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Biofertilizer Production in India: Current Status, Classification and Schemes

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Abstract

A growing number of farmers are embracing soil management techniques such as the use of biofertilizers, which is contributing to an increase in the demand for biofertilizers. Due to their affordability, environmental benignity and guarantee of sustained agricultural productivity, farmers prefer biofertilizers over chemical fertilizers. Biofertilizers are relatively well accepted in India, despite the fact that the country has both government and private sector enterprises. Several aspects of the biofertilizer industry are discussed in this article including the effects of COVID-19 and the production, use, complications and future of biofertilizers in India. There have been numerous government programs developed by the Indian government to encourage farmers to use biofertilizers and to subsidies their purchase. Organizing training programs for the promotion of biofertilizers is essential for the government to adjust its strategy. It would be beneficial to develop demonstration programs to enhance the production and distribution of biofertilizers to farmers, as well as to expand the agro market and develop agricultural institutions. In order to ensure that biofertilizers are accepted by farmers at the highest rate possible, the Indian government has constructed a quality control system and marketing techniques to enable the system to be effective. A significant increase in their commercialization and use in India could be achieved by lowering the cost of biofertilizers by both the public and private sectors.

Keywords: India; Bio fertilizer production; Components; Classification; Applications; Schemes

Introduction

Biofertilizer market in India is predicted to grow at a remarkable Compound Annual Growth Rate (CAGR) between FY2023 and FY2027. The market is expected to grow at the forecast cumulative annular growth rate since fertilizers are essential for the nation's agriculture. Agriculture is one of the most lucrative sectors for the economy of the country. In the Asia Pacific region, India is the country that makes the most money from agriculture. Due to poor soil conditions, farmers and cultivators in India are expected to increase their reliance on bio fertilizers over the next five years [1]. Additionally, the demand for organic and environmentally friendly fertilizers is expected to drive the expansion of the Indian biofertilizers market over the next five years. In addition to technological advancements and research, the market is also experiencing growth. Up to FY2027, the Indian biofertilizers market is expected to expand strongly due to the increasing demand for better farming and agricultural methods. The use of biofertilizers in the next five years will increase crop yields, increase farmer income and contribute to the development of the Indian biofertilizer sector [2]. In the next five years, the potential growth of the market may be limited by inadequate knowledge about the variety of organic products available and inadequate training in organic farming. The Indian biofertilizer market is segmented based on type, application mode, form, crop type, source, geographical distribution and the top

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three states in each area. The market is further subdivided based on the type of nitrogen fixing plant into phosphate fixing plants, potassium fixing plants and other types [3]. As the demand for nitrogen fixing biofertilizers increases to reclaim depleted and contaminated agricultural soil in the coming five years, it is predicted that nitrogen fixing biofertilizers will have the highest market share. In addition, the extensive use of synthetic fertilizers and chemicals is likely to lead to the contamination of water resources, which will contribute to the growth of the Indian biofertilizer market. A few of the leading players in the biofertilizer market in India include UPL limited, T Stanes and company limited, IPL biologicals limited and Kan Biosys Pvt Ltd, Manidharma biotech Pvt Ltd, Biomax naturals, Jaipur biofertilizers, Aumgene biosciences Pvt Ltd, Criyagen Agri and biotech Pvt Ltd, Varsha bioscience and technology India private limited. To satisfy consumer demand, major industry participants are actively engaged in the research and development of cutting edge products. Through ongoing research, better products and services will be introduced in the future [4]. As a result of the rapidly increasing demand for improved products, the new market entrants will have the opportunity to develop their brand. Additionally, it may be possible to obtain government funding for the development of new products by partnering with existing companies or research institutions. In general, biofertilizers are compounds containing microorganisms that help to promote the growth of trees and plants by improving the delivery of vital nutrients to them. There are a number of live organisms found in these structures, including mycorrhizal fungi, blue green algae, and bacteria [5]. It is well known that cyanobacteria are capable of fixing nitrogen; however, mycorrhizal fungi are known to take nutrients from organic matter for the plant. Nitrogen fixation refers to the process of converting dinitrogen molecules into ammonia. As an example, some bacteria convert nitrogen into ammonia. Therefore, plants have access to nitrogen as a result [6].

There are numerous types of biofertilizers are available like

Symbiotic nitrogen fixing bacteria: Rhizobium is one of the most effective symbiotic nitrogen fixing microorganisms. Plants serve as a source of protection and sustenance for bacteria. Plants benefit from fixed nitrogen, which is provided by them in return [7].

Loose association of nitrogen fixing bacteria: A nitrogen fixing bacteria called *Azospirillum* resides close to the roots of higher plants but does not create a tight relationship with them [8]. It is believed that these bacteria are associated with the rhizosphere because they gather and consume plant exudates. Mutualism is the associative term applied to this phenomenon.

Symbiotic nitrogen fixing cyanobacteria: Cyanobacteria or blue green algae from a symbiotic relationship with numerous plants. Lichens, liverworts, cycad roots and ferns are all examples of organisms which fix nitrogen through the use of cyanobacteria. The fern contains Anabaena in its leaf cavities. The process of fixing nitrogen is carried out by it. In the process of decaying the fern plants, nutrients are released for use by the rice plants [9,10]. Rice fields are characterized by the presence of *Azolla pinnate*, a fern that does not interfere with the growth of rice plants.

Free living nitrogen fixing bacteria: They are nitrogen fixing bacteria that live in free-living soil. A number of saprotrophic anaerobes have been identified, such as *Clostridium beijerinckii*, *Azotobacter* and others [11]. The most widely used forms of biofertilizers *are Rhizobium* and *Azospirillum*.

Materials and Methods

Components of biofertilizers

Biofertilizers made up of the following ingredients

Bio compost: This product is one of the most environmentally friendly products since it is made from decomposed sugar industry wastes. As a result, bacteria, fungi and plants that are beneficial to humans can multiply it in the environment [12].

Tricho card: A nonpathogenic, environmentally benign substance, it is used in several crops, horticultural plants and ornamentals such as paddy apples, sugar cane, brinjal, corn, cotton, vegetables, citrus and others. In addition to its ability to destroy eggs of various bugs, it is also a very effective antagonistic hyper parasite against shoots, fruits, leaves and flower eaters [13].

Azotobacter: This compound prevents the roots from becoming infected with soil borne bacterial organisms and facilitates the fixation of atmospheric nitrogen by the roots. Plants require nitrogen to survive and thrive and nitrogen makes up 78 percent of our atmosphere.

Phosphorus: As a crucial component of plant growth and development, phosphorus plays an essential role. The phosphorus solubilizer is a microorganism that hydrolyzes insoluble phosphorus compounds into their soluble forms, which can then be absorbed by plants [14]. A variety of fungi and bacteria were used to accomplish this task, including *Penicillium*, *Aspergillus*, *Bacillus*, *Pseudomonas* and others.

Vermicompost: It contains vitamins, hormones, organic carbon, sulphur and antibiotics in order to improve yield quality and quantity. It is an organic fertilizer that is good for the environment [15]. Increasing soil fertility with vermicompost is one of the fastest ways to do so.

Classification of biofertilizers

Figure 1 illustrates the classification of biofertilizers. Biofertilizers are categorized into three main groups: bacterial, algal and fungal fertilizers. In terms of bacterial biofertilizers, three categories can be distinguished: Nitrogen fixers, K mobilizers and ZN mobilizers and phosphate solubilizer [16]. Nitrogen fixers can classify as symbiotic, nonsymbiotic or associative, with *rhizobium, azotobacter* and *azospirillum* as examples. Nonsymbiotic phosphate solubilizer bacteria include *Bacillus*, *Pseudomonas.* Non-symbiotic algal nitrogen fixers include blue green algae. *Mycorrhizae Glomuse* and *Gigaspora* is symbiotic fungal phosphate solubilizer, while *aspergillus* and *Penicillium* is nonsymbiotic fungal phosphate solubilizer.

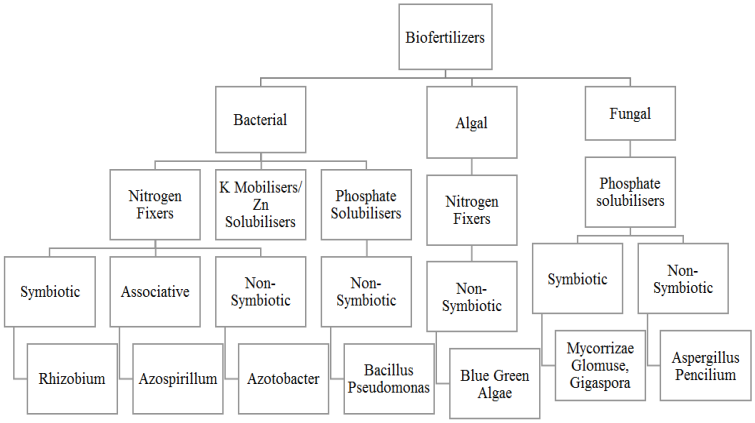

FIG.1. **Classification of biofertilizers.**

Importance of biofertilizers

Biofertilizers are essential for a variety of reasons:

- Biofertilizers improve the texture of the soil and increase plant productivity.
- They prevent infections from flourishing.
- They are both environmentally friendly and cost effective.
- Because biofertilizers are natural fertilizers, they preserve the environment from contaminants.
- Biofertilizers destroy many hazardous chemicals in the soil that can cause plant illnesses.
- Even in semi-arid climates, biofertilizers are successful.

Applications of biofertilizers

Here are some of the most effective uses for biofertilizers.

Seedling root dip: This strategy can use with rice crops. For 8-10 hours, the seedlings planted in a waterbed.

Seed treatment: The seeds soaked in a fertilizer mix of nitrogen and phosphorus. The seeds are dried and sowed as quickly as possible.

Soil treatment: The biofertilizers and compost fertilizers are combined and stored for one night. This mixture is then placed on the soil to seeding with seeds (Table 1).

Bio fertilizer capacity and production

TABLE.1. **Biofertilizer production in India from 1992-93 to 2020-21.**

Year	Production Carrier based (tonnes)	Production Liquid based (KL)
1992-93	2005.00	-
1993-94	3084.00	-
1994-95	5800.50	-
1995-96	6692.30	-
1996-97	7406.60	-
1997-98	7104.60	-
1998-99	5972.10	-
1999-2000	5716.00	-
2000-01	6242.70	-
2001-02	9019.20	-
2002-03	7181.70	-
2003-04	8701.40	-
2004-05	10479.00	-
2005-06	11752.40	-
2006-07	15871.00	-
2007-08	22646.60	-
2008-09	25065.00	-
2009-10	20040.00	-
2010-11	37997.60	-
2011-12	40324.20	-
2012-13	46836.80	-
2013-14	65527.80	-
2014-15	80696.00	4055.00
2015-16	88029.00	6241.00
2016-17	109020.00	7526.00
2017-18	121067.00	9033.00
2018-19	73377.00	22646.00
2019-20	79447.00	30106.00
2020-21 (P)	90431.00	26442.00
Total	1013534.00	106049.00

Average	34949.43	15149.86
Std	36531.84	10842.77
CAGR%	14.58	3.93

P: Provisional; KL: Kilo Litres; Std: Standard deviation; CAGR: Compound Annual Growth Rate.
Source: National Centre of Organic Farming (NCOF, 2020-21), Ghaziabad, department of agriculture and farmers welfare, ministry of agriculture and farmers welfare, government of India.

As shown in Table 1, India produced both carrier and liquid biofertilizers between 1992-93 and 2020-21 [17]. Since 1992-93, the production of biofertilizer (carrier based) has been increasing in India, with the highest production of 121067.00 tonnes in 2017-18. The rate of expansion of biofertilizer (carrier based) production has slowed since 2017-18 (Figures 2 and 3). Until the present day, liquid based biofertilizer production has increased at a favorable rate at a consistent pace since 2015-16 (NCOF, 2020-21).

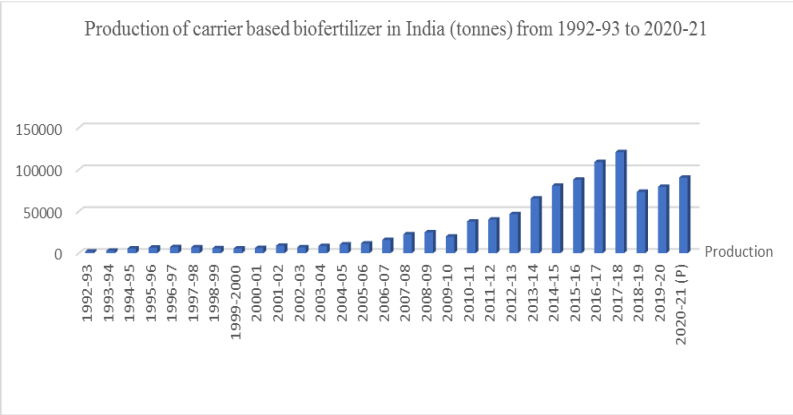

FIG.2. **Production of carrier based biofertilizer in India.**

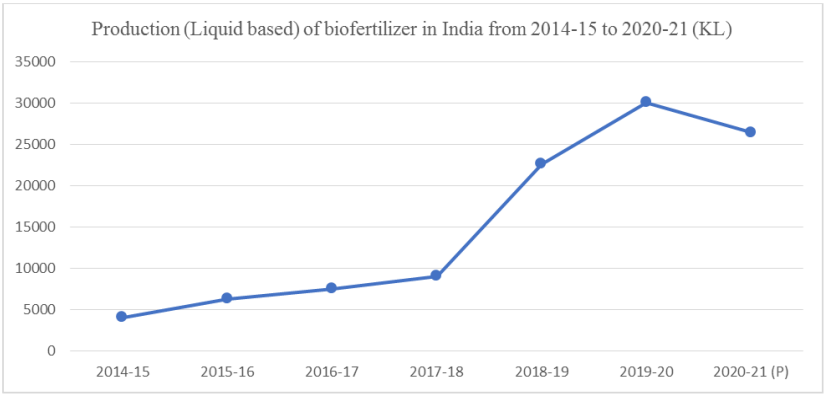

FIG.3. **Production of liquid based biofertilizer in India.**

The overall production of carrier based and liquid based biofertilizers in India is shown in Tables 4-7. These regions include the eastern, northern, southern and western regions of the country. As a result of the availability of high production units in the western region, biofertilizer production has been highest in the western region, followed by that in the northern region [18]. In particular, Gujarat has the highest production capacity in the western region, producing 19483.3 tonnes of carrier based bio fertilizers and 8055.7 kiloliters of liquid based biofertilizers.

Results

Bio fertilizer production in different regions of India (Tables 2-5).

TABLE 2. **Bio fertilizer production in eastern region of India.**

East states	2012-13	2013-14	2014-15		2015-16		2016-17		2017-18		2018-19		2019-20		2020-21(P)	
	CB	CB	CB	LB	CB	LB	CB	LB	CB	LB	CB	LB	CB	LB	CB	LB
Assam	89.0	149.0	88.0	-	1315.0	22.5	1359.1	26.0	1742.6	33.1	617.2	-	640.3	4.9	131.4	34.7
Bihar	52.4	52.4	64.9	-	97.0	-	107.0	-	128.8	0.02	130.8	-	375.0	1900.0	74.6	2.1
Jharkhand	35.3	14.2	9.1	-	9.2	-	18.6	-	21.0	0.01	21.0	-	5.2	-	-	-
Mizoram	-	4.0	3.6	-	4.2	-	2.5	-	9.0	-	2.5	-	1.4	-	1.4	-
Manipur	-	-	-	-		-	25.0	-	23.9	-	81.5	100.0	13.2	11.5	7.0	4.0
Nagaland	7.5	7.50	7.5	-	8.8	-	51.5	-	70.6	-	17.5	-	18.7	-	19.1	-
Sikkim	9.5	10.10	12.4	-	12.9	-	16.3	-	33.2	-	-	51.5	-	-	-	69.0
Tripura	514.0	225.0	240.0	-	1143.1	-	1153.5	-	1187.9	0.03	81.8	-	340.1	39.8	84.3	-
Odisha	407.1	1097.6	1074.5	4.7	467.6	13.7	516.0	-	560.2	46.2	8166.9	149.7	449.2	1719.0	19406.6	859.6
West Bengal	1110.0	1682.7	2061.8	14.6	2826.3	23.5	3195.2	31.8	3513.1	37.7	2050.0	37.7	2200.0	-	448.6	33.5
Arunachal Pradesh		59.0	59.0		118.0	-	119.7	26.2	232.9	0.1	-	-	-	-	-	-
Total	2224.8	3301.5	3620.8	19.3	6002.1	59.7	6564.4	84.0	7523.2	117.2	11169.2	338.9	4043.1	3675.2	20173.0	1002.9

CB: Carried Based in tonnes; LB: Liquid Based in Kilo Litres; P: Provisional
Source: National Centre of Organic Farming, Ghaziabad, department of agriculture and farmers welfare ministry of agriculture and farmers welfare, government of India, (NCOF-2020-21a).

TABLE 3: **Biofertilizer production in northern region of India.**

North states	2012-13	2013-14	2014-15		2015-16		2016-17		2017-18		2018-19		2019-20		2020-21 (P)	
	CB	CB	CB	LB	CB	LB	CB	LB	CB	LB	CB	LB	CB	LB	CB	LB
Haryana	5832.6	1146.5	873.0	46.5	1097.5	58.0	2360.6	70.1	2504.6	76.-	2128.7	246.5	2794.8	-	3105.4	107.5
Himachal Pradesh	-	26.1	0.8	33.1	2.7	190.1	3.3	194.7	8.5	209.7	135.1	12.1	320.0	137.9	0.2	0.2
Jammu and Kashmir	-	45.3	-	-	-	-	-	-	-	0.04	-	0.04	-	-	-	-
Punjab	2311.3	2124.9	6305.5	74.3	2197.2	149.6	5533.8	210.2	5645.3	236.1	7167.4	220.8	9252.2	192.5	15836.5	157.0

Uttar Pradesh	1310.0	2682.2	4099.1	98.0	3053.1	-	2835.8	461.2	3441.3	744.-	2451.8	2444.6	2142.8	2539.9	5725.6	593.1
Uttarakhand	2758.2	5493.9	2130.0	208.0	3549.4	223.3	3720.7	696.9	3942.1	533.9	3359.8	281.4	3119.0	4980.0	3708.8	1150.8
Delhi	-	396.0	104.5	-	106.2	428.2	116.2	-	119.7	-	394.0	-	345.0	-	347.0	-
Total	12212.1	11914.9	13512.9	459.9	10006.1	1049.2	14570.4	1633.1	15661.5	179 9.74	15636.8	3205.44	17973.8	7850.3	28723.5	2008.6

CB: Carried Based in tonnes; LB: Liquid Based in Kilo Litres; P: Provisional
Source: National Centre of Organic Farming, Ghaziabad, department of agriculture and farmers welfare, ministry of agriculture and farmers welfare, government of India, (NCOF-2020-21b).

TABLE 4: **Biofertilizer production in southern region of India.**

North states	**2012-13**	**2013-14**	**2014-15**		**2015-16**		**2016-17**		**2017-18**		**2018-19**		**2019-20**		**2020-21 (P)**	
	CB	**CB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**
Andhra Pradesh	1335.7	2714.2	2668.8	274.9	3062.6	317.8	3375.9	365.2	4983.6	369.8	263.9	-	228.3	-	98.5	1335.7
Karnataka	7683.7	9907.3	16462.6	23.1	23042.9	488.1	31553.1	993.4	34493.0	1352.9	3253.7	758.2	3606.7	1218.0	9712.8	7683.7
Kerala	1045.6	3520.7	4917.0	10.5	4926.0	56.6	4993.9	59.6	6040.1	82.9	108.2	2.1	91.0	5512.1	2112.2	1045.6
Tamil Nadu	11575.7	14104.8	15373.3	11.3	23721.2	862.0	27428.0	875.3	28059.4	983.9	4187.2	536.8	11611.0	1481.6	732.0	11575.7
Puducherry	621.0	517.0	561.0	1.5	283.6	4.1	204.0	11.2	297.6	28.4	121.9	6.2	121.9	7.6	2.2	621.0
Telangana	-	-	-	-	-	-	-	-	574.2	43.7	2556.3	12711.7	1536.3	174.8	150.1	-
Total	22261.7	30764.0	39982.7	321.3	55036.3	1728.6	67554.9	2304.7	74447.9	2861.6	10491.2	14015.0	17195.2	8394.1	12807.8	22261.7

CB: Carried Based in tonnes; LB: Liquid Based in Kilo Litres; P: Provisional
Source: National Centre of Organic Farming, Ghaziabad, department of agriculture and farmers welfare, ministry of agriculture and farmers welfare, government of India, (NCOF-2020-21c).

TABLE 5: **Biofertilizer production in western region of India.**

North states	**2012-13**	**2013-14**	**2014-15**		**2015-16**		**2016-17**		**2017-18**		**2018-19**		**2019-20**		**2020-21 (P)**	
	CB	**CB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**	**CB**	**LB**

Chhattisgarh	501.6	712.1	1024.7	9.6	954.4	9.4	955.1	10.2	969.1	16.6	172.0	133.7	26.8	189.6	101.2	163.3
Gujarat	978.5	6411.4	3667.9	2800.5	3963.4	2873.3	3909.8	2857.8	4248.2	3519.3	10596.0	430.5	20788.0	9444.0	19483.3	8055.7
Madhya Pradesh	1408.1	4824.2	2638.0	119.2	2741.3	131.0	5609.0	238.1	6561.5	290.4	7426.5	327.2	1330.0	315.6	1047.7	262.3
Maharashtra	5897.9	6218.6	14847.4	324.8	7825.1	389.7	8323.6	398.3	10024.9	427.4	15049.8	4193.8	15897.0	237.1	5328.2	2141.0
Rajasthan	982.0	1315.0	599.9	-	680.0	-	711.0	-	791.8	1.1	791.8	1.1	2142.8	-	10612.0	-
Goa	370.0	66.3	802.5	-	820.5	-	822.0	-	838.7	-	2044.0	-	50.0	-	108.7	-
Total	10138.1	19547.6	23580.4	3254.1	16984.7	3403.4	20330.5	3504.4	23434.2	4254.8	36080.1	5086.3	40234.6	10186.3	36681.1	10622.3

CB: Carried Based in tonnes; LB: Liquid Based in Kilo Litres; P: Provisional
Source: National Centre of Organic Farming, Ghaziabad, department of agriculture and farmers welfare, ministry of agriculture and farmers welfare, government of India, (NCOF-2020-21d).

Marketing channels of biofertilizers in India

In India, there are five marketing channels available for the distribution of fertilizers from producer to farmers, which have mentioned below

Channel 1: Producer government level officer's village level workers farmers.

Channel 2: Producer state marketing federation district level cooperatives primary cooperative societies farmers.
Channel 3: Producer state agro industries corporation agro service center farmers.

Channel 4: Producer own depot or service center farmers.

Channel 5: Producer wholesaler private dealer farmers.

Private companies are most likely to use marketing channel 5. Channel 2 is frequently used by both the government and government run fertilizer industries [19]. The majority of private organizations utilize Channel 5 for communication with their end users, even in remote areas. The marketing channel 4 is predominantly used by giant private companies and producer companies for direct marketing to consumers without the involvement of any intermediates.

Ensuring the supply of fertilizers: In India, the cultivation of main crops has increased over the past decade, which has led to an increase in fertilizer production and availability. In Rabi 2021-22, it is predicted that urea, NP/NPKs and SSP will increase by approximately 3.3 percent, 9.8 percent and 38.9 percent, respectively. Despite the significant increase in fertilizer sales in Rabi 2021-22, overall primary fertilizer sales, excluding SSP, are expected to remain flat [20]. The production of fertilizer involves the use of complicated technology in an environment that is high pressure, high temperature and chemically aggressive. Continuous investment is necessary to ensure the smooth operation of fertilizer plants. In 2022-23, urea production is expected to increase substantially due to the establishment of three new plants. P and K fertilizer production continues to suffer from a lack of sufficient raw materials and unfair competition from imports. In recent years, all input costs have increased significantly. Due to this, the cost of producing this fertilizer was extremely high. In order to protect farmers from rising prices, the Indian government increased subsidies significantly. The price of commodities has, however, continued to rise in recent days. In 2022-23, fertilizer needs are expected to increase by 2% to 3% [21]. Due to the confrontation between Russia and Ukraine, supplying fertilizer demand will remain a challenge. It is expected that international energy and commodity prices will remain high for at least the

first half of 2022-2023. Industries will continue to strive for maximum output.

Effect of COVID-19 on the market for biofertilizers: After the COVID-19 pandemic, the global market experienced reasonably steady growth, with a similar trend of strong demand expected in 2020. Biofertilizers are produced by indigenous companies because they are easy to design. Due to the fact that the products can be manufactured locally, the crisis has not significantly impacted the supply chain. In most nations, it is expected that local producers will control the market. The production of food crops has increased significantly worldwide, including rice in Asia, fruits and vegetables in Europe and soybeans in South America. Each nation is under increasing pressure to improve its food supply, therefore repetitive cropping occurs. As a result, biofertilizers have become increasingly popular as a means of replenishing soil nutrition. In spite of the prohibition of dangerous chemical pesticides, the market for biofertilizers has continued to grow [22,23]. In the future, the government is expected to ease restrictions on the use of biofertilizers, leading to a significant expansion of the biofertilizer market.

Opportunities of biofertilizers: A growing interest in biofertilizers has been attributed to the "green revolution" concept, the minimal use of chemical fertilizers and pesticides and the changing social perception of organic products. In recent years, biofertilizers have become increasingly important due to soil, crop and public health concerns as well as changes in the global fertilizer industry. Since Iran began producing biofertilizers ten years ago, the country has enjoyed favourable conditions for their use. In terms of fertilizer consumption, the Asia Pacific region and Africa are the two continents with the highest consumption rates. A significant increase in population, particularly in Asia, has resulted in an increased demand for food, which has led to an increase in fertilizer consumption. Pollution and soil contamination, as well as the negative health effects they have on humans, are the primary concerns in this area [24]. In these areas, the government strongly emphasizes the use of environmentally friendly fertilizers, such as organic manure and biofertilizers, in order to prevent the negative effects of chemical fertilizers.

Challenges in adopting biofertilizers: There is a primary difficulty for this sector due to its reliance on imports for significant inputs and final products. The logistics associated with ocean transportation have become more difficult as a result of vessel shortages and the increase in freight charges associated with COVID [25]. The lack of knowledge about biofertilizers among farmers in India's impoverished and developing states poses a barrier to their adoption. Chemical fertilizers are preferred by them due to their ease of use. The reason for this can be attributed to a lack of education and information. In addition to having a broad range of products, the chemical fertilizers market is well established and has a strong distribution network, all of which contribute to the slow adoption of biofertilizers. Furthermore, consumers are less familiar with the many brands on the market as a result of the extreme geographical fragmentation of the market. Due to their ignorance, farmers are confused. Biofertilizers, for instance, often have a shelf life of six to twelve months when delivered in powder carrier formulations and only three to six months when delivered in liquid carrier formulations.

Schemes related to bio fertilizers and bio pesticides in India

National Food Security Mission (NFSM): A primary goal of the Mission is to promote and spread improved crop package practices through various types of demonstrations (FLDs/Cluster FLDs), distribution of HYVs/Hybrid seeds, seed production, distribution of micronutrients/soil ameliorants/biofertilizers, plant protection chemicals/bio pesticides, improved resource management tools/machines/implementation, efficient water application devices, farmers capacity building, etc. In 2020-21, primary processing units, compact storage bins and flexibility interventions will be installed.

Achievement during 2019-20: Demonstrations of rice, wheat, pulses and nutricoarse cereals on 12.39 lakh hectares have encouraged recommended agronomic practices. Over 10.91 lakh quintals of high yielding rice, wheat, lentils and nutri coarse cereal varieties/hybrids have been distributed. A total of 16.40 lakh hectares have been treated with micronutrients, biofertilizers, and soil ameliorants (gypsum, lime, etc.) while 23.71 lakh hectares have been treated with Integrated Pest Management (IPM). More than 3.61 tons of agricultural machinery, including pump sets and mobile rain guns, were provided. In addition, water carrying pipelines covering 104.02 million meters have been installed on 0.19 million hectares. In approximately 12030 cropping system based trainings, farmers were trained to improve their agricultural skills.

National Food Security Mission (Oilseeds and Oil Palm)-NFSM (OS and OP)

Erstwhile scheme National Mission on Oilseeds and Oil Palm (NMOOP): A number of groups work together to produce and distribute certified seeds, seed hubs and mini kits; inputs (plant protection equipment, bio pesticides, micronutrient distribution, biofertilizer distribution, improved farm implements, pipes, sprinklers, seed storage bins, seed treatment drums) and transfer of technology (block demonstrations, frontline demonstrations, cluster frontline demonstrations). Furthermore, NFSM oilseeds

contribute to the conduct of FLDs on oilseed crops and to the staging of oilseed cluster demonstrations by ICAR-KVKs.

The following are the primary interventions targeted under the oilseeds program in 2020-21:

- Oilseed crop seed production totaled 1.95 lakh quintals, with more than 1.56 lakh quintals of approved seed distribution.
- Block demonstrations on 1.89 million hectares.
- Through ICAR and KVKs, 0.86 lakh acres of Front Line Demonstration (FLD) and Cluster FLDs have been established.
- 2686 farmers and cops have received training.
- Supply of soil ameliorants throughout a 4.33 million hectare region.
- Supply of PP chemicals, bio pesticides, weedicides and micronutrients over a 2.61 million hectare region.
- 3017 sprinklers and 60.92 lakh MT water carrying pipes were distributed, along with 0.50 lakh farm implements and PP equipment.
- Through ICAR, SAUs and KVKs, 35 oilseed hubs have been constructed to produce 60825 quintals of certified seeds.
- In Kharif 2020-21, 25.73 million tonnes of oilseeds were produced (1st advance estimate, DES).

National Institute of Plant Health Management (NIPHM)

NIPHM was established in 1966 as a Central Plant Protection Institute (CPPTI) in Hyderabad. Through capacity building initiatives, the institute expanded its scope in 2008 to include encouraging sustainable plant health management techniques in various agro climatic situations as well as plant biosecurity management and pesticide management. A key function of the NIPHM in the plant protection domain is the organization of capacity building programs in areas such as plant health management, biosecurity and incursion management, pesticide management, and market access, as well as providing advisory services and policy support, and conducting adaptive research. The NIPHM conducted 176 training sessions in 2019-20, with a total of 5121 officers participating. The NIPHM began conducting online training programs for officers in 2020-21 with effect from June 2020. In 2020-21, the Institute has conducted 86 training programs with a total of 3786 officers (up to December). Phytosanitary inspectors began receiving physical instruction in November 2020, and the first batch of trainees has successfully completed the program. The institute also organized farmer programs, both in person and online, in conjunction with KVKs. The plant health clinics also provide farmers with regular opportunities for interaction and training. A total of 298 samples were tested for laced chemical pesticides from April through December 2020-21. The MPRNL program examined 1264 samples of green leafy vegetables for pesticide residues between April and December 2020 and 55 samples of green leafy vegetables were analyzed under the analysis of heavy metals program. As part of the "how safe is your veggies?" initiative, the "how safe is your veggies?" project is being developed. The examination of 70 vegetable samples has so far been completed. Additionally, PMD examines tobacco samples provided by the Tobacco Board. Between April and October 2020, 181 samples of tobacco were tested for pesticide residues. From April to December 2020, 395 government laboratories participated in proficiency testing for three pesticides. A total of 101 laboratories participated in three proficiency testing programs in the area of pesticide residue analysis from April to December. In addition to improving analytical facilities for pesticide quality, pesticide residues, and bio pesticide pollutants, NIPHM proposed building a state of the art analytical laboratory, which could also be used for national training center. The new PFRAC building was inaugurated on 29th December 2020 by the humble union minister of agriculture and farmers welfare, in the presence of ministers of state for agriculture and other dignitaries. The facility should be operational within a month after all the equipment has been relocated.

Webinar series: NIPHM planned and organized online webinars to raise awareness of plant health management among students, faculty, and field staff in honor of 2020, the international year of plant health management as designated by the United Nations. As part of the International Year of Plant Health (IYPH), NIPHM hosted 13 webinars on various topics related to plant health management. In total, 2728 people attended the event and benefited from numerous presentations presented by professionals from national and international institutes.

Bio input production and distribution: During the COVID epidemic, the manufacture and dissemination of bio inputs slowed significantly. Following the lockdown, biofertilizer and bio pesticides mother cultures were resurrected, and insect mother cultures were obtained from preservation facilities. This institution produced biofertilizers (150 liters of various biofertilizers and 25 kg of VAM biofertilizers) and bio pesticides (50 liters of Trichoderma and 25 liters of *Pseudomonas*), SNPV (150 ml) and Entomopathogenic Nematodes mother cultures for farmers as a farmer friendly institution. In June 2020, NIPHM supplied bio pesticides (*Trichoderma* and *Pseudomonas*) to the tobacco board and Andhra Pradesh in response to their requests.

Quality control of bio pesticides: The quality examination of various bio pesticides samples carried out in this laboratory (the gazette of India 12th March 2013). As part of the department's quality control process, the samples received through insecticide

inspectors. The central insecticide laboratory's BIS requirements and technical recommendations followed for all analytical operations. The standard operating procedures updated regularly following BIS guidelines. Every month, five to ten samples received for analysis. During this time, 48 bio pesticides samples received from various Indian states, with 31 samples being tested for quality characteristics.

Plant health clinic: In NIPHM, Hyderabad, a plant health clinic established to provide farmers with timely assistance on handling various forms of plant health problems (insects, diseases, mites, nematodes, etc.) in order to ensure sustainable and profitable agriculture. With financing from the National Horticulture Mission under MIDH, Telangana, plant health clinics were established in four districts of Telangana state (Warangal Urban, Warangal Rural, Suryapet and Rangareddy) to provide services to farmers. NIPHM officials performed off campus training events as part of their plant health clinic efforts to raise awareness in their regular farm activities. Plant health clinics held a demonstration and kits delivered to farmers from several communities (fruit fly lures for fruit crops, vegetable crops and biofertilizers *viz.*, *Trichoderma* and *Pseudomonas*). In the Telangana district of Rangareddy, fourteen training programs were held, resulting in the training of 280 farmers. During the COVID-19 epidemic, nine training programs held in Warangal Dt, Telangana, which trained 150 farmers. Pest advisories issued to over 1480 farmers.

National Mission for Sustainable Agriculture (NMSA)

Integrated Nutrient Management (INM) and organic farming: The INM and organic farming component of the national mission for sustainable agriculture are being implemented by the ministry of agriculture, cooperation and farmer’s welfare's department of agriculture, cooperation and farmers welfare. Financial help is available for the following components:

- Establishment of mechanical fruit/vegetable market waste/agro waste composting plants.
- Under the FCO, a biofertilizer and organic fertilizer testing laboratory will establish or an existing laboratory will strengthen.
- Support for research to produce an organic package of techniques relevant to the State and cropping system.
- Promotion of organic inputs in the farmer's field.
- Establishment of a distinct organic agriculture research and education institute (against the specific proposal).

Discussion

Soil Health Management (SHM): One of the essential interventions within the national mission for sustainable agriculture is Soil Health Management (SHM) (NMSA). SHM aims to promote Integrated Nutrient Management (INM) by judicious use of chemical fertilizers, including secondary and micronutrients, in combination with organic manures and biofertilizers to improve soil health and productivity; strengthening soil and fertilizer testing facilities to provide farmers with soil test based recommendations for improving soil fertility and ensuring fertilizer, biofertilizer and organic fertilizer quality control requirements.

Setting up new static Soil Testing Laboratories (STLs), setting up new mobile STLs, strengthening existing STLs, setting up new Fertilizer Quality Control Laboratories (FQCL), strengthening existing FQCL aside from training and demonstrations on balanced fertilizer use, setting up biofertilizer production units and setting up biofertilizer and organic fertilizer quality control laboratories are all components under soil health. During 2019-20, the SHM Scheme sanctioned the establishment of 15 new static STLs, the strengthening of 116 STLs, the establishment of 1 FQCL, the strengthening of 6 FQCLs, the strengthening of 19 biofertilizer units, the establishment of 2 new Biofertilizer and Organic Fertilizer Testing Quality Control Laboratory (BOQCL), the strengthening of 2 BOQCL and the promotion of micronutrients in 2,18,676 ha.

Conclusion

Nowadays, many developed countries realize the importance of biofertilizers in sustainable agriculture, but there is still low production, awareness and adoption of biofertilizers in some states of India. Thus, fertilizer application should be encouraged by Indian farmers, especially for food security and maintaining good soil health. The quality of biofertilizers is essential for accepting and adopting biofertilizers by farmers. For that Indian government has implemented many other schemes which will help the farmers avail biofertilizers easily. Application biofertilizers will maintain the quality of soil as well as increase the production of quality food grains. The adoption rate of biofertilizers among farmers is not up to the mark, even though the Indian government is providing subsidies for biofertilizers. Farmers think that the application of more quantity of chemical fertilizers will increase the production rate of agricultural goods in terms of quality as well as quality. Production of biofertilizers in India has done by different government and private organizations, but the consumption or application of biofertilizers by farmers is low because of using a high number of chemical fertilizers. Indian government should make strategies to influence the farmers to adopt biofertilizers in their field through their different training programs. These strategies should provide systemic regulation of

biofertilizers for commercialization and the quality of biofertilizers should be well, which launches India into well productivity nation in the world.

Conflict of Interest

None declared

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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