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SD Bavarva
Research Scholar, International Agribusiness Management Institute, Anand Agricultural University, Anand, Gujarat, India

Shakti Ranjan Panigrahy
Assistant Professor & Head, Department of Operations Management, International Agribusiness Management Institute, Anand Agricultural University, Anand, Gujarat, India

Corresponding Author:
SD Bavarva
Research Scholar, International Agribusiness Management Institute, Anand Agricultural University, Anand, Gujarat, India

Prospects and challenges of bio fertilisers in Gujarat

SD Bavarva and Shakti Ranjan Panigrahy

Abstract
India's increasing population and limited resources have put pressure on the country to enhance food production. Excessive use of chemical fertilisers not only leads to the deterioration of natural resources but also opens the possibility of utilizing biological and renewable alternatives. Biofertilisers offer a sustainable solution by efficiently fixing nitrogen in the soil, reducing cultivation costs, and benefiting both producers and the environment. Nitrogen-fixing bacteria have extensively used in biofertiliser products, with the Asia-Pacific region, particularly China and India, dominating the global biofertiliser market. In India, there are 532 biofertiliser manufacturing units, with Gujarat being the fifth-largest user of biofertilisers. However, challenges such as lack of knowledge, unavailability, poor accessibility, and low adoption rates hinder the growth and widespread use of biofertilisers. This research paper focused on the prospects and challenges of biofertiliser application in Gujarat. The first part was based on secondary research, while the second part involves primary research conducted in the Morbi district of Gujarat. A total 180 farmers were interviewed through a semi-structured schedule. The collected data was analyzed Garrett ranking techniques for revealing constraints of producers in biofertiliser usage. The imbalanced and excessive use of chemical fertilisers in Gujarat has negatively impacted soil health and ecological balance. Although Gujarat leads in carrier-based and liquid biofertiliser production, it was limited to a few organizations. This leads to an opportunity to develop and expand biofertiliser production and usage in the state. Challenges persist in biofertiliser applications, including delayed effects, poor results and short shelf life. Addressing these challenges was crucial for the successful implementation of biofertilisers, ensuring sustainable and effective agricultural practices in Gujarat.

Keywords: Biofertilisers, fertiliser, ecology, Gujarat

Introduction
India is facing the pressure of increased food production from its limited resources due to its burgeoning population. Even massive uses of chemical fertiliser to address the crop production not only impact on natural resource deterioration but also open the scope of other biological and renewable input resources in place of it. Judicious use of biofertiliser helps to adhere nitrogen in the soil, sustained use at the root of the plant and reduce the cost of cultivation quite a lot. It is beneficial one for the producers as well as to the nature.

Nitrogen-fixing bacteria have the highest used in biofertiliser product categories. The Asia-Pacific region dominates the global biofertiliser market, with China (32%) and India (18%) being the major contributors. The Asia-Pacific biofertiliser market was valued at $1.2 billion in 2018 and is projected to reach $2.8 billion by 2023, at a CAGR of 18.3 Per cent during the forecast period (Mordor Intelligence, 2019) [8]. Here, In India also, there have 532 biofertiliser manufacturing units across the states. Among them, 424 units spread across 28 states and 8 union territories manufacture carrier-based solid biofertilisers and 108 units spread across 17 states and Union territories manufacture liquid biofertilisers (Ministry of Agriculture and Farmers' Welfare, GOI, 2021) [7]. While south zone of India shared 50 percent of national production in biofertiliser, Western zone shared 28 percent followed by north zone (19%), and eastern zone (3%) only in this segment (Ministry of Agriculture and Farmers' Welfare, GOI, 2021) [7]. Once, country will think over second green revolution in eastern part of India, it needs to rationalize the biofertiliser availability across the zones to maintain a sustained base of crop production.

Gujarat is the fifth-highest user of biofertilisers in India, with over 2 lakh hectares of land under biofertiliser usage. The government has established Gujarat Bio-fertiliser Development Corporation (GBFDC) to promote the production and use of biofertilisers in the state. The GBFDC also provides subsidies to farmers for the purchase of biofertilisers. The states contribute 14 percent in carrier based biofertiliser production and 31 percent in liquid biofertiliser production in India, may be due to large scale of mechanization in agriculture and

it's focused on organic farming and natural farming through different schemes and programmes (Centre for science and environment, 2022) [1].

Despite numbers of use and advantages of biofertiliser for crop production, lack of knowledge, unavailability (Patel *et al*., 2017) [9], poor accessibility (Katole *et al*., 2017) [6], poor adoption rate (Dhaklal *et al*., 2018) [12], lack of knowledge in application (Joshi *et al*., 2019) [5], and unawareness of biofertiliser application (Pathak & Christopher, 2019) [10] were the deterrents in the growth of the inputs for the farmers' benefit. Still, the entry of rural youth through small scale cooperative, "Biofertiliser manufacturing units" at the village level is highlighting its inclusivity in India towards future agricultural development.

In this study, an attempt was taken to understand the prospects and challenges faced by the producers in biofertiliser application in Gujarat. As the state is switching over towards organic farming and natural farming, this study will give a momentum in biofertiliser production and its market.

Materials and Methods

The present research was bifurcated into two parts; *viz*., present status and prospects of biofertiliser used in Gujarat and second one as the challenges in its application at the farmers' level. First part was done through secondary research whereas the second part was through the primary research based one. Challenges of the producers in biofertiliser application were derived through a case study which was undertaken at Morbi district of Gujarat. For that sake, a total 180 farmers were interviewed through a semi structured schedule and after that collected data was analysed through Garrett ranking techniques.

Fig 1: Morbi District of Gujarat (Study Area)

Results and Discussion

Perusal of the table 1 highlighted that total 127.67 kg of fertiliser per hectare was used by the state, Gujarat. Another research work by FAI (2019) [4] highlighted that the fertiliser consumption in Gujarat was 137.40 kg and it was lesser than Punjab (223.6 kg/ha) and quite more than the state like Assam (25 kg/ha). Means to say that consumption of fertiliser was very much skewed according to the crop cultivation practices and subsidy rendered to the producers in different states.

Table 1: District wise per hectare consumption of fertiliser in Gujarat (2013-14) (In Kg/Ha)

Sr. No	District	Nitrogen	Phosphorus	Potash	NPK
1	Ahmedabad	82.29	20.26	4.62	107.17
2	Amreli	82.62	40.4	5.31	128.33
3	Anand	170.74	25.19	11.53	207.46
4	Banaskantha	63.41	18.08	3.66	85.15
5	Bharuch	106.81	28.78	15.1	150.69
6	Bhavnagar	104.76	51.01	7.48	163.25
7	Dahod	41.35	12.62	3.07	57.04
8	Gandhinagar	101.54	25.18	9.51	136.23
9	Jamnagar	78.94	35.22	5.76	119.92
10	Junagadh	95.2	41.49	6.59	143.28
11	Kheda	129.46	21.51	6.64	157.61
12	Kutch	53.75	15.52	0.84	70.11
13	Mehsana	75.27	19.95	2.83	98.05
14	Narmada	89.28	20.78	13.52	123.58
15	Navsari	169.89	66.14	51.79	287.82
16	Panchmahal	102.73	18.19	3.2	124.12
17	Patan	48.55	12.7	0.73	61.98
18	Porbandar	55.49	29.92	4.29	89.7
19	Rajkot	145.11	59.03	14.36	218.5
20	Sabarkantha	86.64	27.72	12.07	126.43
21	Surat	167.64	81.74	51.18	300.56
22	Surendranagar	63.82	19.67	1.6	85.09
23	Tapi	74.48	26.29	18.51	119.28
24	Dang	3.44	0.67	0.8	4.91
25	Vadodara	102.69	22.54	15.63	140.86
26	Valsad	88.42	34.41	22.46	145.29
27	Gujarat state	89.94	29.36	8.37	127.67

Source: Swain and Kalamkar (2016) [11]

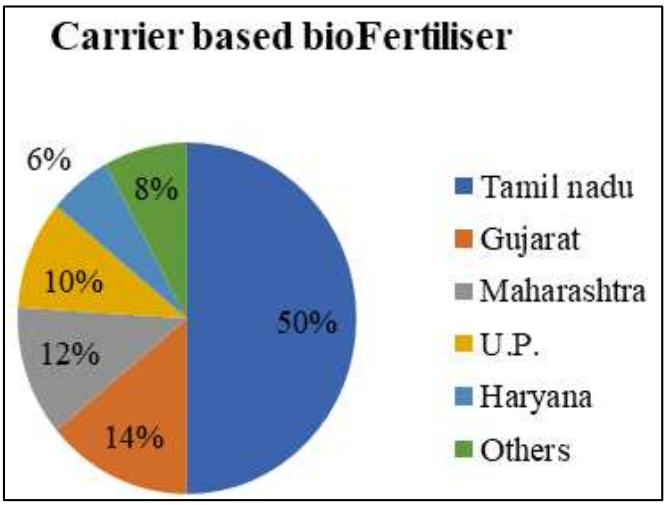
In the similar manner, district wise consumption of fertiliser was also very much skewed as observed in table 1. Surat district stood first in this list of fertiliser consumption in kg per hectare of land and Dang district was last in the anchor in the Gujarat. It was reflected a scenario towards dominance of chemical fertiliser used in different districts and step forward towards organic and natural farming in the state. It was also indicating a total consumption of fertiliser in the state and disturbed soil health ecology for the future crop production.

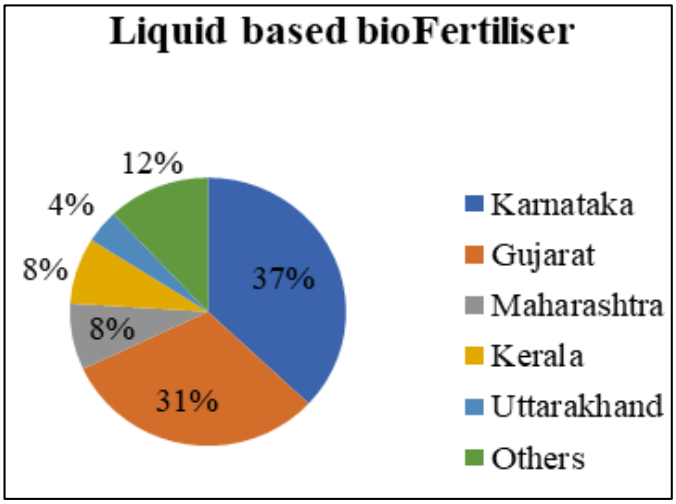
Table 2: N:P:K ratio of fertiliser use in Gujarat

Sr No	District	Nitrogen	Phosphorus	Potash
1	Ahmedabad	17.81	4.39	1.00
2	Amreli	15.56	7.61	1.00
3	Anand	14.81	2.18	1.00
4	Banaskantha	17.33	4.94	1.00
5	Bharuch	7.07	1.91	1.00
6	Bhavnagar	14.01	6.82	1.00
7	Dahod	13.47	4.11	1.00
8	Gandhinagar	10.68	2.65	1.00
9	Jamnagar	13.70	6.11	1.00
10	Junagadh	14.45	6.30	1.00
11	Kheda	19.50	3.24	1.00
12	Kutch	63.99	18.48	1.00
13	Mehsana	26.60	7.05	1.00
14	Narmada	6.60	1.54	1.00
15	Navsari	3.28	1.28	1.00
16	Panchmahal	32.10	5.68	1.00
17	Patan	66.51	17.40	1.00
18	Porbandar	12.93	6.97	1.00
19	Rajkot	10.11	4.11	1.00
20	Sabarkantha	7.18	2.30	1.00
21	Surat	3.28	1.60	1.00
22	Surendranagar	39.89	12.29	1.00
23	Tapi	4.02	1.42	1.00
24	Dang	4.30	0.84	1.00
25	Vadodara	6.57	1.44	1.00
26	Valsad	3.94	1.53	1.00
27	Gujarat state	10.75	3.51	1.00

As from the table 2, it was observed that in all most all the districts of Gujarat, N:P:K ratio was almost disturbed and quite higher than the normal 4:2:1. Perusal of the data in the table 2 also showed that Dang, Tapi, Surat, and Navsari were the districts where soil ecology was at par with normal ratio and in other districts, definite interventions are necessary through biofertiliser application for restoring soil health ecology for crop production.

As per the figure 2, it was observed that Tamil Nadu was the leading state in carrier based biofertiliser[1] categories and Karnataka was the leading state is liquid based biofertiliser[2] in India. Here also Gujarat stood second in both the categories of biofertiliser production; in carried based biofertiliser, it was 14 percent of the national share whereas in liquid bio fertiliser, it was 31 percent of the national share. Advent of mechanisation in the states leads to the more use of liquid form of biofertiliser in the state.





Source: Ministry of Agriculture and Farmers' Welfare, Government of India (30 November 2021)

Fig 2: Carrier and Liquid Biofertiliser status of Gujarat and other states of India

As per the table 3, Anand Agricultural University, Anand, GSFC Agrotech Ltd., Vadodara, and Krishak Bharati Cooperative Ltd., Hajira, Surat exclusively produced liquid bio fertilisers whereas Indian Farmers Fertiliser Cooperative Ltd., Kalol produced both solid form and liquid form biofertiliser in the state. Department of Agriculture, Cooperation and Farmers Welfare, 2021 [7] stated that a total 2 lakh hectare of land used biofertiliser in the crop production practices.

Table 3: Unit wise biofertiliser production in Gujarat

Sr. no.	Unit	Solid (Tonnes)	Liquid (Liters)
1	Anand Agricultural University, Anand	0	8429
2	GSFC Agrotech Ltd., Vadodara	0	22850
3	Indian Farmers Fertiliser Cooperative Ltd., Kalol	12.2	123960
4	Krishak Bharati Cooperative Ltd., Hajira, Surat	0	563420
	Total	12.2	718659

Source: Department of Agriculture, Farmers Welfare and Co-operation, Government of Gujarat, Gandhinagar, 2020 [2]

As demand of biofertiliser has been increasing in the state and production was handled by few of the organisations mentioned in the table 3, it creates a scope of other players to

[1] Biofertiliser are usually prepared as carrier-based inoculants containing effective microorganisms. Incorporation of microorganisms in carrier material enables easy-handling, long-term storage and high effectiveness of biofertiliser.

[2] The advantages of liquid biofertiliser over conventional carrier based biofertiliser are: longer shelf life (12- 24 months), no effect of high temperature and no contamination, no loss of properties due to storage at high temp

come and invest on the sector in future.

As per the academic mandate, Morbi district[3] of Gujarat was taken as a case for understanding the issues prevailed in the area in biofertiliser application at the farmers' field. Perusal of the table 4 highlighted that delayed effect emerged as the most significant issue faced by farmers during the use of biofertiliser. Farmers often needed quick results to ensure their crops grow grew properly. Delayed effect leads led to lower crop yields, which in turn affects affected their income and livelihood. Delayed effect was that it took more time to increase microbes, and optimal conditions were necessary for faster multiplication of microbes.

Table 4: Problems faced by the producers in biofertiliser application

Problems	Garrett Score	Rank
Delayed effect	11639	1
Poor result of product	10233	2
Short shelf life	10110	3
Storage problem	10078	4
Not-timely available	8664	5
Lack of proper technical knowledge	7689	6
Less product range	7109	7
Credit unavailability	6557	8

The second most important issue identified was the poor results of the product. The reason for poor results with biofertilisers was that they required specific conditions for optimal performance. These conditions included adequate temperature and humidity levels, as well as the presence of organic carbon for the microbes to feed on and multiply. Without these conditions, the biofertiliser may not work effectively, leading to poor results.

The third most critical issue was the short shelf life of the biofertiliser products. The sensitivity of microorganisms to environmental factors such as high temperature and low humidity impacted on crop production. These conditions can lead to the death of microbes, which reduces the effectiveness of the biofertiliser. Additionally, the short shelf life may be due to the lack of appropriate storage conditions.

Other issues that were identified in the study include storage problems, untimely availability of biofertilisers, lack of technical knowledge among farmers, limited product range, and inadequate credit facilities for purchasing biofertiliser. These issues were found to be relatively less significant as compared to the three main issues. The storage problems can be addressed through proper storage facilities, while untimely availability of biofertiliser can be mitigated through improved supply chain management. To tackle the issues related to lack of technical knowledge, training and extension services can be provided to farmers.

Conclusion

Fertiliser consumption in the state is very much skewed and it is also observed in the N:P:K ratio of the its use. As poor fertiliser uses and ratio, disturbed the soil health ecology, it opens the scope of biofertiliser use across the state. Gujarat is the leading state in both carried based and liquid biofertiliser production, but it was produced by few of the organisations. It leads the scope of biofertiliser production and use in the state again. Delayed effect, poor result, short shelf life are some of the problems in the biofertilisers applications that is observed in the state.

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[3] Morbi district was formed in August 15, 2013. Before, it was under the Rajkot district and known for the ceramics. This district is known for sesamum in one district one product programme.