Chapter 5

Performance of Agriculture in Gujarat

Ashok Gulati, Ranjana Roy, and Siraj Hussain

5.1 Introduction

There have always been large disparities in India's agricultural performance at the state level because of varying resource endowments and levels of investment in the creation of rural infrastructure. Agriculture states like Punjab and Haryana performed well in the 1960s and 1970s, while Gujarat and Madhya Pradesh have been star performers during the post-2000 period. Other states like Bihar, Odisha and UP have been moderate performers. Gujarat is one of the few states which achieved high growth in this sector; during the period from 2001–02 to 2014–15, Gujarat's agriculture grew at 8.6% per annum. During the same period, the all-India agricultural growth rate was only 3.2% per annum. Gujarat's outstanding performance during this period has been nothing short of an "agrarian miracle", as it surpassed even the growth rate registered by Punjab's agriculture during the heydays of the green revolution. This makes a strong case for looking at the dynamics of change and the factors that drove Gujarat's agriculture to such heights so that this success story can be shared with other states, especially the eastern states of Uttar Pradesh, Bihar and Odisha, which have lot of potential to excel in this sector. However, the state experienced very low growth in agriculture during 2014–15 (0.01%) and 2015–16 (–1.6%), primarily due to droughts.¹

Among the many steps taken by the state, three interventions played important roles in its impressive performance: (i) irrigation facilities (ii) efficient power supply and (iii) all-weather roads to provide rural connectivity. Groundwater irrigation

¹ Some experts suggest that this drastic fall in agricultural GDP for two successive years had political implications for the ruling party, leading to its poor performance in the agricultural belt of Saurashtra in 2017.

through assured power was ensured through power feeder separation. Rationing of farm power supply after *Jyoti Gram*² brought discipline in the extraction of ground-water. Micro-irrigation in the PPP mode and community-based farm ponds are unique examples of sustainable water use in the state. Investment in all-weather surfaced roads ensured efficient and quick movement of products to the market, minimising waste. Dairy co-operatives have provided a stable base for the growth of the live-stock sector so far. Co-operatives procure 53.7% of the milk produced in the state, which is the highest in the country. Complementarities in public policies and private initiatives have made Gujarat's agricultural miracle possible.

Whether Gujarat's agricultural performance will continue to be as strong in the coming decade as it has been since 2001–02 remains an open question. We look at Gujarat's experience more closely, not only to draw lessons for other states but also to sustain its high growth path and guide the state.

This chapter is organised in six sections. After a brief introduction in Sect. 5.1, a detailed overview of Gujarat's agricultural sector is presented in Sect. 5.2. In Sect. 5.3, the composition and sources of agriculture growth in Gujarat have been analysed. Section 5.4 presents the econometric analysis to derive the drivers of agriculture growth in the state. In Sect. 5.5, we have looked at whether the state's agricultural budget is in line with the GVO from agriculture and allied activities. Finally, in Sect. 5.6, we present some concluding remarks based on our empirical and econometric analysis and recommend policy prescriptions to sustain high growth rates in Gujarat.

5.2 Overview of Agriculture in Gujarat

The state, situated in the western part of India, is spread over an area of 196,024 sq. km which is approximately 6.4% of the total geographical area of the country (Census 2011). In Gujarat, rainfall is unevenly distributed spatially. The southern region of the state receives average rainfall ranging from 76 to 152 cm, while the northern region receives average rainfall ranging from 51 to 102 cm. Some parts of Saurashtra receive rainfall of less than 63 cm. Further, the state receives rainfall only during the monsoon season (July–September) (Agricultural Statistics at a Glance, 2014). Uneven rainfall has led to water scarcity in Kutch and some parts of Saurashtra. While Northern Gujarat and Saurashtra are drought-prone, other parts of the state consisting of the lower river basins are prone to floods (Ahmedabad, Surat and Bharuch). Heavy rainfall in the areas of small river basins cause flash floods.

²The Jyoti Gram Yojana was launched in 2003. Under the scheme, agricultural feeders were introduced and rural areas received 24 hours power supply. Details can be found in the upcoming sections.

Fig. 5.1 Average annual growth in agricultural GDP, 2001–02 to 2013–14. *Source* National accounts statistics, MOSPI

5.2.1 Agricultural Growth in Gujarat

Gujarat has been praised for its economic performance, which was led by the manufacturing and services sector during the eighties and nineties, especially after the economic reforms. The agricultural sector did not receive much attention during this time; rather, agricultural growth slowed down during this period (Hirway 2000, Bagchi et al. 2005). Specifically, the agricultural growth rate was not low but was accompanied by very high volatility. But the picture changed after 2000, as the sector picked up dramatically with high growth and low volatility.

In recent years too, the sector continued to achieve a high growth rate with comparatively lower volatility. During 2001–02 to 2013–14, Gujarat's agricultural GDP grew at 9.2%, which was the highest among the major states (Fig. 5.1). However, agricultural growth still has a high correlation with rainfall deviation. The correlation coefficient between agricultural growth (%) and rainfall deviation (%)³ in Gujarat is 0.65, while the correlation coefficient of agriculture growth with rainfall deviation in the Saurashtra region is 0.61 for the period of 2002–03 to 2015–16.

But since 2014–15, agriculture in Gujarat has suffered and the state has lost its position to Madhya Pradesh. Droughts in two consecutive years (2014–15 and 2015–16) led to negative agricultural growth. The situation improved in 2016–17 (9.9% in 2016–17 over 2015–16). But taking the average of the last three years, the sector grew only at 2.8% per annum (Fig. 5.2), which is extremely low compared to Gujarat's earlier experience.

³Excess: +20% or more of long period average rainfall, Normal: Between +19% and –19% of long period average rainfall, Deficient: Between –20% and –59% of long period average rainfall.

Fig. 5.2 Trends in agricultural growth in the period of 2012–13 to 2016–17. *Source* National accounts statistics, MOSPI

5.2.2 *Agricultural Livelihood in Gujarat*

The state's population in 2011 was 60.4 million, and the estimated population for 2018 is 68.2 million, which is 5% of India's population. Gujarat had 49% of its workforce engaged in agriculture in 2015–16 (Labour Bureau, 2015–16), while the contribution of agriculture in overall GSDP was 16% in TE2016–17 (CSO). The agriculture sector is largely dominated by small and marginal farmers. In 2015–16, small and marginal farmers (with a holding size of less than 2 hectares) accounted for 68% of the total number of farmers in the state, and they operated on 34% of the total state's operated area. The average landholding size declined from 2.62 ha in 1995–96 to 1.88 ha in 2015–16 (Table 5.1).

The average monthly income per agricultural household stood at Rs. 7926 in 2012–13, which is higher than the all-India average Rs. 6426. But the growth rate of income (3.4%) is marginally lower than that achieved at the all-India level (3.5%) (NSSO, 2002–03 and 2012–13). This is somewhat puzzling as Gujarat's agricultural GDP growth during this period was more than the all-India average (almost 5.7% per annum). One possible reason could be that the year 2012–13 was an outlier, when Gujarat experienced extremely low rainfall, more than 30% below normal (in Saurashtra, it is was more 38% below normal), leading to a sharp decline in the profitability of most crops. Since income growth is calculated as CAGR between two points (2002–03 and 2012–13), and not as an annual average of all the years in between, this slow growth in income may be due to this statistical glitch. According to NABARD's All India Rural Financial Inclusion Survey 2015–16 (NAFIS), Gujarat farmers' income was Rs. 11,899 per month. This was the fourth highest among all states (after Punjab, Haryana and Kerala). In the longer period of 2002–03 to 2015–16, the state achieved an average annual farmer income growth rate of 4.2%, which is marginally higher than the all-India average growth of 3.7%.

Table 5.1 State-wise distribution of operational holdings in Gujarat

	1995-96			2010-11			2015-16		
	Area (%)	Number (%)	Size of holding (ha)	Area (%)	Number (%)	Size of holding (ha)	Area (%)	Number (%)	Size of holding (ha)
Marginal	5.68	27.34	0.54	8.94	37.16	0.49	10.75	37.93	0.53
Small	15.67	27.97	1.47	20.96	29.25	1.45	23.43	30.37	1.45
Semi-medium	27.35	25.55	2.80	30.19	22.10	2.77	31.79	21.62	2.76
Medium	37.71	16.73	5.90	29.60	10.49	5.72	28.11	9.32	5.66
Large	13.59	2.40	14.81	10.30	1.00	20.91	5.91	0.75	14.79
All	100.00	100.00	2.62	100.00	100.00	2.03	100.00	100.00	1.88

Source Agricultural Census

Fig. 5.3 Composition of agricultural household income from different sources in Gujarat and India in 2015–16. *Source* NAFIS, NABARD

In Gujarat, a major share of agricultural household income came from the cultivation and livestock sector (53.6%) followed by income from wages (40.3%) and net receipts from non-farm activities (6.0%). The wages and salaries' segment includes the incomes earned by working on other's farms and small and marginal farmers who work on others' farms or elsewhere for wages. In 2015–16, the contribution of income from livestock declined and the share of "wages and salaries" increased. The following figure shows the composition of agricultural household income from different sources in Gujarat vis-a-vis India in 2015–16 (Fig. 5.3).

5.2.3 Cropping Pattern in Gujarat

In Gujarat, 54% of the land utilisation is accounted for by cultivation. The total gross cropped area in the state is 12.8 million hectares. The major crops grown in Gujarat are cotton, groundnut, castor, wheat, *bajra*, maize, rice and horticultural crops. Over the years, the state has moved away from food grains to the production of cotton. The share of food grains in GCA declined from 43% in TE 1994–95 to 36% in TE 2014–15, while the share of cotton has doubled from 11 to 20.6% in the same period. Within the food grain sector, there has been a shift from *jowar* to the production of wheat. Further, the share of oilseeds declined from 27.1 to 24.9% during the period. Within oilseeds, Gujarat mainly specialises in the production of groundnut and castor with their share in the total area under oilseeds being 56% and 26%, respectively (Fig. 5.4).

Fig. 5.4 Area under crops as a percentage of total GCA. *Source* Directorate of economics and statistics

5.2.4 Determinants of Agriculture Growth

Physical infrastructures such as irrigation, power and road play a critical role in agricultural growth. There have been several studies that indicate that investment in rural infrastructure has much greater potential to increase agriculture growth than expenditure on input subsidies (Fan et al 2007; Fan and Zhang 2004). In this section, we discuss the development of infrastructure in Gujarat to understand which factors helped in stimulating high productivity and growth in the agriculture sector.

5.2.4.1 Irrigation Infrastructure

Water plays a pivotal role in agriculture, and Gujarat being a drought-prone state with 75% of its area falling in semi-arid and arid zones, irrigation plays a very important role in the state's agricultural development.

The state government's strategic schemes to expand irrigation have resulted in Gujarat increasing its gross irrigated area from 3.3 million hectares in 2000–01 to 6 million hectares in 2014–15. In the beginning of the 1990s, Gujarat's irrigation ratio (share of gross irrigated area as a share of gross cropped area) was 27.5%, below the national average of 34%. But the situation has improved since then and the irrigation ratio for the year 2014–15 stood at 47%, which is close to the national average (49%) (Fig. 5.5).

Source-wise irrigation data reveals that dug wells and tube wells constitute the major share, followed by canals. Disaggregated analysis of source-wise irrigation in Gujarat shows that the area under canal irrigation as a share of net irrigated area has increased from 12.5% in TE 2002–03 to 18.2% in TE 2013–14. Further, the share of tube well declined from 33.5 to 26.5% in the same period.

Fig. 5.5 Gross irrigated area as a percentage of gross cropped area. *Source* Directorate of economics and statistics

Increase in rural electrification and flat tariff rates based on horse power of pumps in the 1980s and 1990s accelerated tube well irrigation. This led to groundwater depletion in Gujarat and optimum utilisation of water became an acute issue. Recent development programmes that have improved availability of water for agriculture use in a sustainable manner are the following:

The largest of all the major irrigation projects is the *Sardar Sarovar* Project. The project is expected to provide irrigation facilities to 3112 villages in 15 districts of Gujarat. In terms of acreage, the project covers 1.84 m ha. The dam was inaugurated by the Prime Minister on September 17, 2017 (<http://www.sardarsarovardam.org/benefits-of-project.aspx>).

Check Dams

When the Saurashtra and Kutch regions suffered groundwater depletion in the 1980s and 1990s, a decentralised movement for groundwater recharge started in these areas. The state government launched the Sardar Patel participatory water conservation project in 2000 for the construction of water harvesting and groundwater recharge structures as a public–private partnership. Check dams, *bori bandhs* and *khet talvadis* are traditional methods of conserving rainwater. Check dams require less operation and maintenance compared to surface irrigation projects. As of 31 March 2016, the number of check dams, *bori bandhs* and *khet talvadis* was 1.68, 1.25 and 2.62 lakh, respectively. These have insulated *kharif* crops in rainfall scarce areas against the early withdrawal of monsoon (Source: Narmada, Water Resources, Water Supply and Kalpsar Department, Govt. of Gujarat). Studies have shown that check dams helped augment groundwater recharge in Saurashtra.

Table 5.2 Status of GW development in different *Talukas* in Gujarat (2004–2013)

	Safe	Semi-critical	Critical	Over-exploited	Stage of ground water development (%)
2004	97 (43%)	69 (31%)	12 (5%)	31 (14%)	76
2009	156 (70%)	20 (9%)	6 (3%)	27 (12%)	75
2013	175 (78%)	9 (4%)	6 (3%)	23 (10%)	68

Source Central Ground Water Development Board

Micro-Irrigation System

Another initiative of the Gujarat government to promote micro-irrigation in the state was the establishment of the Gujarat Green Revolution Company Limited (GGRC) in 2005. Micro-irrigation is an integral part of state government's *Jal Sanchay Abhiyan*. By placing the subsidy with GGRC, the Gujarat government made it easy for farmers to install micro-irrigation systems and avail of the subsidy. Covering the cost of micro-irrigation systems under insurance was also an innovative step. To promote sustainable agriculture, the state implemented a scheme to subsidise 70% of the cost of micro-irrigation systems (MIS) or Rs. 70,000 per hectare (whichever is less). Small and marginal farmers and farmers in dark zones (where groundwater is over-extracted) are eligible for slightly higher subsidy (w.e.f. 1 April 2017). The scheme also prioritises electricity connection for farmers adopting micro-irrigation systems. Since the implementation of the scheme, a total area of 1.1 million hectares was covered under MIS by the end of February 2017. Major crops covered under micro-irrigation are groundnut, cotton, sugarcane, castor, potato, banana and mango. Currently, 8.7% of the gross cropped area (11% of NSA) is covered under MIS of which 4.3% is covered through drip irrigation and 4.4% is under sprinkler irrigation.

Effectiveness of measures undertaken

As a result of the various measures implemented by the Gujarat government, groundwater recharge has increased significantly and there is a remarkable improvement in the groundwater of many *talukas* in the state with an improvement in the overall stage of groundwater development from semi-critical (75%) to safe (68%) for the state (Table 5.2).

While the overall stage of groundwater development in Gujarat at about 68% appears to be comfortable, groundwater development has not been uniform throughout the state. Out of 223 assessment units, 23 units have been categorised as over-exploited, 6 as critical, 9 semi-critical, 175 safe and 10 saline. A large number of the OE/critical and semi-critical units are located in the North Gujarat and Kutch regions of the state. In these areas, intensive groundwater exploitation has resulted in a secular decline in groundwater levels in wells and tube wells. There have been

large seasonal drops in the water level in wells and under certain situations, and deterioration in the quality of groundwater, especially in the coastal areas.

Gujarat needs to aggressively promote rainwater harvesting and recharge of groundwater as well as watershed development based on scientific inputs from the National Aquifer Mapping Programme through the convergence of the activities of various agencies in the state implementing water conservation programmes under MGNREGA, NRDWP, IWMP, PMKSY, etc. This involves, inter-alia, levelling land and tapping rainwater in small structures like check dams, percolation ponds, gabions, recharge wells, etc., in hydro-geologically favourable locations. This will increase soil moisture, recharge groundwater and permit a second crop to be raised. With the support of the government, NGOs, community groups and other civil society organisations, the state of Gujarat has already built over 100,000 check dams, which has contributed significantly to Gujarat's impressive agricultural growth.

5.2.4.2 Power for Agriculture

Power is a prerequisite for unconstrained water supply through groundwater irrigation. The Gujarat government has made conscious efforts to ensure power for agriculture and the *Jyoti Gram Yojana* has helped improve rural electrification. The scheme is considered a model found nowhere in the world. The power situation was alarming before the inception of the scheme. Even though most villages were electrified, they did not receive adequate power due to lack of power supply. Until 2003, a common feeder catered to different types of electricity uses: residential, agricultural, industrial and commercial. Power supply to villages was limited to 8–12 hours a day, that too with interruptions. Another problem with the ongoing system was that agricultural connections were not metered. So, payments were based on the capacity of the electric pump in terms of horse power, irrespective of power use. This led to the unsustainable use of groundwater.

In this backdrop, the *Jyoti Gram Yojana* was launched in 2003 on a pilot basis. It was later extended to over 18,000 villages and more than 16,000 suburbs attached to villages for non-agricultural activities. Under this scheme, there was 24-hour, 3-phase supply through JGY feeders and 8 hours continuous 3-phase supply through the agricultural feeder. With this, Gujarat has become the first state in which rural areas get 24 hours power supply and farmers get non-stop power supply at 430–440 voltage for eight hours with a strict schedule, checking overuse. Prior to the implementation of feeder separation, consumption of power for agriculture was treated as residual use for accounting purposes. Hence, unauthorised use of power was also counted under agriculture. The following diagram shows the trends in the share of power sales for agriculture—it declined from 36.3% in 2002–03 to 27% in 2015–16 (Fig. 5.6). The decline in the share of agriculture in power consumption was the result of reduction in overuse under feeder separation and also because consumption for agricultural purpose increased more slowly than for industrial use.

Power intensity (total power sale/GCA) in Gujarat declined from 1389 kw/ha in TE 2002–03 to 1087 kwh/ha in TE 2015–16. It can be inferred that feeder separation and

Fig. 5.6 Agriculture share in total power sales. *Source* Planning commission, planning and energy division

power rationing increased the efficiency of water and power utilisation for agriculture, which freed up resources for the non-farm sector. It is evident from the last section (irrigation) that the area under irrigation for each crop has increased significantly. An increase in the area under fruits also implies efficient use of water as important fruits grown in Gujarat like banana and mangoes are water-intensive crops. Drawing its inspiration from Gujarat's success, the Government of India launched the *Deen Dayal Upadhyaya Gram Jyoti Yojana* in 2015 as a flagship programme with focus on feeder separation (rural households and agriculture) and strengthening the sub-transmission and distribution infrastructure.

5.2.4.3 Ports and Roads

Gujarat has one major port Kandla, which ranked first in terms of tonnage handling. There has been a huge jump in the tonnage handled at Kandla port after 2004–05 especially due to the capacity extension work initiated during the global recession in 2008–09 (Dholakia et al. 2010). The state has 40 non-major ports which handle around 80% of the total tonnage handled by all non-major ports in India (Table 5.3). The state has one of the best minor road port connectivity in the country. In 2015, Gujarat's minor port surfaced road network's length stood at 142 km. Private ports like Mundra with an annual capacity of 200 million tns also played a major role in infrastructure development.

Roads play an important role in the development of agriculture as they reduce transportation costs and minimises rotting of perishable items. Sometimes, farmers are forced to sell their products at a low price to middlemen because the lack of transport facilities prevents them from reaching the market after the harvest. The state government was motivated to invest in road development right from the sixties to accommodate to the needs of the state's growing co-operative dairy and fruits and

The *Pradhan Mantri Gram Sadak Yojana* was launched in 2000 to provide all-weather roads to unconnected habitations in rural areas. About 7420 habitations in the state were unconnected at the start of the scheme. Until 2016–17, 4573 roads were sanctioned under PMGSY, of which 4480 have been completed (<http://rmbgujarat.org/basic-activities/panchayat.aspx> accessed on 25/1/2017). In March 2015, the length of PMGSY roads was 18,441 km. 92% of rural roads are surfaced in Gujarat, which is very high compared to the national average of 61%.

5.3 Composition of the Agricultural Sector and Sources of Agricultural Growth

The composition of agriculture and allied activities in Gujarat gives an idea of the potential of different segments. Figure 5.8 shows that in TE 2015–16, livestock was the largest segment in Gujarat, comprising 26.2% of the total value of output from agriculture and allied activities, followed by fruits and vegetables (16.7%), fibre (12.7%) and oilseeds (11.8%). The most prominent change was in the case of fibre (cotton)—its share in GVOA increased from 5.9% in TE 2002–03 to 12.7% in TE 2015–16 (Fig. 5.8).

Fig. 5.8 Sector-wise shares in total value of output from agriculture and allied activities (at current prices). *Source* CSO

Fig. 5.9 Segment-wise growth in value of output (2000–01 to 2015–16). *Source* Calculated by author based on data from MOSPI

To calculate the sources of growth, the current series of value of output of each segment has been deflated by the WPI of all commodities at 2011–12 prices. Then, the year-on-year growth of each segment has been calculated by taking the absolute year-on-year difference in GVOA from each segment as a proportion of previous year's GVOA from agriculture and allied activities. The gross value of output from this sector grew at 9.1% in the period 2000–01 to 2015–16. The contribution of different sub-sectors to the total growth of agriculture and allied activities is presented in the following Fig. 5.9. The highest contribution has been from livestock (24.1%) followed by fruits and vegetables (17%), fibre (17%) and oilseeds (16.9%) (Fig. 5.9).

5.3.1 Food Grain Segment

Over the years, Gujarat has moved from the production of coarse cereals to wheat. The area under *jowar* and *bajra* declined from 5.6% and 11.1% in TE1992–93 to 0.9% and 3.4%, respectively, in TE2016–17. The area under wheat increased from 5.4 to 7.8% in the same time period. In tandem with the expansion of acreage under wheat cultivation, the production of wheat has also increased from 1.4 million MT to 2.8 million MT (Fig. 5.10). However, Gujarat's productivity in wheat production has only marginally improved from 2.3MT/ha in TE 1994–95 to 2.8 MT/ha in TE 2016–17.

Fig. 5.10 Production of important cereals in Gujarat. *Source* Directorate of economics and statistics, Government of India

5.3.2 Horticulture

Fruits and vegetables are an important segment in Gujarat accounting for around 7.4% of its GCA (NHB). The share of fruits and vegetables in the total value of output from agriculture and allied activities has increased from 10.9% in TE 2002–03 to 16.1% in TE 2014–15 (Fig. 5.11). Gujarat is the third largest producer of fruits, contributing around 9.7% of total fruit production, after Maharashtra (15.1%) and Andhra Pradesh (11.8%). Further, the state is the fifth largest producer of vegetables after West Bengal, Uttar Pradesh, Bihar and Madhya Pradesh among the major producing states.

Fig. 5.11 Value of output from fruits and vegetables as a percentage of GVO from agriculture and allied activities. *Source* CSO, government of india, state-wise estimates of value of output from agriculture and allied activities

Fig. 5.12 Production of vegetables and fruits in Gujarat. *Source* National horticulture database

The acreage under vegetables increased from 2.32 lakh hectares in 2001–02 to 6.5 lakh hectares in 2017–18. In tandem with this increase, the production of vegetables has also increased from 3.3 million MT to 13.3 million MT between 2000–01 and 2017–18 (Fig. 5.12). Similarly, the area under fruits increased from 1.49 lakh hectares in 2001–02 to 4.1 lakh hectares in 2017–18, and production of fruits increased from 2.3 million MT to 9 million MT in the same time period. In 2017–18, Gujarat contributed 9.5% of total fruit and 6.7% of total vegetable production in the country. The increase in production can be attributed to an increase in yield per hectare for both vegetables and fruits. Productivity of fruits increased from 15.7 MT per hectare in 2001–02 to 21.7 MT per hectare in 2017–18, while vegetable productivity increased from 14.1 MT to 20.5 MT per hectare in the same period.

Currently, Gujarat is the largest producer of beans (30.8% of total production) and third largest producer of brinjal (11.7% of total production) after West Bengal and Odisha (2015–16, National Horticulture Board Database). Further, the state ranks third in potato (8.2% of total production) cultivation. In terms of productivity, the state figure is higher than the all-India average except in the case of cabbage.

Important fruits cultivated in the states are banana, papaya, mango, citrus, *sapota* and pomegranate. Gujarat is currently second highest in banana production after Tamil Nadu and the highest in papaya production. The state produces 14.4% of banana and 22% of papaya of the country's total production of these fruits. Further, the state is the second largest producer of pomegranate and *sapota* with shares of 14% and 25%, respectively, in India's total production of these fruits. Although the largest share of land is devoted to mango production and it saw the highest production growth, the state is only the sixth largest producer in the country.

The state's strong co-operative marketing structure played a crucial role in the development of the horticulture sector. Gujarat has 265 cold storages having a capacity of 12.50 lakh MT. There are about 42 co-operative marketing societies and 197 APMCs dealing with the sale and purchase of horticulture products (Directorate of Horticulture, Gujarat State). The onion dehydration industry in Gujarat is the biggest in the country, accounting for 80% of onion dehydration units. Mahuva,

a small coastal town in Bhavnagar district around 265 km from Ahmedabad, is the largest hub of onion dehydration plants and one of the largest white onion growing regions in India. Mahuva has around 130 dehydration plants (110 in Mahuva and rest around Mahuva) engaged in the processing of onion, garlic and other vegetables. However, it is the dehydration of onion which is the main interest of these plants as it gives 90% of the revenue. Out of the total onions used for dehydration in Mahuva, 75% is white onion, 15% red onions and 10% pink onions. The minimum capacity is 6 tonnes per day per plant in Mahuva, and the average capacity ranges between 7 and 8 tonnes per day. This capacity is way below the capacity of Jain Irrigation System Limited, which is the largest dehydration plant in India located in Jalgaon, Maharashtra. The total capacity of all the Mahuva units is around 1.25 lakh tonnes annually, and the total value of dehydrated onion is around Rs. 750–800 crore. Around 85% of the final product is exported overseas, mainly to Europe, Russia, Africa and Middle East countries. But they have not yet been successful in branding their products (Gulati, Wardhan and Sharma, Forthcoming ICRIER working paper).

5.3.3 Non-food Crops

In TE 2015–16, the non-food segment, comprising oilseeds, fibre and sugar, contributed around 26% of the total value of output from agriculture and allied activities, which is very high compared to the national average of 12.9%. Oilseeds alone comprise 11.8% of GVOA, while fibre/cotton contributes 12.7% of the GVOA. Further, around 47% of total value of output from oilseeds is accounted for by groundnuts and 37% by castor.

Currently, Gujarat is the largest producer of groundnut and castor, and the second largest producer of cotton. There has been a steady increase in the share of the value of output from fibre/cotton in GVOA, while the trend is erratic for groundnuts. As discussed earlier, there has been a decline in the area under oilseeds, which has been replaced by cotton. Production has increased for cotton, groundnuts and castor from TE1994–95 to TE 2016–17 (Fig. 5.13). Cotton production picked up after 2000 as Bt Cotton was officially approved for cultivation in 2002, while a major increase in groundnut production took place in the period between TE 1994–95 and TE 2004–05.

5.3.4 Livestock

Livestock is the largest segment in Gujarat, contributing around 26% of the total value of output from agriculture and allied activities in TE 2015–16. Around 82% of the total value of output from the livestock segment was contributed by milk, while meat accounted for around 10% of the total value of output from livestock in TE

Fig. 5.13 Production of cotton, groundnut and castor. *Source* Directorate of economics and statistics

2015–16. The share of milk in the total value of output from the livestock segment has fallen from 87% between TE 1993–94 to 82% in TE 2014–15 while that of meat has increased marginally from 7 to 10%.

5.3.4.1 Dairy Sector

Milk production in Gujarat increased from 5.3 million MT in 2000–01 to 12.8 million MT in 2016–17 (Fig. 5.14). The average annual growth of milk production for the period of 2001–02 to 2016–17 is 5.7% per annum for Gujarat compared to the national average growth rate of 4.6%. In terms of volume, Gujarat is the fourth largest milk producing state, contributing around 8% of total milk production with Uttar Pradesh, Rajasthan and Madhya Pradesh being the top producers.

Fig. 5.14 Milk production in Gujarat. *Source* National dairy development board (NDDB)

Both supply- and demand-side factors played significant roles in the growth of the livestock sector in Gujarat. At the initial stage of development, starchy staples account for a very high share of calorie and protein consumed. But as a nation grows, the food basket gets more and more diversified and simple carbohydrates are replaced with animal products, leafy vegetables, fruits and so on. In Gujarat, the average per capita monthly intake of milk increased from 5.4 litres in 1993–94 to 6.1 litres in 2011–12. This is higher than the all-India average of 4.6 litres per capita per month in 2011–12. There has been a significant change in the pattern of consumer expenditure spent on different food items in Gujarat. There has been a decline in share of expenditure spent on cereals. This decline has been picked up by “milk and milk products” with a significant increase in consumer expenditure on this food group. With Gujarat being predominantly a vegetarian state, milk is a major item in the consumption basket of a large section of the population.

On the supply side, better productivity, institutions and a conducive environment played a significant role in influencing the dairy sector.

It is well known that the co-operative milk model is the dominant procurement system in Gujarat. The state holds the first position in milk procurement by the organised sector in major producing states (Fig. 5.15). The Gujarat Co-operative Milk Marketing Federation Ltd. is the state’s largest food product marketing organisation. In 2015–16, the total number of working co-operative societies in Gujarat was 18,149 with a total of 3.6 million producer members. In TE 2017–18, 53.7% of total milk produced was procured by co-operatives (Fig. 5.15).

In the budget for 2018–19, the finance minister announced that the facility of *Kisan* Credit Card would also be extended to animal husbandry. Gujarat, with its successful model of milk procurement by co-operatives, can increase the penetration of loans, particularly short-term loans, through KCCs for animal husbandry and dairy sectors

Fig. 5.15 Processing by organised sector (percentage of production) in major producing states, TE2017–18. *Source* Calculated from NDDDB data

Fig. 5.16 Production of meat and eggs. *Source* CSO, government of India, state-wise estimates of value of output from agriculture and allied activities and basic animal husbandry and fisheries statistics

by publicising the new facility. Similarly, Gujarat may formulate appropriate projects that can be funded from the newly announced Animal Husbandry Infrastructure Development Fund.

5.3.4.2 Meat and Egg Segment

Production of meat and eggs together constitutes 3.2% of the total value of output from agriculture and allied activities in Gujarat. Between 2000–01 and 2014–15, the value of output of eggs and meat increased at an annual average rate of 17%. The production of meat increased from 17 thousand metric tonnes to 33.2 metric tonnes in 2016–17. In the same period, the production of eggs increased from 0.83 billion to 1.79 billion (Fig. 5.16).

5.3.5 Fisheries

Gujarat has the longest coastline of 1290 km. It contributes 25% of India's marine fish production. Marine fish constituted 88% of the total fish production in the state in 2013–14. At present, the Gujarat fisheries department owns 36,090 boats of which 23,927 are machine operated (Commissioner of Fisheries, Government of Gujarat). The gross value of output from fisheries as a share of GVOA was 6.7% in TE 2002–03; it declined to 4.04% in TE 2015–16. The production of fish increased from 6.61 lakh MT in 2000–01 to 8.10 lakh MT in 2015–16 (Fig. 5.17).

Fig. 5.17 Production of fish in Gujarat. *Source* Handbook of fisheries statistics

5.4 Drivers of Agricultural Growth: Econometric Analysis

Agricultural growth is influenced by many supply- and demand-side factors. We would expect agricultural growth to be influenced by (i) technology (irrigation, seed replacement ratio, fertiliser consumption, farm mechanisation, extension, etc.) (ii) incentives (ToT, MSP) and (iii) infrastructure (electricity, road). However, it is difficult to analyse the effect of all the variables in one single framework, since many of these variables are correlated among themselves.

Hence, we use different models to analyse the potential drivers of growth. The correlation matrix is presented in the Annexure Table 5.5.

In our model, the log of GSDP from agriculture at 2004–05 prices and the variables mentioned above are the independent variables using data from 2000–01 to 2015–16. We have run many equations but presented only those variables that have a significant impact on agricultural GDP (Table 5.4).

Table 5.4 Construction of variables

IRR	Share of irrigated area as a share of GCA	Directorate of Economics and Statistics (DES)
Fertilisers	Fertiliser consumption per ha of GCA	Fertiliser association of India, DES
SR_Density	Surfaced road length(km) per 1000 sq km of geographical area	Ministry of Roads, Transports and Highway
TOT	Agriculture deflator/industry deflator	CSO
VOF	Value of output from fibre as a share of the value of output from agriculture and allied activities	CSO

Model 1:

$$\text{GSDPA} = 1.86 + 1.42\text{IRR}^{***} + 1.22\text{SR Density}^{**}$$

(2.15) (0.26) (0.43)

Adjusted R Square = 0.91**Model 2:**

$$\text{GSDPA} = -1.44 + 0.65\text{VoF}^* + 2.24\text{SR Density}^{**}$$

(3.47) (0.37) (0.64)

Adj R square = 0.77**Model 3:**

$$\text{GSDPA} = 12.54^{***} + 0.47\text{ToT}^* + 0.53\text{fertiliser}^{**}$$

(1.07) (0.25) (0.23)

Adj R square = 0.73

Note: (i) Numbers in the parentheses are t values. (ii) *** significant at 1% level (p-value < 0.01); ** significant at 5% level (p-value < 0.05)

In model 1, irrigation and roads have a significant and positive impact on agricultural GDP. The two variables together explain around 91% of the variation in agricultural GDP. As we have estimated a double log function, the coefficients can be interpreted as the elasticities, i.e. a 1% growth in irrigation will increase GSDPA by 1.42% ceteris paribus. Similarly, a 1% growth in surfaced road density will increase GDPA by 1.22%. In model 2, the value of output from fibre as a share of GVOA and total road density has significant impact on GSDPA. In model 3, terms of trade between agriculture and industry and fertiliser consumption have a significant influence on GSDPA.

5.5 Assessment of Budgetary Allocation to Agriculture and Allied Activities

The government has played an important role in promoting agricultural growth in the past years. Our objective is to see if there has been any change in the historical trends of budgetary support provided to the major sub-sectors of agriculture. The responsibility of government is to put the economy on the path of sustained growth in a way that the benefits trickle down to all sections of the population. We have analysed the budgetary expenditure of three financial years– FY 2016–17 (Actual), FY 2017–18 (RE) and FY 2018–19 (BE) (Fig. 5.18). The broad allocation under agriculture and allied sectors for TE 2018–19 shows that crop husbandry (48.9%)

Fig. 5.18 Allocations for broad heads as a share of total allocation to agriculture and allied activities.
Source Finance Department, Government of Gujarat

had the largest share in total expenditure followed by animal husbandry and dairy development (12.3%) and co-operation (12.2%) in 2018–19 (BE).

Crop husbandry comprises of expenditure on food grains, horticulture and commercial crops. It also includes expenditure on support services attributed to extension services, crop insurance and input subsidies. Within crop husbandry, major allocations were made for the crop insurance programme (38.1%) and horticultural and vegetable crops (17%) in TE 2018-19 (Fig. 5.19).

This section discusses both expenditure in agriculture (cereals, fibre, oilseeds, fruits and vegetables, livestock and fisheries) and expenditure on agricultural infrastructure (road, irrigation, research and education, extension and training) from the state budget documents. It cannot be expected that the share of budgetary expenditure on various segments will exactly correspond to the share of the segments in GVOA. However it is hoped that sub-sectors of agriculture and allied activities that show major potential in boosting farmers' income and bringing sustainability to state's agriculture will attract higher allocation of funding in the budget. The study finds that there is a large mismatch between budgetary allocation in each of the agricultural sub-sectors and their respective contribution to the gross value of output from agriculture and allied activities (Fig. 5.20).

Fig. 5.19 Allocations for broad heads as a share of total allocation to crop husbandry in TE 2018–19.
Source Finance Department, Government of Gujarat

'Others' in sector wise budgetary allocation include co-operation, soil and water conservation, manure and fertilisers and seeds.

Fig. 5.20 Alignment of agricultural budget with GVO in agriculture and allied activities

Livestock constitutes 26% in GVOA, whereas budgetary expenditure on the sector is 10% of the total budget outlay. Within livestock, the dairy sector is a major contributor to Gujarat's agriculture. An amount of Rs. 54 crore was allocated in FY 2018–19 for dairy development. This is mainly for the purchase of bulk milk coolers, automatic milk collection systems, milk adulteration detection machines, livestock insurance and cattle feed.

One of the major challenges facing the livestock sector is the prevalence of communicable disease like foot and mouth disease in farm animals. According to ICAR, indirect losses due to FMD costs Rs. 30,000–35,000 crore annually. However, the Government of Gujarat has allocated only Rs. 22 crore to check the disease in 2018–19 (BE). The high elasticity of GDP from livestock with respect to expenditure of 5.89 indicates that increasing expenditure on livestock will result in a manifold increase in GDP from the sector. Hence, there is need to increase expenditure on both dairy development and animal husbandry.

Fibre contributes 12.7% of GVOA, whereas expenditure on commercial crops including plant protection is only 2.3% of total budgetary allocation. In the recent past, cotton has been affected by pink bollworm, which could affect productivity. Due to this problem, government has increased allocation on plant protection more than 50 times from Rs. 4.4 crore in 2016–17 to Rs. 206 crore in 2018–19.

Oilseeds contribute 11.8% of GVOA, while expenditure on development of oilseeds crop is only 0.6% of total budgetary allocation. Gujarat is the largest producer of groundnut, but the exportable quality of this crop remains a major concern. This is due to the presence of high levels of aflatoxin in the crop, which is a result of traditional method of harvesting groundnuts. Budgetary expenditure on the development of oilseeds is miniscule and stands at Rs. 39 crore in FY 2018–19. An increase in the provision under this programme will enable farmers to buy modern machinery at subsidised rates. This could help farmers adopt more modern methods of cultivation and fetch higher prices for their produce.

A major expenditure under crop husbandry is directed towards horticultural and vegetable crops. Expenditure has risen to Rs. 365 crore in FY 2018–19. The Government of India (GOI) has approved a new central sector scheme—*Pradhan Mantri Kisan SAMPADA Yojana* (Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters) with an allocation of Rs. 6000 crore for the period 2016–20. Gujarat is one of the leading producers of vegetables (brinjal, potato, cauliflower and cabbage) and fruits (banana, papaya, pomegranate and sapota). One of the reasons behind the increase in the share of fruits and vegetables in GVOA could be the increased allocation for this sector.

Gujarat has a vast coastline of 1290 kilometres and contributes 25% of India's marine fish production. Currently, both the contribution of fisheries to GVOA (4%) and budgetary expenditure (4.3%) are quite low. Various equipment like fishing nets, fish seeds, fisherman accident insurance scheme, diesel, etc., are available to fishermen at subsidised rates. But there is need to divert more resources towards fisheries so that the contribution of the sector to GVOA increases.

The increased expenditure on crop insurance was mainly due to the implementation of *Pradhan Mantri Fasal Bima Yojana* (PMFBY) in 2016. The insurance premium has been capped at 2% in the *kharif* season and 1.5% in the *rabi* season of total sum insured; the difference between the actuarial rates and the premium rates borne by the farmers is shared by the central and the state governments in equal proportions. This has led to an increased financial burden on state governments, and much of their financial resources devoted to the agricultural sector have had to be transferred to this programme. As a result, the allocation on crop insurance increased

almost five times from Rs. 207 crore in FY 2014–15 to Rs. 1011 crore in FY 2018–19, taking away almost 20% of the total budgetary allocation.

Gujarat has one of the highest shares of surfaced roads (87% of total road) and rural surfaced road (90% of total rural road) in the country and has performed well in this sector. As a result, allocation is low and expenditure on PMGSY stood at Rs. 55 crore in 2017–18. The expenditure on major, medium and minor irrigation projects in Gujarat was Rs. 9697 crore in TE 2017–18 (RBI, State Finance). One of the most important irrigation projects in the state is the Sardar Sarovar, estimated to cost a total of Rs. 31,522 crore, of which 85% has already been spent. The project will create an additional irrigation potential of 1.85 million hectares (75% of the area is drought-prone). Once the project is completed, Gujarat's irrigation ratio will go up from 47% to 60%. The area under micro-irrigation in Gujarat is the third highest in the country (11% of net sown area). It is necessary to expand the area under minor irrigation suitable for orchards like citrus, banana, papaya and mango, row crops like cotton and groundnuts and vegetable crops like tomato and potato. Under the National Mission of Micro-Irrigation, physical (area under micro-irrigation) and financial targets have always been achieved. Despite achieving these targets, the area under micro-irrigation was only 1.1 million ha in 2017 (up to February). Thus, there is a possibility of increasing government expenditure and bringing in more area under micro-irrigation. Expenditure on micro-irrigation under PMKSY has been budgeted at Rs. 226 crore in FY 2017–18.

There are many pre- and post-harvest issues in the cultivation of Bt cotton and groundnuts, which could be addressed with efficient extension services. But in Gujarat, only 2.7% of the total budgetary allocation has been for extension services, which needs to be increased substantially. Expenditure on agricultural research and education, and extension and training accounts for 0.52% of GDPA in Gujarat in 2016–17 as compared to 0.70% of GDPA at the all-India level (2014–15).

5.6 Policy Recommendations

Our research shows that in the recent years, agriculture growth plummeted in the state and farmers' profitability has declined sharply. The situation needs to be taken seriously. We recommend some policies based on our research.

a. Cotton Revolution: Farm-Factory-Fibre-Fashion-Foreign

Gujarat's agriculture was driven by three factors (technology, basic infrastructure and marketing institutions). The development of cotton cultivation was aided by technology adoption. Gujarat benefitted the most from the decision to allow the commercial use of Bt cotton. From nowhere, the area under Bt cotton increased to more than 90% of the area under cotton. Production increased enormously. India's raw cotton exports increased from a meagre \$10 million to \$4258 million by 2011–12, making India the world's largest cotton producer and exporter (Fig. 5.21). A forthcoming study by Gulati et al. shows the cumulative gain from import saving,

Fig. 5.21 Production and export of cotton, India. *Source* Cotton Corporation of India and Ministry of Commerce

extra raw cotton exports and extra yarn exports— compared to the business-as-usual scenario—between 2003–04 and 2016–17 at an estimated \$67.4 billion at the all-India level.

Gujarat had a big share in this export surge, but since 2011–12, raw cotton exports have declined rapidly because China, which was India’s biggest export destination, reduced imports from India. It is time India develops its export value chain by moving away from raw cotton exports to exports of textile and apparel. Currently, Coimbatore is the textile hub of India. Gujarat should exploit its position of being one of the largest producers of raw cotton and its excellent port connectivity to become a major textile export hub, targeting in particular the markets of Europe and the Middle East. GoG should be pro-active in this direction and attract investors in the cotton-textile value chain through suitable incentive packages and reforms in the textile sector, especially in labour laws. Failure to do so is likely to prove a major setback for Gujarat’s farmers.

b. Technological Revolution

Bt cotton seeds came to India from a global seed company—Monsanto—in association with an Indian partner, Mahyco. However, recently, a dispute between the centre and Monsanto has resulted in the company’s decision to withhold the launch of Bollgard-III. In 2017, farmers in Maharashtra suffered due to the Pink Bollworm, a pest that has developed resistance to Monsanto’s second generation biotechnology Bollgard-II seed. It should not be repeated in Gujarat. They must try to get access to the next stage technology of Bt cotton, namely Bollgard-III. The current dispute over trait fees of MMB with its licensees needs to be resolved in an agreeable manner so that farmers do not suffer. Else, there is danger that the gains of the cotton revolution that Gujarat reaped during 2002–17 could disappear.

c. Revolutionary Approach to Ramp Up F&V Sector

Gujarat has been a pioneer in giving India a model of “Operation Flood” in the case of milk (the AMUL model), which aggregates production at the village level and links it to processors and retailers through a well-organised logistics network. It claims to pay to milk farmers 75–80% of the price that consumers pay for milk in urban areas. The model should be extended to other commodities, especially fruits and vegetables, bypassing the *mandi* system. Farmers should receive at least 60% of what consumers pay. “Operation Veggies TOP (Tomatoes, Onions and Potatoes)” should be on the lines of “Operation Flood” so that farmers are able to command a high share of consumer prices. To tackle the crisis in handling perishable products, the Gujarat government has initiated a tie-up with Amul to create a strong co-operative under “Operation Green Gujarat”, which is a welcome step. Gujarat has the highest number of onion dehydration plants in the country. Bulk consumption of dehydrated onion can be promoted by supplying it to hotels, the army and schools. Gujarat should also undertake dehydration of mangoes and export it to Western countries. The government’s recent decision to delist fruits and vegetables from the APMC Act is a positive step. “Operation Green” should aim at fulfilling three major objectives. First, connect major consumption and production centres to minimise the number of intermediaries. Second, invest in logistics like cold storages and warehouses, which can minimise wastage. Currently, post-harvest losses range from 15–20% of total produce. Third, the processing industry should be linked with organised retailing. At present, only 6–7% of the production is being processed; this should be scaled up to at least 25% of production. By developing such forward and backward linkages, the government can reduce large price fluctuations and increase farmers’ share in the price paid by the consumer.

d. Export of Groundnuts: Managing Aflatoxin

India is one of the largest producers of groundnut and also exports some quantities of hand-picked select (HPS) groundnuts, but it has faced lot of difficulties in accessing international market because of high aflatoxin levels, making it unfit for human consumption (permitted level is 4 parts per billion (ppb) in the European Union, 20 ppb in the US and 30 ppb as per Agmark). Harvesting groundnut becomes difficult when the crop has passed the stage of full maturity and the soil has hardened. Farmers generally irrigate the field the previous day so that the soil becomes loose and it becomes easy to pull out the plants along with the pods. But this increases the moisture content in the kernels, leading to fungal infection that raises the level of aflatoxin in the crop. This has resulted in many sanitary and phytosanitary (SPS) notifications being flagged against India. It is time that this traditional method of manual harvesting is replaced by automatic groundnut harvesting machines. The government should provide loans at subsidised rate to enable farmers to buy agricultural machines; alternatively, it should develop custom hiring services that enable affordable access to such machinery.

e. Better Extension Services

Farmers are often unaware of simple practices and technological changes that could help both improve productivity and reduce the chances of pest infestations and the incidence of plant disease that inflict considerable losses. For instance, farmers planting crops with Bt attributes must also plant blocks of crops without the Bt trait. The refuge area prevents pests from developing resistance to technology. It is the duty of the extension service officials to educate farmers about these techniques. Simple pest control tools like pheromone traps should be distributed by extension agents to help monitor and control insect infestations. There is also the chance of pre-harvest contamination due to wrong farming practices as in the case of groundnut. These include the repeated cultivation of host plants on the same piece of land, which leads to contamination of crops in the field. As a result of late planting, crops sometimes suffer end-of-season droughts and insect attacks. Extension service officials are obliged to disseminate knowledge on these issues. There should be proper monitoring of performance of extension service officials.

“Krushi Mahotsav” was a new initiative started by the state to promote extension services. This needs to be evaluated by a third party to assess its impact, and if need be, modify it in line with emerging requirements. Digital initiatives can also be useful to provide farmers with best techniques and farming practices. Agricultural entrepreneurs can be brought into deliver farm services from technology information to marketing of produce, and who can be incubated in FPOs under public–private partnerships. Their knowledge can be regularly updated with emerging new technologies and best practices in production and marketing.

f. Promote Micro-Irrigation

The success of agriculture in Gujarat lies in irrigation. Water harvesting has a positive effect on agriculture in a year of good monsoon, but droughts may create a crisis. Dams should be connected with small water conservation units in order to save flood water. Gujarat (11% of NSA) has the third highest area under micro-irrigation systems after Andhra Pradesh (21% of NSA) and Haryana (16% of NSA). Drip irrigation is suitable for orchards like citrus, banana, papaya and mango, row crops like cotton and groundnuts and vegetable crops like tomato and potato. Sprinkler irrigation is suitable to all soil types and topographic situations and all types of crops except rice and jute. Gujarat can incentivise and scale up the area under drip and sprinkler irrigation, giving a much needed fillip to the “more crop per drop” slogan. In fact, this needs to be combined with solar power driven micro-irrigation at farmers’ fields, with a provision enabling the sale of excess solar power back into the grid. This would not only ensure higher water use efficiency and enable the cultivation of at least two crops by the farmer; it would also augment farmers’ incomes through solar power as “third crop”. Appropriate incentives at the policy level with sizeable budgetary support for this, therefore, would usher micro-irrigation-cum-solar power technologies in rural Gujarat, promoting sustainable, productive and profitable agriculture.

g. Institutional Reform

Ad hoc export bans and stock limits deter private investment and restricts the flow of resources into food processing and cold storage facilities. Policies in India have generally been pro-consumer, allowing large quantities of imports of some agricultural products like edible oils and pulses at low to negligible import duties to keep domestic prices low. This hurts farmers cultivating oilseeds and pulses. At times, even cotton exports have been banned or restricted, which particularly hurt Gujarat farmers. It is time now to switch to agricultural trade and tariff policies that help the farming class. This would mean ensuring that there are no export bans, abolishing stocking limits on private trade, carrying out marketing reforms of the archaic *mandi* system so that processors and retailers can buy directly from farmers/FPOs, etc.

h. Continue investing in roads and power to improve quality

Gujarat has performed very well in improving the basic infrastructure of roads and power over the last 15 years. However, it is still necessary to continue on that path for the next 10 years as it gives very high returns in terms of improving the performance of agriculture and raising farmers' incomes. Focus may have to shift from the quantity to the quality of these services.

Annexure

See Table 5.5.

Table 5.5 Correlation matrix

	GSDPA	IRR	SR_Density	TOT	VoF	Fertilisers
GSDPA	1					
IRR	0.94***	1				
SR_Density	0.87***	0.78***	1			
TOT	0.88***	0.90***	0.90***	1		
VoF	0.79***	0.90***	0.73**	0.88***	1	
Fertilisers	0.78***	0.87***	0.58**	0.73**	0.88***	1

*** significant at 1%, ** significant at 5%

References

- Ahluwalia, M. S. (2000). Economic performance of states in post-reforms period. *Economic and Political Weekly*, 1637–1648.
- Bagchi, A. K., Das, P., & Chattopadhyay, S. K. (2005). Growth and structural change in the economy of Gujarat, 1970–2000. *Economic and Political Weekly*, 3039–3047.
- Basic Animal Husbandry & Fisheries Statistics. (2014). *Department of Animal Husbandry, dairying and Fisheries*. Ministry of Agriculture.
- Census. (2011). *Census of India*. Retrieved May 2019, from Registrar General of India, Ministry of Home Affairs, Government of India.
- Chand, R. (2015). *Subsidy Structure too complex for knee-jerk response*. In Farmers' Forum (Vol. 14, No. 6).
- Dholakia, H., & Datta, S. (2010). *High growth trajectory and structural changes in Gujarat agriculture*. New Delhi: Macmillan Publishers India Ltd.
- Fan, S. et al. (2007). *Investment, subsidies, and pro-poor growth in rural India* (Discussion Paper No. 00716). New Delhi: IFPRI.
- Government of India. (2008). *State-wise and item-wise estimates of Value of Output from Agriculture and allied activities (1999–00 to 2005–06)*. Central Statistic Office, Ministry of Statistics and Programme Implementation.
- Government of India. (2016). *State-wise and item-wise estimates of Value of Output from Agriculture and allied activities (2011–12 to 2013–14)*. Central Statistic Office, Ministry of Statistics and Programme Implementation.
- Gulati, A., Shah, T., & Shreedhar, G. (2009). *Agriculture performance in Gujarat since 2000: Can it be a divadandi (lighthouse) for other states?* International Water Management Institute (IWMI); International Food Policy Research Institute (IFPRI).
- Gulati, A., Manchanda, S., & Kacker, R. (2016). *Harvesting solar power in India*. ZEF-Center for Development Research University of Bonn, Working Paper, 152.
- Gulati, A., Wardhan, H., & Sharma, P. (Forthcoming). *Deconstructing value chains of tomatoes, onions and potatoes (TOP)*. New Delhi: NABARD-ICRIER.
- Hirway, I. (2000). Dynamics of development in Gujarat: Some issues. *Economic and Political Weekly*, 3106–3120.
- Livestock Census. (2007). *16th Livestock Census-2007 All India Report*. New Delhi: Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India.
- Livestock Census. (2012). *19th Livestock Census-2012 All India Report*. New Delhi: Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India.
- Shah, T., Gulati, A., Shreedhar, G., & Jain, R. C. (2009). Secret of Gujarat's agrarian miracle after 2000. *Economic and Political Weekly*, 45–55.
- Wooldridge, J. M. (2009). *Introductory Econometrics: A modern approach*. South Western CENGAGE Learning. IWMI Water Policy Research Highlight.

Links

<http://dfpd.nic.in/>.
<http://eands.dacnet.nic.in/>.
<http://www.imdpune.gov.in/>.
<http://www.indiastat.com/agriculture/>.
<http://www.mospi.gov.in/>
<http://www.nddb.org/information/stats>.

<http://www.seedsindia.org/>.
<http://financedepartment.gujarat.gov.in/budget.html>.
http://gujecostat.gujarat.gov.in/?page_id=12.
<http://inputsurvey.dacnet.nic.in/>.
<https://doah.gujarat.gov.in/dairy-development.htm>.
<http://www.amul.com/>.
<http://ggrc.co.in/webui/home.aspx>.
<https://agri.gujarat.gov.in/index.htm>.
<http://www.jains.com/>.
<http://ipa.nic.in/>

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.