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Agroforestry in Tribal Areas of Gujarat: Move towards Sustainable Agriculture?

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Abstract

This paper examines the agroforestry initiative adopted by the Government of Gujarat with the aim to enhance the incomes of tribal households facing numerous production constraints. The specific objectives of this paper are to (a) explore achievements and challenges faced by beneficiaries adopting agroforestry, and (b) draw policy implications. The first half of the paper rests on the analysis of the nature and extent of agricultural growth in tribal areas using secondary data. Using primary data and the existing literature, the second half of the paper undertakes an early assessment of the implementation of the agroforestry programme.

The contention of this paper is that diversification of cropping pattern toward high valued crops could enhance income and productivity of land and conserve soil moisture in fragile tribal areas. While agroforestry offers the scope for such diversification, it is essential that the critical constraints faced by the households in adopting the new crops are addressed. The central thrust, therefore, should be given to providing agricultural extension services in promoting sustainable agriculture practices. Experiences from the study area emphasise the need to build synergy of agroforestry programme with larger extension programmes. A well coordinated extension system may help overcome some of the critical constraints/limitations of the programme, viz., location specificity in choice of species as well as technology, effective communication and frequent interactions, close monitoring and follow up, balancing food security with commercialisation, and access to markets. These experiences may offer significant learning for implementation of agroforestry programmes in other parts of the country facing problems relating to dryland/ semi arid conditions with significant tribal population.

Keywords : Sustainable agriculture, tribal, agroforestry, Gujarat

JEL Codes : Q12, J15, Q15

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1. Subsistence Agriculture and Constraints in Tribal Areas

Tribal people are fraught with a number of constraints operating at both individual and community levels. Tribal farmers in Gujarat like in other parts of the country face numerous production constraints like uncertain and erratic rainfall, degraded forests, sloppy and hilly terrain, and thin fertile soil. These factors along with poverty and low capacity of investment, unavailability of inputs, inadequate knowledge about cultivation practices, improved variety of seeds and other inputs, and lack of proper markets force tribal farmers to practice subsistence agriculture by cultivating traditional crops. Green Revolution has by and large bypassed the agriculture in tribal regions thereby depriving farmers of the new technology as well as markets. At the same time, natural resources like land and water have also undergone severe depletion both in terms of quality and quantity. As a result tribal areas face severe production constraints as compared to non-tribal areas in the state. This is often reflected by the productivity differentials across the two sets of regions within the state (Bose, 1981). Another important factor influencing tribal agriculture is the strong link between forests and tribal population as the latter is largely dependent on forest for food, fuel and fodder requirements (Saxena, 2000; Nair, 2001). It is, therefore, imperative that the root cause of resource degradation faced in tribal areas should be addressed as an important component of the strategy for developing agriculture in tribal areas. As a thumb rule, enhanced and sustained productivity could be seen as directly related to regeneration of natural resource base of the region.

Traditionally tribal farmers cultivate a wide range of crops in order to a) meet the food requirement of the household, and b) mitigate the impact of crop failure by spreading the risk over several crops. Though fairly sound and rational, an approach of growing multiple crops by adopting inter-culture practices makes it difficult for the existing agriculture extension system, which has strong orientation towards crop-specific technologies, to reach out to the

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tribal farmers. In fact, tribal agriculture has certain peculiar characteristics that may have been evolved over time, especially to suit the ecology, human need and culture of the people from time to time. Therefore, what appeared to be an appropriate farming strategy or practice under the overall context of subsistence economy may not prove to be commercially profitable under a situation of market economy.[1] This is particularly true in the case when crop diversification does not involve shifting to high valued and commercial crops.

Given this context, options for increasing income of the tribal farmers in constrained conditions may need carefully worked out strategies without damaging the core characteristics of the area, resources and the people dependent on it. This may imply that a differential approach from the ones adopted for the rest of the areas/communities needs to be adopted for promoting development in tribal areas (Shah and Sajitha 2008). It is, therefore, imperative to lay special emphasis on technologies that may address issues of enhancing land productivity for simultaneously meeting the requirements of food, fodder and fuel and also ecology in a sustainable manner. Recognising the link between agriculture, forestry and need for livelihood of tribals, crop diversification, especially, toward high valued crops (rather than subsistence crops) may be seen as an important policy option for enhancing the income of tribal farmers. This kind of diversification, however, needs to be designed in a manner that takes care of resource sustainability in tune with the land capability and agro-climatic conditions in the given socio-economic context.

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1 Three components of spatial dimension of diversification are (a) diversity in the cropping pattern; (b) spread of the cropping pattern; and (c) land allocation in favour of high value crops. However, over time, due to the changing market and technological conditions, the cropping pattern undergoes the change and thus alters the pattern of diversification.

2. Potential Role of Agro-Forestry in Tribal Economy

There has been a fairly wide recognition of the fact that agroforestry[2] may act as a buffer against deforestation in fragile areas, given the symbiotic relationship between tribal economy and the forests (Bawa and Dayanandan, 1997; Singh et al., 2002; Srivastava et al., 2002; Sunderlin et al., 2005; Arunachalam et al., 2004). According to Kulkarni (1987) development of social forestry, farm forestry and agro-forestry could bring multiple benefits by way of increasing the production of fodder, fuel wood and fertiliser, generating employment, improving environment, and reducing the drudgery for women involved in collecting fuel and fodder. Ecologically sound agroforestry systems with intercropping and mixed arable-livestock systems can increase the sustainability of agricultural production while reducing on-site and offsite consequences (Rasmussen et al., 1998). Further, it creates landscape structure that is important for biological pests control (Bridge, 1996). In addition to addressing some of the concerns associated with environmental conservation, agroforestry is well suited to small farms and has the potential for raising their standard of living. Thus, agroforestry can be seen as a risk avoidance strategy that diversifies sources of income for farmers (Nair, 1990).

Tree-based agro ecosystems have more closed nutrient cycles that help conserving soil productivity (McGrath et al., 2000). Agroforestry, agrosilvipasture and agrohorticulture are believed to complement chemical fertilisers in enhancing soil fertility (Manna et al., 2003). In the regions where Green Revolution has failed to make its mark, due to thin fertility soil, agroforestry holds the potential of yielding better returns and maintaining the

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[2] Agroforestry involves the growing together of perennial crops with annual crops and/or animals. Three main types of agroforestry systems are generally recognized in the specialist literature: agrosilvicultural, agrosilvipastoral, and silvopastoral (Nair and Dagar, 1991). Internationally, the definition adopted as the basis for an international scientific journal (Agroforestry Systems Journal) and the International Council for Research into Agroforestry (now the World Agroforestry Centre) in the early 1980s defined agroforestry as a collective name for land use systems and technologies, where woody perennials are deliberately used on the same land unit as agricultural crops and/or animals either in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both economical and ecological interactions between the different components (Lundgren, 1982). Reid and Stephen (2001) argued that farm forestry and agroforestry are terms that relate not to the outcome but to the process by which these forests are established and managed and that it is this process of farmer decision-making that should guide the research and development of agroforestry.

organic content of the soil (Sanchez, 2000 and 2002). Agroforestry systems have the potential for improving water use efficiency by reducing the unproductive components of the water balance (runoff, soil evaporation and drainage) (Lovenstein et al., 1991; Droppelmann and Berliner, 2003). It could double rainwater utilisation compared to annual cropping systems.

Moreover, being labour intensive agroforestry holds the potential of generating employment in own land and helping farmers in fetching better returns from land in otherwise fragile areas with poor infrastructure. In the central Indian upland rice fields, agroforestry trees account for nearly 10 per cent of the annual farm income for the farmer with less than two acres of land and is distributed uniformly throughout the year. This is greater than the income earned from rice (Pandey, 2007). Available evidence shows that one hectare under horticultural crops can generate an annual income up to Rs. 20,000, compared to hardly Rs. 10,000 and Rs. 4,000 by rice and *ragi* respectively (Singh et al., 2002). Cultivation of fruits can generate employment to the tune of 860 man-days as against 143 man-days for cereals. In the north-eastern states of Meghalaya and Assam, guava and lemon based agrihorticultural agroforestry systems (farming combined with domesticated fruit trees and forest trees) gave 2.9- and 1.9-fold higher net returns respectively in comparison to farmlands without trees. Such systems are useful livelihoods improvement strategies in the rainfed agriculture of Meghalaya (Bhatt and Misra, 2003). A study of eight-year-old agroforestry intervention in Jharkhand found that community dependent solely on rainfed farming and animal husbandry definitely gains positively by agroforestry interventions (Minj and Quli, 2000). Nair (1990) and Nair and Dagar (1991) suggested that agroforestry systems could be tailored to a wide range of ecological and socioeconomic conditions. Such programmes in tribal areas have more chances of success as communities are heavily dependent on wild resources for livelihoods (Kumar and Pandey, 1995).

The existing evidence, by and large, suggests that agroforestry may work better in a situation where agriculture is already commercialised. On the other hand agroforestry may not bring the expected benefits under conditions of subsistence farming in dry land regions characterising many parts of tribal agriculture in India. Studies by Nair (2001) and Miller and Nair (2006) have identified number of factors responsible for slow progression towards agroforestry in different parts of the world. These include: (i) lack of adequate support services designed to reach marginal and small farmers, (ii) inadequate

water availability, (iii) poor input quality like saplings, (iv) trade-offs between cultivating agroforestry crops and agricultural crops, (v) long gestation period and slow and at time intangible impact, and (vi) unavailability of forward linkages like storage, market for the produce, especially in rainfed-tribal dominated areas. There is a need for addressing these negative impacts while making effort in promoting agroforestry technology, particularly, in tribal areas fraught with problems related to production, lack of demand, lack of market access, market imperfection, and loss in agricultural production. It may be noted that the issues pertaining to the effective extension as well as support services that could help overcome some of these have received rather limited attention among scholars (Scherr and Muller, 1991; Dean et al., 1994; Tschinkel, 1987; and Murray, 1991).

In India, studies by Saxena (1992) and Pingali and Rosegrant (1995) show that agroforestry programme has achieved spectacular success only in regions characterised by commercial and monetised agriculture. The picture was significantly different in eastern states like Orissa, Bihar and Madhya Pradesh where farmers continue to practice subsistence agriculture, hence remained indifferent to private tree planting. This is despite the fact that rainfall and soil conditions tend to be more favourable for growing trees in the case of eastern states as compared to the western and northern parts of India, especially those under semi-arid conditions.

Gujarat has a fairly long history of promoting tree plantation especially in the central-southern districts that partly overlap with the tribal belt in the eastern part of the state. National Horticultural Board was constituted in 1984 on the lines of National Dairy Development Board. Its aim was to coordinate the production and processing of fruits and vegetables. The government of India established the Agricultural and Processed Food Products Export Development Agency to strengthen food processing and promote its export. The main aim was to build links between Indian producers and the global markets. It yielded promising results (Shah, 2005). The experience notwithstanding the commercial orientation of farmers has at best remained mixed (Saxena, 1992). Of late there has been a revival of interest in tree plantation and agroforestry, especially, under the Tribal Sub Plan. Given the good potential the scheme is considered as one of the important components of the strategy in addressing certain major constraints noted here. As part of this policy approach, the Government of Gujarat has devised the Integrated Horticultural Development Programme (IHDP) as a special initiative to offer technological option for promoting high value crop diversification to enhance incomes of tribal farmers in the state.

This paper is an attempt to examine the experience of IHDP in the larger context of agroforestry programme in the region. With the help of a case study effort is made to understand the strategy, performance, constraints and lessons from implementation of IHDP in the state. The analysis has been placed in the context of a comparative assessment of agricultural scenario across tribal and non-tribal areas in the state. The paper is divided in six sections. The next section describes the main objectives and methodology. The third section provides a brief overview of the status of the programme, followed by a comparative analysis of agriculture in tribal and non-tribal areas in section four. Section five presents findings of the assessment of IHDP programme and discusses the constraints faced by the farmers covered under the programme. The last section discusses policy implications.

3. Objectives and Methodology

Specifically the paper tries to examine i) the process of implementation and adoption of improved crop-mix and farm practices among the beneficiaries; ii) the extent to which the programme has helped overcoming some of the initial constraints for the adoption across different categories of tribal farmers; and iii) policy implications for tapping the full potential on a sustained basis.

The analysis is based mainly on the primary data collected from a sample of villages and households in seven districts (Dahod, Panchmahal, Sabarkantha, Vadodara, Valsad, Surat and Tapi) in the state, whereas the comparative assessment of agriculture presented in section four is based on secondary data pertaining to major crops covering a period of 15 years, 1991–92 to 2005–06. The analysis consists of comparison of compound growth rates, yield levels, and crop diversification measured in terms of Herfindahl Index (HI) for three sub-periods of five years each.

The primary data have been collected from a sample of 684 (out of 42,433) beneficiaries covered under IHDP since 1997. The sample households are selected through stratified random sampling method. Of these 54 are female headed households (FHH). The first step was to select the block having the largest coverage of area (thereby beneficiaries) under the project in each of the seven districts selected for the study. A village representing median value of the area covered under the project was selected for the survey. In all 90 beneficiary households were selected in each village from three categories of operational land holding size representing marginal, small, and the rest (30 households each from each category). The primary survey of households was conducted during 2008–09 using a detailed questionnaire.

4. Integrated Horticultural Development Programme in Tribal Areas of Gujarat

The Government of Gujarat under the Vanbandhu Kalyan Yojana (VKY) has initiated IHDP known as '*Wadi* in the year 1997[3]. Several programmes promoting horticulture development, ensuring supply of inputs, providing agricultural extension services to tribals using improved method of horticultural practices and usage of various inputs are incorporated under IHDP with the aim of increasing income of farmers (GoG, 2005b: pp 67). A booming economy and changing consumption pattern in favour of non-staple crops both in the rural and urban areas and trade liberalisation supports the move towards growing horticultural crops. This is evident from the share of these commodities in the total expenditure on food which increased from 34 per cent in 1983 to 44 per cent in 1999–2000 in rural areas, and from 55 per cent to 63 per cent in the urban areas (Kumar and Mruthyunjaya, 2002). Thus, horticulture and forestry in India command high value not only in terms of their potential in generating income and employment but also on the basis of export-earning opportunities.

The approach of *Wadi* programme was first evolved by Bharatiya Agro Industries Foundation (BAIF), a non governmental organisation (NGO) in south Gujarat. The Wadi programme covered a range of different horticulture species (and their combinations) such as mango, cashew, amla, chikoo and other fruit crops suitable to the area. Since fruit crops generally have a gestation period of four to five years, farmers were encouraged to cultivate agricultural crops as intercrops in the meanwhile so as to get an uninterrupted flow of income. Combining horticulture with forestry species (planted on field boundary) is another important feature of IHDP. This provides a fence and acts as a shelter belt to check soil erosion. It also meets the requirement of fuel, fodder and small timbers. Additionally, it eases off the pressure on existing forests.

Under IHDP programme, the initial mandate of the Tribal Development Department was to distribute 50 fruit trees and 150–200 forestry trees in an acre of land. The government made an innovative move by partnering with NGOs as project implementing agencies (PIAs) entrusted with the task of educating farmers and motivating them to gradually shift from traditional method of cultivation to agroforestry. They are required to make farmers aware about the various species of horticulture and forestry trees. Successful cases of agroforestry are demonstrated to them. As gestation period of fruit

[3] The literal meaning of *Wadi* in Gujarati is orchard.

trees is long, farmers are supposed to be trained to cultivate food grains as intercrops. On the whole, NGOs are responsible for involving the tribal community in planning and implementing the programme.

The extent to which the programme is able to address production constraints faced by tribal areas would generally depend on the capacity of the PIAs in the social and technical aspects of agroforestry. It is the common perception that NGOs are strong in social aspect whereas government can take care of the technical aspects with ease. There are instances in India where community has adopted agroforestry on a large scale (Reid and Stephen, 2001). But there are ample numbers of cases where both government and NGOs have failed to deliver services as promised (Saxena, 1992). It is important to bear in mind that in a real life situation adoption of the prescribed technology (crop-mix and farm practices) is far from the ideal. This is particularly true for tribal farmers operating under a number of constraints such as the following

(a) The tribal belt of Gujarat is located in the diverse agro-climatic regions like central northern and southern region. However, the same project is designed to cater to the need of these diverse agro-climatic regions.

(b) Agriculture department under various programmes are distributing fruit trees with the aim of promoting cultivation of horticultural crops. Apparently there is no mechanism to link these schemes.

(c) There is no direct linkage between various line departments like soil and water conservation and agricultural extension services.

Given these initial conditions the implementation of agroforestry programme cannot be seen in isolation. It will have to be viewed in the broader framework of regional specificities like agro-climatic conditions, socio-economic conditions, prevailing cropping pattern, and available sources of irrigation. The succeeding section will portray the characteristics of tribal area, where this programme is being implemented.

5. Characteristics of Tribal Areas of Gujarat

5.1 Land Use, Irrigation and Area under Crops

Gujarat is predominantly characterised by dry land conditions spread over large parts of cultivated area. During 2001–05, about 58 per cent of the state's reported area was under cultivation whereas 10 per cent was under forest. Of the remaining land, close to 30 per cent of the reported area is

under the categories of barren and uncultivated land, cultural waste, pasture, and permanent fallow. About 36 per cent of the net sown area receives irrigation (GoG, 2008). With a population of 50.7 million in 2001, the population density was 258 per sq. km. Poverty head count ratio was 18.9 per cent during 2004–05, which was among the lowest across the major states in India (Dev and Ray, 2008).

An attempt has been made to compare the state level indicators with the 11 districts in the state (out of a total 26) where the tribal blocks are located. The idea is to see whether these districts depict a situation different than the state level aggregates. The comparison, however, is constrained by the fact that in seven out of the 11 districts (except Dang, Dahod, Valsad and Narmada) the averages may tend to reflect more of non-tribal rather than tribal situation owing to relatively lower concentration of tribal population (ranging from about 8 per cent to 48 per cent).

Table 1 suggests that whereas the tribal areas shows relatively adverse socio-economic indicators such as higher poverty ratio, lower proportion of households reporting food adequacy, and cultivation of subsistence (food) crops, the districts seem to be fairly comparable (e.g., average land holding size and proportion of gross cropped area (GCA) to total reporting area). What is noteworthy is that the tribal districts are relatively placed better than others *vis-a-vis* a number of indicators such as (lower) population growth, rainfall profile, proportion of forest area, proportion of area irrigated, and storage facility per unit of land.

Two observations emerge from the comparative scenario in Table 1 notwithstanding the aggregation problems noted above. First, tribal areas have relatively better potential especially in terms of rainfall, forest ecology, irrigation, and cultivation of food crops with more or less comparable land holding size. Second, despite these the poverty and food adequacy situation are found to be worse among the tribal as compared to non-tribal areas.

Table 1: Characteristics of the Study Area

Indicators		Tribal area (11 districts)	All Gujarat (26 districts)
(i)	Population in million (2001–02)	7.5	50.7
(ii)	Poverty (HCR) (2004–05)	34.3 (tribal community)	18.9
(iii)	Population growth per annum (1991–2001)	2.1. (tribal community)	2.3
(iv)	Rainfall (Minimum - Maximum)	475 mm in Dahod-3825 mm in Dangs	351 mm in Kachchh-3825 mm in Dangs
(v)	Average size of the land holding (in ha.) (2003–04)	1.9	2.1
(vi)	Area under forest (% geographical area) (2001–05)	18.2	9.8
(vii)	GCA as % to reporting area (2001–05)	54.6	58.0
(viii)	Gross irrigated area to GCA (2001–05)	40.7 (9.8)	35.7 (4.6)
(ix)	Use of chemical fertilisers (per ha. of GCA)	109.5 [49.6]	120.0 [41.8]
(x)	No. of storage facilities per 1000 sq. km.	3.7	2.1
(xi)	No. of pump sets per 1000 ha. of net sown area	49.1	56.2
(xii)	Share of food crops to GCA	62.0	44.5
(xiii)	% of households reporting enough food for year (2002–03)	26.2 (tribal community)	31.5

Notes:
(i) Figures in brackets ( ) indicate percentage change between 1991–95 and 2001–05.
(ii) Figures in brackets [ ] indicate percentage change between 1992–93 and 2002–03.
Source: (i) GoG (1996, 2003, 2005a, 2007); (ii) Shah and Sajitha (2008) for indicators (ii) and (xiii).

5.2 Status of Irrigation and Sources of Irrigation

Tribal areas, as noted earlier, have relatively higher proportion of irrigated area as compared to the non-tribal areas during three sub-periods

(i.e., 1991-95, 1996-2000 and 2001-05). The pattern holds true in the case of northern and southern tribal regions, whereas in the central tribal region the proportion of irrigated area is marginally lower than the non-tribal areas within the state (Table 2).

Table 2: Change in the Share of Gross Irrigated to Gross Cropped Area by Region

Regions	Percentage of gross irrigated area to gross cropped area			
	1991–95	1996–2000	2001–05	1991–2005
1. Tribal region	30.9	35.8 (4.9)	40.7 (4.9)	35.4 (9.8)
1.1. Northern	33.2	40.8 (7.6)	46.0 (5.2)	39.4 (12.8)
1.2 Central	26.9	30.3 (3.4)	30.9 (0.6)	29.2 (4.0)
1.3 Southern	31.7	34.1 (2.4)	43.4 (9.3)	35.9 (11.7)
2. Non-tribal region	28.4	30.8 (2.4)	33.0 (2.2)	30.6 (4.6)
3. Gujarat	29.4	32.6 (3.2)	35.7(3.1)	32.3 (6.3)

Note:

(i) For the three sub periods, figures in parentheses indicate change in percentage share of GIA to GCA between two consecutive sub-periods.

(ii) For 1991-2005, figures in parentheses indicate change in percentage share of GIA to GCA between 1991-95 and 2001-05.

Source: GoG (1996, 2003, 2005a, 2007).

The increase in the proportion of irrigated area is particularly higher in the second and third sub-periods as compared to the first sub-period. During 1991–95 to 2001–05, the proportion of irrigated area had increased by 9.8 and 4.6 per cent in tribal and non-tribal areas respectively. In tribal areas, this increase was particularly high in northern and southern regions. This *prima facie*, may raise a concern about sustainability of ground water resources that are already in depleted conditions in most parts of the state including the tribal areas (Bhatia, 1992; Hirway, 2002; Planning Commission, 2007).

Table 3 indicates that more than 80 per cent of the total irrigated area in the state is served through ground water resources, i.e., through tube wells and dug wells. The proportion of ground water irrigation is relatively lower (76 per cent) in tribal as compared to non-tribal areas (90 per cent). In tribal areas, this proportion is particularly lower in the case of tube wells, thus

suggesting somewhat limited pressure on the deeper aquifers in these areas as compared to the non-tribal areas. This is mainly due to a combination of factors such as relatively better rainfall, better access to surface (canal) irrigation through medium and large projects and, perhaps, lower financial capacity of households in tribal areas as compared to non-tribal areas to draw water from deeper aquifers. It may be noted that a large part of the tribal areas except Banaskantha and Sabarkantha belongs to relatively more conducive agro-ecological conditions in comparison with Saurashtra, Kachchh and parts of north Gujarat within non-tribal areas, which face far more adverse agro-climatic situation in the state.

Table 3: Percentage of Irrigated Area by Source of Irrigation and Compound Growth Rate (CGR) of Gross Irrigated Area

Region	Sources	Gross irrigated area as % to gross cropped area				CGR (%) of irrigated area (1991–92 to 2005–06)
		1991–95	1996–2000	2001–05	1991–2005	
Total Tribal	Tube wells	13.8	23.8	30.8	22.8	13.0***
	Dug wells	55.4	55.8	45.3	52.4	0.9
	Canals	28.0	18.3	21.7	22.5	0.0
	Others	2.4	2.2	2.2	2.3	0.7
	Total	100	100	100	100	2.8***
Non-tribal	Tube wells	30.8	35.2	32.7	33.0	4.0***
	Dug wells	53.0	51.1	57.0	53.6	3.8***
	Canals	15.3	12.8	9.6	12.6	-3.6
	Others	0.8	0.8	0.7	0.8	6.4
	Total	100	100	100	100	2.1**
Total	Tube wells	24.2	30.6	32.0	28.9	5.2***
	Dug wells	54.0	53.0	52.3	53.1	2.5
	Canals	20.2	15.0	14.4	16.5	-1.8
	Others	1.4	1.4	1.3	1.4	0.5
	Total	100	100	100	100	1.9**

Notes : *** at 1 per cent level of significance; ** at 5 per cent level of significance; and * at 10 per cent level of significance.

Source : Same as Table 2.

The concern about ground water depletion noted above gets further substantiated by the fact that the growth rate of area irrigated by tube wells is particularly high (13 per cent) among tribal areas as compared to a moderate rate of 4 per cent among the non-tribal areas. Within tribal areas, the growth rate of irrigated area especially through tube wells is significantly higher when compared to other sources. The growth rate of area irrigated through tube wells during the entire period of 1991 to 2005 is found to be 5.2 per cent per annum for the state. This suggests that the tribal areas, of late, have started catching up with the non-tribal areas in terms of exploiting deeper aquifers. While a part of the significantly higher rate of growth in the area irrigated by tube wells could be due to conjunctive use, especially, in the canal irrigated areas in the tribal areas, it is likely that a small part of the increase in tube wells is also prompted by compelling conditions of competitive withdrawal of ground water even in the heartland of tribal dominated areas in these districts.

It appears that the ground water irrigation, especially, in the four tribal dominated districts (Dangs, Dahod, Narmada and Valsad) have not shifted in a major way from dug wells to tube wells owing to the combination of factors noted above.[4] It is imperative that a shift such as this is kept under restraint through a well thought out and comprehensive policy for ground water resources in the tribal dominated areas that also coincide with relatively better forest cover. This may imply going beyond a sectoral approach to water resource development. This aspect may deserve special attention while promoting crop diversification as discussed later in this paper.

Besides sources of irrigation, we have also tried to map the level of some of the important physical infrastructure facilities across tribal and non-tribal areas and also across regions within tribal areas. We assumed that some of the physical infrastructures like roads are implemented in the entire state. As a result, their impacts should be evident everywhere including tribal regions. On the whole, barring length of the road and storage facilities, tribal regions lag behind non-tribal areas in all other physical infrastructures (Table 4). Even within tribal regions, some of these developments, by their nature, are confined to one or more regions. For example, tribal areas of southern region tend to be at higher altitudes and form catchment areas of most irrigation projects of the state. This forms the basis for high canal network in the

[4] In other districts having relatively lower proportion (i.e. < 30 per cent) of tribal population especially Banaskantha, Sabarkantha, and Vadodara the increase in tube wells is likely to be relatively higher.

southern region. Since, canal irrigation underwent major reforms or received large investments, its impact is expected to be strongly felt on the agricultural performance of southern districts where much canal networks are located. Also, the industrialised districts of Surat and Bharuch form part of this region. High industrialisation, availability of surface water and better rainfall have positively impacted agriculture of this belt. All this may have resulted in an improvement in storage. Unlike the southern region, majority of area in the northern region is under tube well irrigation. Thus, this region fares well in terms of tubewell, tractor and electric pump sets. The point that we want to make is not that all the tribal regions are lagging behind in terms of physical infrastructure, but that these regions are generally not isolated from the main trends of development.

Table 4: Rank Correlation of Physical Infrastructure during 2001–05

(in descending order)

Region	Canal	Tube-Well	Tractor	Electric pump set	Chemical fertiliser	Road length in km.	Storage	Market
Tribal region	6	4	4	4	5	3	2	4
Northern	5	1	1	1	3	4	3	6
Central	1	5	6	6	6	2	4	5
Southern	2	6	5	5	4	1	1	1
Non tribal region	4	2	2	2	1	6	6	2
Gujarat	3	3	3	3	2	5	5	3

Source: Same as Table 2.

5.3 Area under Crops

Gujarat is predominantly non-food crops economy with majority of the cropped area - 56 per cent - being under non-food crops (Table 5). The cropping pattern in tribal areas shows the reverse pattern. Among the non-food crops, cotton and groundnut assume special importance. During 2001–05, the area under these two crops remained significantly higher (45 per cent) in non-tribal areas as compared to tribal areas (9.6 per cent). Conversely, food crops occupied more than 60 per cent of the area in tribal areas, the main crops being paddy, bajra, maize and pulses.

Over time, the growth rate of major crops grown in tribal areas has remained more or less the same except jowar and bajra, which show a significant increase in cropped area. Cotton and paddy have shown a declining but non significant growth in area as against a positive and non significant growth in the area under jowar, bajra, maize and pulse, all subsistence crops, grown mainly under un-irrigated conditions (or limited irrigation) in these districts. In non-tribal areas, significant increase in the area has been found in the case of wheat, jowar, bajra and pulses.

Table 5: Percentage of Area under Major Crops to Total Crop Area

Major Crops	Tribal region		Non-tribal region		Gujarat	
	1996–2000	2001–05	1996–2000	2001–05	1996–2000	2001–05
Paddy	10.5 (1.2)	11.7 [-1.83] (1.0)	3.9 (0.1)	3.5 [0.69] (-0.4)	6.3 (-0.1)	6.4 (0.69) (0.1)
Wheat	4.9 (-0.7)	4.2 [0.46] (-0.4)	5.4 (-0.8)	6.1 [1.16**] (0.7)	5.2 (-0.4)	5.4 (0.93) (0.2)
Jowar	4.5 (0.0)	4.5 [5.20**] (0.0)	2.2 (-2.0)	0.5 [7.65***] (-1.7)	3.0 (-2.4)	1.9 [8.14***] (-1.1)
Bajra	10.4 (-0.7)	9.7 [3.99***] (-1.3)	11.5 (-2.4)	10.3 [3.51*] (-1.2)	11.1 (-1.7)	10.1 [3.51**] (-1.0)
Maize	10.2 (1.8)	12.0 [2.33] (2.9)	0.4 (0.1)	0.5 [2.57] (0.1)	4.0 (0.4)	4.5 [1.86] (0.5)
Cereal	42.1 (0.5)	42.6 [-0.69] (-2.1)	24 (-4.8)	21.2 [1.86] (-2.8)	30.6 (-4.1)	28.8 [0.1] (-1.8)
Pulse	13.9 (-0.3)	13.6 [1.86] (-1.8)	2.1 (0.0)	4.1 [3.04*] (0.0)	7.7 (-0.6)	7.4 [2.57*] (-0.3)
Cotton	8.5 (-1.1)	7.4 [-3.17] (0.2)	20.3 (3.9)	18.7 [-2.95] (0.4)	14.7 (3.0)	15.6 [-2.95] (0.9)
Groundnut	1.9 (0.3)	2.2 [2.8] (-0.1)	25.5 (-1.3)	26.8 [2.8] (1.3)	16.8 (-0.9)	18.1 [5.2] (1.3)
Fruits and vegetables	3.3 (-0.6)	2.7 (0.0)	2.2(0.5)	2.2 (0.0)	2.6(0.5)	2.7(0.1)
Food crops	65.5 (-4.1)	61.4 (-7.1)	32.0 (-4.6)	32.0 (0.0)	44.5(-4.0)	44.5(0.0)

[contd...

Table 5 contd...]

Major Crops	Tribal region		Non-tribal region		Gujarat	
	1996–2000	2001–05	1996–2000	2001–05	1996–2000	2001–05
Non-food crops	34.5 (4.1)	38.6 (7.1)	68.0(4.6)	68.0 (0.0)	55.5(4.0)	55.5(0.0)
GCA	100	100 (0.0)	100(0.0)	100 (0.0)	100(0.0)	100(0.0)

Notes:

(i) Figures in brackets ( ) indicate percentage change in area between two sub-periods.

(ii) Figures in brackets [ ] indicate growth rate of area during 1991–02 to 2005–06. ***, ** and * indicate 1%, 5% and 10% level of significance.

Source: Same as Table 2.

Comparison of yield during 2001–05 suggests that non-tribal areas have higher levels of yield in almost all major crops except bajra and jowar. This is shown by the negative sign of the yield gap presented in Table 6. In tribal areas, yield of paddy and cotton, the crops requiring more water, have declined, whereas yield levels in the case of four major crops viz., wheat, jowar, bajra, maize, pulses and groundnut have increased over time. Bajra and jowar grown mainly under un-irrigated conditions have also witnessed a significant increase in the cropped area as noted above. It is important to note that not only the yield levels in non-tribal areas are higher, the change (increase) in yield over time is also found to be higher in the non-tribal as compared to tribal areas; the only exception is maize.

Table 6: Average Yield (kg/ha) and Fluctuation in Production of Crops by Tribal and Non Tribal Regions (1991–91 to 2005–06)

Crops	Tribal region		Non-tribal region		Yield gap ** between tribal and non-tribal regions (2001–5)	Gujarat	
	1996–2000	2001–05	1996–2000	2001–05		1996–2000	2001–05
Rice	1333 (-12.4)	1256 (-5.8) [-17.5]	1711 (-1.4)	1902 (11.2) [9.6]	-646	1503 (-7.6) [-0.4]	1621 (7.9)
Wheat	2223 (5.2)	2208 (-0.7) [4.5]	2516 (6.9)	2635 (4.7) [11.9]	-427	2265 (3.2)	2384 (5.3) [8.6]
Jowar	851 (59.4)	906 (6.5) [69.7]	665 (76.9)	686 (3.2) [82.4]	220	760 (50.5)	757 (-0.4) [49.9]
Bazra	1264 (24.3)	1457 (15.3) [43.3]	1000 (30.4)	1128 (12.8) [47.1]	329	1066 (23.0)	1250 (17.3) [44.2]
Maize	1526(36.4)	1669 (9.4) [49.2]	1456 (29.2)	1681 (15.5) [49.2]	-12	1498 (33.6)	1676 (11.9) [49.5]
Total Food Grains	1127 (16.3)	1239 (10.0) [27.9]	1353 (13.6)	1603 (18.5) [34.6]	-364	1219 (17.3)	1396 (14.5) [34.3]
Total Pulses	642 (-0.3)	648 (1.0) [0.7]	553 (7.6)	651 (17.7) [26.6]	-3	602 (3.1)	650 (8.0) [11.3]
Cotton	280 (-6.9)	45 (-83.9) [-85.0]	350 (7.0)	199 (-43.0) [-39.1]	-154	298 (-3.6)	165 (-44.6) [-46.6]
Groundnut	1167 (19.4)	1407 (20.6) [44.0]	1062 (15.1)	1462 (37.7) [58.4]	-55	1098 (17.3)	1451 (32.1) [55.0]

Note:

(i) Figures in brackets ( ) indicate percentage change between two sub-periods, i.e., 1991–95 to 1996–2000; and 1996–2000 to 2001–5.

(ii) Figures in brackets [ ] indicate percentage change in yield between 1991 and 2005.

(iii) Average yield and yield gap between tribal and non-tribal areas in kg/ha.

Source: Same as Table 2.

The relatively lower yield among tribal areas in spite of some of the more favourable conditions noted earlier poses important questions as to what explains the lower yield, how to improve the yields, and how far diversification towards high value crops such as horticulture could help tribal farmers earn better income from agriculture.

5.4 Diversification: A Risk Mitigating Strategy

The decision by a farmer for crop diversification is considered to be one of the major economic decisions that have a strong bearing on income and the stability thereof (Heady 1952). An attempt is made here to examine the extent of diversification of crops by working out HI-index.[5] HI-index was computed from the proportions of area under each crop by taking averages for the period 2001–05. The HI-value suggests degree of specialization. Thus the higher the value of HI, the higher is the specialization of crops and the lower is diversification. We have ranked the different spatial units according to the HI-index in Table 7. In a relative sense tribal region as a whole has the highest degree of diversification, whereas non-tribal areas and the state as a whole have relatively very low level of diversification. Among tribal areas, the highest diversification is found to be in northern region, followed by southern and then by central region. The results presented in Table 7 thus substantiate the point made earlier that tribal farmers tend to grow multiple crops, though much of the diversification is of low value (or subsistence) type as noted earlier.

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5 HI index is computed by taking sum of squares of acreage proportion of each crop to the total cropped area i.e., HI = Σ (i=1...N) P^2_i where N = total number of crops and P= acreage proportion of the i^{th} crop in total cropped area. It should be noted that the Herfindahl index is the index of concentration and thus the higher value is an indication of specialisation of crop activities. Therefore, to obtain the index of diversification, it is subtracted from one.

Table 7: Crop Diversification Indices and Average Physical Infrastructure, 2001–05

Region	HI-Index (2001–05)[6]	Rank *
Tribal region	0.0721	1
Northern	0.0798	2
Central	0.1559	6
Southern	0.0931	4
Non tribal region	0.1241	5
Gujarat	0.0832	3

Note: The highest rank i.e., 1 is given to the region signifying high diversification and the lowest 6 to the least diversified region.

Source: Same as Table 2.

Any future strategy of agricultural development in tribal areas has to strike a balance with environmental and ecological concerns in the interest of long-term wellbeing of the people. Thus, there is a need for recasting strategies for reducing inter-regional disparities. This can be done by increasing the productivity of land by:

- Introducing new technology
- Imparting proper extension services for promoting sustainable agriculture.

Both these may play a significant role in enhancing the production potential of tribal areas in the state.

6. Agroforestry in the Study Area - Some Early Assessments

This section examines the experience of IHDP from seven districts in the state. The analysis draws mainly upon the primary data collected from a sample of 684 beneficiary households who had participated in the project during 2004. The most prevalent agroforestry systems found in the study area are fruit trees, particularly mangoes which are planted along with forestry trees as live fences. Evidence of recent adoption was a mix of alley cropping, home gardens and windbreaks. The choice of particular species for use in the

[6] HI index was calculated for the year 1991–95, 1996–2000 and 2001–05. As there was no change in the indices, we have only retained HI for 2001–05 in Table 7.

farms was dictated by considerations such as availability of saplings from NGOs, familiarity of farmer in cultivating it, ease of propagation, management and project recommendations.

6.1 Sample and Coverage

At the time of the survey a total of 2087 acres of land was cultivated by the 684 beneficiary farmers covered by the study. This worked out to be 3.05 acres per household. Out of the total cultivated land, nearly 45 per cent is irrigated (Table 8). Nearly 12 per cent of the total cultivated land is under agroforestry plantation adopted by 637 sample households. The remaining 47 were from the category of female headed households. The main reason for their non-adoption was to avoid the risk of early adoption. Of the 239 hectares of land brought under plantation, 66 per cent was under mangoes, 30 per cent was under various horticultural crops while the rest is planted with the mix species of fruit and forest trees. A mix of 35 different types of fruits is cultivated. Of the total trees grown, 51 per cent are cultivated in southern region and the rest in northern region.

Table 8: Percentage Distribution of Cultivated Area and Irrigated Area by Region

Details	Central & northern regions* (391)	Southern region ** (293)	All study area (684)
Land cultivated (area in acres) and % share	1160.4 55.6 % (391)	926.6 44.4 % (293)	2087.0 100 % (684)
Average operational land	2.97	3.16	3.05
Percentage of cultivated to owned	92.4	94.5	93.3
Irrigated land (acres) and % area irrigated	653.3 56.3 % (289)	276.1 29.8 (125)	929.4 44.5 (414)
No. of households with irrigation (%)	289 (73.9)	125 (42.6)	414 (60.5)
Sources of irrigation (% of households)			
Wells	65.1	81.9	65.0

[contd...

Table 8 contd...]

Details	Central & northern regions* (391)	Southern region ** (293)	All study area (684)
Tube wells	11.1	7.0	11.4
Canals	5.5	2.3	5.1
Rivers/Kotars	10.7	8.4	13.1
Others (check dams, hand pumps etc.)	7.6	0.5	5.6
Total	100.0 (289)	100.0 (125)	100.0 (414)
Area of land under agroforestry (in acres)	123.2 (363)	125.7 (274)	248.9 (637) $
Irrigated area under agroforestry (in per cent)	32.3	22.3	27.2
Percentage of area under agroforestry to total cultivated area	10.6	13.4	11.9

Notes:

(i) Figures in parentheses indicate number of observations.

(ii) * Dahod, Godhra, Chhota Udaipur and Khedbrahma constitutes central and northern regions.

(iii) ** Mandavi, Songadh and Vansda fall in southern region.

(iv) 47 housesholds did not adopt agroforestry.

Source: Same as Table 2.

Adoption of farm forestry was found to be positively associated with size of the land holding though the difference across land holding sizes is fairly marginal. Among the large farmers 98 per cent were adopters of farm forestry as against 89 and 94 per cent among marginal and small farmers respectively (Table 9). The relatively lower rate of adoption in the last two categories of farmers is due to factors like concerns for household food security, non-availability/shortage of water, and small land holding size, besides the risk of early adoption. These factors often operate in an interconnected manner.

Table 9: Percentage Distribution of Area under Agroforestry by Crop and Farm Size by Region

Details	Central & northern regions* (N=363)	Southern region ** (N=274)	All study area (N=637)
Mangoes	50.9	80.0	65.6
Other horticultural crops	44.0	17.2	30.4
Forest trees	5.1	2.8	3.9
All	100 [49.5]	100 [50.5]	100
% of households growing plantation to the total (Total area under agroforestry = 248.9 acres)			
Small farmers (up to 2.5 acres) (N=187)	83.8	95.7	89.0
Medium farmers (2.51–5.0 acres) (N=197)	98.3	88.2	93.8
Large farmers (> 5.0 acres) (N=206)	98.3	97.8	98.1
Female headed households (N=47)	87.5	85.7	87.0
Total (N=637)	92.8	93.5	93.1

Note: Figures in brackets [ ] indicate percentages to the respective totals.
Source: Same as Table 2.

6.2 Inadequate Water Availability

Water plays a key role in the success of agroforestry programme. Table 8 shows that 45 per cent of the area operated by the beneficiary households was under irrigation; 56 per cent in central and northern region and 30 per cent in southern region. Only 27 per cent of land under agroforestry is under irrigation. About 60 per cent of the farmers reported access to irrigation, most of which is from non-perennial source where water is available for six months in a year. The remaining area was irrigated using water from tubewells, rivers, hand pumps and other sources.

Whereas almost all farmers having the access had reported inadequacy of water as a major problem, some of them also faced problems of power

supply and energy cost for lifting water from ground water sources. Some of the farmers have tried to overcome water related problems by way of accessing water from public and private sources. However, 61 per cent of the farmers could not find any alternative source for getting water. This includes 40 per cent pf those not having reported any source of irrigation and about 21 per cent having tried out alternative means of irrigation like purchase of water, lifting from check dams, hand pump and other public sources (Table 10).

Table 10: Percentage of Households Reporting Problems Faced in Irrigating Plants and Methods Adopted to Resolve these Problems

Problems	Ways to resolve the problem				
	No actions taken	Purchase water	Lifted water from nearby sources	Other sources (hand pump, kotars)	Total
Untimely water availability (N=39)	29.4	12.1	21.3	37.2	100
Inadequate water availability (N=47)	38.5	12.3	19.3	29.9	100
Other problems (shortage of diesel, lack of mgmt) (N=14)	22.9	15.7	18.6	42.8	100
Total	30.2 (125)	17.9 (74)	23.7 (98)	28.3 (117)	100.0 (414)

Note: Figures in parentheses indicate number of observations.
Source: Same as Table 2.

Overall the evidence suggests that a substantially large proportion of the beneficiary households did not have access to irrigation and that those having the access faced inadequacy of water as a major problem. This depicts a serious situation, especially, when the project envisaged access to irrigation as an important pre-condition for successful implementation of agroforestry in the region. This raises twin questions of selection of the technology (including species and agronomic practices) or beneficiaries or both. Some of these issues have been discussed in the next section.

7. Effectiveness of Adoption

IHDP offers a fairly comprehensive package of technology and farm management practices that bring positive results in terms of survival of plantation and farm income, besides sustainable natural resource management. Extension is a critical component of the programme. In what follows we try to examine initial experience with respect to some of the important components of the IHDP-package.

7.1 Inter-cropping

Inter-culture of food crops with plantation in the first three-five years is an important part of the farm management practice under the IHDP. This essentially helps cover at least part of the income loss arising from shifting of land from annual to perennial crops. The initial experience suggests that only about 25 acres of agroforestry land operated by 49 beneficiary farmers had adopted intercropping during the first year. This of course increased significantly in the next year when about 118 acres of land operated by 243 farmers had adopted the practice. What is strange is that the adoption of intercropping was drastically reduced in the subsequent year (Table 11). To a large extent this is mainly because intercropping is a somewhat complicated practice, hence difficult to adopt at once. It becomes all the more difficult if farmers have not been adequately informed and supported by the extension services in the initial years.

Table 11: Percentage Distribution of Area under Intercrops by Season

Years	Area in acres (no. of households)			
	Kharif	Rabi	Summer	Total
2004–05	16.3 (32)	8.4 (17)		24.7 (49)
2005–06	97.6 (204)	18.0 (35)	2.0 (4)	117.6 (243)
2006–07	46.9 (93)	7.7 (16)	1.5 (2)	56.1 (111)

Note: Figures in parentheses indicate number of observations
Source: Same as Table 2.

On the other hand, there are evidences to suggest that intercropping was adopted fairly successfully in an earlier project implemented by BAIF in parts of the study area. What was, however, surprising is that the practice is not

adopted under the present project even in the same area where BAIF had worked. One of the most striking reasons for the low adoption of inter cropping is that unlike the BAIF project the approach adopted for actual implementation of IHDP is adhoc and disjointed while introducing the package of technology and farm management practices.

It may be recalled that responsibility of the project implementation was given to the NGOs. The observed limitations of this arrangements are with respect to prior experience and capacity of NGOs and effective coordination of efforts between the them and government agencies. The field observations suggest substantial gaps in terms of most of these aspects which rendered the NGOs with limited preparedness / effectiveness required for implementing the project.

7.2 Scale and Pace of Adoption

As per the project design 50 fruit trees and 150–200 forest trees were to be distributed for one acre of land under the project. However, as noted earlier, only 27 per cent of the operated area was brought under agroforestry, which works out to be about 0.4 acre of land per household having adopted the crop. This implies that on an average a beneficiary farmer had planted 20 trees, which amounts to a total of 11653 trees planted by the sample farmers. The survival rate declined from as high as 43 per cent in 2005 and 26 per cent in 2006 (Table 12). A part of the severe drop in the survival rate could be attributed to unfavourable rainfall during 2006 and water shortage faced by the farmers. It is likely that the farmers have started realising the enormous efforts involved in fetching water form the distance for watering the plants.

Table 12: Number of Saplings Sown in 2004–05 and its Status in 2005–06 and 2006–07

Region	Averge area under agroforestry (acre)	Years							
		2004–05		2005–06			2006–07		
		Total plants	Survival rate	Total plants	Gap filling	Survival rate	Total plants	Gap filling	Survival rate
			(per cent)		(per cent)			(per cent)	
Northern region	0.34(123.2)	5637	33.9	2307	10.6	40.9	1379	27.9	24.5
Southern region	0.46(125.7)	6016	44.8	2276	5.7	48.4	1681	15.9	27.9
Total	0.39(249.0)	11653	39.6	5061	6.4	43.4	3060	21.5	26.3

Notes: Figures in parentheses indicate total acreage under cultivation.
Source: Same as Table 2.

What appears to be a more convincing reason for the sudden drop in the survival rate is the neglect of gap filling especially after the first year, i.e. 2005, when the survival rate was almost half. For instance, only 6 per cent of dried plants were replanted in 2005, which increased to 22 per cent in 2006. Overall the low survival rate is a reflection of a number of inter-related factors such as limited access to irrigation, disjointed approach for extension and inadequate follow up in terms of gap filling etc. The NGOs were supposed to replenish the sapling stock by distributing new saplings to fill up the gap. Only 36 per cent farmers reported of having received new saplings to fill up the gap of those that had dried off.

We tried to enquire about the problems faced by farmers with respect to the planting material and the measures taken for overcoming the problems due to poor quality of the material. Almost three fourth of the farmers having planted the trees reported some kind of problem with the planting material given to them. Nearly 18 per cent stated that the saplings had dried or broken down at the time when they received them for planting whereas about 61 per cent reported that the saplings were of an inferior variety (Table 13). Farmers tried to circumvent these problems of the inferior quality of saplings by increasing the use of fertiliser and water, which resulted in increased input cost than what was anticipated. About 33 per cent of farmers did not take any measures for improving the survival of the plants. Apparently this suggests weakness on the part of the NGOs to carry out the various extension activities such as training, demonstration in plots and raising awareness among farmers.

Table 13: Percentage of Households Reporting Problems Faced and Measures Taken

Details	Total	Adopters	Total	Adopters
	(in numbers)		(%)	
(i) Total sample beneficiaries	684	637*		
(ii) Households satisfied with saplings	182	135	26.6	21.2
(iii) Problems faced by households with regard to quality of material (N=502)				
Dried off/broken	116	116	17.0	18.2
Inferior quality	386	386	56.4	60.6
(iv) Method adopted to resolve problems (% to total households facing problems)				
Use of fertiliser and water	158	158	23.1	31.5
Gap filling and support	180	180	26.3	35.9
No solution and crop dried off	164	164	23.9	32.6

Notes: * 47 households are non-adopters.
Source: Same as Table 2.

7.3 Extension Services

7.3.1 Awareness of the Agroforestry Systems

IHDP aims at targeting farmers of tribal areas for growing agroforestry crops. The analysis of all beneficiaries of the programme shows that out of the total 684 sample households, 512 were aware of the agro-forestry programme, which constitute 75 per cent of the households (Table 14). There is a marginal difference between the percentage of awareness of households who have adopted this programme and who failed to adopt it. Nearly half of the households reported that they had come to know about the agroforestry systems from the staff of NGOs, whereas another 24 per cent learnt from their neighbours and friends. Nearly 26 per cent of the households were not informed by anyone about this programme. They came to know about it only when the NGOs visited their village to distribute saplings of plants.

Table 14: Awareness about IHDP Programme in Tribal Areas of Gujarat

Details	Total	Adopters	Non adopters	Total	Adopters	Non adopters
	(in numbers)			(%)		
(i) Total sample beneficiaries	684	637	47			
(ii) Whether respondents are aware about IHDP programme	512	471	41	74.9	73.9	87.2
(iii) Who informed about the programme (% to total)?						
No one informed	134	113	21	26.2	24.0	51.2
Staff of the NGO	256	255	1	50.0	54.1	2.4
Neighbours and friends	122	103	19	23.8	21.9	46.3
Total (N)	**512**	**471**	**41**	**100**	**100**	**100**
(iv) How did you like the programme?						
Programme was useful	188	188	0	0.3	0.3	0.0
Never had the prior experience, hence cannot say	308	283	24	45.0	44.4	51.1
Total	496	471	24	100 (72.5)	100 (73.9)	100 (51.1)
(v) Whether any meeting was organised to motivate you to grow agroforestry	27	17	10	3.9	2.7	21.3
(vi) Input material received	684	637	47	100	100	100
(vii) Did the Household receive the advice?						
Yes	460	434	30	67.3	68.1	63.8
(viii) Who advised you	460	434	30	89.8	92.1	73.2
Farmer leaders	52 (11.3)	52 (12.0)		10.2	11.0	
Staff of NGOs	284 (61.7)	264 (60.8)	24 (80.0)	55.5	56.1	58.5
Neighbours and friends	124 (27.0)	118 (27.2)	6 (20.0)	24.2	25.1	14.6
(ix) What type of advice did the household receive?						
Informed about maintaining the distance of planting saplings and digging pit. This was given at the time of distributing saplings	446	422	24	**87.5**	86.8	100.0
Informed that intercrops can be done between agroforestry	14	12	6	**2.7**	2.5	25.0
(x) Why did you cultivate agroforestry in small plot/did not cultivate?						
Not sure about the yield as it was on the experimental basis	288	264	24	48.2	47.9	51.1
Small plot of land	139	118	21	23.2	21.4	44.7
No/unreliable source of irrigation	102	102		17.1	18.5	0.0
Others (lack of money to buy saplings, fertilisers)	69	67	2	11.5	12.2	4.3
Total	598	551	47	100.0 (87.4)	100.0 (86.5)	100.0 (100)

Note: Figures in parentheses indicate percentages to the respective totals.
Source: Same as Table 2.

Out of the total 684 sample households who reported awareness about the programme, only 3 per cent felt that the programme was useful. As the programme was in the nascent stage, another 45 per cent of beneficiaries failed to comment on its effectiveness in terms of net earning. One important observation emerged from this analysis is that as this programme is evolving, both adopters and non-adopters of this programme felt it difficult to comment on the effectiveness of this programme. It may be noted that 44 per cent and 51 per cent of farmers in both the category of adopters and non-adopters respectively reported that lack of prior experience of growing agroforestry limits their expectations from the new technology. It may however, be noted that most of the beneficiaries having planted trees under the programme were passive recipients rather than having proactively demanded the planting material based on their conscious choice or decision.

Table 14 shows that barring 33 per cent households, majority of farmers reported that they came to know about the agroforestry systems from various sources like staff of NGOs (62 per cent), neighbours and friends (27 per cent) and farmer leaders (11 per cent). Thirty farmers out of 47 non-adopters had also received the advice, majority of them from the NGO (24 farmers). As NGOs were entrusted with the task of promoting this programme, their role in disseminating this technology is quite expected. One of the major components of this advice was about the cultivation practice that includes method of sowing of saplings and maintaining the distance between plants (88 per cent). Besides this, 3 per cent of farmers reported to be informed about the method of cultivating intercrops.

Then why 637 farmers (93 per cent) adopted it in small plot of land while the rest did not adopt this technology at all? While investigating this question, we found that nearly 48 per cent of farmers who were unsure of the yield, experimented with growing agroforestry in their small plot of land. Another 23 per cent of households reported small size of land holding as the main reason for not being able to cultivating agroforestry. Additional 17 per cent and 12 per cent of households lacked irrigation facilities and other resources respectively which limit their capacity in adopting fully to this programme. Those households who did not adopt this technology held uncertainty about the expected yield (51 per cent) and small size of the land holding (42) responsible for not adopting this technology.

7.3.2 Training and Dissemination of the Programme

We also tried to enquire about the effectiveness of information-dissemination and the training programmes conducted under the project. Only 3 per cent of the total beneficiaries who were aware about the programme were satisfied with the information provided to them about this new technology (Table 15). Another 23 per cent of households could not grasp the information fully as they were informed about cultivation practices of a new crop only once (at the time when saplings were distributed). Nearly 61 per cent of respondents found the advice inadequate in addressing the challenges faced by households in adopting agroforestry like inadequate and untimely irrigation facilities, low fertility of the soil, lack of resources for purchasing fertilisers and other inputs. This was the major reason that discouraged non adopters (95 per cent) from adopting the new technology despite having received the saplings and an advice of cultivation practices.

Startlingly, only 15 per cent of the beneficiary households who were aware of the programme reported to have received training in the new technology. More or less the similar percentages of adopters have received training from various sources (Table 15). Demonstrating the method of cultivation of various crops helps farmers in understanding the process of cultivation. Only 6 per cent of farmers who were aware of the IHDP programme reported to have received demonstration of new crops. Little more than this (7 per cent of adopters) who adopted it reported to have received the demonstration of this new technology (Table 15).

Interaction of the beneficiaries with the experts like NGO staff and government officers was also found to be fairly limited. Only about 1 per cent from the total sample, who was aware about the programme, interacted with the officials of the government, while 19 per cent said that they discussed with NGO staff. Such an interaction with the officials of the government is expected to complement efforts made by NGOs in disseminating information about this new technology.

Table 15: Training and Dissemination of Information about the IHDP

Details	Total	Adopters	Non adopters	Total	Adopters	Non adopters	Total	Adopters	Non adopters
	Total (N)			Percentage from the sample who are aware about IHDP			Percentage of the total respondent sample		
(i) When was the advice given (Along with inputs)	457	457		89.3	97.0		66.8	71.7	
(ii) Did you find the advice useful? (Total)	443	404	39	86.5	85.8	95.1	64.8	63.4	6.1
Satisfactory	14 (3.2)	14 (3.5)		2.7	3.0				
Did not understand fully	119 (26.9)	119 (29.5)		23.2	25.3				
Inadequate	310 (70.0)	271 (67.1)	39 (100)	60.5	57.5	95.1			
(iii) Training provided by NGOs	79	79		15.4	16.8		11.5	12.4	
(iv) Demonstration provided by NGOs	33	33		6.4	7.0		4.8	5.2	
(v) Interaction with the staff of the NGOs	98	98		19.1	20.8		14.3	15.4	
(vi) Interaction with government officials	4	4		0.8	0.8		0.6	0.6	

Note: Figures in parentheses indicate percentages to the respective totals.
Source: Same as Table 2.

7.3.3 Adoption of Cultivation Practices

Some of the important cultivation practices for agro-forestry include digging the pit of required size to sow the saplings, application of adequate quantity of fertilisers, maintaining the distance between rows and columns of saplings planted, and method of irrigation. Table 16 shows that nearly 65 per cent of the sample farmers who were aware of this technology and adopted it knew about the method of cultivation of trees, horticultural crops and agricultural crops. However, only 18 per cent of them followed the practice of cultivating crop mix.

Out of the total farmers who were aware of this programme, 54 per cent of adopters knew about the method of sowing the saplings, but only 20 per cent of them actually tried it in their field. Nearly 56 per cent of farmers who were adopters of this new technology were also aware of the quantity of application of fertilisers. However, 41 per cent adopted it. A few of the farmers actually adopted the advice of maintaining the distance between rows and columns. Nearly 49 per cent of farmers who were aware of this programme knew about

the method of irrigating plants. Only 16 per cent of them actually adopted it. This shows that majority of the sample households did not adopt any of the new improved practice thus indicating a wide gap between the information base and the actual adoption (Table 16).

Table 16: Adoption of Cultivation Practices under IHDP

Details	Total	Adopters	Total	Adopters	Total	Adopters
	Total (N)		Percentage from the sample who are aware about IHDP		Percentage of the total respondent sample	
(i) Cultivating practice like horticulture in the field, forestry in the boundary and agricultural crops as intercrops	306	304	59.8	64.5	44.7	47.7
(ii) Adopted cultivation practice of crop mix	85	85	16.6	18.0	12.4	13.3
(iii) Sowing the saplings by digging the pit	256	256	50.0	54.4	37.4	40.2
(iv) Adopted the method of sowing saplings	98	92	19.1	19.5	14.3	14.4
(v) Application of fertilisers	265	265	51.8	56.3	38.7	41.6
(vi) Adopted the method of application of fertilisers	210	210	41.0	44.6	30.7	33.0
(vii) Distance between rows	76	76	14.8	16.1	11.1	11.9
(viii) Adopted the advice of maintaining the distance between rows	29	29	5.7	6.2	4.2	4.6
(ix) Distance between columns	58	58	11.3	12.3	8.5	9.1
(x) Adopted the advice of maintaining the distance between columns	18	18	3.5	3.8	2.6	2.8
(xi) Application of Water	253	253	49.4	53.7	37.0	39.7
(xii) Adopted the method of application of irrigation	83	83	16.2	17.6	12.1	13.0

Source: Same as Table 2.

8. Major Limitations and Ways Forward

Some of the important limitations of IHDP could be summarised as follows:

(i) Flaw in the design of the programme: Selection of beneficiaries, selection of crop mix, availability of irrigation facilities, extension services,

coordination between NGOs and government officials were some of the essential components of IHDP programme. For example, while selecting beneficiaries for this programme, irrigation, one of the crucial inputs in growing agroforestry was neglected. The evidence clearly suggests that a substantially large proportion of the beneficiary households did not have access to irrigation. Those who have access faced inadequacy of water as a major problem. To resolve some of these problems, beneficiaries fetched water from distant sources using bullock cart, cycle, and even by lifting water pots on their head. Despite these efforts, the outcome in terms of survival of the plants was far from satisfactory, which in turn led to increased cost and wastage of resources on the part of farmers as well as state.

Another limitation pertains to the choice of tree species. A few horticultural crops like mango, amla, cashewnut were given to beneficiary farmers along with forest trees. These trees were given without taking comprehensive view of the need of the region. Such a one-shot intervention was made by emphasising certain number and species of trees that had yielded good results in certain areas. For example, mango was given to farmers of all tribal regions irrespective of its agro-climatic suitability for growing this crop.

(ii) Role of NGOs and officials of the government: Apart from the design constraints, quality of material and extension services also appeared far from desired. Though the programme mentions the need for growing intercrops, farmers were left to fend for themselves in exploring practices for ensuring stable and profitable production. The gains for those who cultivated intercrops were not significant enough to have demonstration effect on other farmers. The field observations suggest substantial gaps in terms of a prior experience of NGOs with limited preparedness / effectiveness required for implementing the project, their capacity building and an effective coordination between the government agencies and the NGOs. Moreover, the government failed to complement efforts made by NGOs in addressing these issues by strengthening the capacity of farmers and their own staffs, making extensive use of media and information technology in disseminating information and providing storage for the produce.

(iii) Training and Demonstration: Training and demonstration of cultivation practice of agroforestry had the potential in generating successful experiences of growing agroforestry in tribal areas. Though, training

and demonstration was one of the essential components of the programme, there was little intervention made on this front. Consequently, this led to inadequate adoption of the design and method of cultivation of agroforestry. For example, beneficiaries planted saplings of fruit and forestry trees in the backyard of their homes or on the periphery of their fields without taking active interest in cultivating them. This defeated the whole purpose of the programme. Findings suggest that this programme was adopted on adhoc basis without integrating the package of technology and farm management practices that are essential to this programme. All these resulted in low survival rate of plants of a number of inter-related factors such as limited access to irrigation, dis-jointed approach for extension and inadequate follow up in terms of gap filling etc.

(iv) Proper Monitoring: Government failed to monitor the work of the NGOs who were implementing the project. Government officials lacked understanding of various factors that affected adoption of this programme. Discussion with them suggests that they also lacked proper understanding of the method of cultivation, potential risks and returns if any. Consequently, a piecemeal approach of distributing sapling among beneficiaries was driven by targets without addressing the overall objective of the programme. All these explain the lack of interest of beneficiaries in adopting this programme.

All these suggest that in spite of the increasing emphasis on the integrated approach, the actual implementation remained confined only to plantation of horticulture and other trees in isolation of the requisite support from other schemes/interventions closely linked to IHDP.

9. Policy Suggestions

To sum up, it may be reiterated that the success of the agroforestry programme would depend on whether the programme is built in consonance with the traditional practices existing in the regions and is implemented in close consultation with as well as involvement of farmers. This would require a fairly proactive role to be played the NGOs, whose role needs to get redefined from one of a provider of agroforestry inputs to that of a coordinator and a facilitator. In the absence of extension services provided by the government a large section of small and marginal farmers residing in remote and backward regions would continue to rely on services of NGOs, which may possibly lead to greater participation of the community and also improve accountability.

There is a need to build synergy of agroforestry programme with larger extension programmes. A well coordinated extension system may help overcome some of the critical constraints/limitations of the programme, viz., location specificity in choice of species as well as technology, effective communication and frequent interactions, close monitoring and follow up, balancing food security with commercialisation, and access to markets. All these would also require:

- revisiting the role of agroforestry, especially for poverty reduction, in regional and national planning;
- developing and disseminating extension manuals for agroforestry specifically suitable for dryland conditions and communicating key messages through various media channels;
- strengthening the role that agroforestry could play simultaneously in supporting livestock, beside income enhancement.

The challenge is to design and deliver an extension package that effectively and efficiently integrates various initiatives aiming at addressing a range of interconnected aspects of farming and livelihood promotion in the region.

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2. **Industry, Infrastructure, Trade and Public Finance**
   The main themes include policy dimensions concerning the micro, small and medium enterprises, industrial clusters and intellectual property rights. Studies on basic infrastructure and linkages between infrastructure and regional growth have also been carried out. Trade and development and public finance are new areas of interest.

3. **Employment, Migration and Urbanisation**
   Studies under this theme relate to employment, labour, diversification of economic activities and migration. International migration has emerged as an additional theme along with urban services and aspects of urban economy and governance.

4. **Poverty and Human Development**
   Issues examined include access, achievement and financing of education and health sectors. Studies on poverty relate to conceptual and measurement aspects, quality of life, livelihood options and social infrastructure. There is an increasing interest in understanding urban poverty, rural-urban linkages and issues in microfinance.

5. **Regional Development, Institutions and Governance**
   Recent studies enquire into regional underdevelopment and the dynamics of local level institutions. Tribal area development mainly relating to livelihood promotion and human resource development has been a focus area. Recent analyses have also looked into Panchayati Raj Institutions, Forest Rights Act, MGNREGA and Right to Education Act.

Much of the research informs national and regional policies. The Institute also undertakes collaborative research and has a network with governments, academic institutions, international organisations and NGOs. A foray into specialized training and doctoral programme has just been made.

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