# 4

# Agriculture and PURA

## THE RELEVANCE OF AGRICULTURE

The agriculture sector is by far the largest employer in terms of human resources in India as well as elsewhere in the world. Ironically, at the same time it is also the smallest sectoral contributor to the GDP of the nation. It is strange that food—the most fundamental requirement of human beings, which also forms the bulk of our agricultural produce—is largely considered an unrewarding sector in the nation.

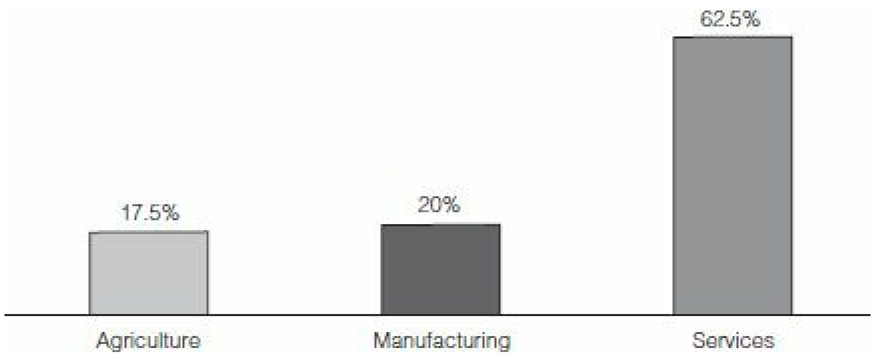


**FIGURE 4.1**: Sector-wise GDP share

Eight out of every ten BPL families in India reside in villages as depicted in Figure 4.2.[1] Further, three out of every four Indian rural dwellers are dependent on agriculture for their livelihood. It is estimated that any returns on investment in agriculture would be at least four times[2] as effective in eradicating poverty as any other sector, and transformation in this sector would directly impact the lives of more than 600 million Indians.

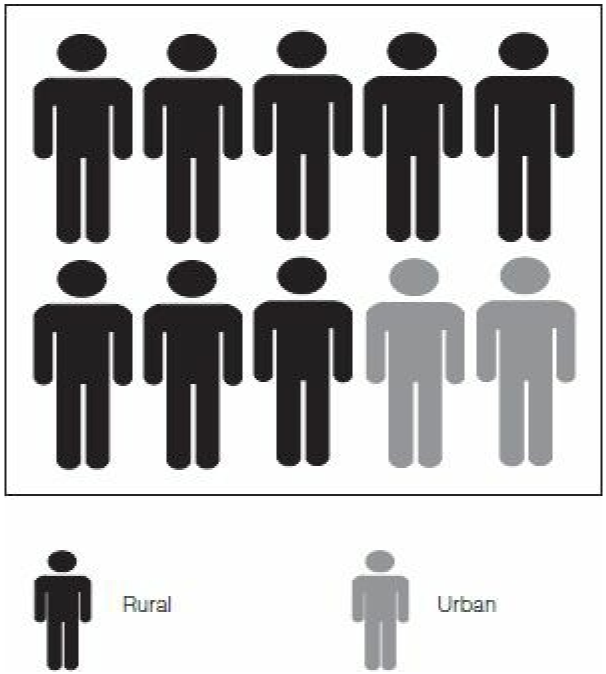


**FIGURE 4.2**: Distribution of BPL population across rural and urban India

There is still more to the story of Indian agriculture. The rural economy is largely dependent on agricultural produce, with more than 55 per cent of the rural economy coming from agriculture (Figure 4.3).

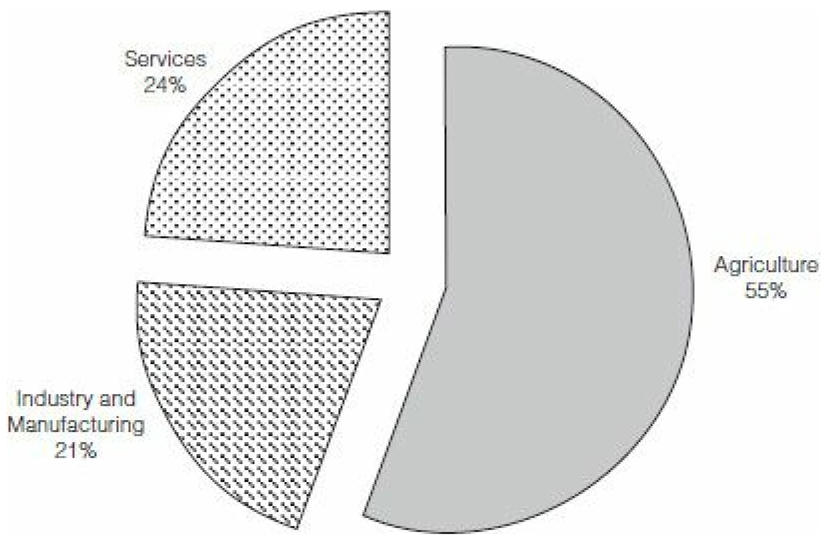


**FIGURE 4.3**: The share of rural economy in India

In fact, more than half the Total Domestic Product of India's rural economy is based on agriculture. Agro-products form the bulk of tradable goods and services emanating from it and thus they act as a benchmark for the valuation of all other goods and services, especially the non-tradable ones, even if they fall into the high-productivity bracket.

To understand this, let us take a scenario, such as the USA or other Western economies, where the productivity of industrial workers is very high due to better mechanization and training. Hence, understandably, they get higher wages.

But, this productivity logic does not hold good for subsidiary services. For example, ticket collectors on Indian railways or buses process a higher number of tickets per hour and hence have more productivity. Despite this, why do ticket collectors in the USA receive much higher wages than their more productive Indian counterparts?

The key lies in the fact that it is the higher productivity of the primary tradable goods or services which acts as a benchmark for the valuation of non-primary or non-tradable goods and services. The reason is also simple: when primary goods or services are marked with high productivity and hence, a high income, the overall purchasing power of the region or nation goes up and people are generally able to pay more for non-tradable goods or services.[3]

$$\text{Wage or Valuation of Non-Tradable } (V_{NT}) =$$
$$\text{Function of the Primary Tradable's Productivity i.e.}$$
$$V_{NT} = F\ (V_T) + \text{constant}$$

Hence, any improvement in the agricultural yield will also lead to a consequent rise in market wages and the value of non-tradable services and commodities. Our most effective weapon in our endeavour to eradicate poverty from the nation before 2020 will be targeted and mission-focused investment in agricultural, financial, managerial and technological sectors.

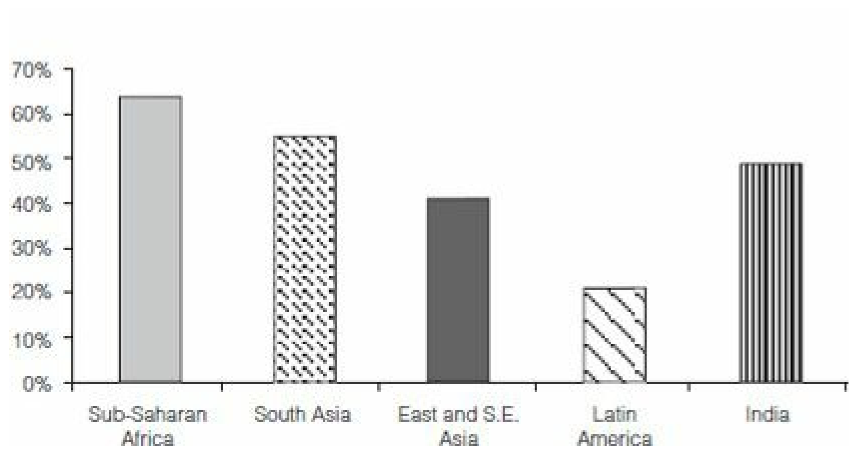


**FIGURE 4.4**: Agriculture—the largest employer in various regions of the world

Source: Derived from World Bank data

This situation as regards agriculture is not unique to us, and is commonly shared, in varying proportions, with the rest of the world.

THE INDIAN AGRICULTURAL SECTOR: THE FARM

We have already highlighted the relevance of agriculture, both in terms of rural economy as well as employment. Our dependency on agriculture goes far back in history.

**INDIA'S AGRICULTURAL POTENTIAL**

- India has 52 per cent cultivable land as compared to the world average of 11 per cent
- All fifteen major climatic regions are present in India
- Forty-six out of sixty soil types are present in India
- India has twenty agro-climatic regions

- There are ten biodiversity regions
- The hours of sunshine and the length of days are ideal for round-the-year cultivation
- India has the largest livestock population

Since Independence, there has been a continuous thrust on reforms and improvements in the agricultural sector—farm-based and not farm-based—which have helped India move away from starvation and severe food shortage. At the same time, efforts have been made to make agriculture independent of weather factors as far as possible.

Today, India has the largest irrigated land area.[4] With the added usage of fertilizers and researched seeds, India is in a top position in many areas of agro-production. India is also lucky in terms of sunshine, river networks and diversity in climate zones.

**TABLE 4.1**: India's global position in unprocessed agro-production

| Rank | Commodity | Rank | Commodity | Rank | Commodity |
|---|---|---|---|---|---|
| 1 | Lentils | 1 | Jute | 2 | Wheat |
| 1 | Fruit | 1 | Buffalo milk, whole, fresh | 2 | Onions |
| 1 | Castor seed | 2 | Beans, dry | 2 | Indigenous goat's meat |
| 1 | Spices | 2 | Nutmeg, mace and cardamoms | 2 | Silkworm cocoons |
| 1 | Chillies and peppers, dry | 2 | Pumpkins, squash and gourds | 2 | Rice, paddy |
| 1 | Bananas | 2 | Cow's milk, whole, fresh | 2 | Cotton seed |
| 1 | Millet | 2 | Groundnuts | 2 | Cabbages |
| 1 | Goat's milk, whole, fresh | 2 | Garlic | 2 | Eggplant (brinjal, baingan) |
| 1 | Indigenous buffalo meat | 2 | Tea | 3 | Cashew nuts |
| 1 | Ginger | 2 | Vegetables, fresh | 3 | Linseed |
| 1 | Pulses | 2 | Peas, green | 3 | Peas, dry |
| 1 | Chickpeas | 2 | Cauliflower and broccoli | 3 | Potatoes |
| 1 | Lemons and limes | 2 | Sugar cane | 3 | Tobacco |
| 1 | Mangoes and guavas | | | 3 | Coconuts |

Source: Food and Agriculture Organization (FAO)

However, even though India is in a leading position as regards much of the perishable produce, Indian agriculture is low on yield—low efficiency in terms of water, land usage, the labour employed and the quality of the goods.

This is exhibited in Figure 4.5, which shows the comparative yield of cereals (in rice-milled equivalent) of India, China and Brazil. Notice that all three started at almost the same level of productivity around 1960, all three are known as being among the most promising economies of the twenty-first century and have been categorized as BRIC.[*] It shows that China's yield took off during the late-1970s, roughly when India's Green Revolution was finally implemented.[†] This also corresponds to the time when China removed the tightly controlled system of communes[#] and gave greater freedom to the farmer in matters of production. This marked a phase of relative liberalization in China's rural, and particularly agricultural, policy. Households were given crop quotas in return for the tools, animals and seeds that were provided. The farmers were given the liberty to put their land to use in whichever way they liked provided they delivered the minimum yield. In addition to these structural changes, the Chinese government also engaged in irrigation projects and encouraged mechanization.

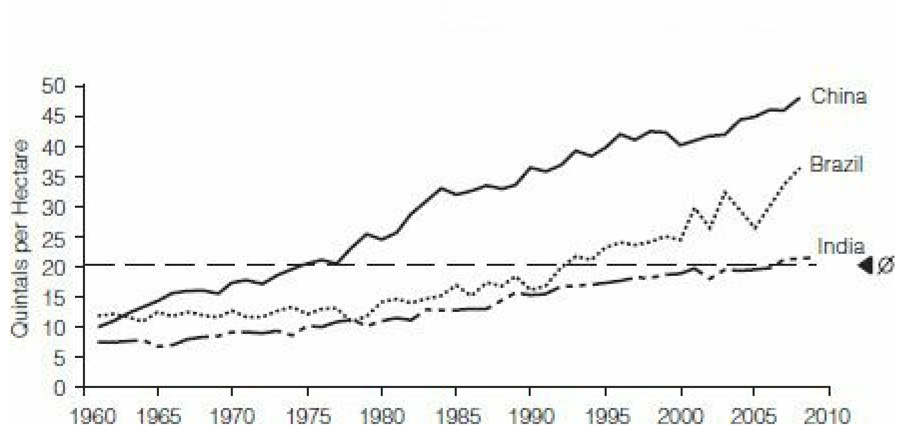


**FIGURE 4.5**: The yield of India, Brazil and China since 1960

Source: Derived from data available from FAO

Similarly, Brazil's yield took off sharply at the beginning of the 1990s owing to liberalization and the removal of tight controls, which led to more efficient farming and better yields. The key to the 'take-off' in yield has been mechanization, technology, market access and greater liberty for the farmers.

Analysing on a global comparative scale, too, the surge in the nation's economic growth has not translated optimally into productivity improvements in farming. India's relative position in cereal productivity has been stagnant since the 1990s as shown in Table 4.2.

**TABLE 4.2**: The relative ranking of nations in cereal productivity

| COUNTRIES | 1994–96 | 1999–2001 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| China | 17 | 19 | 22 | 20 | 18 |
| Egypt | 9 | 5 | 3 | 4 | 4 |
| Germany | 10 | 8 | 9 | 9 | 11 |
| **India** | **78** | **80** | **90** | **90** | **85** |
| Brazil | 68 | 59 | 71 | 62 | 52 |
| Japan | 6 | 12 | 14 | 14 | 13 |
| Philippines | 72 | 73 | 65 | 63 | 59 |
| Pakistan | 84 | 82 | 84 | 84 | 77 |
| USA | 14 | 14 | 10 | 10 | 7 |
| Malaysia | 42 | 54 | 53 | 56 | 57 |
| Bangladesh | 60 | 46 | 42 | 41 | 37 |
| New Zealand | 12 | 10 | 5 | 7 | 2 |

Source: Derived from data available with FAO

This may be partly due to the low base in yield with which we started, but with the growth of technology and budgetary allocation, liberalization and reform, we can aim at being among the best in the world.

On the other hand, investment in agriculture, rural development and irrigation has been rising since Independence (Figure 4.6).

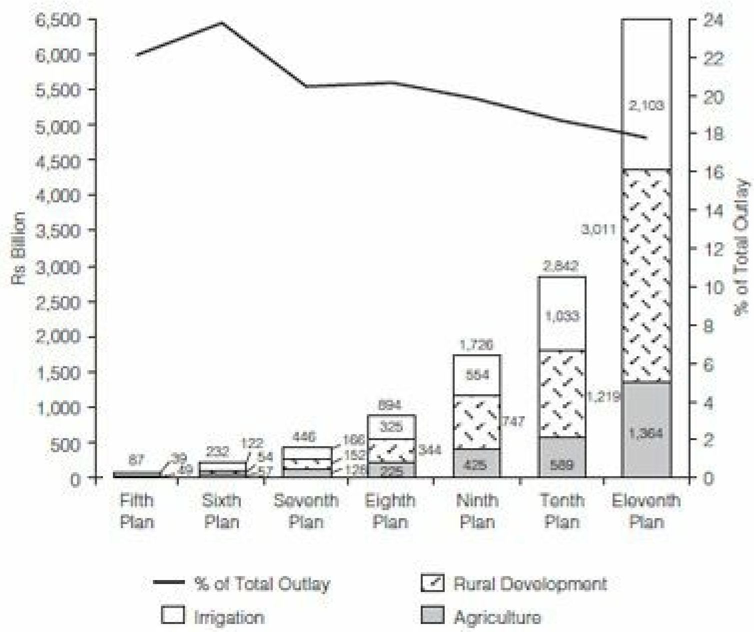


**FIGURE 4.6**: Planned investment in agriculture, rural development and irrigation since the Fifth Plan

Source: Calculated using data from the Economic Survey, 2009–10

Continuously, around 20 per cent of the total Plan outlay has been earmarked for investment in agricultural and rural development, and irrigation and flood control measures—one of the highest in the world.[5] Yet, a growth of merely 2 per cent in agricultural output with about 20 per cent investment indicates poor returns and the need for transformative systems.[6]

There is a similar vast gap as we move up the chain of value addition. While we grow a wide range of perishables on a large scale, the level of processing is far lower than in the West, or even in many Asian countries (see Table 4.3). A low level of processing translates into a lower shelf life for the product and hence, a lower bargaining power for the farmer.

**TABLE 4.3**: Processing in India and other countries

| Segment | India | Other Countries |
|---|---|---|
| Fruits and Vegetables | 2% | USA (65%), Philippines (78%), China (23%) |
| Marine | 12% | 60–70% in developed countries |
| Meat and Poultry | 1% | |
| Milk | 37% | 60–75% in developed countries |

Source: Report on 'India: Food Processing Industry', compiled by Swiss Business Hub India, 2008

Moreover, it diminishes the prospect of exporting the product over longer distances to places where a higher realization of value could be achieved. At the same time, it significantly reduces employment opportunities beyond production, which translates into more pressure on employment on the farm side, reducing the size of the farm and bringing down the yield.

This low value addition comes from a lack of technological knowledge and mismatched investment schemes. Investments are often in a mixed form: various parties—banks, governments, private investments and panchayats—are supposed to contribute towards a seed fund, which may result in an uncoordinated and untimely disbursal of monies from different points, leading to failure of enterprises.

### INTERACTION WITH FARMERS AT RASHTRAPATI BHAVAN

I have had a lot of interaction with ground-level farmers from all over the nation. Each meeting brought in some new perspectives and strengthened some known issues too.

Let me share my experiences with you. More than 6,000 farmers from different states and the Union Territories visited the Mughal Gardens at Rashtrapati Bhavan (the Presidential Estate) on 23 March 2007. They also saw the Herbal Garden which includes Jatropha, the biodiesel producing plant, the Spiritual Garden, the Musical Garden and the Nutrition Garden.

The farmers were shown organic farming and the Biodiversity Park and informed about the commercial aspects of various plants and herbs by a panel of experts from leading agricultural universities.

During the interaction, the following suggestions were given to me by the farmers:

- Arrangements need to be made for selecting eligible agricultural farmers from all over the country to go to foreign countries to study their methods and developments; farmers from various states can also be taken to Punjab to see its progress in the agricultural sector.
- Farmers may be given assistance for manufacturing natural agricultural inputs.
- The acquisition of agricultural land for purposes other than agriculture should be stopped in the larger interests of the farming community and the agricultural sector.
- Other alternative biofuels besides Jatropha should be explored, and farmers guided accordingly.
- Agricultural and horticultural techniques should be made available in regional and local languages.

### WHAT TARGETS SHOULD SUSTAINABLE PURAS HAVE?

The five points summarized above all point to the one pressing need which Indian farmers experience and express—empowerment. This empowerment has to come through knowledge, technology, investment and decision-making power in the hands of the farmers.

The most pertinent aspect of reforming agriculture through the evolution of a sustainable development system is a focus on the integration of efforts towards well-defined goals. Our challenge is not so much in terms of lack of investment but rather in terms of finding effective returns and outputs on the massive funds being employed.

For an effective output, we need a cadre on the farm with capable skills; we need an environment which promotes an output-oriented entrepreneurial approach; and we need integration in our thinking and efforts. The three distinct segments of the value chain—production, processing and marketing—have to move round one pivot. A summary of the efforts needed in each of these segments is illustrated in Figure 4.7. Especially noteworthy is the need to design systems which are inherently participative and inclusive and which result in the benefits accruing back to the first producer—the farmer. This is essential because farmers will thrive and become innovative only when the benefits really reach them which is often not the case, not even in the most advanced countries.

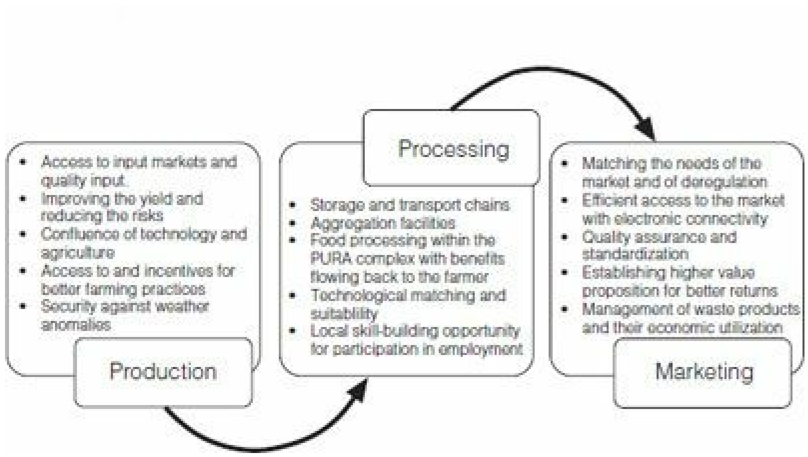


**FIGURE 4.7**: Strategy for sustainable development in the agriculture sector

For example, in the United States, studies show that from 1990–99 the marketing cost of food rose by 45 per cent, much of which transmuted into increased food expenditure for the consumer. However, at the farm gate, the price received by the producer rose only by 13 per cent.[7] Similarly, in 1990, marketing accounted for 76 per cent of the total consumer expenditure, with the farm gate value at 24 per cent.

In 1999, when the share of marketing increased to 80 per cent the farm gate share came down to 20 per cent of the total expenditure.[8] These numbers point to the need for building systems which are capable of backward-integrating benefits and forward-integrated processing. In the rest of this chapter we will discuss examples and challenges that can fulfil these goals.

## TAKING TECHNOLOGY TO THE FIELDS

One of the problems is the failure to take laboratory science to the fields, or doing so inefficiently. Without the meeting of technology and ground-level implementation, the benefits of modern technology and science cannot be optimal. This problem may arise due to a variety of reasons, some of which could be:

- Unsuitability of technology given the local agro-climatic conditions
- Unawareness of technology due to a communication gap
- Unwillingness to take unknown risks due to lack of trust
- Improper use of technology at the field level due to lack of knowledge
- Cultural barriers to adoption of modern technology
- Lack of adequate credit or of support investment which is a prerequisite to the adoption of technology

To overcome these barriers, sound management of the technology dissemination needs to be followed. This would require out-of-the-box ideas which, in a cost-effective way, can overcome these issues. We will now discuss some of the examples of how this has been achieved.

## EXPERIENCES FROM THE STATES OF BIHAR AND TAMIL NADU

Technology can be a game changer in the agro sector, especially in the developing world. Let us analyse two experiences from north and south India, where technology has been employed instrumentally to reform the productivity and yield of the farmlands.

### *Bihar: Paliganj*

An experiment was carried out by the Technology Information, Forecasting and Assessment Council (TIFAC) team in the north Indian state of Bihar, in RP Channel 5 and Majholi distributary, and later extended to Paliganj and five other distributaries at the request of farmers in the year 2000. The yield of paddy has increased in these villages from 2 tons per hectare to 5.8 tons per hectare, and that of wheat from 0.9 ton per hectare to 2.6 tons per hectare. At present, the paddy and wheat crops are spread over an area of more than 2,500 hectares and involve 3,000 farmers.

This project was carried out by TIFAC in collaboration with a farmer's cooperative society, the Indian Agricultural Research Institute (IARI) and the agricultural university in Pusa, Bihar. By using scientific methods of farming, such as soil characterization, matching the right seed to soil, planting in time, proper selection of fertilizers and pesticides, water management, pre-and post-harvesting methodology, the productivity has been more than doubled.

When I addressed the Bihar Assembly on 28 March 2006, I requested the Assembly to adopt this system-oriented approach in all the thirty-eight districts of Bihar which would enable the state to triple its paddy and wheat crops. The aim should be to increase the rice production from 5.5 million tons to 15 million tons, and the wheat production from 4 million tons to 12 million tons in four years' time. This would make Bihar the Grand Granary of India. Whether we have replicated this success story across the nation is a point for discussion.

### *Tamil Nadu: Precision Farming Project*

Precision Farming or Precision Agriculture—technology adopted in Tamil Nadu—implies doing the right thing, in the right place and at the right time. It has created awareness among the farmers because it has given higher productivity and access to markets, and has turned farmers into entrepreneurs. With this procedure, the collected information may be used to evaluate the optimum sowing density, to estimate fertilizers and other input needs, and to predict the crop yield more accurately. It helps avoid the application of unwanted practices to a crop without taking into consideration local soil and climate conditions, that is, it reduces labour, water, inputs such as fertilizers and pesticides, and ensures quality produce.

The Precision Farming Project was first started in Tamil Nadu in the Dharmapuri district during 2004–05. It was implemented initially on 250 acres, then 500 acres in 2005–06 and 250 acres in

2006–07. The Tamil Nadu Agricultural University was the nodal agency that implemented this project. An amount of Rs 75,000 for the installation of drip irrigation and Rs 40,000 for crop production expenses was given to the farmers. The first crop was taken up under the total guidance of scientists from the university, while the subsequent five crops were taken up by the farmers in three years. In the first year, the farmers were unwilling to undertake this project because of their frustration due to the continuing drought in that area for four years since 2002. But after seeing the success of the first 100 farmers and the high market rate for the produce obtained from this scheme, farmers started registering in large numbers for the second year (with 90 per cent subsidy) and the third year (with 80 per cent subsidy).

The farmlands of the Krishnagiri and the Dharmapuri districts are predominantly rain-fed. Elements of extremism are ripe in the general community—particularly the youths—in certain pockets close to the Andhra Pradesh border and the hills. The government of Tamil Nadu has undertaken the task of implementing the Precision Farming Project on 400 hectares as a turnkey project, with the main focus on a 40–60 per cent enhanced yield and effective market linkage.

One unit is equivalent to one hectare and a farmer is eligible for one hectare only. Under the project, 100 hectares during 2004–05, 200 hectares during 2005–06 and 100 hectares during 2006–07 were covered. Not only the farmers of these two districts, but the farmers of the other districts who were taken to the Precision Farming sites too were amazed by what they saw. The farmer-to-farmer mode added strength to the outcome, and all the other districts of the state made a demand for implementing the project.

Later, the project was scaled up to 40,000 hectares across the state with budget support by the Government of India, under the National Development Project (NADP). The university and the departments of agriculture and horticulture jointly set up the project during 2007–08 and 2010–11. The states of Kerala, Karnataka, Andhra Pradesh, Orissa and Maharashtra have adopted this project on a large scale, and training has been provided for all the farmers and the developmental workers at Dharmapuri in Tamil Nadu.

The processes had been given deep thought, and the products delivered the expected quality. The cluster members were brought together under an association called the Precision Farmers' Association registered under the Societies Act.

The process finally led to the establishment of a farmer-owned producing company called Dharmapuri Precision Farmers' Agro Services Ltd, registered under the Company Act, the first producing company in the Tamil Nadu state, in which 166 farmers of Dharmapuri are shareholders. Later, a second producing company owned by the farmers, Erode Precision Farm Producers' Company Ltd, was established during 2008–09.

The result of this experiment has had multiple effects because it not only focused on maximizing the productivity and enhancing the profitability, but also on empowering the farmers socially, economically and technically. The emphasis was also on social capital through the strengthening of cluster-level associations and district-level limited companies. For example, during an Annual Farmers' Day meeting held in Salem, one of the precision farmers said during his speech, with tears in his eyes that, for the first time, his family had been able to see the 'one lakh currency' bundles. This had attracted the attention of policymakers, bankers and insurance firms, whose frequent visits to the project site brought further economic relief to the farming community. A minimum of Rs 1,00,000 and a maximum of Rs 8,00,000 were the gross returns from one hectare, and this factor has helped every farmer own a project. P.M. Chinnasamy, a farmer, produced 500 MT of brinjals from one hectare in fifteen months, and he has become the resource farmer for hundreds of others who are cultivating brinjal. The precision farmers have doubled the yield in forty-five crops, as compared to the national and the state average.

### LONI PURA

One of the most successful initiatives of the Loni PURA* model is the Krishi Vigyan Kendra at Loni. It applies a three-tiered model to ensure that the farmers are a partner in research and that the full impact of agro-sciences reaches the fields.

Loni PURA assists farmers by operating an award-winning KVK or an agro-science centre where it carries out research and trains the farmers in scientific farming practices.

The KVK at Loni has established a unique way of involving the community in the process of agro-innovations. This has not only led to better knowledge but has also made technology much easier and more acceptable on the ground level.

**KRISHI VIGYAN KENDRAS**

Krishi Vigyan Kendra (KVK) or Agriculture Science Centre is an initiative by the Indian Council of Agricultural Research (ICAR) to promote the transfer of technology in agriculture, animal husbandry, beekeeping and many other fields to farms. ICAR is establishing these KVKs across the nation with private partners. Each KVK adopts five to six villages in a radius of 10–20 km around it for upgrading farm technology, agriculture extension services, conducting training courses and live demonstrations, offering advisory services on farm testing, and a wide range of knowledge services in a participative manner. There are, at present, 571 KVKs in the nation with the Eleventh Five-Year Plan envisaging the number as going up to 667.

Source: ICAR website

This has come about through the formation of the Innovative Farmers' Club (Prayog Pariwar) which has a membership of 712 farmers. This is the first tier of the system and it helps identify requirements which need to be addressed. It does a basic scientific analysis at the local level and facilitates the dissemination of the available technology in the villages. They are the first, the ground-level, evaluators of technology and help assess and refine it. They conduct quarterly meetings and share their experiences. The KVK has an incentive structure to encourage farmers to join the Innovative Farmers' Club. Thus, they ensure that the technology offered suits local conditions and that, seeing their enhanced yield due to scientific farming methods, other farmers also start to place their trust in scientific methods.

The next tier of the system consists of the Conventional Farmers' Clubs at the village level. There are 148 clubs with a membership of 2,977 farmers. Once the efficacy of the technology has been evaluated by the Prayog Pariwar, these clubs have the responsibility of disseminating it. They draw up an action plan for technology dissemination within each village and help in the selection and evaluation. They also help in the creation of SHGs, the next level of the system. They ensure that the intended users of the technology are fully aware of how to apply it to their farms and help overcome the communication gap between research and the farms.

The last tier of the system is the self-help groups of farmers. There are 485 SHGs with over 7,275 members. They help disseminate technology at the field level and undertake the vital task of credit mobilization, to give the farmers financial power to adopt the technology. The SHGs also help in developing entrepreneurship and year-round employment.

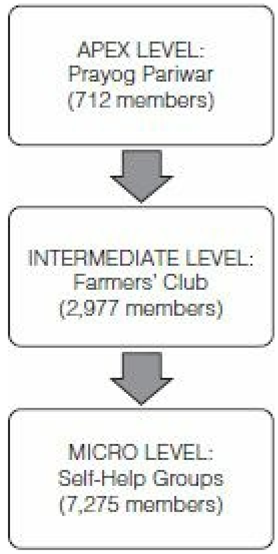


**FIGURE 4.8**: Levels of farmer participation

Using this three-tier system of employing farmers' clubs at different levels, the Loni KVK and Loni PURA were able to find support for scientific farming in the local community. Moreover, the Innovative Farmers' Club also acts as a decentralized point for generating technological awareness, thereby assisting farmers who have newly adopted methods of scientific farming. The SHG system too helps in accessing markets and hence, the farmers are assured of the saleability of their product.

**INNOVATIONS IN ORGANIC FARMING**

The National Innovation Foundation (NIF) has compiled data about the innovative and progressive farming practices adopted by farmers in different parts of India. Areas where the rainfall is poor, or where the land remains flooded for long periods of time, mountain regions and forest areas are the most suitable for organic farming. These are the areas where farmers should take up organic farming immediately. The NIF has reported over 240 combinations of herbal pesticides being used in different parts of the country. There are many other local cost-effective solutions for the problems faced by the farmers.

For example, planting lady's fingers (bhindi) as a border crop prevents cotton crops from being attacked by pests which are, instead, attracted to the flowers of the lady's fingers, and the cotton crop grows well. This is an important zero-cost solution since 40 per cent of the pesticides in use in the country are for protecting cotton crops. I have come across the successful production of organic paddy in many parts of the country. In one of the districts, 2,400 farmers joined together to cultivate organic paddy in 2,500 acres of wetland in the panchayat areas, and they realized a productivity of 6.25 tons per hectare, which is on par with international standards.

LIVE DEMONSTRATION FARMS IN CHITRAKOOT PURA

The Chitrakoot PURA* complex in Madhya Pradesh operates two KVKs in Majhgawan and Ganivan, which use an innovative methodology for imparting practical, hands-on training to the farmers. The

Chitrakoot PURA operates live demonstration farms of 1.5 acres and 2.5 acres, an area that corresponds to the typical landholding size in the area. The 'demo farm' is a farm-laboratory which shows the farmers how to work on farms of this size, so as to increase both farm and non-farm income through improved sustainable agricultural inputs.

The KVKs calculated the balanced nutritional requirement for a small family, the required income for non-food expenses and other contingencies, and then mapped out a season-wise production plan for the standard farm size. To drive their point further, they started implementing this plan on their demo farm. This helped overcome doubts as regards the suitability of the plan, given the local conditions and, at the same time, gave the farmers the confidence which can be generated by a working model.

Scientific agriculture is further forwarded by ground-level workers in the form of Samaj Shilpi Dampati. We will discuss them in detail later in this book.

### SEED CLUBS AT CHITRAKOOT PURA

Small-scale farmers face a huge problem when it comes to purchasing good quality seeds. Besides, there is always a doubt about the performance of particular seeds when subjected to local agro-climatic conditions. Other major issues which the small farmer faces are the increase in the cost of seeds, poor germinating qualities, limited availability of seeds, lack of access to the market and difficulty of transport. It was observed that, as a result, many farmers still rely on the older generation of seeds.

During a baseline survey of some of the villages by the Chitrakoot PURA, farmers repeatedly expressed a desire that seeds of improved varieties should be made available to farmers on a barter basis. However, the Chitrakoot PURA and the KVKs have limited resources and are not in a position to conduct such large-scale seed production. Moreover, it is important to empower the farmers or farmer groups to fulfil most of their requirements independently.

The Majhgawan KVK of Chitrakoot PURA then proceeded to introduce seed production programmes in selected villages. Under this programme, seed clubs at the village level and a seed village in a cluster of villages were developed. The KVK demonstrated seed production technology at its instructional farms (the 1.5 and 2.5 acre demonstration farms). Seed villages and seed clubs are now involved in the production of seeds under the close supervision and guidance of KVK scientists and experts.

These villages are not only meeting with their own seed requirements but are also supplying the surplus seeds to nearby villages, bringing in good income for the growers. A seed exchange has been set up where the innovative farmers can exchange the seeds for grain at an exchange rate of 1.25 kg of grain for every 1 kg of seeds.

This initiative highlights three aspects. First, farmers have been empowered not only as users of technology but also as producers of knowledge. Second, a new value-adding farm technology entrepreneurship has been set up with the focus on quality production. Third, a market-linked incentive to innovate has been nurtured with a 25 per cent mark-up on growing seeds, thereby adopting technology. This is an example of how, even with village-level knowledge and entrepreneurship, a friendly environment can be created through shared investment.

### WARANA COOPERATIVE SUGAR FACTORY

We have already discussed the various initiatives which have been undertaken by the Warana PURA complex in Maharashtra (Chapter 3). In the 1950s, most of the sugar cane produced by small and marginal farmers was used for the production of jaggery which requires low investment. The price of jaggery has always fluctuated and, in the early-1950s, its price crashed and brought ruin to small farmers including those in the Warana region. That was when the Warana Mission was set up under the leadership of Tatyasaheb Kore. In 1953, he started to collect money from the small farmers on an equity basis and tried to raise loans from other sources. The mission was supported by many socio-political leaders of the state and, with the help of equipment imported from Buck Wolf Company, the Warana Cooperative Sugar Factory was formed, the first of the twenty-five cooperatives which would later come up in the area.

The Warana Sugar Factory has about 20,000 cooperative farmers as its members and covers around sixty-nine villages with an area of 10,800 hectares under sugar cultivation (2009–10). The factory is an outstanding example of how the collective will of small farmers—with the able guidance of a social leader—was able to overcome obstacles of technology, investment and market mismatch. The factory is a dynamic model with both forward and backward integration for enhancing the benefits to its shareholders, the farmers, to whom it extends credit and subsidy facility so that their productivity is enhanced. This includes subsidies on herbicides (15 per cent), pesticides (60 per cent), micro nutrients (25 per cent) and spray pumps. To further increase the productivity, the Warana Sugar Complex has implemented a three-tier nursery programme to provide quality sugar cane seed. The breeder seed is purchased from the Vasantdada Sugar Institute, Pune, and the Central Sugar Cane Research Station, Padegaon, and then reared on the farms of progressive farmers. Later, it is distributed to the farmers on credit. Similarly, a seedling scheme has been set up, managed largely by women who, over the last two years, have sold more than one million seedlings packed in bags. Once again, we observe how a PURA creates farm workers with knowledge who can derive great social benefit.

Further along in the spectrum of Knowledge Connectivity, the Warana Sugar Cooperative offers free soil-testing facility and recommends optimal fertilizer usage, thereby saving the farmers' money.

Sugar cane is a water-intensive crop. The sugar cooperative also manages eleven big irrigation and thirty-eight small irrigation schemes for its farmers. It has reduced the requirement of water by its drip irrigation assistance which it extends to even the non-member farmers.

To integrate the vertical chain, the Warana Sugar Cooperative has produced innovative products which it is exporting both to other Indian cities and abroad. It has recently come up with processed, packaged and flavoured sugar cane juice which is available in Tetra Pak.

As a result of the cooperative movement to enhance the productivity and income of the 20,000 farmer families, the average yield of Warana cooperative farmers is much higher than that of the state or the nation as shown in Figure 4.9. Over the past decade, the average yield in tons per hectare of Warana has been 30 per cent more than the national yield and 20 per cent more than that of the state of

Maharashtra. Moreover, since it is a cooperative where the farmers are owners of the sugar-processing plant, the Warana Cooperative is able give one of the highest sugar recovery rates from sugar cane leading to better income and less waste. The sugar recovery rate of Warana is more than 12 per cent which is one-fifth above the national average.

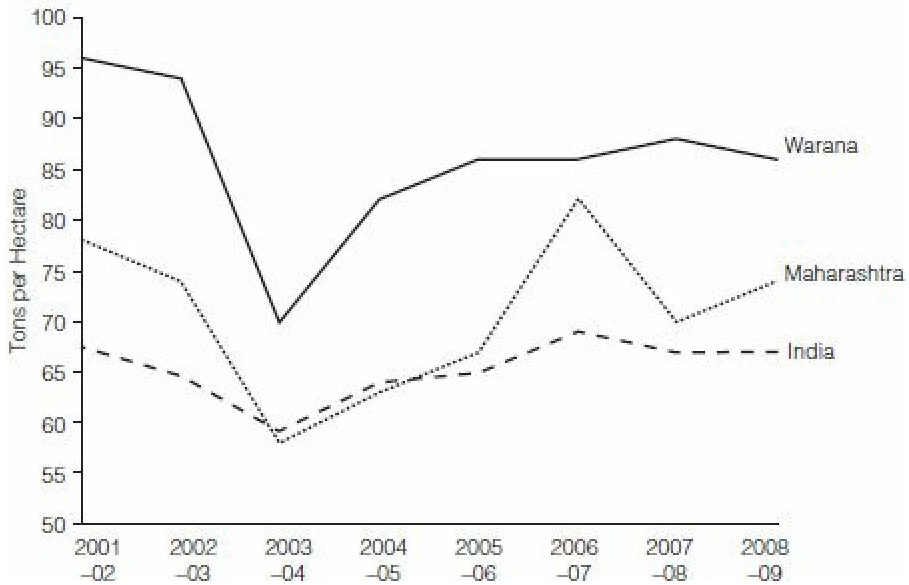


**FIGURE 4.9**: Yield of sugar cane in Warana as compared with state and national levels

The Warana Sugar Cooperative Factory model highlights the benefits and needs of a vertical integration of systems. It is a unique model, rolling the benefits back to the farmers both in cash and in terms of better inputs for improving productivity at the farm level. It also shows how a vertically integrated model with community participation can lead to implementing better technology and investments through aggregation. Finally, it exhibits the role of ground-level social leadership in development.

Let us now study how, nationally, India has seen some of the great agricultural visions translating into action and what future action is needed.

## THE FIRST GREEN REVOLUTION

In the 1960s, the then prime minister of India, Lal Bahadur Shastri, coined the term 'Jai Jawan, Jai Kisan'.* One of his first acts as prime minister was to increase the agricultural budget because, at that time, the agricultural output was barely able to keep pace with the population growth. He then appointed C. Subramaniam as a minister with a definite agenda for transforming the Indian agriculture sector.

The first Green Revolution, launched by the visionaries, the minister for food and agriculture C. Subramaniam and his adviser Dr M.S. Swaminathan, in partnership with agricultural scientists and farmers liberated India from the situation of what was called a 'ship-to-mouth existence'.# It was supported by renowned scientists from abroad as well, like Nobel Peace Prize awardee Norman Borlaug. The primary focus of the first Green Revolution was HYV (high-yielding variety) crops which absorb nitrogen much faster and whose growth is better. However, it also meant greater usage of fertilizers, water and pesticides.

Through an effort of historical magnitude, India attained near self-sufficiency in food which was important not only from the point of view of food security but also for national self-esteem. As a result of this first Green Revolution, the country has been able to produce over 200 million tons of food grain per year on an average.

AGRICULTURE REFORMS IN THE STATE OF GUJARAT

In October 2009, my team and I met with the professors and researchers at the Centre for Management in Agriculture (CMA) at the Indian Institute of Management, Ahmedabad (Gujarat), to discuss the problems of the agricultural sector and the solutions thereto. While interacting with the experts, I noticed that the agricultural growth rate in the state of Gujarat has been phenomenally high, at 9.5 per cent per annum[9] for the past decade (2000–10), that is, more than three times the 2.8 per cent agricultural growth in the rest of the country,[10] and even significantly higher than the overall national GDP growth for the period. This has also contributed to the above-average total Gross State Domestic Product (GSDP) for Gujarat at 10.2 per cent for the period 2000–10.[11]

I had a discussion with the experts at CMA about the methodology through which such an impressive performance had been achieved. They then prepared a document titled 'High Growth Trajectory and Structural Changes in Gujarat Agriculture' which listed out the reasons for the increased productivity:

## PHYSICAL CONNECTIVITY

### *Water Management*

Gujarat is not very rich in terms of water availability; moreover, it has the added problems of a falling water table, irregular rainfall and salination of the soil due to sea water ingress. However, in a typical public–private and community partnership, the state has managed to overcome these problems in one decade and shown remarkable growth rates. This was achieved through an extensive and careful supply-and-demand management of water. On the supply side, massive watershed programmes were executed and check dams constructed. Additionally, farmers were encouraged to construct farm ponds for creating localized and small-scale water reservoirs.

**NATIONAL AGRO FOUNDATION: THE STORY OF INTEGRATED AGRICULTURAL REFORM**

On 15 October 2008, I visited Illedu village in Kancheepuram district, Tamil Nadu, where the National Agro Foundation (NAF) is engaged in improving the quality of life for rural citizens by providing know-how on advanced agricultural practices; characterization of soil; soil upgrading through proper systematic soil-testing; matching seed to soil; a systemic approach to pre-and post-harvesting methodologies; and providing market connectivity. The farmers have achieved an increase in productivity ranging from 40 per cent to 150 per cent in different agriculture produce such as rice, sugar cane, vegetables and other horticulture products. In addition, they have very active self-help group systems which are empowered with knowledge of dairy farming, craftsmanship, making home-made products and selling to the nearby cities and villages. They have also launched a literacy movement and achieved 100 per cent sanitation in one of the villages.

With the help of the National Bank for Agriculture and Rural Development (NABARD), they have created watersheds with inlet and outlet channels for recharging the ground water. NAF enabled an urban garment export company to get relocated in the rural area, and it now provides value-added employment to sixty women from these villages. The members of NAF have also trained rural women to provide cutting and stitching support to garment manufacturers in Chennai and other places, who are engaged in export of garments. This activity has considerably changed the economic condition of the farmers and the craftsmen in the rural areas. There are many such success stories available across the country. We have to take a systematic approach in order to enable a larger number of farmers in the nation to reap the benefits of success.

The management of the demand side was undertaken through micro irrigation* schemes, which were readily accepted by the farmers who were conscious of the falling water levels and also of the sustainability aspect. Within four years (2006–10), more than 180,000 hectares were covered under micro irrigation, which contributed substantially towards managing the demand side of water consumption.

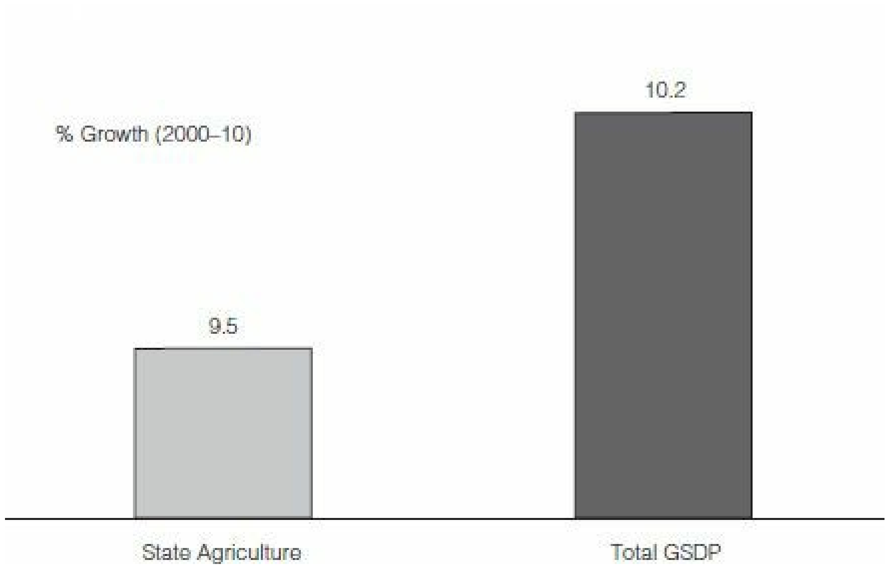


**FIGURE 4.10**: Agriculture and the GSDP growth rate for Gujarat

**WATER MANAGEMENT INITIATIVES IN GUJARAT**

- Check dams: 113,000
- Bori bandhs: 56,000
- Farm ponds: 241,000

Source: Data from ‘Frontiers of Agricultural Development in Gujarat’, Centre for Management in Agriculture (IIMA), 2010

*Interlinking of rivers*

Under various schemes, the surplus water of the Narmada and the Kandana dams was diverted to seventeen rivers and seven water-starved districts through a 330-km-long canal.[12]

*Quality power supply*

This was achieved through the action taken by the Gujarat Electricity Board under the Jyotigram Yojana which was started in 2003. Under this scheme, the Gujarat government, which had never before given free power to farmers, now ensured electrical power supply to villages on a 24/7 basis, by segregating the power for domestic consumption from the power for agricultural consumption. This resulted in reduced theft of electrical power and increased its availability to farmers. Moreover, the quality of the power was maintained.

## ELECTRONIC AND KNOWLEDGE CONNECTIVITY

Special efforts were made to guide and encourage farmers to produce quality products and organic products. Soil Health Cards were issued to farmers to support scientific farming methods. A World Trade Organization (WTO) cell was set up to increase export-related competency of major agricultural commodities. E-governance was used for programmes intended for the farmers, and credit, insurance and financial support were extended to them. Cattle-breeding was encouraged and efforts made to produce good quality wool from sheep. For the first time, the Krushi Mahotsav, conducted in campaign-mode, helped bring critical stakeholders and service providers to the farmers themselves in their own villages. A mobile exhibition (rath) travelled to every village, and provided an opportunity for the farmers to interact with different government officials and agencies. Even after the rath had passed through the villages, the programmes which were planned under the mahotsav continued to be implemented throughout the month.[13]

## ECONOMIC CONNECTIVITY

### *Agro Export Zones*

Across the state, Agro Export Zones have been set up for mangoes, vegetables and onions, and contract farming was encouraged in a big way. The Agro Industrial Policy is set to support agro exports and to process agro products.

### *Managing investments*

The Gujarat Green Revolution Company was established to help the farmers with investments and give them access to technology. The farmers had to contribute 5 per cent of the investment, while 45 per cent of the funds would be made available by way of loans from NABARD. The balance 50 per cent comprised the subsidy component to be borne by the Gujarat Green Revolution Company. At the end of six years, the farmers' agriculture income was doubled and it has been continuously growing. While the national average of agriculture exports was recorded as 3 per cent, Gujarat achieved a record growth of 12 per cent agricultural export growth.

To sum up, what does this imply? The fact that Gujarat should have achieved 9 per cent growth, while the rest of Indian agriculture was recording a 2 per cent growth, is due to its vision and its system-oriented approach, enabling irrigation and power infrastructure. Proper management of natural resources is vital not only for increasing agricultural yield and income, but also for mitigating adverse impacts of water scarcity in a state. Integrated land and water management activities, improved farming practices and appropriate market and credit linkages have the potential to increase the productivity of natural resources in a sustainable manner, and to ensure the nurturing of the local economy which would ultimately translate into national growth.

India gets approximately 4,000 billion cubic metres (BCM) of water every year from all natural sources. Out of this, 700 BCM are lost by evaporation and another 700 while flowing on the ground. Also, a large quantity of water—1,500 BCM—flows into the sea during floods. Thus, the remaining available water is only 1,100 BCM. Out of this, ground water recharge accounts for 430 BCM per year, while the present utilized surface water is 370 BCM. The balance unutilized water which can be harnessed is 300 BCM.

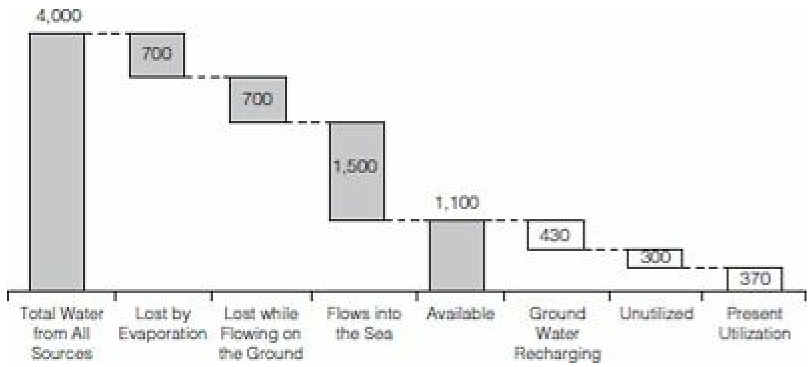


**FIGURE 4.11**: India's water balance

Sustainable development systems of 2011 and beyond will have to develop the management of the water resources of the nation with regard to supply and demand, and to promote flexible ways and means of making water resources available over time and location.

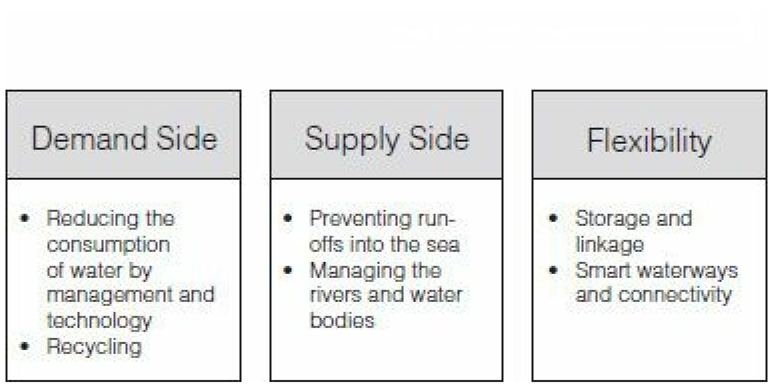


**FIGURE 4.12**: Required strategy for water management

LOW WATER EFFICIENCY IN AGRICULTURE

With over 70 per cent[14] of the developed water sources being used exclusively for it, irrigation is the largest consumer of water resources in the nation. India has the highest area of irrigated land and the second-highest area of arable land in the world. For long-term sustainable development, the PURA model has to evolve a judicious action plan to study how expansion of irrigation facilities and water management can work in synchrony.

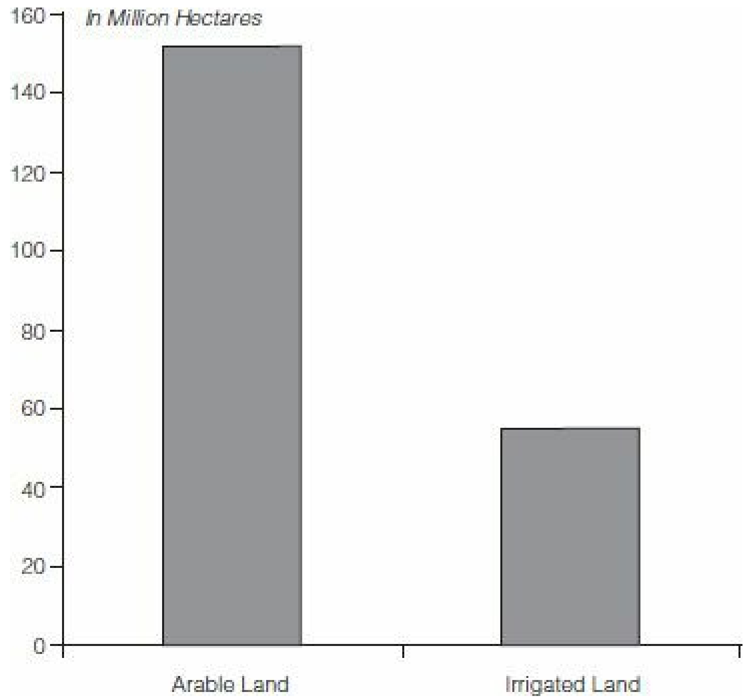


**FIGURE 4.13**: Arable and irrigated land in India

On the demand side, our sustainability has to focus on how to reduce the consumption of water per unit crop generated. The water efficiency of our current crop generation is a matter of concern. Every cubic metre of water consumed produces 300 gm of crops in India, while the same amount of water can generate 1,300 gm of crops in a developed world nation like the United States, giving them a four-fold advantage in the water efficiency of crops. This situation is reflected in most of the developing and underdeveloped world.

Every plant generally requires the same amount of water for its growth irrespective of location. The fact that India receives abundant sunlight—due to which there is more evaporation—can account for, perhaps, not more than 10 per cent extra water usage. PURA's sustainable system has to deliberate on how this can be improved. The competitive advantage lies largely in productivity. While about 600,000,000 litres of water is diverted every year per hectare, the land would yield 2.3 tons of cereals in India but more than 6.6 tons in the United States.

Secondly, and closely related, is the need for scientific cultivation using less water and less land and, instead, using methods such has drip irrigation. Technology can definitely play a major role in water management if it is able to customize itself according to the needs and constraints present at the field level.

**AGRICULTURE SUSTAINABILITY: THE EPCOT EXPERIENCE**

In October 2009, my team and I visited the Experimental Prototype Community of Tomorrow (EPCOT) located in the Walt Disney World Resort, Florida, USA, where actual experimentation is taking place in agricultural technology, in 2.5 million square feet of greenhouses.

The entire agro-tech research centre area has been rebranded in the name of sustainability, and now includes a public exhibition on agricultural technology and global ecology called 'Living with the Land'—an amazing exhibit on organic farming and agricultural innovation which takes a 1950s-like position that humanity can solve its food shortage and environmental problems by improving agricultural technology.

When the required mineral nutrients are introduced artificially into a plant's water supply, the plant no longer requires soil to thrive. Crop yields can ultimately be limited by factors other than mineral nutrients, like light. Soil-less culture is a broader term than hydroponics; it only requires that no soils with clay or silt be used. Tomatoes, harvested by these techniques from a single plant in one year, weighed 522 kg. Similarly, greenhouses can be built in rural areas with the help of SHGs, cooperatives and enterprises, and plants grown using drip irrigation with organic farming practices and hydroponic techniques.

This would reinvigorate rural economy by creating a sustainable alternate farming ecosystem from seed to market. These technologies, if taken properly under well-established alternative farming ecosystems, will certainly bring about a transformation in the agricultural economy of India. It will help reduce our dependence on water and, more significantly, will also assist in reducing our dependence on natural forces especially rainfall. For sustained growth, agriculture has to be transformed. For agriculture to be transformed, technology has to be matched with farming in an entrepreneurial manner.

ADVANCED RESEARCH AND DEVELOPMENT AND MARKET MANAGEMENT IN AGRICULTURE

On 9 November 2006, I inaugurated the GFAR (Global Forum on Agricultural Research) Third Triennial Conference, in New Delhi, with the theme 'Re-orienting Agricultural Research to meet the Millennium Development Goals'. I met with researchers and agriculture scientists from over eighty countries around the world. I highlighted the strong linkages between science and agriculture, and suggested the following seven areas for research missions which, by using scientific tools, would ensure a bright future for agriculture:

**WATER USAGE EFFICIENCY**

Across the world, water engineers use Water Usage Efficiency (WUE) as a parameter to evaluate the proportion of irrigation water to the amount of water which reaches the crop root zone.

WUE is broken down into two terms, Conveyance Efficiency (CE) and Field Efficiency (FE), where,

$$WUE = CE \times FE$$

CE refers to the amount of water from the irrigation system which reaches the fields, and FE is the amount of water applied to the field which actually reaches the root zone. Worldwide, the quest for higher water efficiency has to begin with efforts to improve Conveyance and Field Efficiencies, in a balanced and cost-effective way.

We need a focused approach to address both these components. CE, for example, has been improved in various parts of the world through measures like lining canals to reduce seepage (CE improvements were up to 10 per cent). The use of pipes instead of earth canals improved CE by about 30 per cent in the North China Plain. It must be understood that much of the CE improvement would take place over aggregated levels and hence would require policy action with public and private partnerships.

FE or Field Efficiency improvement, on the other hand, is pertinent to the action at the field level. It includes better irrigation equipment and technology, and the cultivation of plants which consume less water. For example, in Israel, drip irrigation has been extensively applied to bring down water usage per acre by 33 per cent. Reducing field evaporation is being developed as an alternative to the traditional method of flooding rice fields to further improve the FE.

Improvement in CE and FE to impact the Water Usage Efficiency requires technological development. It would also require an understanding of the available resources, needs and the costs involved, which would be specific to local conditions. For example, a region with high labour costs would probably find investing in drip irrigation more feasible than a region where cheap labour was available. Community awareness and action are vital for activating measures for WUE improvements, and managing and maintaining the development measures.

Source: IFAD (International Fund for Agricultural Development), *Report on Rural Poverty, 2001, and FAO*

## HIGH-YIELDING VARIETIES

The productivity of current varieties has reached a plateau. We have to develop high-yielding varieties with more quality characteristics, namely, more vitamins and minerals, which will help reduce nutrition-dependent health problems. For example, lack of vitamin A in food leads to night blindness. To overcome this problem, rice and other stable foods must possess adequate quantities of vitamin A. Research in genetically modified plants, such as the Golden Rice programme, needs to be speeded up.

## TISSUE CULTURE AND CLONAL PROPAGATION

There are many variations in productivity. Wherever possible, micro propagated plants which have high-yield capabilities and are free of disease should be used.

## GLOBAL WARMING

This has resulted in an increased $CO_2$ percentage in the atmosphere. It favours the cultivation of $C_3$ plants (rice, wheat), which has to be oriented towards enhanced yield by absorbing more $CO_2$ from the atmosphere.

## RADIOISOTOPES

Research and Development (R&D) can be focused on the use of radioisotopes to diagnose nutritional deficiency in plants and soils for the precise application of fertilizers.

## PRECISION FARMING AND AUTOMATION

R&D should concentrate on precision agriculture. Mechanization has to be resorted to for providing the right quantity of water and nutrition to the crops.

## ENERGY FARMING

1. Wastelands have to be fully utilized for energy crops (sweet sorghum, sugar beet and cassava for ethanol production). Appropriate technologies have to be developed for making these crops economically viable.
2. R&D has to be applied to power generation through biomass which has extensive application in agriculture.

## ASSISTIVE TECHNOLOGIES FOR FARMS

Out of consideration for the environment and to reduce the usage of fossil fuel, we have to design farm vehicles and farm equipment which can run on 100 per cent biofuels or can be electrically operated. Researchers must focus on developing intelligent farm machines. For example, a harvester should record the yield per unit area while harvesting. Intelligent mechanization—like removing only weeds and not plants—has to be developed.

I further highlighted the necessity of carrying out market research to have a market focus for maximizing the returns of the agriculture sector. It is necessary to examine the products that are in demand due to the changing lifestyles of the modern generation. For example, a special type of corn is required for making cornflakes and a special kind of potato for making chips. Hence, farmers should take into account the demand for the end processed product when selecting the seed. Government agencies should facilitate the dissemination of such information to enable farmers to get better value for their increased output.

The agro-processing industry across the world has to consider the retention of nutritional value; possible side effects from the use of additives and preservatives for increasing storage life; and aesthetic, eco-friendly and cost-effective packaging. In addition, agriculture and the agro-processing industry have to observe many new standards and perceptions for cleanliness, generally described as phyto-sanitary requirements. Scientists have to reorient their research projects to achieve these goals.

### NATIONAL MILK VISION FOR INDIA

India is the largest producer of milk in the world.[15] As an industry, the Indian dairy industry contributes 13 per cent in terms of employment and 5 per cent in terms of its share in the national GDP. Much of the milk production is concentrated in the rural regions of the nation. Roughly, in India, about 45 million full-time employees are engaged in producing milk, which makes it the largest sector across the world in terms of employment. Also, India has more cattle—numbering about 283 million—than any other country. With such a huge human and animal capital, the opportunities in the Indian dairy sector as a contributor to the national GDP are immense. Cooperative milk product brands like AMUL have become household names, both in the rural and the urban areas. But the challenge to the milk industry still remains to be tackled in terms of the productivity per animal, which is currently about one-tenth that of the United States. There is also a need for organized processing and marketing at globally competitive standards.

I have interacted with various milk producers, processors and milk production support organizations in the last two decades. In March 2010, I addressed the Convocation of the National Dairy Research Institute in Karnal where we evolved the National Milk Vision.

As envisaged in India Vision 2020, we need to launch a ‘National Milk Vision’ in an integrated manner in the following areas:

1. Cattle breeding
2. Feed and nutrition
3. Cattle health care
4. Farm management
5. Improved production of clean and good quality milk
6. Milk procurement and transportation

## CATTLE BREEDING

It is essential to have a progressive breeding policy on the national level and to draw up consistent policies at the state level for increasing the input-to-output (feed-to-milk) ratio. The major technologies implemented and tried are cross-breeding through Artificial Insemination (AI); Embryo Transfer (ET); and the development of transgenic animals. It is necessary to enhance and enrich the number of semen banks; to have properly trained human power; an infrastructure for monitoring the blood levels of cross-bred cows; and good quality-proven mates. Also, we need to add more than 30,000 AI centres before the Eleventh Five-Year Plan period. In order to accelerate the progress, the policy may be implemented in the public–private partnership mode and, through the Knowledge Connectivity of the PURA platform, efficient, quality breeding services may be provided at the farmers' doorstep. Embryo Transfer has to be commercialized and made into an economically viable proposition. Patenting of cross-breeds through DNA markers for adoption may be considered in the short term.

## FEED AND NUTRITION

Feed accounts for almost 60 per cent of the cost inputs for milk production and has a direct bearing on the yield of cattle. At present, the primary feed for cattle is crop residue and seasonal fodder because of which the yield—particularly that of cross-bred animals—is low in lean seasons. The area under cultivated fodder production is only 4.6 per cent of the total cultivable land, and it is essential to increase it to 12 per cent. Here, too, there is a need to carry out research for producing quality fodder from dry land.

Research and innovations carried out by various agencies may be studied and introduced, depending on the suitability of their adoption to the Indian environment, such as straw soaked in urea water; appropriate feeding systems for buffaloes and cows; medicated urea-molasses blocks (UMBs) for parasite control; agro-forestry systems of livestock production; the use of herbal anthelmintics for cattle; genetic characterization of livestock; laboratory-based feed evaluation systems (in vitro and nuclear techniques); feeding systems using unconventional low-cost feed and integrated rice; and forage production.

Besides this, appropriate management intervention has to be focused on increasing the average milk production per cow per day. Increasing the lactation period, decreasing the age to first calving and decreasing the calving interval, could be expected to triple the yield and the average income. The utilization of grassland and wasteland for fodder cultivation is expected to take place only in medium-to long-term because of social factors associated with the development of such lands.

Apart from that, a large quantity of oil cakes is being exported. Consequently, the prices of groundnut cake, soya extraction, rapeseed extraction and sunflower extraction have increased by 60 to 66 per cent between 2009 to 2010. This has resulted in an increase in the cost of feeding and maintenance of milch cattle which, in turn, has added to the cost of production. Recently, I came to know that there is an effective method of removing toxicity from Jatropha oil cake, after which it can be used as cattle feed. According to the International Dairy Federation (IDF), farmers in India are paid the lowest price in the world for their produce. A critical situation is already developing because dairy farmers find it more profitable to sell off buffaloes since, due to the export initiatives by the government, the export of meat is fetching good prices. We need to implement policies which will help enrich the feed and nutrition for cattle at an affordable price. The most pressing need is to empower dairy farmers.

## CATTLE HEALTH CARE

India has the largest number of cattle in the world—283 million. It occupies the first position in the world in respect of milk production and the fourth position in egg production. But, a comparative analysis in various countries shows that the yield of milk per head of cattle in the major milk-producing countries is six to twelve times higher than that in India. This is largely due to the presence of a large number of unproductive cattle and a scarcity of feed resources. In this connection, it is beneficial to study the model created by Baba Shri Bhadariya Maharaj in the desert area of Pokhran. His ashram has provided shelter for nearly 20,000 stray cattle, reared them and converted them into milk-yielding cows. He provides free milk and buttermilk to those travelling through the desert.

The most fundamental factor behind low productivity is ill health, lack of nutrition and the poor stock of a large number of cattle. High yield per cattle, which is the function of its breeding, feed and nutrition, health care and farm management are the essential requirements. It is essential to inform farmers of effective breeding programmes; of the availability of veterinary drugs and antibiotics; and of the need to ensure satisfactory hygiene conditions for housing cattle. Providing better accessibility to veterinary services at the village level is also essential.

## FARM MANAGEMENT

Farm management is one of the factors that affect the productivity of cattle and thereby, milk production. Currently, there are very few organized dairy farms in the country. Most of the dairy farming is undertaken by small farmers whose primary activity is agriculture. They have small landholdings and a few heads of cattle. They need proper education and training so that their cattle are housed in hygienic conditions, provided with a feed of increased nutritional value and adequate water and given good health care; and so that the milking process is automated at the central level.

### AN EFFICIENT MILK-BASED ECONOMY IN WARANA PURA

During the visit to the Warana PURA in Kolhapur district in Maharashtra we witnessed a sugar factory, banking and retail services. It also operates the Warana Milk Cooperative which has about 20,000 milk producers as its members spread across eighty-nine villages. Formerly, it used to take at least three to four hours for the milk to reach from the producer to the Warana Dairy processing facility. This presented the risk of the milk getting spoilt or the bacterial count increasing, thereby reducing the hygienic quality of the final product. The Warana Milk Cooperative is implementing a unique method for improving milk procurement from individual milk producers.

Each village has formed one or more primary cooperative societies where farmers can ‘deposit’ the milk. The milk producers are free to select the primary cooperative of which they wish to be a member. That way, there is an incentive for the primary societies to give the best price to the producers and also to handle the milk in a way in which it is preserved best.

For every five to six villages, the Warana Dairy is setting up micro chilling plants with capacities of about 5,000 litres, where all the primary milk societies in the cluster deposit their milk. When the micro chilling plant is full, a tanker takes the milk to the Warana Dairy for processing. In this way, the exposed time for the milk is reduced to about thirty to forty-five minutes, allowing the milk to be unspoiled by keeping down the bacterial count, lengthening its shelf life and hence improving the final quality of the product.

## IMPROVED PRODUCTION OF CLEAN AND GOOD QUALITY MILK

In order to boost the yield of clean and good quality milk, it is important to improve the productivity of dairy livestock. This can be achieved by following clean and hygienic practices during manual milking and also by mechanized milking. By doing so, the bacterial quality of the milk can be maintained. This has been demonstrated by TIFAC milk projects in Punjab, Karnataka and Andhra Pradesh and should be applied in other states too. With these favourable conditions, we should be able to target, per animal, the annual milk yield at 1,000–1,200 litres in the short term, 1,500–2,400 in the medium term, and 2,400–3,000 in the long term.

## MILK PROCUREMENT AND TRANSPORTATION

We also need to concentrate on milk procurement and transportation by empowering the village cooperative societies to take up this task with the participation of private entrepreneurs. They should have local quality-testing centres as in Anand, Gujarat, to create awareness among the farmers of the desirability of a minimal microbial count and a low degree of contamination.

### PROCESSING AND MARKETING

It is essential to make farmers realize the importance of producing bacteria-free milk. However, this needs the setting up of adequate chilling plant facilities, proper maintenance of equipment and the provision of venture capital loans for periodic enhancing of processing capabilities. The level of processing is expected to be around 15 per cent in the short term, 20 per cent in the medium term and 30 per cent in the long term. We need to inform the farmers so that large and modern, commercially viable units are encouraged to enter into the field of manufacturing indigenous dairy products; and to introduce improved quality standards, commercially viable technologies, nano technology-based packing and refrigerated transportation systems for hygienic distribution and an increased shelf life.

### WORLD TRADE

Today, India is not a major player in the international milk trade. India's share of dairy products in world trade is negligible (0.2 per cent),[16] and in meat and poultry too it is very low (0.5 per cent).[17] The global export from India of dairy products (in milk-equivalent terms)[*] was projected at 40.4 million tons (2008–09), up by almost 3 per cent from the previous year. The export during 2008–09 was worth around US$224 million.[18] In the long term, we should aspire to exports of over US$4 billion, at least 15 to 20 per cent of our production. For this, it is essential to concentrate on (1) improving the quality of raw milk; (2) high standards of dairy hygiene; (3) maintaining the consistency of supplies; (4) improving the packaging systems; and (5) formulating a consistent and clearly enunciated export policy for dairy products which could include incentives for exports, particularly in view of global competition.

### LAUNCH OF NATIONAL MILK VISION

When we launch National Milk Vision II, as a variant of the White Revolution, we will enable the farmers by implementing the above missions; we will put India on the high-yielding milk map; we will bring sustainable development in the rural areas, enriching agriculture, animal husbandry and food processing; we will create value-added employment opportunities for 60 million families. The second Green Revolution will be accelerated by this National Milk Vision, because it will act as a feeder channel and result in an economic multiplier for the nation, especially during these times of recession.

There are already many inspiring initiatives in the milk sector which can be emulated across the nation. We have a number of success stories which have made a difference in the life of rural citizens, such as the Gujarat Cooperative Milk Marketing Federation Ltd (GCMMF) pioneered by Verghese Kurien; the Bharatiya Agro Industries Foundation (BAIF); the JK Trust Gram Vikas Yojana; and other successful models operating in various states.

**THE BHARATIYA AGRO INDUSTRIES FOUNDATION (BAIF) MODEL FOR TRIBAL REHABILITATION AND DRY REGIONS**

I saw the integrated village cluster development programme during my visit with Narayan G. Hegde, an IIM graduate and an expert in farming and dairying. Chonda and Lachakadi, two village clusters in south Gujarat, have a population of 5,000. The tribal people from these villages migrate to nearby towns every summer. The BAIF model was installed here with the cooperation of the people and the participation of state authorities. First, water harvesting was undertaken to make water available to all. Every home was provided with livestock and a market for the milk produced by them.

**DAIRY HUSBANDRY**

BAIF members demonstrated the possibility of producing high-yielding cows by cross-breeding uneconomic, nondescript cattle with exotic dairy breeds while conserving the elite native breeds. Unemployed local youths were trained to undertake livestock breeding, pregnancy diagnosis, vaccinations for preventing disease, primary health care, forage production, feeding and other technical aspects of livestock development in rural areas. Each para-veterinarian assistant was assigned twelve to fifteen villages. This programme has enabled needy farmers to regain their self-confidence and produce good quality cattle. Door-to-door service has helped them avail of timely assistance and to develop faith in adopting technology. This programme has also helped conserve community pastures and forests, and promoted organic farming, women's empowerment and food security through the easy supply of milk and the enhanced agricultural production.

**CATTLE-BREEDING CENTRE**

BAIF runs nearly 1,850 cattle breeding centres which they propose to increase to 5,000. The country needs over 30,000 cattle breeding centres in order to generate the cattle needed by 50 million families. This requires a replication of the BAIF type of organization in different parts of the country and simultaneously, additional input to BAIF, so that it can train and empower the local people to undertake the tasks involved in cattle breeding, cattle care, milk processing and marketing.

The BAIF model of integrated economic development with knowledge empowerment is an ideal example of the approach we need to take in order to empower the 3 billion rural population of the world through the PURA platform.

## THE FISHING INDUSTRY IN THE COUNTRY

India is the third largest fish harvesting country in the world. The sector has immense potential for rural development, domestic food security, employment generation, women empowerment as well as earning through export. The Indian fisheries sector has been witnessing a steady growth, and the annual fish production has risen to over 7 million tons.[19] The rate of growth of the inland sector has been faster than that of the marine sector. The inland fish production is close to 4 million tons and has almost doubled in the last decade.

At present, fisheries and aquaculture contribute to nearly 1 per cent of the GDP and 5 per cent of the agriculture and allied activities. Considering the output of the sector, it can provide livelihood for over 10 million citizens at a subsistence level of annual income. To achieve a rapid growth for this sector, we have to address the problems of seed, feed and capacity-building of the fishing community, promotion of the latest technological practices, administrative skills and disaster management. We need to carry out a full-fledged study for increasing the output of the fishing industry to a minimum of 10 million tons by the year 2013.

One of my suggestions for improving the industry is to create a Ministry of Fishing and Fish Products at the Centre and corresponding departments or ministries in the states. Some of the methods by which marine fishing can be improved is by the use of large trawlers, high-sea processing, packaging and marketing. Value addition to fishing and fishing products by using high technology is indeed an important mission.

## CHALLENGES FOR THE INDIAN FISHERIES SECTOR

The fisheries sector in our country has to overcome many challenges. The industry is still dominated by 'capture fisheries', that is, by creating a 'property rights' problem, which subsequently becomes a threat to the sustainability of not only the aquatic species harvested but also the fishermen engaged in this activity. In marine fisheries, there is a decline in the catch rates along with a rapid increase in the mortality rates of fish. Slow-growing and low-fecundity species like lobsters, sharks and catfish have started showing signs of vulnerability. The number of marine species that recorded reduced landing between 1994 and 2005 is significantly high, and the landing of some traditional, indigenous inland species has also gone down considerably during the same period. We need to pioneer strategies by which the biodiversity of the Indian marine species can be nurtured and conserved. Satellite observation can be used for generating database and mapping.

In order to facilitate the seamless movement of fisheries products—fresh fish—from harvesters to the ultimate consumers, an effective and efficient cold supply chain management, interlinked with a value chain management, has to be put in place. It is noteworthy that in 2004 about 83 per cent of the Indian fish catch was marketed fresh, a significant and steady jump from 1977, when the proportion of fish sold fresh was a little less than 66 per cent of the total catch.[20] We need to spearhead the development of cost-effective and efficient technologies which can promote fish processing and storage. Regarding the efficiency of fishing vessels, the cost of fuel and clean fuel are important factors and have to be considered and developed.

**A CASE STUDY: ICELAND'S FISHING INDUSTRY**

In 2005, I visited Iceland, a small-sized island nation in the northern Atlantic Ocean. There, my team and I studied its unique fishing industry. Iceland harvests 2.13 million tons of fish every year. Deep-sea fishing on a large scale has become possible for Iceland mainly due to its large fleet of 330 mechanized boats. Also, its population of 290,000 is largely seafaring and capable of using modern fishing vessels, state-of-the-art fish processing and marketing methods for servicing the European markets. It has a strong fisheries management system and control over the total fleet through the well-networked Iceland Defence Agency. There is an annual quota system for individuals based upon the total permissible catch. What is most remarkable is the fact that the entire cycle of catch–storage–process and market is managed at sea, on the trawlers. The developing parts of the world can learn from this experience and empower the coastal-region PURA systems to use this technology.

Our discussions so far clearly indicate what the agenda for the Indian agricultural sector has to be for the next decade and beyond. India now has to embark on the second Green Revolution which will enable it to further increase its productivity in this sector. Above all, it has to be designed keeping in mind the needs of the small farmer as well: the success of the next agricultural revolution will be more proportional to the benefits it delivers to 5-acre farms than the 500-acre farms.

**FIRST GREEN REVOLUTION**

- Seed
- Fertilizers
- Water management
- Training farmers
- Cultivation management
- Harvest and post-harvest
- Output = 200 MT Grain

**SECOND GREEN REVOLUTION (2010–20)**

- Soil characterization
- Matching the seeds
- Fertilizer management (organic farming)
- Water management
- Drip irrigation: halving water consumption
- Training
- Cultivation
- Post-harvesting (silos)
- Output = 400 MT Grain
- Food processing (value addition)
- Marketing

By 2020, India will be required to produce over 340 million tons in view of the population growth, and the increased purchasing power will mean a further demand for food per capita. The increase in production will have to surmount many impeding factors. The requirement of land to satisfy the needs of the increasing population as well as for more afforestation and environmental preservation activities will bring about a situation where the present 190 million hectares of arable land will not be fully available. It might shrink to 140 or even 120 million hectares by 2020. In addition, there will be a shortage of water due to competing demands and a reduction in the agricultural workforce. We have already seen that with the current availability of water, it would be very difficult to double the output in a sustained fashion.

India has to work hard to increase the average productivity per hectare: from about 2 tons to more than 4 tons per hectare of the available land for cultivation, with less water. The technologies needed would be in the area of developing seed varieties that would ensure a high yield even under constraints of water and land.

Support infrastructure, too, has to be ensured. We have to get rid of the typical picture of low-cost, low-productivity agriculture and, instead, have a vision of integrated technology and value-added agro-business. Farmers will have to graduate from being agrarian to becoming agro-technicians and agro-businessmen. For that, we need research of the highest order, technology transfer to the fields, and better access to credit with quality in terms of timeliness and accountability. Farmers will have to be encouraged to integrate vertically into storage and processing, but only when proper access to markets has been ensured. For that we need a competitive storage network and processing facilities, which can ensure a fair price at the farm-gate level. This will give the farmers' products a longer shelf life which, in turn, will help them have greater bargaining power. These facilities can be owned by the farmers themselves in a cooperative or can be a network of enterprises.

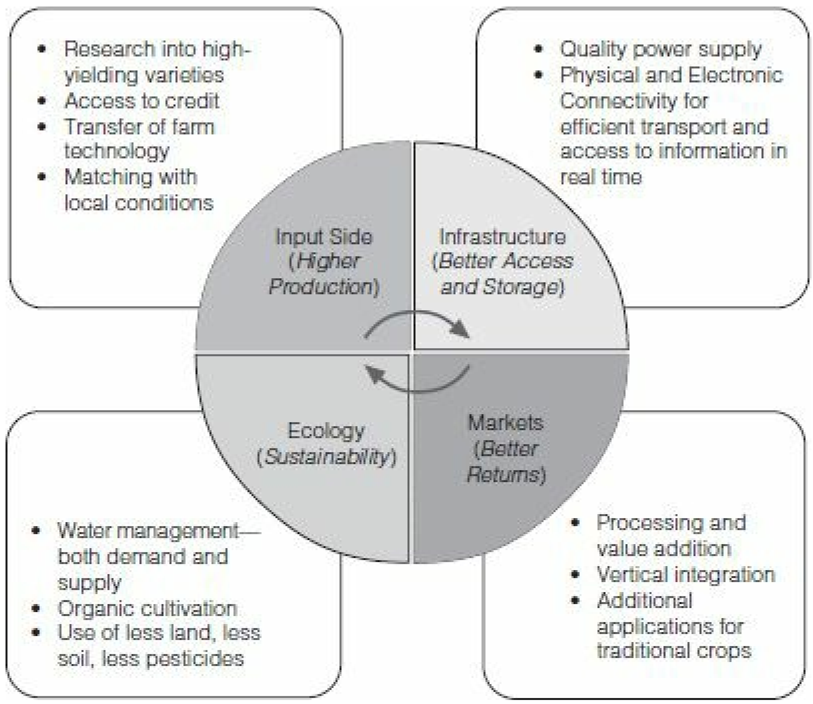


**FIGURE 4.14**: The focal areas of the second Green Revolution

**EFFICIENT INNOVATIVE TRADITIONAL METHODS**

It is indeed important to use science and technology as a tool to reform the agriculture sector in India and the world. But while we focus on science, it is also necessary to assess the efficacy of certain traditional methods, and study how carrying out innovations in them can lead to convergence with technology for enhanced returns. India and the rural world are rich in traditional methods which have been passed from one generation to the next, often limited to local application. Let us discuss one such innovation which has brought large areas of barren land under cultivation in Burkina Faso and Niger where the soil was sealed by a thin crust that prevented the entry of water. The innovation used to reclaim the land was simple, cost-effective and yet efficient, through Tassas.

Tassas are 30-cm holes which are filled with manure as the soil is dependent on organic material. This environment promotes the growth of termites, which increase infiltration by air and moisture. In the rainy season, these holes get filled with water and the farmers plant millet in them. In Yatenga (Burkina Faso), about 10,000 hectares of land have been thus treated. They are yielding about 1,000 kg of cereal per hectare per annum as against 150 kg without the application of Tassas. Wherever fertilizers were also used, the yield went up to 1,400 kg per hectare per annum.

The International Fund for Agricultural Development (IFAD) Report on Rural Poverty (2001) highlights that 'the average family in Burkina Faso and Niger, using these technologies shifted from an annual deficit of 644 kg (6.5 months of food shortage) to a surplus of 153 kg'.

Every village in the world has some unique skills in agriculture learnt over generations, often purely based on experience and the test of time. These innovative technologies are vital as they are customized to local conditions. Two important steps are needed in this area.

First, we need to create an open source and multilingual directory of all the traditional innovations and technologies which are being applied across the world.

Second, there is a need to find out the environmental conditions to which they are applicable, and the active ingredient in the technology. This would help identify how a particular technology from one part of the world can find application in suitable conditions in another village, miles away from the place of origination.

Source: *IFAD Report on Rural Poverty, 2001* and FAO

The second Green Revolution will indeed be a graduation of knowledge: from characterization of soil to the matching of the seeds with the composition of the fertilizer; water management; and evolving pre-harvesting techniques for such conditions. The sphere of a farmer's work would expand from mere grain production to food processing and marketing. While doing so, utmost care would have to be taken for various environment-and people-related aspects leading to sustainable development.

## THE LOW VISION TRAP

I have seen and interacted with rural regions in India throughout my life. I know how an Indian fisherman works at sea and I have watched an Indian farmer toiling in the field. I am aware how difficult it is for their families to meet the basic human needs for food, medicine and shelter. The problem is that we have set a low vision for our agriculture sector—one of low cost, low technology and low value production. It is a precarious outlook to have for a sector on which more than half of India depends directly as the primary source of food, especially as India has the second highest number of people to feed in the world.

PURA's sustainable development system has to be given a new vision in all sectors of growth, especially that of agriculture. It has to be an infusion of technology with the participation of the community; an improvement of yield with regard to its impact on the environment; and integrated action for value addition.

Our agriculture sector has to graduate from a mere low-value employment provider to a vertically integrated chain which will provide employment and opportunities for entrepreneurship at all levels of the value chain, including the services in the rural sector. Excessive employment pressure on limited land, water and other resources has led to smaller-sized holdings which suffer from the disadvantages of small scale. While it is a fact that agriculture—especially the growing sector—employs more than 70 per cent of rural Indians and about half of the overall population, this system will have to change in the long run. Compared to some of the developed nations of the world, we find that the USA employs about 1.7 per cent and the European Union about 4.3 per cent of the total workforce in agriculture[21] (Figure 4.15). This also means that each farmer is able to support roughly fifty-eight non-agriculture people in the USA and twenty-three in the European Union, while the ratio for India is around one.[22]

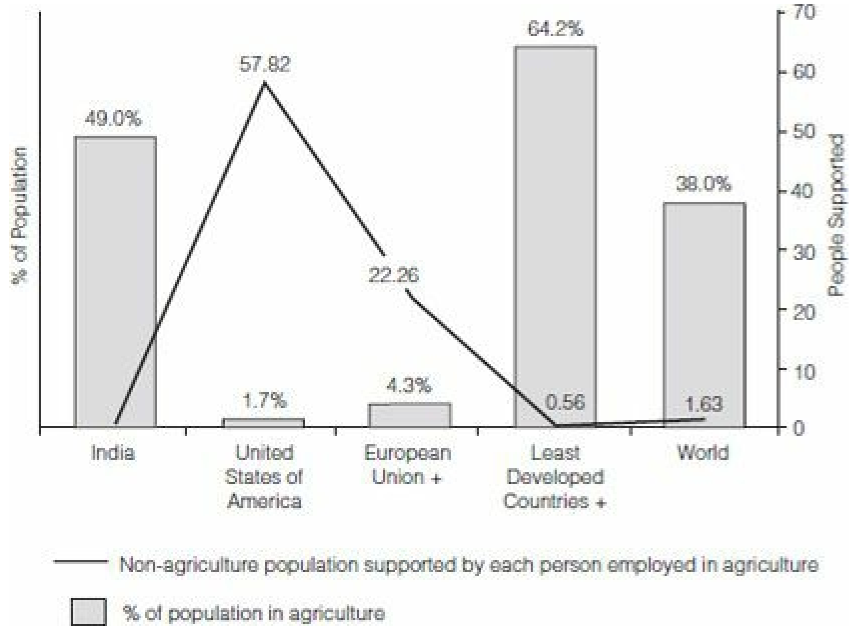


**FIGURE 4.15**: Employment and dependence ratio in agriculture

In India's context, it is true that given the large population and demographics it would not be feasible for us to reach similar figures, but in the long run we could definitely see around 25 per cent of the total population engaged in agriculture, many of whom should be employed in value addition rather than just production. This would mean that every farmer would be able to support three non-agriculture jobs. This does not mean that it would lead to mass rural unemployment with jobless farmers. The agricultural sector with value processing would lead to higher income levels, create more demand and increase the paying capacity for services and other production in rural areas. This effect, coupled with the creation of connectivity, which would aggregate the markets, and the effect of creating amenities as envisaged in PURA, would be able to spur non-agro sector employment and entrepreneurial opportunities in rural areas. In the following chapters, we will discuss how non-farm and service sector employment opportunities can be created and nurtured for achieving a good balance between sectors, achieving economies of scale and promoting sustainable growth in rural India.