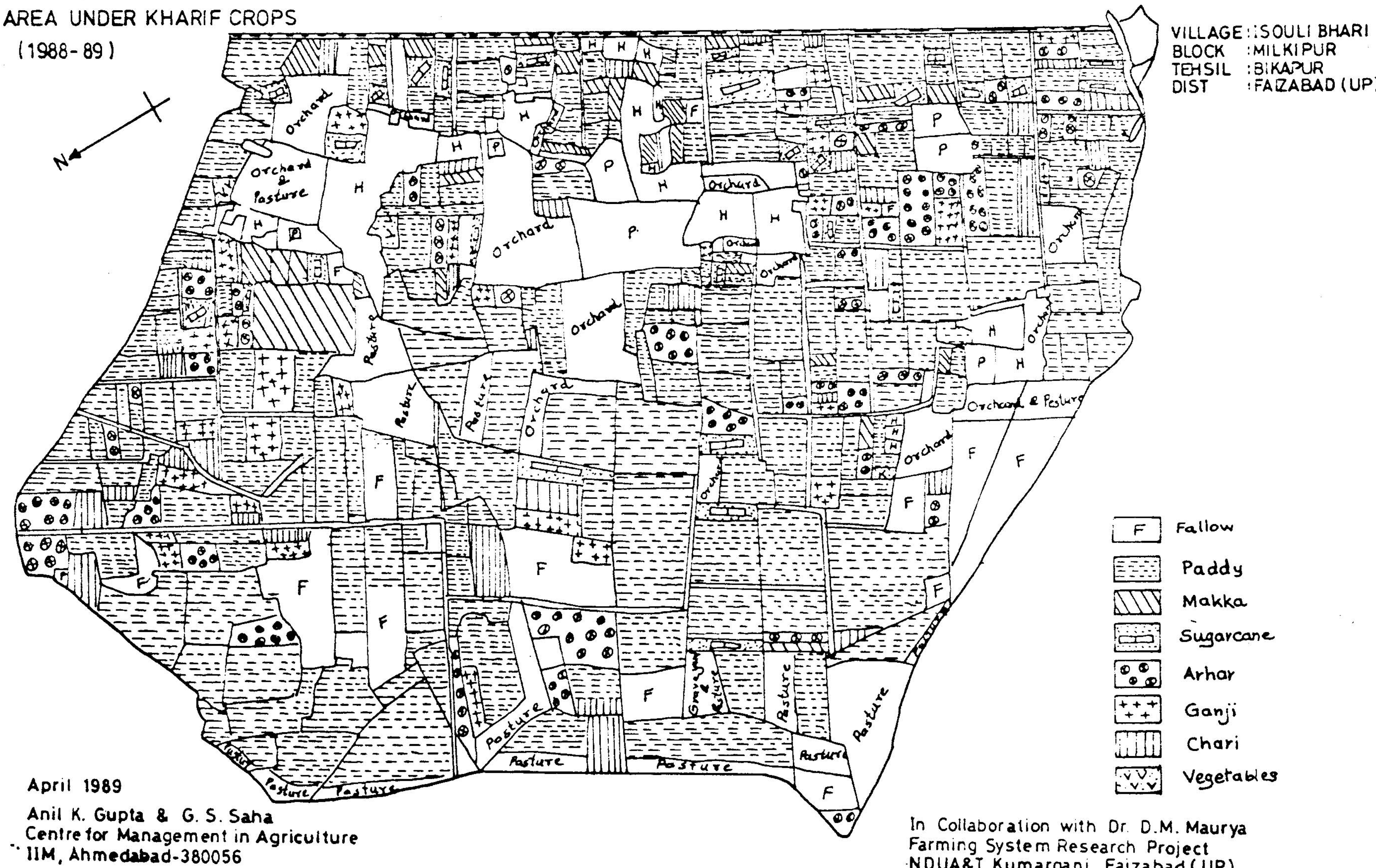
DECADAL RESURVEY MAP (1989-90 TO 2002-03)

VILLAGE : ISOULIBHARI
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation. Indian Institute of Management, Ahmedabad.


AREA UNDER KHARIF CROPS
(1988-89)
VILLAGE : SOULI BHARI
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DIST : FAIZABAD (UP)
N
F Fallow
Paddy
Makka
Sugarcane
Arhar
Ganji
Chari
Vegetables
April 1989
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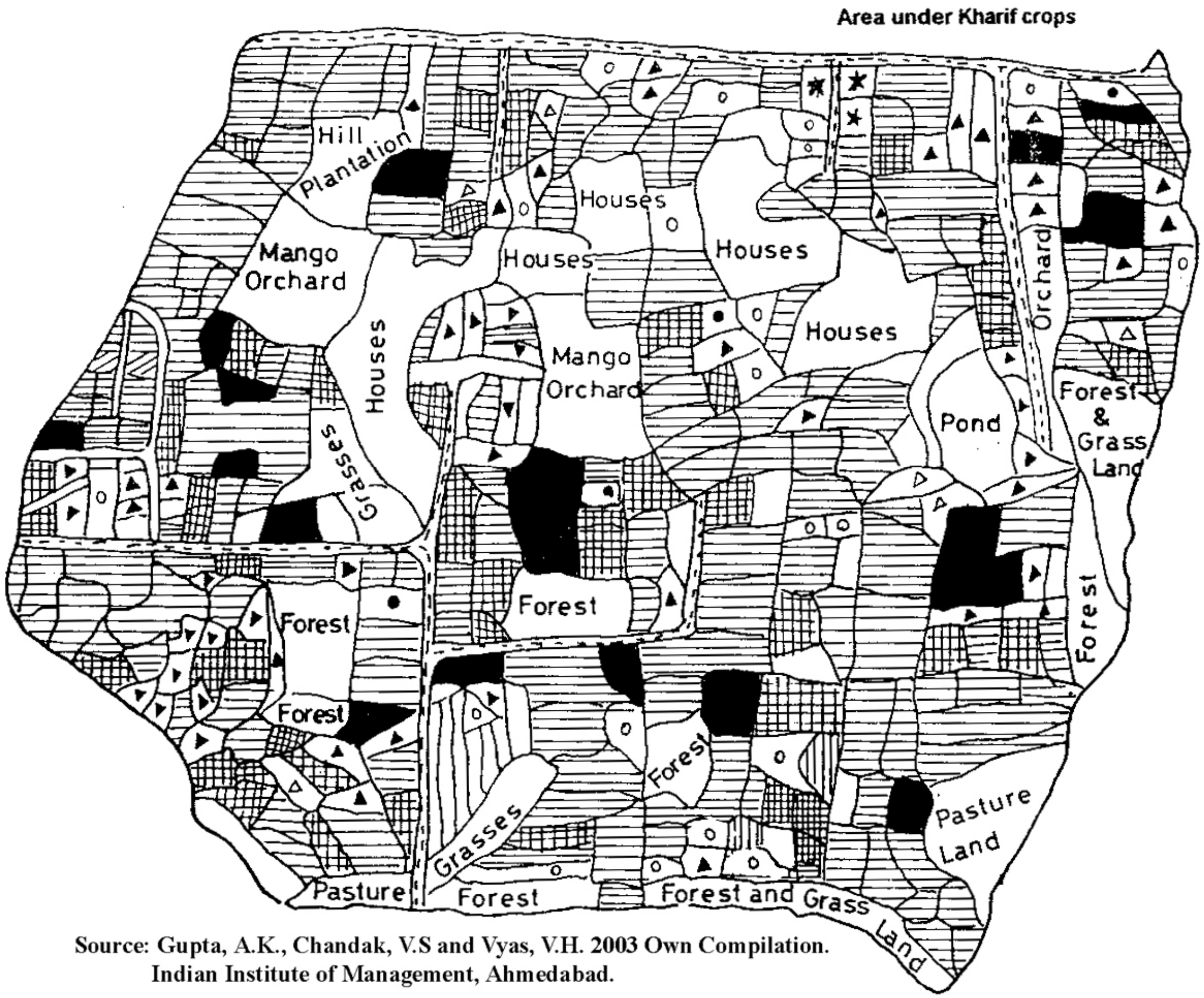
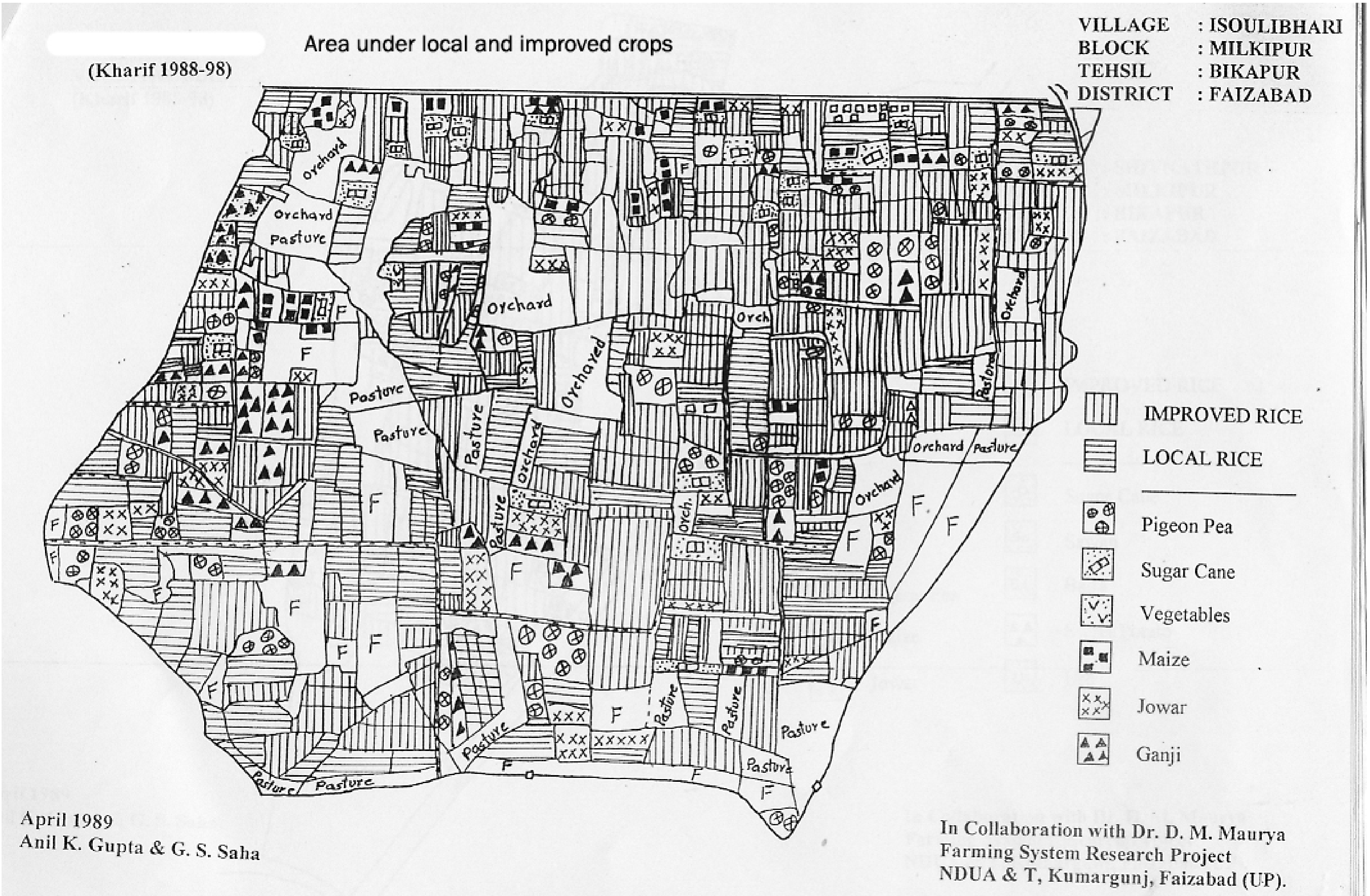
DECADAL RESURVEY MAP (1989-90 TO 2002-03)

VILLAGE : ISOULIBHARI
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.


Area under local and improved crops
(Kharif 1988-98)
VILLAGE : ISOULIBHARI
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD
IMPROVED RICE
LOCAL RICE
Pigeon Pea
Sugar Cane
Vegetables
Maize
Jowar
Ganji
April 1989
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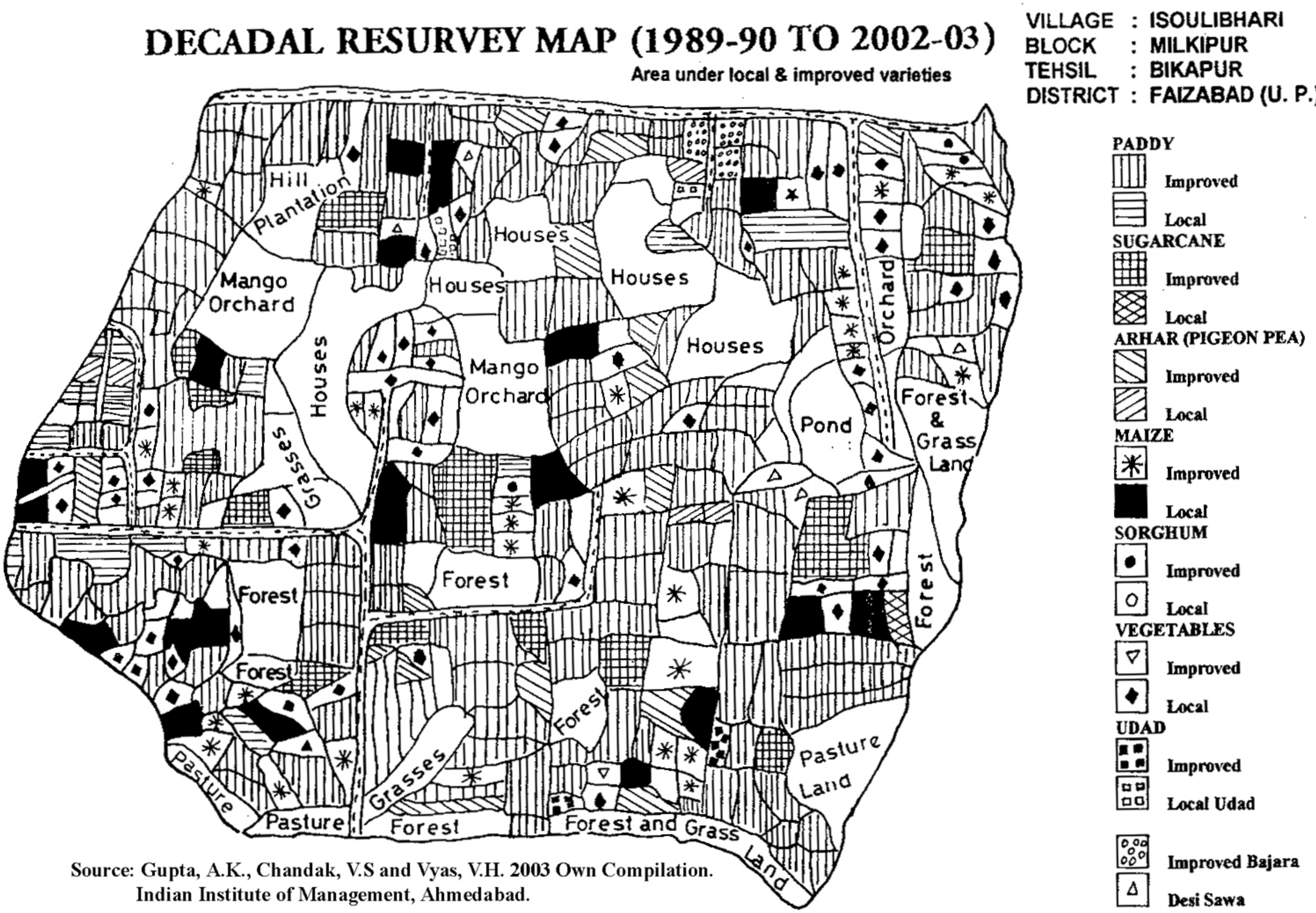
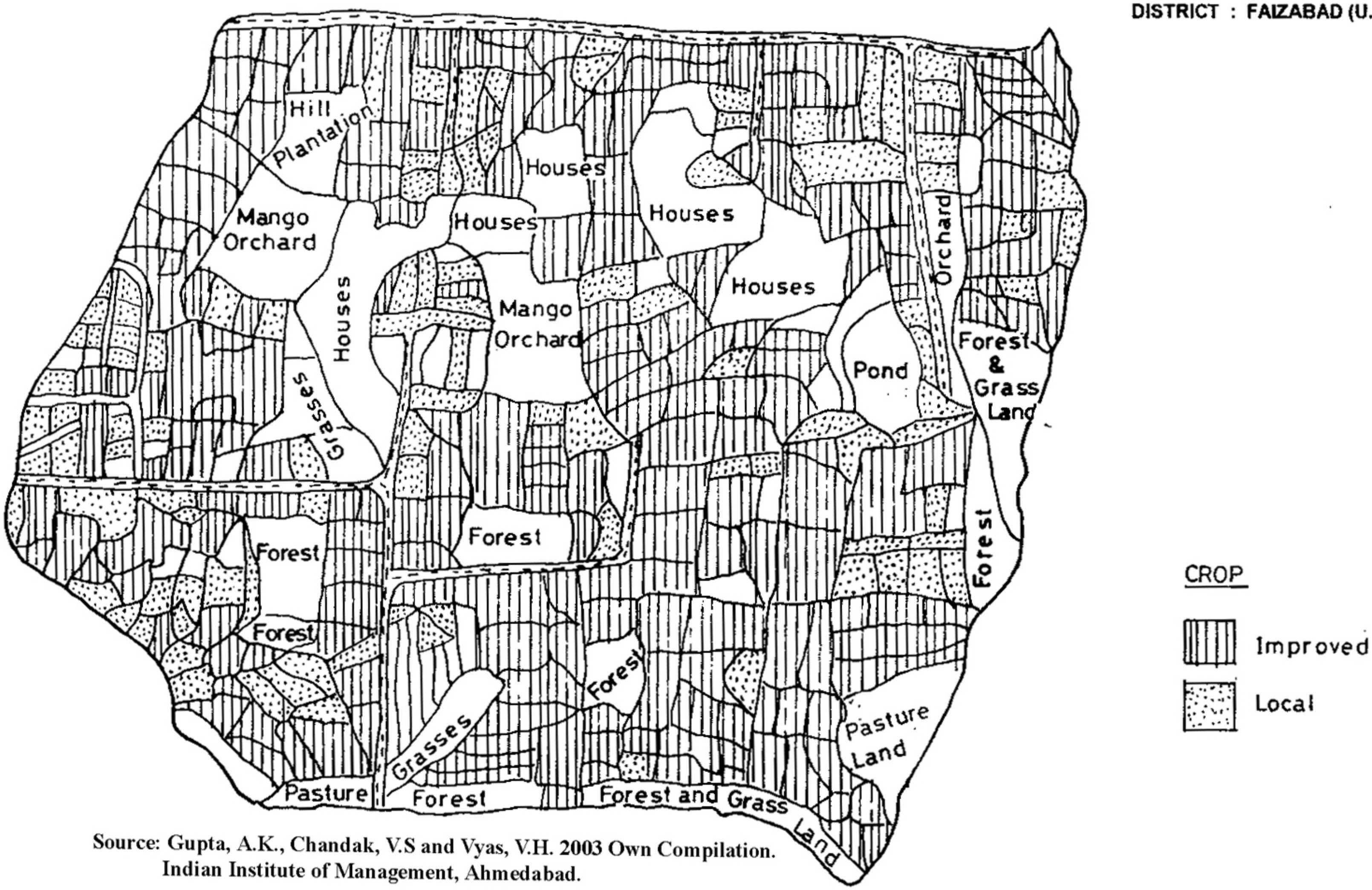


Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.

DECADAL RESURVEY MAP (1989-90 TO 2002-03)

Area under Local & Improved crops

VILLAGE : ISOULIBHARI
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)

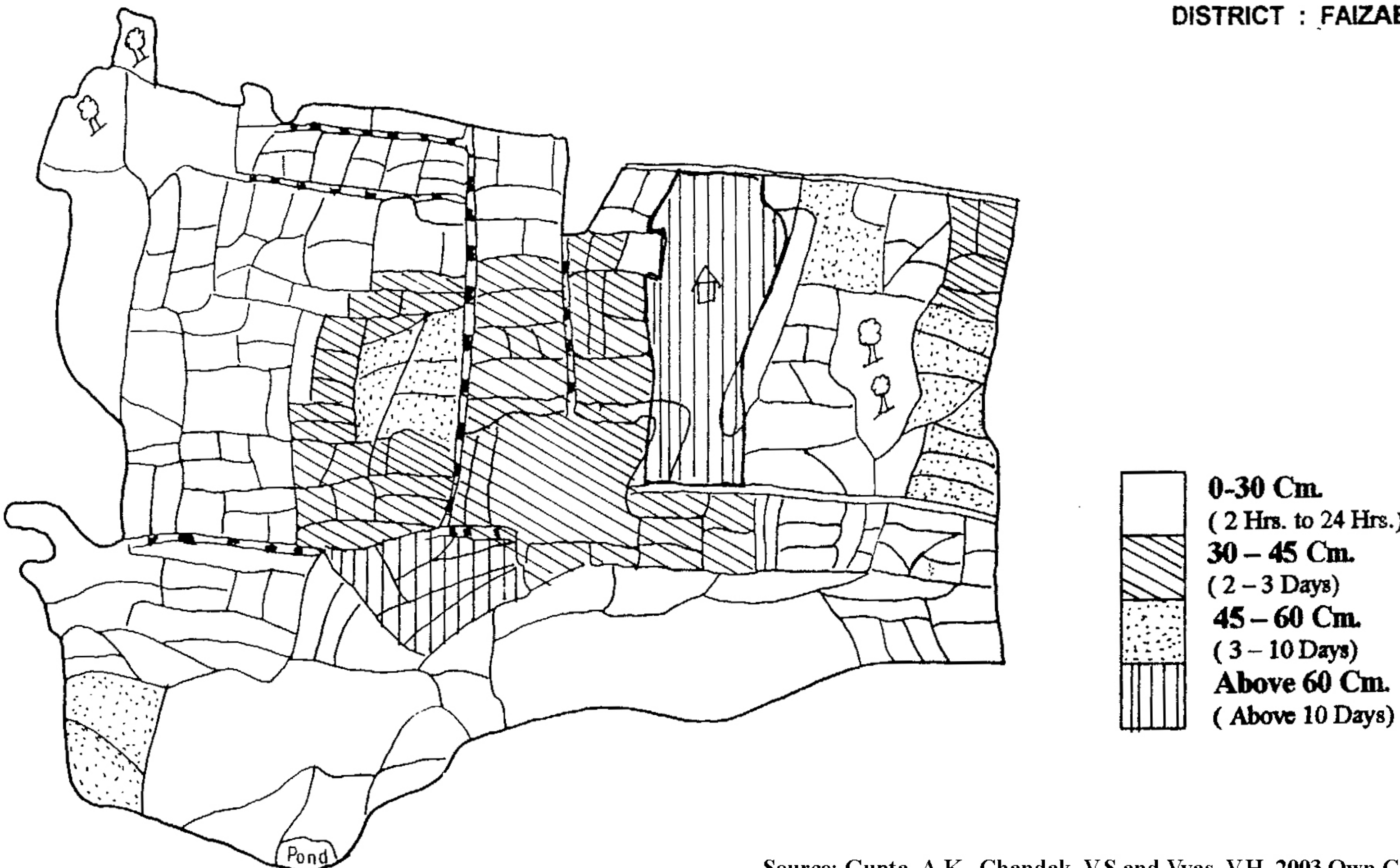


Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.

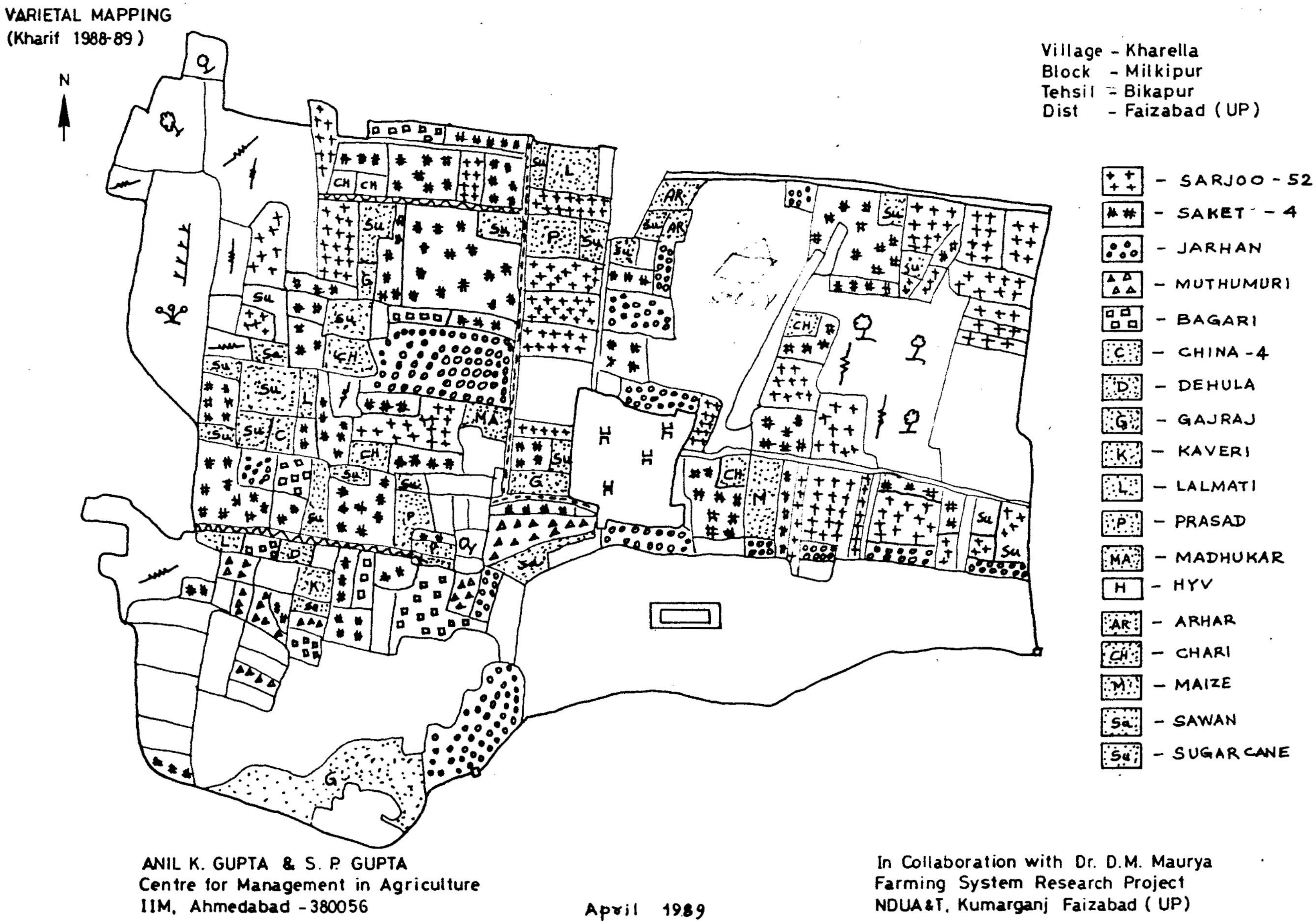
DECADAL RESURVEY MAP (1989-90 TO 2002-03)

Flooding level

VILLAGE : KHARELLA
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation. Indian Institute of Management, Ahmedabad.


VARIETAL MAPPING
(Kharif 1988-89)
N
Village - Kharella
Block - Milkipur
Tehsil - Bikapur
Dist - Faizabad (UP)
- SARJOO - 52
- SAKET - 4
- JARHAN
- MUTHUMURI
- BAGARI
C - CHINA - 4
D - DEHULA
G - GAJRAJ
K - KAVERI
L - LALMATI
P - PRASAD
MA - MADHUKAR
H - HYV
AR - ARHAR
CH - CHARI
M - MAIZE
Sa - SAWAN
Su - SUGARCANE
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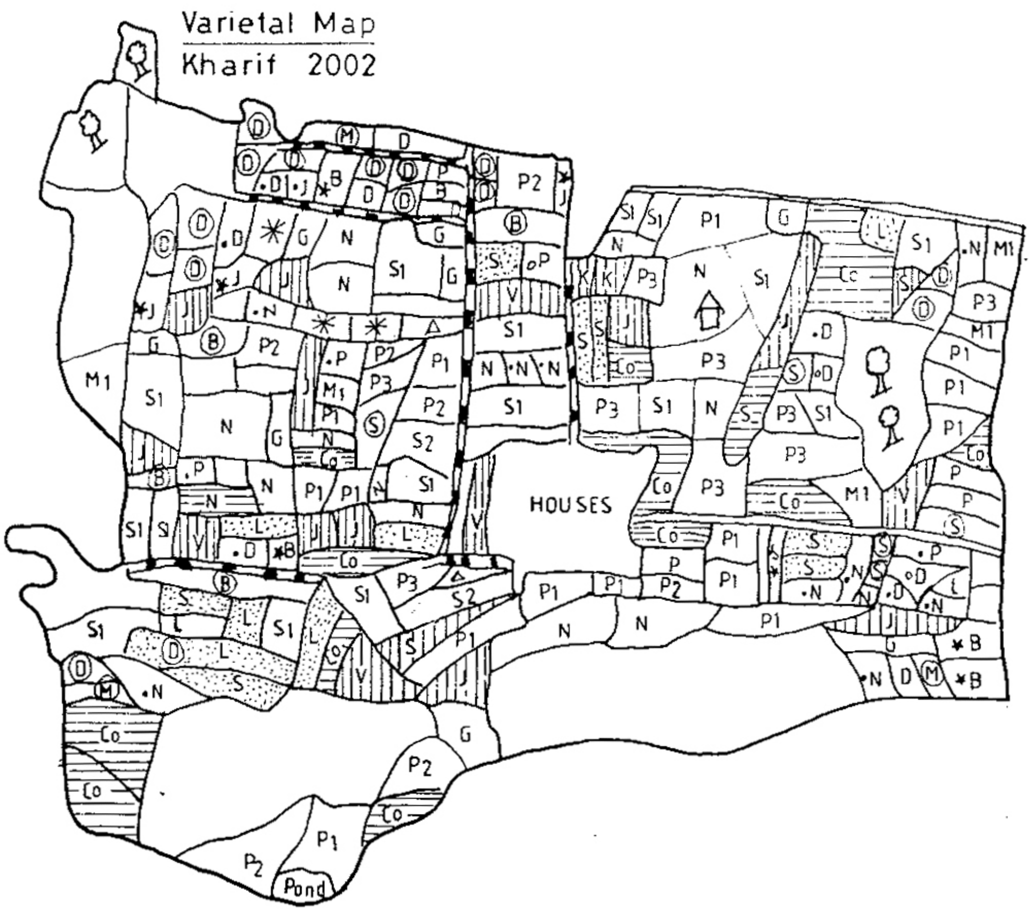
DECADAL RESURVEY MAP (1989-90 TO 2002-03)

VILLAGE : KHARELLA
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.

PADDY

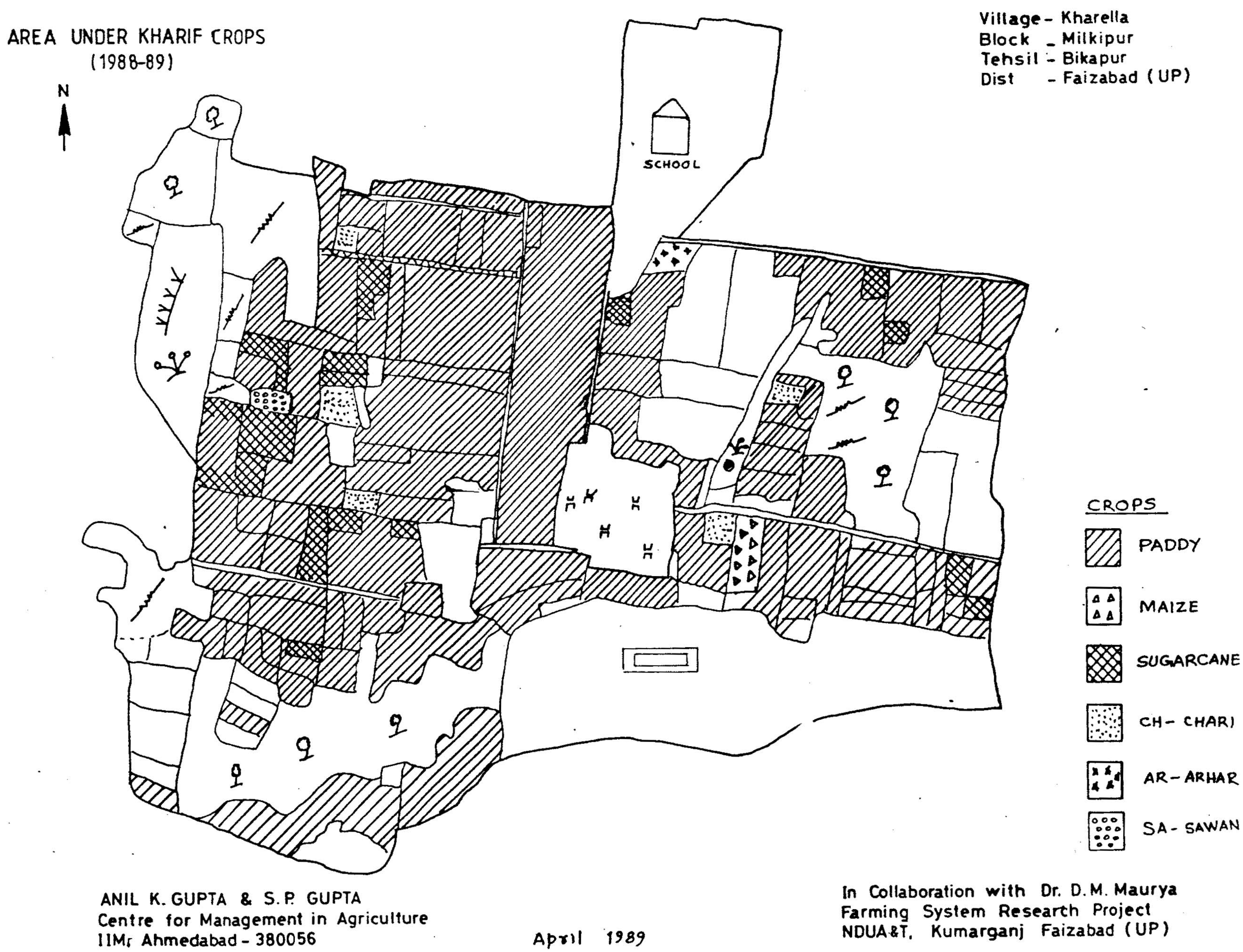
- S1 Sarjoo-52
- N NDR-118
- P1 Pant 10
- P2 Pant 12
- P3 NDR-90
- M1 Mansoori
- S2 Hybrid
- D Dehula
- B Baghari
- (M) Muthmuri
- L Lalmati

Other crops

- (B) Bahar(Pigeon pea)
- (D) Desi Arhar(Pigeon pea)
- Narednndra-369(Pigeon pea)
- V Vikram (Maize)
- K Kanchan (Maize)
- J Jonhari (Maize)
- S Shankar (Maize)
- Co CO (S cane)
- N Nadsari (S cane)
- S Sarauti (S cane)
- S Sudan chari (Sorghum)
- L Lenhari (Sorghum)
- oD Desi udad (Black gram)
- oP Improved Udad
- (S) Shankar bajra
- P PSB-8 (Bajra)
- ✱B Desi Sawa (*Echinocloa*)

VEGETABLES

- ✱J Tomato
- G Desi Ganji (S. potato)
- .D Desi chilli
- Δ Improved Chilli
- .N Other (Carrot, okra, etc)
- .P Aghani Gobhi (Cauli flower)


AREA UNDER KHARIF CROPS
(1988-89)
N
Village - Kharella
Block - Milkipur
Tehsil - Bikapur
Dist - Faizabad (UP)
SCHOOL
CROPS
PADDY
MAIZE
SUGARCANE
CH - CHARI
AR - ARHAR
SA - SAWAN
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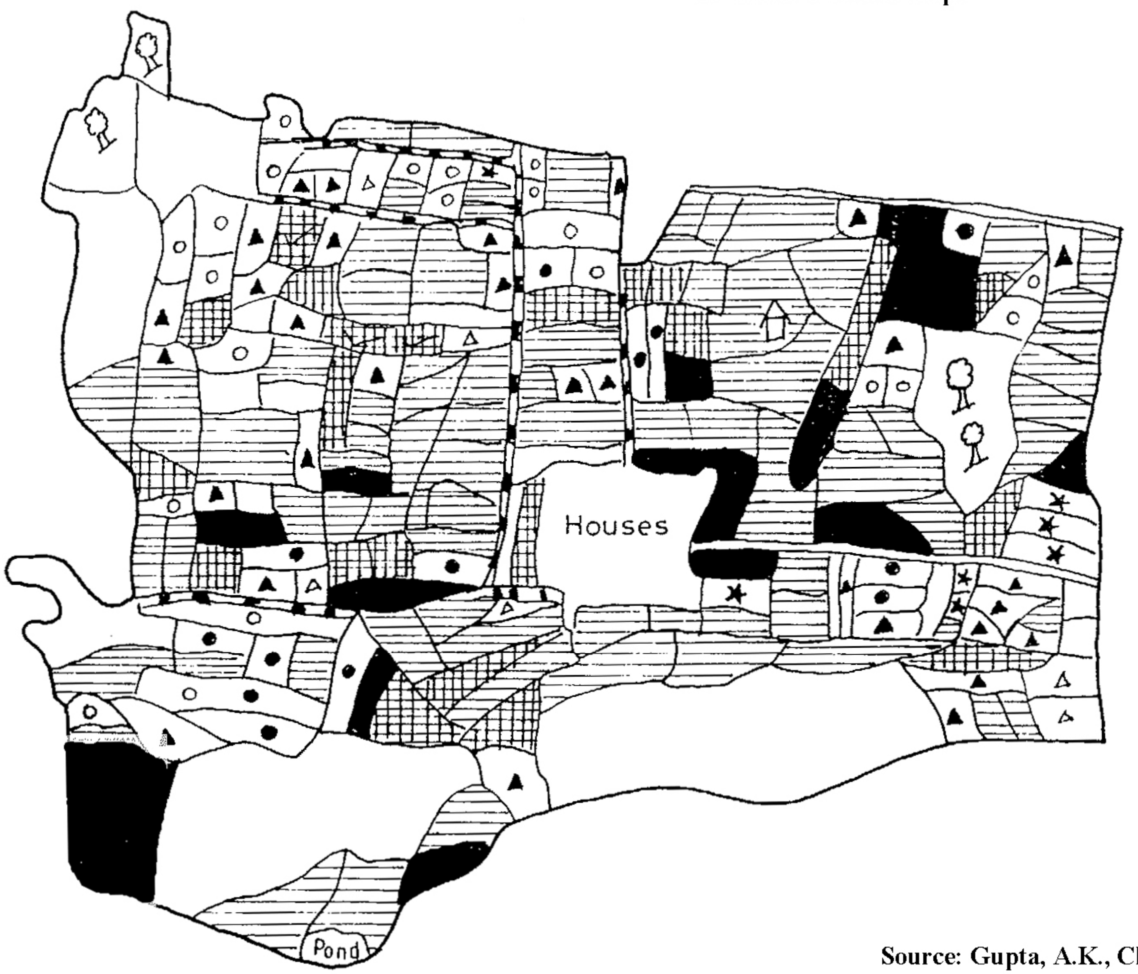
DECADAL RESURVEY MAP (1989-90 TO 2002-03)

Area under Kharif crops

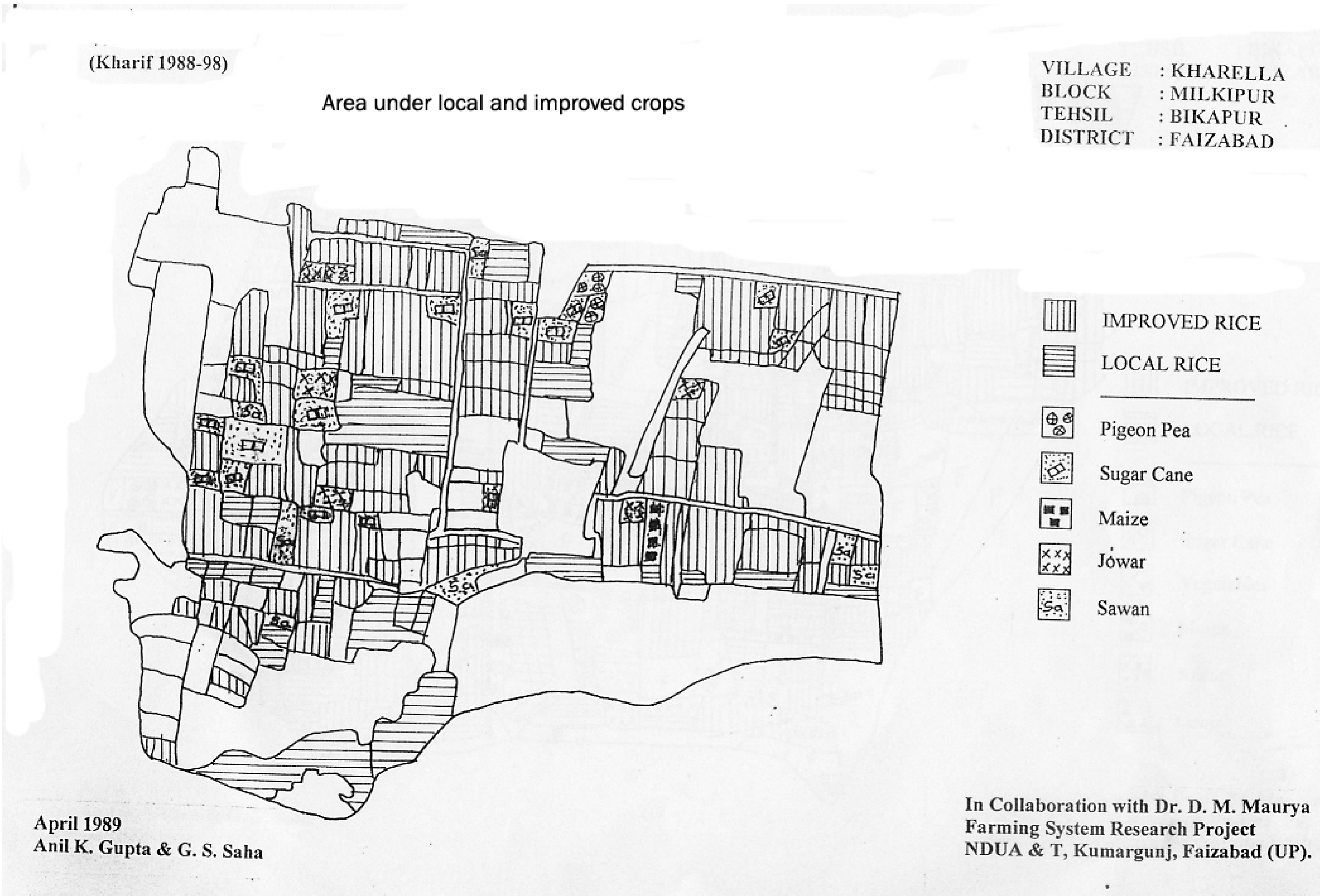
VILLAGE : KHARELLA
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)



CROPS

- Paddy
- Sugar cane
- Maize
- Vegetables
- Pulses
- Bajara
- Chari (Sorghum)
- Desi Sawa

Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation.
Indian Institute of Management, Ahmedabad.


(Kharif 1988-98)
Area under local and improved crops
VILLAGE : KHARELLA
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD
IMPROVED RICE
LOCAL RICE
Pigeon Pea
Sugar Cane
Maize
Jowar
Sawan
April 1989
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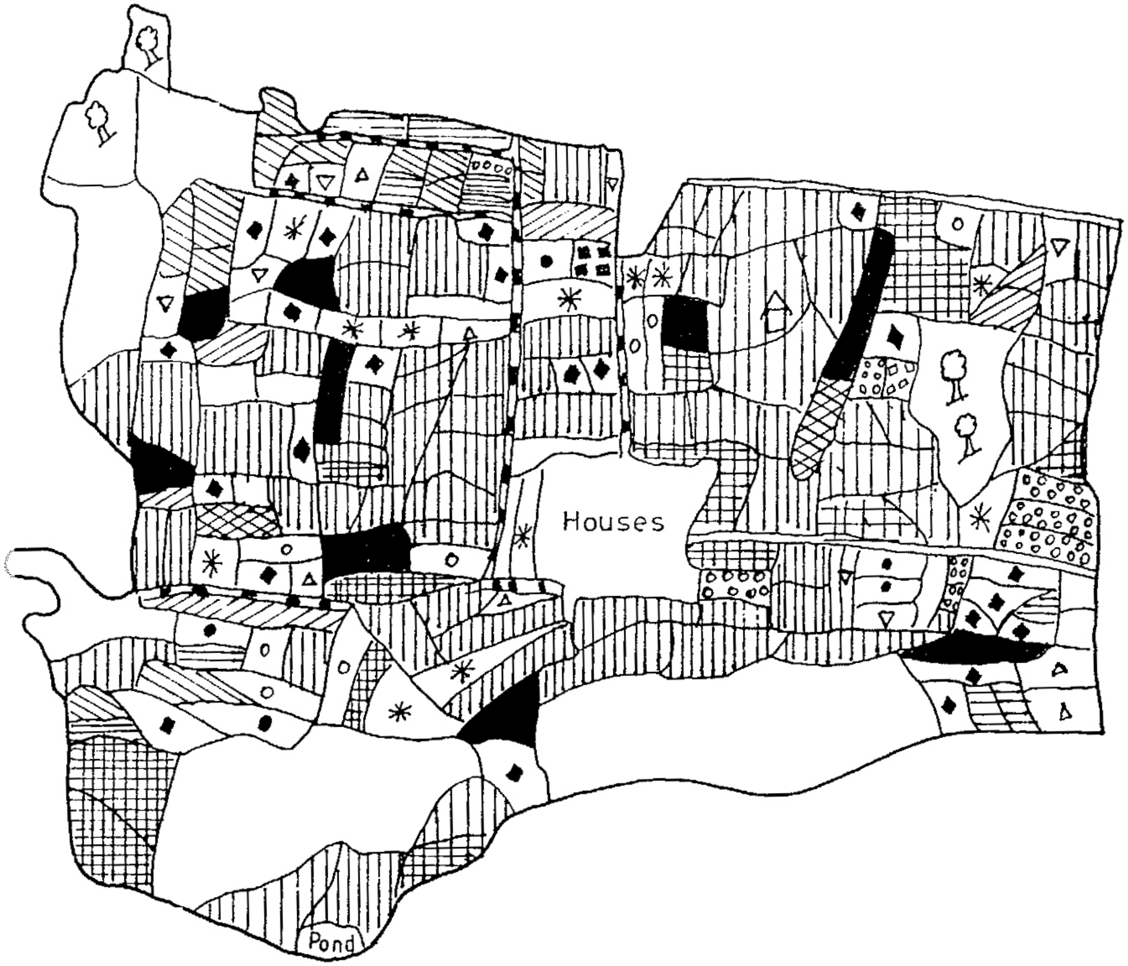
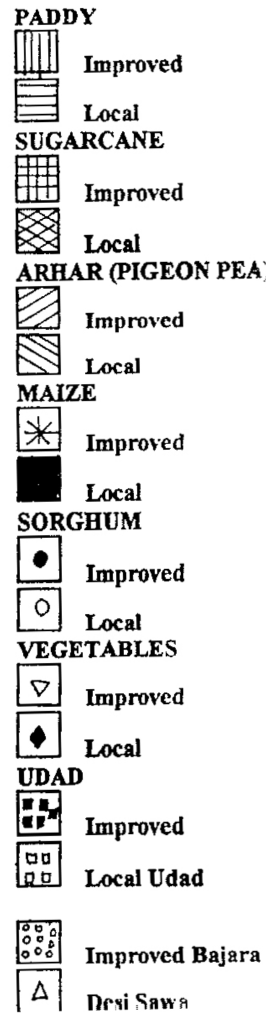
VILLAGE : KHARELLA
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)

DECADAL RESURVEY MAP (1989-90 TO 2002-03)

Area under local & improved varieties



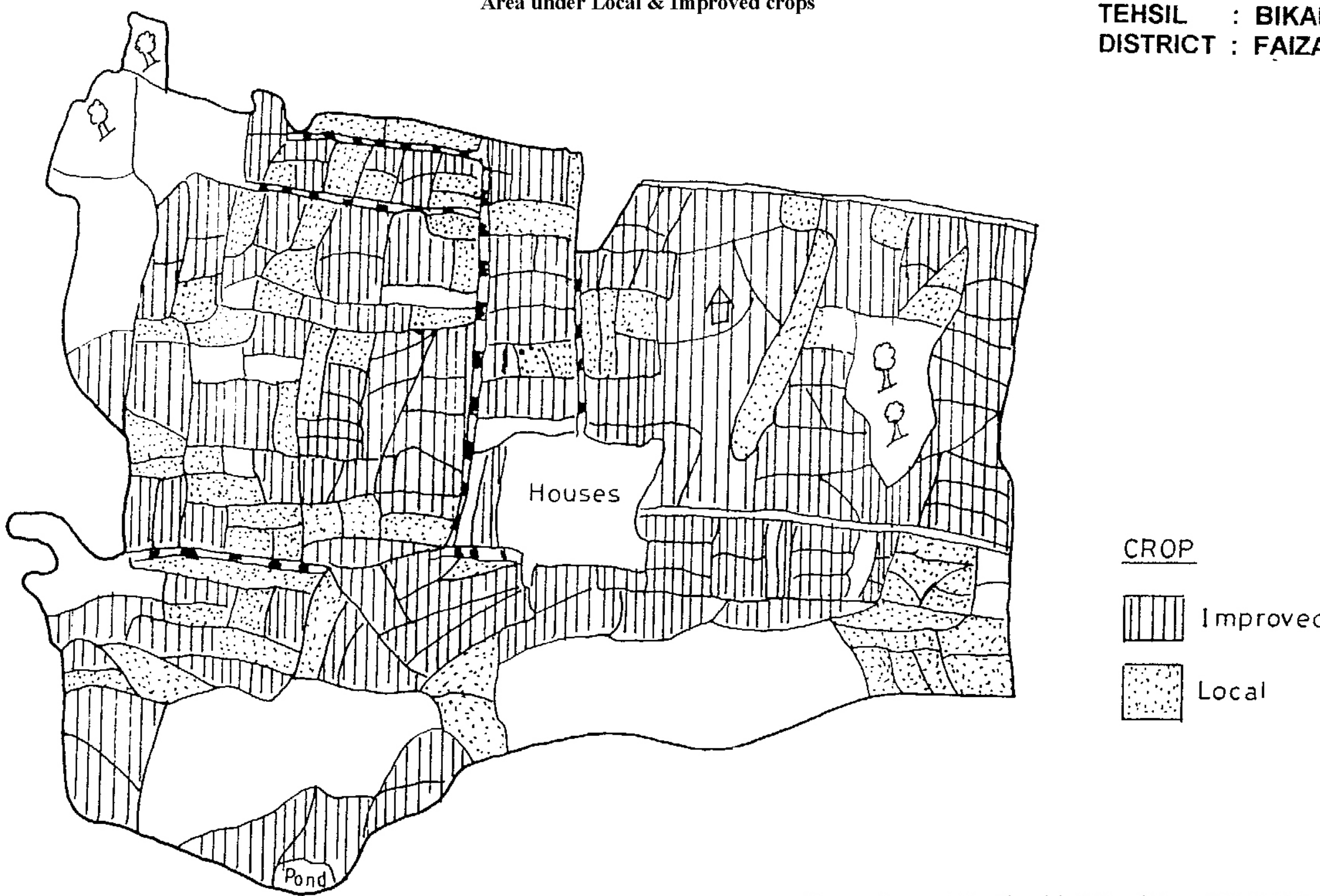


Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation. Indian Institute of Management, Ahmedabad.

DECADAL RESURVEY MAP (1989-90 TO 2002-03)

Area under Local & Improved crops

VILLAGE : KHARELLA
BLOCK : MILKIPUR
TEHSIL : BIKAPUR
DISTRICT : FAIZABAD (U. P.)



Source: Gupta, A.K., Chandak, V.S and Vyas, V.H. 2003 Own Compilation. Indian Institute of Management, Ahmedabad.

The End