12 To Adapt or Not to Adapt: The Dilemma between Long-term Resource Management and Short-term Livelihood

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Introduction

It has been estimated that groundwater contributes 9% to India's gross domestic product (GDP) (Vaidyanathan, 1999). Most of this contribution comes from the use of groundwater in agricultural and livestock production. Put the other way, agriculture and livestock – the two chief sources of livelihood for the masses of India – have come to depend heavily on groundwater use. While this use has brought much benefit to these sectors and the people who depend on them, the historically water-focused, narrow engineering approach of the government, combined with the tendency of people to 'make the most when available, otherwise the neighbour will take it away' has led to secular decline in groundwater levels in many parts of the country (Janakarajan, 1993, 2003). This has resulted in what may be termed the 'tragedy of the open access'. The increasing number of dark and grey zones,[1] and the persisting dependence of millions of farmers on groundwater indicate the chaos that will likely continue in the groundwater sector. The description of groundwater governance in India as a 'colossal anarchy' seems apt (Mukherji and Shah, 2003).

The groundwater problem in India is particularly acute in arid and semi-arid areas. Here, private investment has largely driven the groundwater boom. Farmers now chase the water table by digging and drilling deeper and investing in higher-capacity pump sets. These actions have far-reaching impacts that go beyond the simple economics of groundwater abstraction (Mudrakartha, 2004).

There is already a serious shortage of irrigation water, whether sourced from surface water or groundwater. In many areas, the situation has become so precarious that any shortfall in rainfall even in one season immediately generates a 'drought condition' affecting the lives of people in many ways. The falling groundwater levels also have resulted in drinking water scarcity, in particular where the centralized piped water supply schemes[2] source from groundwater (Mudrakartha and Gupta, 2004). Farmers are compelled to respond and adapt

 The Agricultural Groundwater Revolution: Opportunities and Threats to Development (M. Giordano and K.G. Villholth)

to these changes in a variety of ways to keep the hearth burning, even at the cost of disruption of their social and family life. At the extreme in terms of resource management, farmers sell their topsoil to brick kilns to abet other forms of land degradation (Moench and Dixit, 2004; Mudrakartha, *et al*., 2004a). This indicates the desperation of some farmers who are not able to adapt.

What we now see is a dilemma between short-term livelihood and long-term resource management, between immediate gains and long-term human welfare as well as resource sustainability. The tendency to obtain short-term benefits even at the cost of resource degradation seems to have set in; the segment of population that depends directly on groundwater for its primary livelihood seems to be facing a constant threat to its conservation and resource management efforts.

This chapter attempts to capture the multifaceted social, physical, cultural, policy and economic dimensions of this dilemma through the study of farmer response to drought, an extreme and compressed example of the general decline in groundwater resources. The study was focused on three arid and semiarid districts in the Indian state of Gujarat, which experienced drought over the period 1999–2002 (Fig. 12.1).

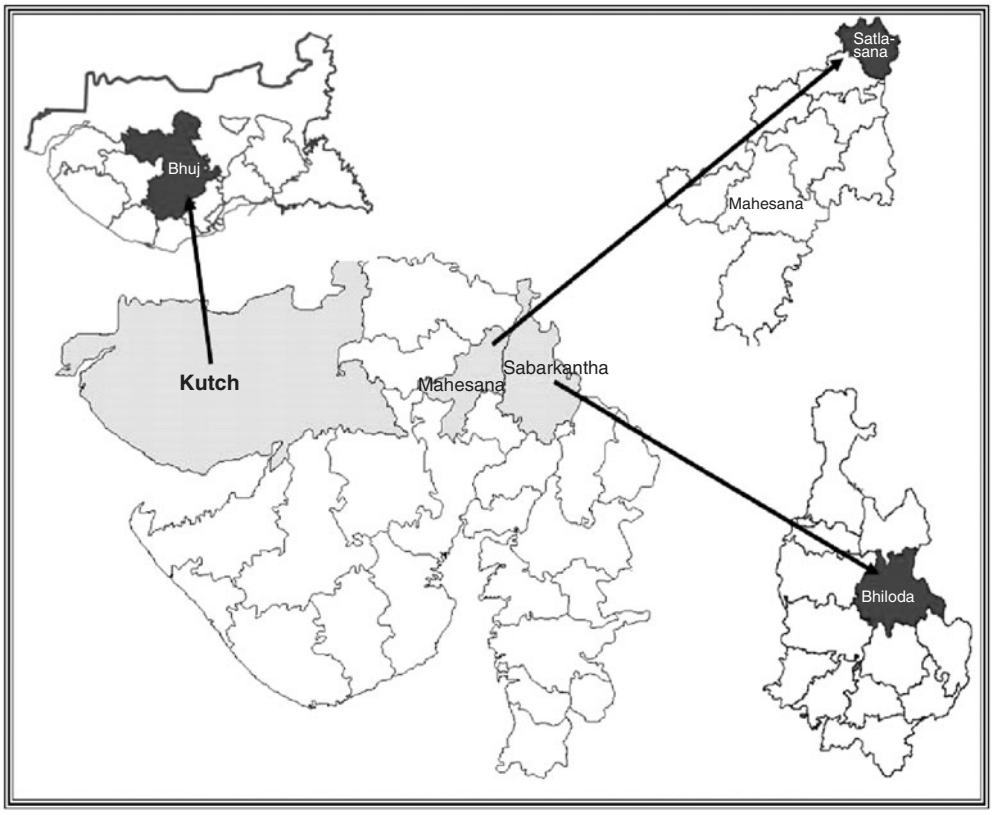

Fig. 12.1. Map of Gujarat showing areas of research study on adaptive strategies.

The chapter first describes the groundwater situation and drought in western India. It then depicts the differential impact of drought on agricultural production and the adaptations farmers have made to respond to new conditions. Finally, it examines how the impact of drought varies across the three study areas, the factors behind this differentiation and what it tells us about policy and practical options for groundwater management.

Drought and Groundwater Hydrologic Response

The definition of drought varies across countries and also within different areas of a country. Half of India, at any point of time, generally suffers from some kind of drought conditions. A meteorological drought[3] is defined as 'a sustained, regionally extensive, deficiency in precipitation condition' (Ramachandran, 2000). The impacts of meteorological drought on water resources, agriculture as well as social and economic activities give rise to what have been called hydrological[4] and, most important for our purposes, agricultural[5] droughts.

Agricultural drought occurs widely in India. About 68% of net sown area in India is highly vulnerable to agricultural drought. Most of this area is located in the 60% of the country that is arid and semiarid (Tenth Five Year Plan, 2002–2007). When drought occurs, there is a loss of biomass along with essential soil-building microorganisms due to the denuded soils being subjected to prolonged periods of dryness. As pressure on resources grows, there is often no time for the land to recover before it is put to use again.

Effects of prolonged agricultural drought, particularly in western India, are manifest in the form of drastic declines in groundwater levels. Out of the 7928 assessment units, 673 units fall under the overexploited category and 425 units under the 'dark' category. Gujarat falls in the highly overexploited category.[6]

As also highlighted by Shah (Chapter 2, this volume), data from the Minor Irrigation Census (Government of India, 1996) have shown that continuous decline of groundwater levels has resulted in a large number of wells and bore wells going dry in many parts of India. In western India, where depletion is the highest, more than 50% of the wells and bore wells are out of commission.

The most recent major drought spell in India was from 1999 to 2002/03, with conditions in 2000 being most severe. In 2000, as can be seen from Table 12.1, almost 55,000 villages or 12% of India's total were affected. The state of our case study region, Gujarat, too suffered from drought during the same period, again with 2000 being the most severe. In fact, the situation was so severe that not only water for agriculture but also drinking water for cattle and human consumption was in extremely short supply.

Description of the Research Study Areas

In the context of the 1999–2002/03 drought, we conducted a study in three areas of Gujarat, to try and understand how people respond differentially to changing resource, in particular groundwater, conditions and what that may suggest

Table 12.1. Losses due to drought 1999–2001. (From Tenth Five-year Plan, 2002–2007.)

Serial number	Year	Districts affected	Villages affected	Population affected (million)	Damage to cropped area (million ha)	Estimated value of damaged crops (million $)	Cattle population affected (million)
1	1999	125	NA	37.00	13.42	1.44	34.56
2	2000	110	54,883	37.81	36.70	79.12	54.17
3	2001	103	22,255	8.82	6.74	NA	3.428

for groundwater management paradigms. The 20 villages studied are located in the Bhuj *taluka* of the arid Kutch district, and in the semiarid Gadhwada[7] region of Satlasana and Bhiloda *talukas* in Mehsana and Sabarkantha districts respectively of the Aravalli Hills region, which forms the uppermost catchment of the Sabarmati river basin. All the study areas are drought-prone where climate is a major factor contributing to regular drought occurrence and desertification processes; in Kutch, there is also a salinization dimension. During the last 50 years, Kutch suffered 30 years of predominantly agricultural drought, while north Gujarat suffers drought 3–5 years in every 10-year period. The key socio-economic and physical aspects of the study sites are given in Table 12.2.

The study was conducted across 400 households spread across 20 villages in the three study sites. The study was conducted over a 2½-year period during 2002–2004. Data from beyond the study duration were also used as these were from regular project villages of Vikram Sarabhai Centre for Development Interaction (VIKSAT).[8] The study was carried out with structured questionnaires and unstructured checklists to capture certain adaptive strategy dimensions through focus groups such as with farmers and women. Since migration formed a key adaptive strategy, there was interaction with families also for understanding stress dimensions, and the extent of their willingness and comfort.

Both north Gujarat and Kutch are drought-prone regions; but the frequency, intensity and type of drought are different and so also is the perception of the people and their adaptive mechanisms. As seen from the following table, the rainfall conditions, social caste composition, natural resource conditions, hydrogeology and livelihood composition are all different.

Groundwater Decline, Drought Conditions and Associated Impacts

The study found that water level declines have been quite drastic in all the three study areas. For example, in Satlasana, the wells were dry with the shallow yielding aquifers totally dewatered. Attempts by farmers to deepen their wells, including drilling of vertical extension bores, met with limited success, as the additional yield did not sustain long. Some farmers took the risk and drilled

Table 12.2. Key characteristics of the study areas.

Serial number	Satlasana	Bhiloda	Bhuj
Literacy (state) 69.97% Male: 80.5% Female: 58.6%			
• *Taluka* (%)	61	70	50
• Male (%)	69	57	56
• Female (%)	31	43	43
Caste composition	Thakore; Chauhan (backward communities) and Patels	Scheduled tribes; Muslims	Rabari; Bharvad; Darbar and others
Livelihood options			
• Primary	Agriculture	Forest products; agriculture; animal husbandry	Animal husbandry; handicrafts
	Animal husbandry	Government	Agriculture
• Others	Service (mostly private) and small business	service	
Climatic conditions	Semiarid zone	Semiarid zone	Drought-prone arid zone; disaster-prone (earthquake, cyclone)
Rainfall	650 mm	750 mm	350 mm, erratic
Resource condition (water and soil/land)	Moderate soil fertility; high groundwater depletion and quality deterioration	Moderate soil fertility; ground-water quality medium	Poor to moderate groundwater occurrence; high TDS in ground water; saline soils
Marginal farmers (%)	63	71	(20)
Landless (%)	14	3	57
Women	Practice *purdah* (veil) system	Practice *purdah* (veil) system	Practice *purdah* (veil) system
Others	Improved local breed of livestock; changing agricultural practices	Local breed of livestock; traditional` agricultural practices	Local breed of livestock; traditional agricultural practices

new deep bore wells. Only 5 out of 11 bore wells drilled across four villages yielded a reasonable quantity of water. The rest were dry. By 2001, most of the existing and new wells as well as the bore wells had more or less dried up. Low rainfall did not result in much surface water flows, and hence there was not much recharge to the ground, with the result that the cultivated area and the yields suffered a drastic reduction.

Figure 12.2 for Nana Kothasana is a typical representation of the above scenario for the Gadhwada region, while Table 12.3 presents data on the yield obtained based on focus group discussion in Bhanavas. The comparison was between a normal year (considered here as 1998) and the drought period 1999–2002. It is clearly seen that in Satlasana, the total annual agricultural production was reduced by a drastic 60–70% during *kharif* (monsoon) and 80–95% during *rabi* (winter); for summer crops, the reduction was in the range of 90–95% between 1996/97 and 2002/03. In many cases, the summer crop was almost nil.

Similarly, the impact on livestock was also severe: 10% of the cattle died in Bhiloda, 17% in Bhuj and 16% in Satlasana. The arid Bhuj also witnessed the death of 21% of its camels, in spite of their known resilience and adaptability to water-scarcity conditions (Mudrakartha, 2002 ; Mudrakartha *et al*., 2004a).

The fall in agricultural output and loss of livestock generally had an adverse impact across all the rural families in the study areas. Rural families, who have a tradition of ensuring their family requirement of food grain through agriculture, were instead forced to purchase their food grain requirements from the market. The much-needed cash flow for this was coming from the animal husbandry, which had assumed greater significance as livelihood realignment took

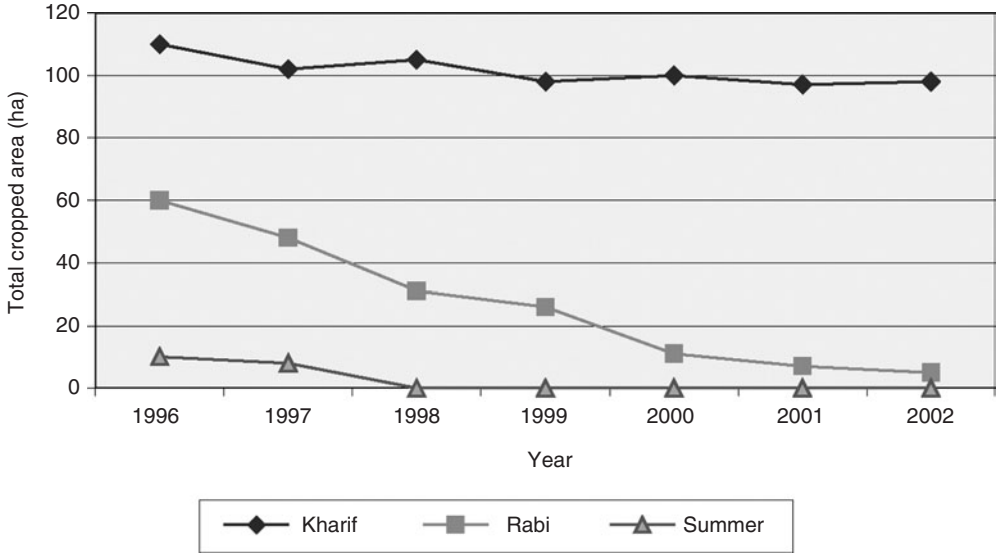

Fig. 12.2. Trends in cropped area in Nana Kothasana village.

Table 12.3. Decline in production of selected crops in Bhanavas village. (From Mudrakartha *et al*., 2004a.)

Crop year	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)
Monsoon crops					
Groundnut	100	50	Did not cultivate	Did not cultivate	Crop failed
Cluster beans	100	30	Did not cultivate	Did not cultivate	Crop failed
Maize	100	50	Did not cultivate	Did not cultivate	Crop failed
Minor millet (*bajra*)	100	70	50	25	Crop failed
Winter crops					
Wheat	100	50	25	10	5
Mustard	100	50	Did not cultivate	Did not cultivate	Did not cultivate
Tobacco	100	10	Did not cultivate	Did not cultivate	Did not cultivate

Note: Year 2000 was the severest of all the 4 years of drought.

place. Figure 12.3 is a typical representation of the livelihood realignment in the study villages. As can be seen from the figure, there was an overall drop in income to 33% of its previous levels by the end of the 4-year drought period. However, this drop and the overall impact of drought were not uniform across study sites. Reduction of income has also led to families spending less on food. While this reduction was 70% in Satlasana and 30% in Bhiloda, Bhuj families ended up spending 9% more than usual. It is interesting to note that the availability of work and cash flow in Bhuj in the years after the earthquake of 2001 helped them to spend money on food.

A few more things were happening on the agriculture front. First, due to the prolonged drought there was total erosion of the well-established agro-biodiversity using local composite seeds and low-chemical fertilizers. Second, since farmers' cash flow was greatly eroded during, or at the end of, the drought period, they bought poor-quality seeds pushed by moneylenders who also sell agricultural inputs. Third, newer seed varieties pushed by the market replaced the conventional, pest-tolerant local varieties.

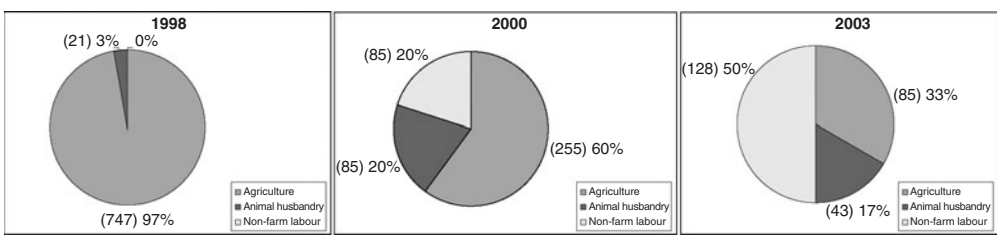

Fig. 12.3. Changes in relative share of livelihood income sources.

Economic Impacts

Figure 12.4 shows the economic impact of drought on the people in the three study sites. As can be seen, there is a movement of families from both higher to lower income levels and below poverty line (BPL)[9] under the influence of prolonged drought conditions. In other words, people have become poorer in

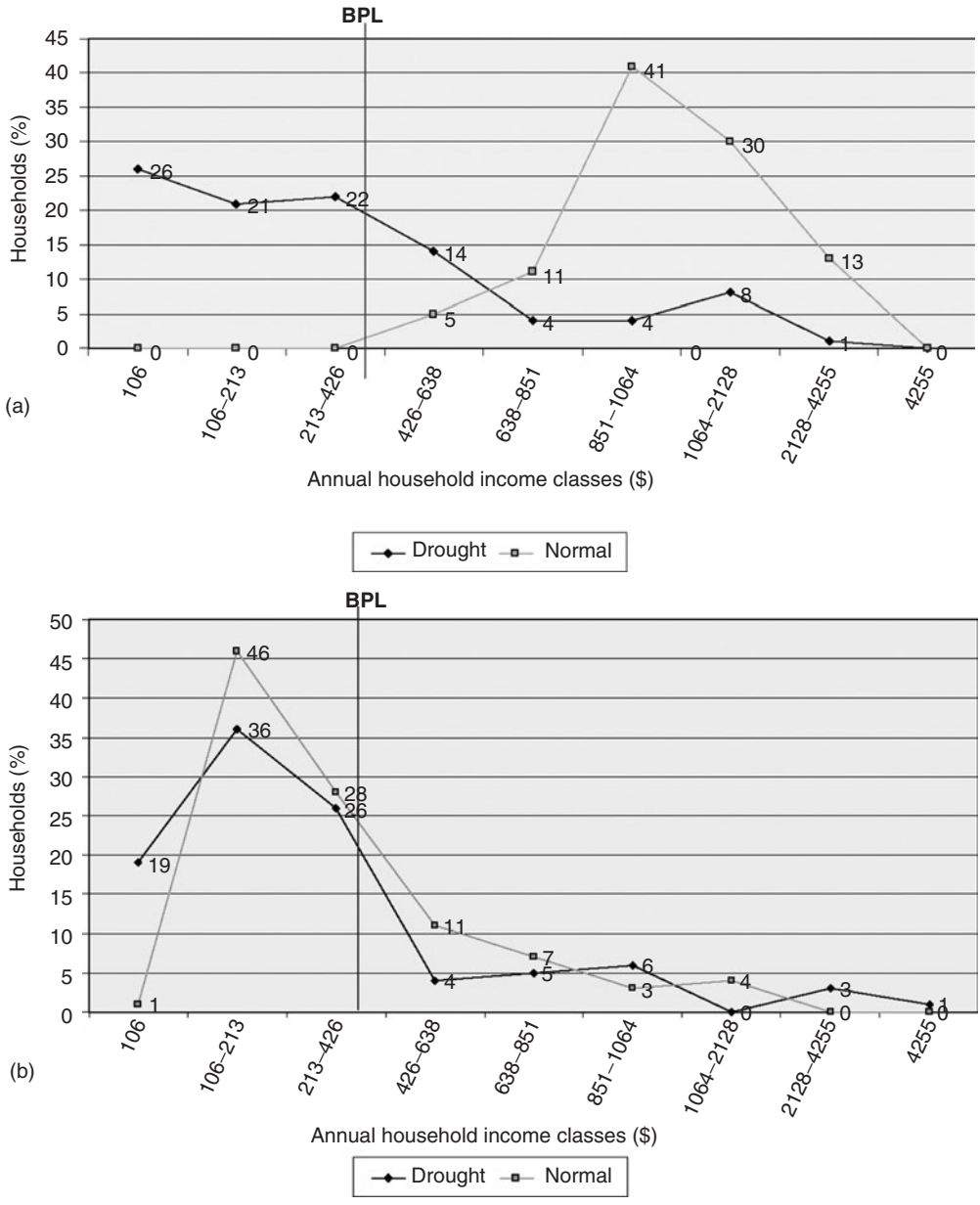

Fig. 12.4. Income distribution of sample households in drought and normal years in (a) Satlasana area, (b) Bhiloda area, and (c) Bhuj area.

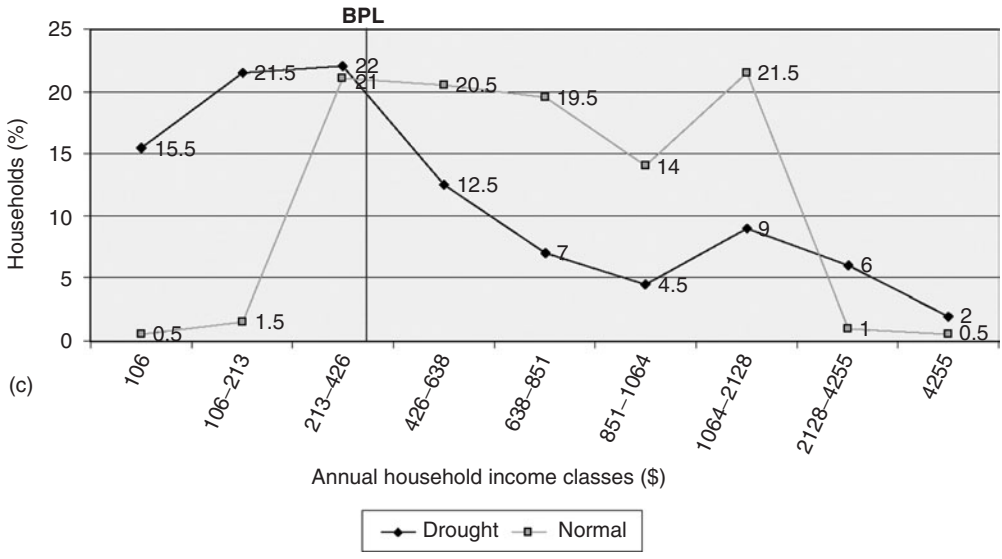

Fig. 12.4. *Continued*

both relative and absolute terms. However, the impacts were not the same in each study area.

Satlasana turned out to be the most vulnerable in spite of people's generally good economic condition. From almost nil during normal years, the number of BPL families during drought swelled to as high as 69%. High drought proneness has made Bhuj families to evolve handicrafts and metalwork, often for the international market, which provide significant income and cash flow throughout the year. Although Bhiloda suffered less relatively, in terms of intensity and magnitude, it was significant. In-depth discussion is available in Moench and Dixit (2004).

Adaptive Responses

How did the people respond to the declining water levels and the drought conditions? In the first instance, those families who had savings tended to use them to cover food expenses and other basic requirements. During the initial years of drought, about 35% of the respondents in Bhiloda and 13.5% in Bhuj, though none in Satlasana, used up their past savings. Many families also resorted to borrowing money: 47% in Bhiloda, 23% in Bhuj and 19% in Satlasana.

In addition to current consumption, farmers also deepened wells, drilled new bore wells and invested on higher horsepower pump sets in an effort to meet with critical irrigation and livestock needs. People sought to raise the required money mostly from traders and moneylenders, often at a very high rate of interest (36–60% per annum depending upon credibility, amount of loan, duration and mortgageability). Interestingly, banks were not willing to finance drilling of bore wells. For example, out of the eight farmers who drilled bore wells in Bhanavas village, five borrowed from moneylenders at a 3%

monthly interest, one sold jewellery to raise money and two others borrowed from better-off farmers in a neighbouring village, Mumanvas. In addition to the 3% monthly interest, the moneylenders also charged one-third of the crop share. A significant number of families also sold trees, livestock or other assets. People rarely sold their agriculture land due to the social status attached to it but often mortgaged it. Interestingly, in the case of land mortgage, the creditor carries out agricultural operations on the mortgaged land and does not share any returns with the landowner.

Some farmers also responded to the challenging water resource conditions by creating new institutions for access. For example, some small and marginal farmers in Satlasana pooled in their resources and went in for joint bore wells in a bid to access groundwater for irrigation. This strategy to share the high cost of investment meant access to water that these farmers could never afford individually (see Box 12.1).

There was a drastic impact on the livelihood occupation scenario between the normal year 1998 and the drought years 1999–2002. As can be seen from

Box 12.1. Groundwater and livelihood change

Chhatrasinh of Bhanavas, high school–educated, married, father of three, has 4 acres of land in two pieces. The 3-acre piece has irrigation facility from a joint well. He followed the general cropping pattern of the area, i.e. groundnut, *gowar* (cluster beans), *bajri* (pearl millet), castor and maize in *kharif*; wheat and castor in *rabi*; and *bajri* in summer. He dug these wells in 1980 and installed electric pump sets of 5 hp each in 1987. Plenty of water was available at a depth of 5–8 m below ground level. Responding to the demand, Chhatrasinh used to sell water to seven farmers to irrigate 10 acres of land. The payment terms varied. Some paid at the rate of one-third of the crop, while others paid $0.25/h. The farmers who used to cultivate castor needed only two irrigations for 4 h in a month, whereas crops such as wheat needed 6–7 irrigations in a month. Hence, the castor cultivators used to pay in cash and the wheat cultivators, in kind. Chhatrasinh used to earn about $425 per year by selling water for winter and summer crops.

Chhatrasinh sold water this way for almost 8 years till the water levels started to dip in 1995. During that year, he deepened both the wells by 8 m each. Within 5 years, i.e. by 2000, both the wells dried up again. Chhatrasinh decided to drill a new bore well. Although drilled to a depth of 80 m the new well struck no water. A few months later, he drilled another bore well of 100 m depth. This well struck water at 65 m, which was enough to irrigate 4 acres of land. For 2 years, the second bore well yielded. By 2003, i.e. within 3 years, the bore well could irrigate just 1 acre of fodder crop (*bajri*). This was a jointly owned well, shared with his cousins. Together they had borrowed $1065 at a monthly interest rate of 3% for drilling this bore well from a private source. So far they could not repay the loan.

After the depletion of groundwater and subsequent collapse of agriculture, for the last 2 years, Chhatrasinh and his son are working as labourers wherever work is available. During 2003, although the monsoon was good after a bad spell of 4 years, he had sown only *bajri* as he did not want to take any major risks with the uncertain monsoon.

Fig. 12.3, in 1998, 97% of the people were engaged in agriculture, which reduced drastically to 33% in 2002. The displaced farmers abandoned agricultural operations temporarily and migrated to urban centres to work as construction labourers, or as agricultural wage labourers in better water-endowed areas (Moench and Dixit, 2004; Mudrakartha *et al*., 2004a).

Animal husbandry gradually emerged as an important means of livelihood occupation during drought in Mehsana and Sabarkantha districts as it could feed easily into the existing dairy co-operatives (Fig. 12.3). The drought compelled the people to take a re-look at their animal husbandry practices. They abandoned their unproductive cattle, and took better care of the productive ones indicating a significant change in the mindset. This has allowed them to increase their net returns from animal husbandry in spite of animal deaths (Fig. 12.7).

Dairies such as the Mahesana Dairy in Gujarat that have a mandate to take care of the small milk producers take up collection, storage, processing and redistribution of milk to the whole district and beyond. The dairy also manufactures and sells milk products throughout the year. During the drought, the dairy came forward to supply food concentrate for cattle so as to maintain its own production schedules. Since the returns were quick, and the much-needed cash was available in dairy farming, farmers ploughed back some earnings from the milk income for purchasing fodder at higher cost from elsewhere; they also outsourced subsidized fodder supplied by the government as part of the drought relief programme.

Migration (permanent, temporary and commuting to nearby villages and urban areas for work) emerged as another important adaptation strategy. Around 15.5%, 10.8% and 21.4% of the population migrated from Bhiloda, Bhuj and Satlasana, respectively. About 21% of the working population of Satlasana commuted to the nearby town for work on a daily basis. About 2.3% of children below the age of 14 from Satlasana had migrated for work. Child migration also took place either along with parents or individually, which not only affected their education but also exposed them to greater health and security risks (Mudrakartha *et al*., 2004b; Moench and Dixit, 2004).

The study found that the overwhelming reason for migration was livelihood-related employment. As much as 100% of the migrants in Satlasana, 96% in Bhiloda and 87% in Bhuj migrated in search of employment. In Bhuj, since livestock is a major source of livelihood, 13% of migrants migrated purely for the purpose of grazing cattle.

The caste system and infrastructure development also played an interesting role in facilitating migration. For example, people used their kinship relationship and social networks for obtaining information about the availability of wage labour (civil, construction, semi-skilled and others) and job opportunities through caste members residing in nearby well-endowed villages, cities and towns. The massive expansion of road network, power projects, bridges and communications in recent decades facilitated the movement of information as well as labour force. Although migration was prompted by immediate need, in a number of cases migrants stayed on, leaving agriculture to other family members or leasing away their land.

Further, some farmers have also resorted to the extreme option of selling or leasing away topsoil to manage livelihood stress. This phenomenon is seen in areas with severe water scarcity and dried up aquifers such as in Satlasana.

What role does the forestry management play? The study shows that consistent, longer-term investment on resource regeneration has a positive impact on the environmental flows, and thereby reduces the impact of, and vulnerability to, drought. The following report compares the three study sites from this angle.

Bhiloda villages have invested time and efforts on forest protection and regeneration in thousands of hectares under the inspiration and guidance of VIKSAT and the Bhiloda federation. Regeneration of catchment areas has helped significant surface water conservation, resulting in availability of groundwater throughout the year. A noteworthy difference is that while the impact of rainfall failure is felt immediately in Satlasana, it is felt with a time lag of 1½ years in Bhiloda. In other words, Satlasana was less prepared when a prolonged and intense period of drought occurred recently (1999–2002/03) and therefore had to suffer the most. As negligible forest area exists in Satlasana, people have of late focused more on the non-land-based income-generating activities. One of the most popular alternative options for women is the diamond-polishing industries and private businesses.

It may be mentioned that the forestry programme in Bhiloda has been active for the last two decades supported by an non-governmental organization (NGO)[10] through promotion of effective, robust institutions at village[11] and *taluka*[12] levels and was expanded to the state[13] level. Furthermore, not just a few villages, but most of the Bhiloda *taluka* is engaged in the ongoing successful joint forest management[14] programme, which, in addition to maintaining the environmental flows, also provided them interim forest products. These include non-timber products (*amla*, *timru* leaves, gums and resins, *safed musli* and other herbal products) as well as fuel wood, fodder and grasses; small timber products help them to obtain critical additional cash income. On an average, a family earns $25–110/year from any one product, in addition to fuel wood and fodder collection. Wage labour is also available in forests for plantation and other works regularly provided by the forest department (VIKSAT Annual Reports, 1998–2005).

Further, the tribal job reservation policy has ensured that there is at least one working member from every third family in Bhiloda; the policy of free education for women has encouraged more women to go to schools and colleges in order to improve their chances of obtaining jobs. Finally, prolonged exposure to drought conditions historically has led families in Bhuj to evolve alternative income-generating occupations such as handicrafts and metalwork. They have also developed reasonable links with the international market.

People's Perceptions and Responses to Droughts

People's responses to a particular event have a strong relationship with the social, cultural, climatic, physical and psychological aspects. There has been a perceptible change in the manner in which disasters, in this case droughts, are being viewed and managed. Prolonged and frequent innings with droughts have compelled people to evolve adaptive and coping mechanisms in tune with the

changing externalities. Drought is no more considered in its conventional sense, but means different things to different people. For instance, farmers from western Rajasthan and Gujarat feel that drought is when their son loses job in the city (Moench and Dixit, 2004) or when they are forced to employ at least one male member outside of the family avocation. This perception also varies with caste. For Darbars (a forward caste), drought is when the woman is also forced to work as labourer, as happened in the 1999–2002/03 drought spell.

The study found out that about 60% of the population in Satlasana and Bhuj areas believe that the drought is due to insufficient rain while in Bhiloda, only 28% subscribe to this view. On analysis, it is found that the risk-taking ability in Satlasana and Bhuj is low, while it is high in Bhiloda, aided by the confidence derived from healthy management of village forests that yields fuel wood, fodder and non-timber forest products, some of which they sell and obtain reasonable cash flow (VIKSAT Annual Reports, 1998–2005). The tribals of Bhiloda find that investment in forest management would secure their livelihood. Further, resource exploitation and consequent livelihood erosion is not a major issue in Bhiloda due to restrictions by certain tribal-related policies. For example, sale of land beyond tribal families is legally prohibited with a view to protecting their livelihood. However, such policy may also restrict development of tribal areas, although agriculture- and livestock-based livelihood is less threatened. Further, tribal job reservation policy assures government service for at least one member per family; women increasingly participate in small businesses, all of which develops a sense of confidence.

The perception of scarcity of water as a major reason for drought comes out clearly as believed by 80–90% of the respondents from Satlasana and Bhiloda and only 16% from Bhuj.

On the practical front, diversification is emerging as a major strategy to reduce livelihood vulnerability. Diversification is happening on two fronts: one externally, beyond the primary vocations, agriculture and animal husbandry; two internally, within the agriculture sector, for example, by going in for a mix of crops as in the case of Satlasana farmers.

The study also identified some extreme cases of adaptive mechanisms such as sale of assets (land and cattle) and topsoil, which are often difficult to earn back. People are aware that removal of topsoil leads to serious micro-level ecological and soil nutritional imbalance, which has not only immediate effect on yields but also livelihood implications for generations. Although faced with the immediate need of maintaining the families, farmers chose this option because they prefer selling topsoil to land. This option not only jeopardizes the family-level food security system (for both humans and livestock) but also results in loss of contribution to the national food basket.

People have been increasingly adopting external diversification too. Possessing diverse skills is being recognized as a sure way of widening the safety net against drought. For example, in the tribal Bhiloda *taluka*, there has been a perceptible increase in the attendance of school- and college-going children, both boys and girls, primarily motivated by the job opportunities. Every third house has at least one person working in government service, in addition to a significant number working in private establishments and in small-scale industries.

The last 4 years have seen women self-help groups (SHGs) increasingly seeking loans from financial institutions such as the nationalized banks and National Bank for Agriculture and Rural Development (NABARD)[15] for various livelihood purposes, which indicates the increasing role of women in livelihood, and their concern to become 'creditworthy' (Mudrakartha, 2006). Access to funds has helped women members to really consolidate the livelihood options, not only the primary occupations, but also the non-land income-generating activities. This increased basket of options is enhancing people's capabilities to face future drought events with confidence.

Gender Implications of Drought Events

The study shows that female literacy is very low at 31% in Satlasana (a heterogeneous community), compared to the state average 38%, because of the strong perception that girls should take care of household work and siblings. Consequently, 98% of women are engaged in household work (Mudrakartha *et al*., 2004b; COMMAN, 2005).

Interestingly, the Bhiloda tribal belt and Bhuj have a higher female literacy rate at 43%. The availability of service sector options in Bhiloda has encouraged enrolment of girl children in schools, which is higher compared to other study areas. Women also take up business (22%) in Bhiloda. In contrast, in Satlasana, women do not go in for either service or business. This is because of the sociocultural restrictions on women, especially those of higher castes.

Although Bhiloda and Bhuj show similar female literacy, the business opportunity for females is slightly more in Bhiloda. In contrast to Bhiloda, the service opportunity in Bhuj is found to be nil.

Notably, a disturbing trend is found in the sex composition across the study areas. The overall sex (female/male) ratio (Bhiloda, Bhuj and Satlasana) was 920:1000 as per primary survey (Moench and Dixit, 2004; Mudrakartha *et al*., 2004b) comparable with official record of 919:1000 (Census, 2001). However, the primary survey threw up the following startling facts:

- Bhiloda: 928:1000; Bhuj: 965:1000; Satlasana: 920:1000.
- Sex ratio of children up to 5 years: Bhiloda: 717:1000 (highly unfavourable to females); Bhuj: 855:1000; Satlasana: 756:1000.
- In Satlasana, the sex ratio in the age group of 6–14 years is 662:1000, which is alarming (due to preference for male children, *inter alia*).

In other words, the overall sex ratio of children up to 5 years of age in the study areas is 789:1000, which is a matter of serious concern. Of much more concern are the Bhiloda and Satlasana areas where the ratio is even more skewed. This scenario projects a great gender and social disparity for the future.

Does drought have an impact on the adverse sex ratio? It was difficult to establish a direct link between the adverse sex ratio and droughts, also because this dimension was beyond the scope of the project. However, indirect evidences include, in addition to the sociocultural beliefs and other practices, the drastic reduction in the expense on food consumption in chronically

drought-affected areas, which was 70% in Satlasana and 30% in Bhiloda. In contrast, the expense increased by 9% in Bhuj due to the availability of cash flow because of the large number of post-earthquake relief and rehabilitation programmes. Such an adaptive approach has more inherent sacrifice by womenfolk, who in Indian custom prefer to feed the adult male and the male children first. It was informally gathered that this often led to malnutrition and increased susceptibility to illnesses of mother and child – all of which was beyond the scope of the research study.

Was there an effect on the marriage prospects of girl children in view of the economic and health impacts of drought? The study established a direct link in terms of a rise in the marriage age of girls as prospective families avoided marrying their children into families living in drought-prone areas. Early marriages were also reported as some poor families married off girl children because they were unable to feed them; often, two sisters were married off at a time to save on the marriage costs. The lower dowry demand for younger girls also contributed to early marriage. Ironically, there was also a rise in the marriage age of girls as some parents delayed the marriage of the second daughter because they needed time to gather money. This was particularly observed in families with 2–3 girls or more.

Interestingly, over the last 6–7 years, the Prajapati community of Satlasana *taluka* has evolved a system of 'mass marriages' as a coping mechanism. This is a low-cost marriage arrangement where many girls and boys are married off in a common ceremony, and there is no demand for dowry.

Carrying Forward Adaptive Strategies

In the post-drought spell of 1999–2002/03, specific efforts were made both by the community-based institutions and the local NGO (VIKSAT) to take forward people's adaptive strategies.

- Convinced by the performance of the water-harvesting structures built by VIKSAT in 2001, an increasing number of village institutions are drawing government schemes for construction of check dams and farm ponds under Sardar Jal Sanchay Yojana and Sujalam Sufalam schemes, respectively. They now recognize that in semiarid and arid zones, enhancing water storage is imperative and, if possible, within the subsurface to avoid the high evaporation losses. For example, in Satlasana, more than 100 check dams have been constructed during the last 4 years. The Augmentation of Groundwater Resource through Artificial Recharge (AGRAR)[16] study established that the tanks and check dams, in that order, are the most efficient structures in the given hydrogeological conditions to enhance groundwater recharge and stabilize agricultural yields, and would help reduce vulnerability to rainfall uncertainties (Mudrakartha *et al*., 2005). In Mehsana and Sabarkantha, water-harvesting structures are still less in vogue.
- Initially supported by NABARD, women in Satlasana and Bhiloda have started forming into SHGs 3–4 years ago. Taking bigger strides, they have recently

federated at the *taluka* level to carry forward the process to the large number of villages in the *talukas*. Significantly, in Satlasana, the State Bank of India (SBI) was so impressed with the functioning of the SHGs that it extended loans to these villages previously considered non-creditworthy (Fig. 12.5). Over the last year, these groups have taken loans to the extent of $90,000 with 100% repayment. Interestingly, some groups have also taken loans for the purpose of constructing check dams, which they repaid once the installment from the government scheme was available. This new initiative and noteworthy performance of the Satlasana groups has encouraged the bank to make the check dam construction a bankable scheme, which is a significant policy change.

- Looking at the Satlasana experience, the same bank (SBI) has extended financial support to Bhiloda and Bhuj villages also. Thus, all the three study areas now have access to funds on repayment basis. This also signifies a marked change in the mindset of the people, from expectations of charity or doles to self-reliance with dignity.
- Linkage with banks and access to funds allow people to earn back their lost assets such as livestock and jewellery and strengthen agriculture. More importantly, they only need to pay 8–11% rate of interest per annum (as against 36–60% charged by money lenders). In other words, people are now better equipped to face any future drought thanks to the access to bank loans, which was absent during the 1999–2002 spell.
- Analysis of bank loan utilization indicated that almost 70% of the loan was for agriculture and animal husbandry, while 10% was for releasing land mortgaged during the drought period. This interesting paradigm shift is clear evidence that women's participation in family livelihood has gone up, adding

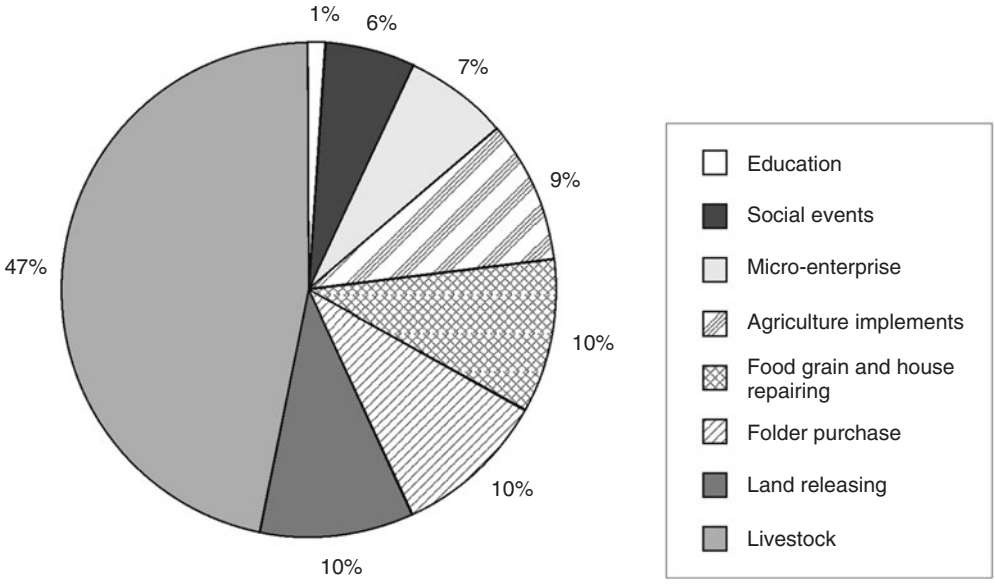

Fig. 12.5. Loan from State Bank of India and purposes.

a new dimension to livelihood management. It has also initiated a direction towards women empowerment evident from their decision-making role at family and village levels. Historically, men used to take 7–12 years to release the mortgaged land or to repay loans taken from moneylenders. Women could hasten livelihood restoration because of their intrinsic risk-taking ability and vision (Mudrakartha and Madhusoodhanan, 2005; Mudrakartha, 2006).

- In addition to banks, many families have taken loans from the revolving fund of the local NGO (VIKSAT) for purposes such as releasing pawned jewellery, setting up small businesses, purchasing food grains and fodder (Fig. 12.6). This fund, operated by a committee comprising representatives of the people's institutions, local leaders and the NGO as per certain norms, catered to those needs that are not covered by the bank, have high interest rate or entail cumbersome procedures. Almost 62% of the fund was used for purchase of seeds and agricultural inputs, while 17% was used for purchase of livestock as it could easily feed into the existing dairy business (Mudrakartha, 2006). Farm-based micro-enterprises such as *amla* products, processed condiments, spices and chilies, as well as non-farm-based enterprise such as handicrafts, bakery, *kirana* shops, flour mill, washing powder preparation and cloth products are slowly picking up. Transactions to the tune of $85,000 are made till date, which indicates vision, commitment and financial management skills of the women's groups and the federations.
- Concepts of seed village and fodder security have been introduced, as a part of which select farmers from within a village were given good-quality improved seeds for multiplication. Beginning with one village in 2003, in 2005/06 almost 200 farmers across eight villages are raising seeds that would meet the requirements of approximately 10–12 villages. Similar procedures are being adopted for fodder, but generally as part of the integrated agriculture approach.

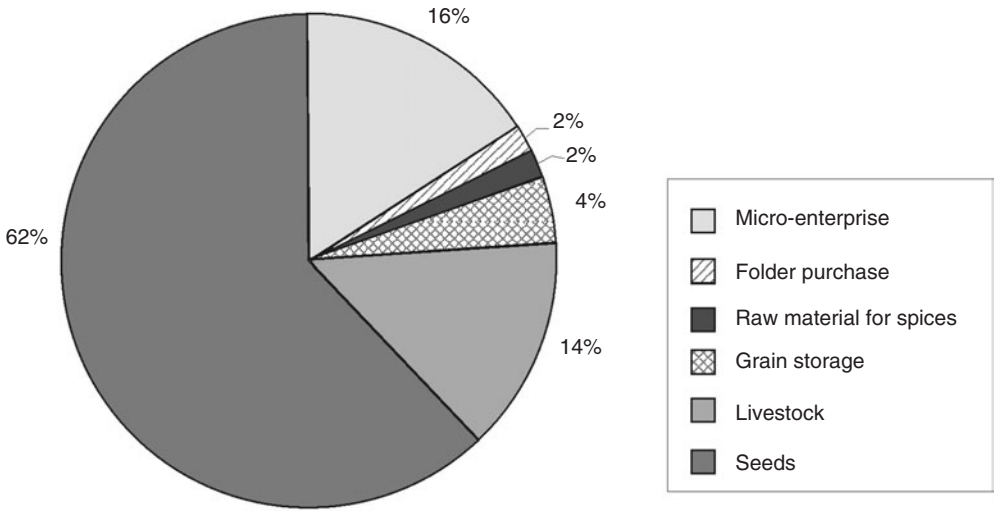

Fig. 12.6. Loan from VIKSAT revolving fund and purposes.

- In the context of institutions, the community-based institutions are more or less in place. Post drought, specific efforts were made to link up with concerned government departments of agriculture, research, extension, seeds, horticulture, livestock and water resources in order to benefit from their technical knowledge as well as draw projects and schemes, including demonstration experiments.
- The federations are taking up a bigger role in terms of sourcing agricultural inputs and fodder in bulk and trading, in the process, providing a decent saving for the farmer as well as improving the federation's financial position. Women's groups and women's federations are making progress in terms of rendering loans accessible to more number of members who are investing in agriculture as well as in livestock purchase. The milk production is linked with the local diary, increasing cash availability (Fig. 12.7).
- Migration resource centres are planned to help migrating families make informed choices so that vulnerability is reduced. In addition to making use of information technology (IT), these centres will be operated by educated members from the villagers themselves. However, the NGOs will help manage and train on the technical part. As part of the activities, information on the menu of adaptive strategies in vogue will be disseminated. This strategy is relevant due to the fact that the understanding of, and response to, drought events is not uniform among villages and within villages.

Implications for Policy

First, there is a need to recognize the fundamental link between groundwater and drought, particularly in the semiarid and arid zones (Mudrakartha

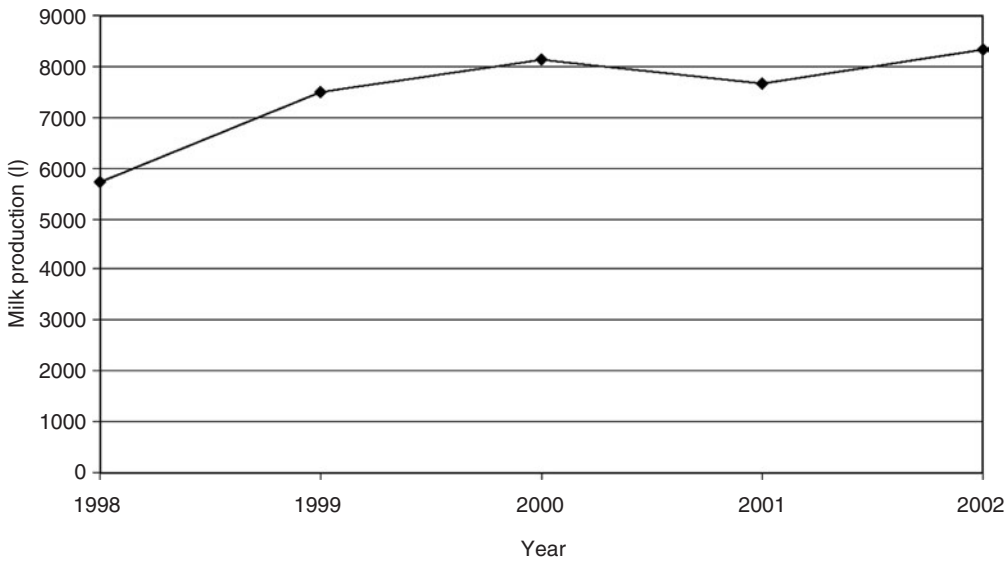

Fig. 12.7. Milk production in Umri village, Satlasana *taluka*.

and Madhusoodhanan, 2005). Two aspects are important: (i) the role of the community in planning, implementation and monitoring, which should include space for community management of groundwater; and (ii) the need for integrating drought interventions into the district perspective plan[17] so that ad hoc spending of large funds during drought events is avoided.

Annual recharge is a crucial element in the context of community management of groundwater and forms the lifeline of the productive systems in drought-prone areas. Therefore, rainwater harvesting for enhancing recharge artificially on a scientific basis should form an integral part of the district perspective plan taking into consideration the site-specific hydrogeology to make the recharge activity effective and meaningful (Mudrakartha and Madhusoodhanan, 2005). Site-specific research is essential to evolve an array of artificial recharge standards to suit different hydrogeological settings (Mudrakartha *et al*., 2004a).

Second, appropriate policy change to promote community management of ground water is an immediate necessity. Indian experience with forestry management, canal irrigation, watersheds, etc. shows that without people's participation resource protection, development and management is not possible. It is logical that the same principle be extended to the management of groundwater. This is relevant even in the face of the rapidly changing externalities as a majority of the population still depends upon natural resource-based primary productive systems.

Third, there is a need for convergence of institutions. Many institutions are promoted as part of various rural development programmes, often in the same village or in a cluster of villages. While multiplicity of institutions is not an issue, convergence and mutuality constitute the need of the hour. Therefore, an institutional arrangement that coordinates the functions of the various institutions within the perspective plans of an area or an agroclimatic zone needs to be evolved.

Fourth, management of resource through community (e.g. forestry or groundwater) always throws up a variety of management issues. Lack of legal authority, in particular, related with resources, severely hampers their effective functioning. This would also bring about conflicts and litigations leading to an adverse impact on the resource management. Appropriate policy changes are therefore needed to empower the people's institutions. A related concern is the convergence with the *gram sabha* in some way.

Fifth, the changed resource paradigm demands co-management of conventional and people's adaptive strategies (Mudrakartha, 2004). Conventional strategies provide a broader canvas, including linkages with micro-level implementation while adaptive strategies help rooting the conventional strategies in the community domain.

Sixth, livelihood diversification both within and beyond the primary productive sectors needs a stronger push. Although this is happening, the efforts are mostly straitjacketed, i.e. highly sectoral. While the financial institutions push for formation of SHGs and micro-enterprises, the backward and forward linkages are often neglected and, as a result, weak. While a focused, target-oriented approach may help in achieving scale, a broader policy canvas should be spelt out to convey the larger picture.

Seventh, women have proved their skills in strengthening livelihood and also diversification in order to reduce vulnerability. Ensuring backward and forward linkages with women's enterprises for better results will help build stronger and more resilient adaptive mechanisms. Necessary capacity-building strategy should become an integral component of the programme implementation (Mudrakartha, 2006).

Eighth, access to credit is important to help communities come out of the indebtedness trap. A proper combination of community-based institutions, local formal institutions (e.g. dairy) and a committed NGO with active financial agency (e.g. SBI or NABARD) could result in strengthening people's capacities to evolve more effective adaptive strategies.

Communities are increasingly making use of communications technology such as telephones and mobiles through social networks for making informed choices of work during migration. However, since this trend has set in only of late and as it depends upon a variety of complex factors, it may be too premature to expect people to be in complete command and control of their adaptive strategies in the choice of work. The key message is that people are developing confidence both at the family level and the community or village level to face droughts. Their attempt is to develop the ability to maintain the primary livelihood systems, namely agriculture and animal husbandry, mostly in combination. They would like to complement these efforts with non-land-based options to build in the required capacity to adapt to increasing resource challenges. They are also increasingly becoming conscious of the need for an institutional approach to take full advantage of the social capital they have built up over a period of time. This strategy allows them to choose occupations they prefer, and not any occupation under compulsion, as it used to be.

In order that community's efforts are effective, suitable policies to check resource (groundwater, surface water, land, etc.) depletion, degradation and diversion should be formulated carefully. Policies should not be wishful statements but rather those that value processes and are community-centric. They should aim at bridging disconnects – a major lacuna – not only in many of the policy statements but also in implementation. The fact that in India livelihood and natural resources are intricately connected for a vast majority of the population should be borne in mind. Realignment of livelihood and trimming down the huge (and unwieldy) number of agriculture-dependent families up to a certain level may happen naturally because of the availability of an increased range of non-land income-generating options, thanks to IT, infrastructure and communication projects. However, for the adaptive strategies, this is a welcome trend as a wider basket of options reduces vulnerability and increases stability.

Conclusion

Groundwater decline and the associated quality problems in India during the past couple of decades have resulted in severe challenges to the primary productive systems, namely agriculture and dairy. As much as 60% of India's geographic area is under semiarid and arid conditions where the agriculture-based and dairy-based livelihood often gets jeopardized due to long spells of drought conditions.

A study on 400 households in three locations in arid and semiarid regions of Gujarat found that people's response to such drought conditions is not uniform. It varies from a reasonably well-thought-out strategy to ad hoc measures, from household-based to community-based institutions. This variation is found to be dependent upon factors such as social and kinship networks, awareness and education levels, ability to diversify within the primary productive systems and beyond, and non-land-based income options. This is in addition to the economic status of the family and the cohesiveness of the particular caste.

However, it is also found that in spite of the social, economic, caste and gender differences, the presence of a strong and robust institutional mechanism (e.g. dairy, village and *taluka*-level co-operative societies and a committed NGO) goes a long way in providing a complementary, enabling support to families in their adaptive efforts. In particular, during drought conditions, people often made desperate efforts to corner whatever groundwater was available to sustain their *kharif* and *rabi* crops. But long dry spells tended to erode even local seeds and biomass, placing the affected in the hands of the market forces.

Although perceptional differences exist among communities from the three areas as to the causes of drought, a majority believed in the lack of adequate and timely water availability, including from groundwater sources, as a key reason for the livelihood woes. As part of their adaptive strategy, people resorted to borrowing money, selling away jewellery, migration and dairy business. Extreme cases of selling away topsoil for brick making were also identified; farmers who did this were fully aware of the long-term implications on future crop yields. However, they perceived this as a better option than selling away the land, which is linked with the family's social status.

What then is the way out? The study indicates the need for viewing through a livelihood lens, and not through a pure economics lens. The study underlines the dire need for enabling policies and, more importantly, their effective implementation to complement and supplement people's own efforts and adaptive strategies at local level. It also highlights some policies and programmes that have made positive contribution, intended or unintended, to the adaptive strategies of the people. Examples include tribal job reservation policy, free education for girls and the joint forest management programme. Significantly, the regenerated forest cover in Bhiloda has also helped maintain environmental flows that delayed the effects of drought compared to Satlasana and Bhuj areas where such a programme was absent, primarily due to non-availablity of forest land.

Finally, the study emphasizes that adaptive strategies of the people do need to be embedded in the larger conventional resource management systems and welfare measures.

Notes

1 Used in India to denote problem zones in groundwater maps. The zones are categorized based on annual groundwater withdrawals in relation to utilizable recharge: more than 100% of withdrawal to recharge ratio is called 'overexploited'; 85–100% 'dark'; 65–85% 'grey' and less than 65% 'white'.

2 For the past few decades, drinking and domestic water to cities and towns is supplied through pipelines sourcing from either surface water or groundwater.
3 As per the Indian Meteorological Department, a meteorological drought is said to occur when the deficiency of rainfall at a meteorological subdivision level is 25% or more of the long-term average of that subdivision for a given period. The drought is considered 'moderate' if the deficiency is between 26% and 50%, and 'severe' if it is more than 50%.
4 Prolonged meteorological drought causes hydrological drought in the form of scarcity of surface water and declined groundwater levels, resulting in severe shortage of water for both human and animal needs.
5 Agricultural drought is said to occur when soil moisture and rainfall are inadequate during the crop-growing season to support healthy crop growth to maturity. For crops, this causes extreme stress and wilting. Technically, for the purpose of assessment, agricultural drought is defined as a period of four consecutive weeks of severe meteorological drought with a rainfall deficiency of more than 50% of the long-term average or with a weekly rainfall of 5 cm or less during the period from mid-May to mid-October (the *kharif* season) when 80% of the country's total crop is planted, or 6 such consecutive weeks during the rest of the year.
6 According to the Central Groundwater Board, Ministry of Water Resources, Government of India, the dark zones in India are growing at a rate of 5.5% per annum; if corrective measures are not taken, by 2017/18, roughly 36% of the blocks in India will face serious problems of overexploitation of groundwater resources.
7 Gadhwada is a cluster of 27 villages (including the study villages) in Satlasana *taluka* of Mehsana district in north Gujarat with similar sociocultural conditions.
8 VIKSAT Nehru Foundation for Development, Thaltej Tekra, Ahmedabad, is engaged in promoting people's institutions for natural resource management and livelihood enhancement for the last three decades through its five field offices, all located in arid and semiarid regions of Gujarat.
9 The BPL income generally considered as per the World Bank norms is $1/day or Rs 17,000/year. We have used a generous figure of Rs 20,000/year.
10 VIKSAT
11 Tree Growers Co-operative Societies, a common form of village-level institutions in Gujarat registered under the Co-operative Societies Registration Act.
12 Bhiloda *taluka* Lok Van Kalyan Sahkari Sangh Ltd., a *taluka*-level federation of village-level institutions, registered under the Co-operative Societies Registration Act.
13 Sanghathan Kshamata Manch-SAKSHAM; Secretariat at VIKSAT, Ahmedabad. SAKSAM is a state-level federation of federations registered as a Trust and Society.
14 VIKSAT and one of the villages have been awarded the prestigious national award – Indira Vriksh Mitra Award – in 1999 and 2005 respectively.
15 National Bank for Agriculture and Rural Development is established as a development bank, in terms of the preamble of the act: 'for providing and regulating credit and other facilities for the promotion and development of agriculture, small scale industries, cottage and village industries, handicrafts, and other rural crafts and other allied economic activities in rural areas with a view to promoting integrated rural development and securing prosperity of rural areas and for matters connected therewith or incidental thereto'.
16 AGRAR is an international collaborative research project of which VIKSAT is a partner. The project is supported by DFID-UK and coordinated by British Geological Survey, UK. Available at: www.iah.org/recharge/projects/html/.
17 Under the National Food for Work Programme (now renamed National Rural Employment Guarantee Scheme), the Government of India has identified 150 back-

ward districts for preparation of District Perspective Plans, which are underway. VIKSAT has prepared such a perspective plan for Sabarkantha district including artificial recharge activities as one of the major components.

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