**Original Research Article**

**FACTORS INFLUENCING AND PROBLEMS FACED BY FARMERS IN THE ADOPTION OF BIOSTIMULANTS IN DANTIWADA TALUKA OF BANASKANTHA DISTRICT, GUJARAT**

**Abstract:** Agriculture is backbone of the Indian economy. In India, about 60 to 70 per cent of the population is employed in agriculture, which generates around 20 per cent of the GDP of the nation.There is a shift observed in input usage**.** Different agencies are laying emphasis on the use of biological inputs like biostimulants**.**The study on factors influencing and problems faced by farmers in the adoption of biostimulants in Dantiwada taluka of Banaskantha district, Gujarat was carried out. Multi stage sampling was used to select 200 respondents from the Dantiwada taluka of Banaskantha district.The result indicates that majority of farmers are in the 36 to 50 years age group, about half of the respondents were having family size of 3 to 5 members.About the respondents, 27% of the farmers had primary education, 50.50% had SSC education, and 21% had HSC education.The main occupation was farming with animal husbandry and the income of majority farmer is between 1 lakh to 5 lakh. Average land holding size of farmers was 2-5 acres.The main crop in kharif season was Groundnut with 100 percent. The main crop in rabi season was potato followed by wheat, mustard, amaranth. And in zayad season Groundnut was main crop followed by Pearlmillet, Muskmelon, Watermelon. In the survey, it was observed that 82.50 percent farmers were aware about biostimulants and among them 86 percent have used biostimulant in field.Also, they strongly believed that application of biostimulant helps in bloom more flower of and increase crop yield. Acording to study most of farmers were influencing with a dealers/distributors recommendation. In the problems of adoption of biostimulants was lack of proper technical knowledge followed by delayed effect.

**Key words:** Farming, Biostimulants, Farmers, Awareness, Chemical inputs, Factors

**1. Introduction**

India faced a severe food crisis between 1947 and 1960, struggling to produce enough food to meet the demands of its rapidly growing population. The situation worsened due to recurring famines, natural disasters, and poor climatic conditions that devastated crops and reduced agricultural output (Nelson *et al.*, 2019).During this period, the daily per capita availability of food was alarmingly low, estimated at around 417 grams, which was insufficient to ensure nutritional security for the masses (Sharma & Singhvi, 2017). Faced with such daunting circumstances, India was compelled to look for transformative solutions to address the threat of chronic hunger and poverty. Around the same time, in other parts of the world, agronomist Norman Borlaug made groundbreaking progress in developing high-yielding, disease-resistant crop varieties that responded well to chemical fertilizers and had the potential to revolutionize food production (Unger, 2015).Inspired by these international advancements, India adopted a similar approach, and under the guidance of renowned geneticist Dr. M. S. Swaminathan, the first Green Revolution was introduced in 1966-67, aiming to rapidly boost agricultural output through scientific farming methods (Swaminathan & Kesavan, 2015). The main goal of this massive agricultural transformation was to eliminate hunger and malnutrition and uplift the rural economy, goals that were largely achieved by the early 1980s when India became self-reliant in food grain production (Chand & Singh, 2023). This success was driven by the use of high-yielding variety seeds, chemical fertilizers, pesticides, and improved irrigation facilities, which significantly increased crop productivity (Verma *et al.*, 2019).

The Green Revolution has some negative effects on the environment in addition to its positive ones. Deforestation, declining water resources due to pollution and salinity, loss of biodiversity, increased greenhouse gas emissions and global warming and an increase in human and livestock diseases are some of the negative effects of farmers using agricultural technologies excessively to ensure the success of the Green Revolution. Other negative effects include land degradation, such as loss of soil fertility, soil erosion, and soil toxicity; and deforestation. India is among the biggest producers of pesticides in all of Asia as a result of the sharp rise in pesticide usage. This has led to an increase in the pesticide's residual activity. Pesticides are present in large quantities in soil and waterbodies, which contaminate the ecosystem (Ameen & Raza, 2017).

Chemical inputs, including pesticides, herbicides, fungicides, insecticides, and fertilizers, are used in agriculture to control pests and promote crop growth. South Asian countries regulate these chemicals, but improper use leads to negative impacts on human health and the environment. The indiscriminate use of synthetic fertilizers, pesticides, and herbicides has led to soil degradation, loss of biodiversity, and contamination of resources. (Gyeltshen, 2021)

The study examines global trends in synthetic agricultural inputs use, food grain availability, undernourishment prevalence, and non-communicable diseases.The per capita net availability of foodgrain has increased, but undernourishment remains high. The increasing use of synthetic agricultural inputs negatively impacts biodiversity, environment, climate, human life, and health. Excessive use of these inputs leads to chemical residues in food, negatively affecting human health.(Deshmukh et al., 2023)

**1.1 Need for Bio inputs products in agriculture**

Sustainable agricultural practices have successfully emerged from the thoughtful integration of plant protection into various agroecosystems. The innovative use of bioproducts is a promising alternative to conventional agrochemicals in plant protection. Applying these controlled, carefully monitored methods yields an impact on field production levels. It significantly contributes to the commercial development of high-value crops critical to local and global markets. Bioproducts encompass diverse technologies and strategies, including biological control methods, host resistance techniques, and the utilization of naturally occurring bioactive chemicals such as plant extracts, essential oils, pheromones, and practices like intercropping. Furthermore, developing and implementing natural ecosystems as valuable sources of beneficial species are crucial in enhancing agricultural resilience and sustainability. (Giraldo *et al.*, 2023)

Bio-inputs are defined as biological substances derived from biotic organisms used to improve soil fertility, support plant growth and enhance crop health. They include biofertilizers, bio stimulants, biopesticides and natural farming inputs that can provide sustainable alternatives to chemical inputs.(Singh & Yadav, 2020)

**1.2 Biostimulants**

While biopesticides protect against biotic stress (i.e., attack by pests), biostimulants protect the plant against abiotic stress (i.e., frost, drought, salinity). The effectiveness of these agronomic products can be assessed by, e.g. rootmass measurement, the intensity of photosynthesis and the extent of the harvested quantity on experimental plots in relation to the control ones and those on which the reference product was used. The effect of biostimulants is very clear when abiotic stress conditions occur. If stress is not present, the differences may not be observed. Biostimulants are thus a means of protection for the plant in the case of abiotic stress.(Chojnacka, 2015)

**Plant Biostimulants of Microbial Origin:** Microbial Plant Biostimulants (PBs) include fungi, bacteria, and Arbuscular Mycorrhizal Fungi (AMF). Through rhizosphere engineering, microbial inoculants like Plant Growth Promoting Rhizobacteria (PGPR) and Trichoderma spp. enhance soil fertility and restore microbiomes depleted by crop domestication. Additionally, microbial fermentation now allows large-scale enzyme production for soil application. (Papnai *et al.*, 2022)

**Plant Extract Based Biostimulants:** Plant extract PBs, particularly protein hydrolysates (PHs), contain amino acids, oligopeptides, and polypeptides, produced through enzymatic or chemical hydrolysis. Rich in antioxidants and osmoprotectants like proline and sugars, these extracts improve stress tolerance, productivity, and nutrient use efficiency. Extracts from tropical plants are widely used for their beneficial agricultural effects.(Papnai *et al.*, 2022)

**Seaweed Derived Plant Biostimulants:** Seaweed biostimulants are cost-effective and enhance plant biomass production. Most extracts are derived from brown algae, especially Ascophyllum nodosum, using alkali extraction. Liquid extracts and powders are preferred over dried seaweed due to slower decomposition. Popular species include Macrocystis pyrifera, Ecklonia maxima, and Laminaria digitata. (Papnai *et al.*, 2022)

**Protein Hydrolysate Derived Plant Biostimulants:** Protein hydrolysates, produced via acid, alkaline, thermal, or enzymatic hydrolysis, consist of amino acids, oligopeptides, and polypeptides. Applied as foliar sprays or near-root applications, they improve nutrient uptake, nitrogen metabolism, and crop productivity. They are derived from plant residues and animal waste. (Papnai *et al.*, 2022)

**Humic Substances Derived Plant Biostimulants:** Humic substances (HS), derived from organic carbon products like compost and manure, enhance root and shoot growth. HS improves nutrient uptake and soil organic matter content. Techniques like ultracentrifugation and sedimentation are used for molecular characterization. Extraction involves alkali or acid hydrolysis. (Papnai *et al.*, 2022)

Research and development efforts are introducing innovative biostimulants tailored to regional needs. Major companies are investing in collaborations, mergers, and acquisitions to strengthen their market presence. The biostimulant market is expected to grow at a compound annual growth rate (CAGR) of 11.2%, reaching approximately $ 7.6 billion by 2030 (MarketsandMarkets, 2023).

The biostimulant market in India has shown significant growth in recent years, primarily due to the increasing focus on sustainable agricultural practices and the need for higher crop productivity. Biostimulants play a crucial role in enhancing nutrient use efficiency, improving plant tolerance to abiotic stress, and promoting overall crop health. Their adoption has become essential in addressing challenges like soil degradation, water scarcity, and climate variability (Patel *et al*., 2022).Indian farmers have shown a growing interest in biostimulants, especially in horticultural crops like fruits, vegetables, and spices. States like Maharashtra, Gujarat, and Punjab have reported higher adoption rates due to favorable climatic conditions and increased farmer awareness (Sharma & Kumar, 2020).

The increasing consumer demand for organic and chemical-free produce has also driven market growth. As consumers become more conscious of food safety and sustainability, farmers are inclined to reduce the use of synthetic inputs and adopt biostimulants as a reliable alternative (Jain et al., 2022).

**1.3 Objectives**

1. To study the socio-economic profile of farmers
2. To find out factors influencing farmers’ preference for biostimulants
3. To study the problems faced by farmers in adoption of biostimulants
4. To find out the market potential of biostimulants
5. **Materials andMethods**

The study employed a structured interviews chedule together data aligned with its objectives. It was conducted in selected villages of Dantiwada taluka of Banaskantha district, using primary data from farmers and secondary data from literature ,publications, andwebsites. Adescriptive research approach was adopted to explore key aspects of farmers. Using non-probability purposive sampling, 200 farmers were surveyed over 60days.Datawereanalyzedthroughtabular methods and statistical tools such as WeightedAverage Mean and Garret Score (Nemoto and Beglar, 2014, Guh *et al*. 2008 & Christy, 2014).

1. **Result and Discussion**

During the study, following result was founded. All the findings and conclusions are drawn from the questionnaires, which were field out by the respondents in persons.

**3.1To study the socio-economic profile offarmers**

**Age of farmers**:

Table 1. Age of the farmers

|  |  |  |
| --- | --- | --- |
| **Age (Years)**  | **Frequency**  | **Percentage**  |
| 21-35 | 20 | 10.00 |
| 36-50 | 156 | 78.00 |
| 51-65 | 24 | 12.00 |
| **Total** | **200** | **100** |

Table 1 provides detailed information on the age wise distribution of different groups in the population. According to the survey, Table 1 indicates that the age range of 36-50 years represents 156 farmers, equivalent to 78.00 per cent of the total. The age range of 51-65 years represents 24 farmers, which was equivalent to 12.00 per cent of the total. The age ranges above 21-35 years represent 20 farmers, equivalent to 10.00 per cent of the total.

**Annual income of farmers:**

Table 2. Annual income of farmers

|  |  |  |
| --- | --- | --- |
| **Annual Income** | **Frequency** | **Percentage** |
| <1 Lakh | 1 | 0.50 |
| 1 - 5 Lakhs | 146 | 73.00 |
| 5 - 10 Lakhs | 39 | 19.50 |
| > 10 Lakhs | 14 | 7.00 |
| **Total** | **200** | **100** |

Table 2 revealed information about the distributions of income levels within a given population, indicating the frequencies and percentages for different income brackets. It was observed that 73.00 per cent of the respondents had a family income of 1-5 lakh, 19.50 per cent of respondents had 5-10 lakhs, 7.00 per cent of respondents family income had more than10 lakhs and only 0.50 per cent respondents family income is less than 1 lakhs.

**Education of farmers:**

Table 3. Education of farmers

|  |  |  |
| --- | --- | --- |
| **Education Level**  | **Frequency** | **Percentage** |
| Up to Primary | 54 | 27.00 |
| <SSC | 101 | 50.50 |
| <HSC | 42 | 21.00 |
| Graduate | 3 | 1.50 |
| **Total** | **200** | **100** |

Education helps farmers to incorporate the latest scientific advances and technology tools into their daily operations.Table 3, highlighted a comprehensive overview of the educational distribution within the studied population, shedding light on the educational composition of the individuals. Table 3 revealed that 54 farmers had studied up to primary level with contributing to 27.00 per cent, <SSC there were 101 farmers, which contributing 50.00 per cent, also 21.00 per cent of farmers had education level up to <HSC and only 3 per cent of farmers were graduate.

**Occupation of farmers:**

Table 4. Occupation of farmers

|  |  |  |
| --- | --- | --- |
| **Occupation** | **Frequency** | **Percentage** |
| Farming | 15 | 7.50 |
| Farming + AH | 164 | 82.00 |
| Farming + AH + Service | 12 | 6.00 |
| Farming+ AH + Business | 9 | 4.50 |
| **Total** | **200** | **100** |

Occupation play important role for the knowledge of trending in agriculture. There were mainly four occupation was found. Table 4 revealed that, 7.50 per cent farmers depend only on farming, around 82.00 per cent farmers were engaged with farming and animal husbandry, also 6.00 per cent farmers doing a service with farming and animal husbandry,4.50 per cent farmers occupation was farming and animal husbandry with business.

**Family size of farmers:**

Table 5. Family size of farmers

|  |  |  |
| --- | --- | --- |
| **Family Size** | **Frequency** | **Percentage** |
| 2 Member | 6 | 3.00 |
| 3-5 Member | 158 | 79.00 |
| Above 5 members | 36 | 18.00 |
| **Total** | **200** | **100** |

Family size plays important role in the research. Table 5 highlighted about distribution of family sizes within the given population. It revealed that the majority of families fall within the 3-5 members range (79.00%), followed by families with above 5 members (18.00%). There were only 3.00 percent families with 2 members.

**Experience in farming of farmers:**

Table 6. Experience in farming of farmers

|  |  |  |
| --- | --- | --- |
| **Experience in Farming** | **Frequency** | **Percentage** |
| Up to 5 years | 2 | 1.00 |
| 5 to 10 years | 12 | 6.00 |
| 10 to 15 years | 11 | 5.50 |
| More than 15 years | 175 | 87.50 |
| **Total** | **200** | **100** |

Table 6 showed that the vast majority of respondents87.50 percenthad more than 15 years of experience in farming. A smaller segment, about 6 percent, had between 5 to 10 years of experience, while 5.5 percent reported having 10 to 15 years. Interestingly, only 1 percent of the respondents were relatively new to farming, with less than 5 years of experience.

**Total land holdings of farmers:**

Table 7. Total land holdings of farmers

|  |  |  |
| --- | --- | --- |
| **Total Land (Acre)** | **Frequency** | **Percentage** |
| Below 2 | 20 | 10.00 |
| 2 to 5 | 108 | 54.00 |
| 5 to 10 | 43 | 21.50 |
| 10 to 20 | 25 | 12.50 |
| Above 20 | 4 | 2.00 |
| **Total** | **200** | **100** |

Table 7reflected the landholding size of the respondents, showing that a majority54 percent owned between 2 to5 acres of land. About 21.5 percent of respondents had slightly larger holdings, between 5 to 10 acres, while 12.5 percent reported owning 10 to 20 acres. A smaller segment10 percent had less than 2 acres, indicating the presence of marginal farmers with limited cultivation space. Interestingly, only 2 percent of the respondents had more than 20 acres of land, reflecting that large-scale landownership is rare in this region.

**Main Crops Grown By Farmers Across Different Seasons:**

**Main crops grown by farmers in kharif season:**

Table 8. Main crops grown by farmers in kharif season

|  |  |  |
| --- | --- | --- |
| **Name of main crop in Kharif** | **Frequency** | **Percentage** |
| Groundnut | 200 | 100 |
| **Total** | **200** | **100** |

Table 8 shows that groundnut is the sole crop grown by all respondents during the Kharif season, representing 100 percent of the sample. This indicates a strong reliance on groundnut cultivation in the region during this period.

**Main crop grown by farmers in Rabi(winter) season:**

Table 9. Main crop grown by farmers in Rabi(winter) season

|  |  |  |
| --- | --- | --- |
| **Name of main crop in Rabi(Winter)** | **Frequency** | **Percentage** |
| Potato | 135 | 67.50 |
| Wheat | 38 | 19.00 |
| Mustard | 18 | 9.00 |
| Amaranth | 9 | 4.50 |
| **Total** | **200** | **100** |

Table 9shows the main crops grown during the Rabi (winter) season. Potato emerged as the most commonly cultivated crop, reported by 67.50 percent of the respondents. This was followed by wheat at 19 percent, mustard at 9 percent, and amaranth at 4.50 percent. The data indicates a preference for potato cultivation during Rabi, likely due to its higher market value and better returns. The presence of other crops suggests some level of diversification based on land suitability, market demand, and individual farmer practices.

Main crop grown by farmers in Zayad(summer) season:

Table 10. Main crop grown by farmers in Rabi(winter) season

|  |  |  |
| --- | --- | --- |
| **Name of main crop in Zayad(summer)** | **Frequency** | **Percentage** |
| Groundnut | 129 | 64.50 |
| Pearlmillet | 44 | 22.00 |
| Muskmelon | 22 | 11.00 |
| Watermelon | 5 | 2.50 |
| **Total** | **200** | **100** |

Table 10 shows the main crops grown during the Rabi (winter) season. Groundnut was the most preferred crop, cultivated by 64.50 percent of the respondents. It was followed by pearl millet at 22 percent, muskmelon at 11 percent, and watermelon at 2.5 percent. This distribution indicates that while groundnut remains dominant even in the Rabi season, there is a noticeable shift toward crop diversification based on market preferences, irrigation availability, and land suitability.

**3.2 To find out factors influencing farmers’ preference for biostimulants**

**Farmers’ awareness regarding biostimulants:**

Table 11. Farmers' awareness regarding biostimulants

|  |  |  |
| --- | --- | --- |
| **Awareness regarding biostimulants** | **Frequency** | **Percentage** |
| Yes | 165 | 82.50 |
| No  | 35 | 17.50 |
| **Total** | **200** | **100** |

**Usage of biostimulants among farmers:**

Table 12. Farmers' awareness regarding biostimulants

|  |  |  |
| --- | --- | --- |
| **Usage of biostimulants by farmers** | **Frequency** | **Percentage** |
| Yes | 142 | 86.00 |
| No  | 23 | 14.00 |
| **Total** | **165** | **100** |

**Factors that influencing farmers’ preferances for biostimulants:**

Table 13. Factors that influencing farmers’ preferancesfor biostimulants

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sr.No. | Factors | SD | D | N | A | SA | Total | WAM score | Rank |
| 1 | Dealers / Distributors recommendation | 0 | 5 | 26 | 31 | 80 | 142 | 4.31 | 1 |
| 2 | Effectiveness/ Yield improvement | 0 | 9 | 24 | 48 | 61 | 142 | 4.13 | 2 |
| 3 | Quality | 4 | 9 | 22 | 63 | 44 | 142 | 3.94 | 3 |
| 4 | Co-farmers’ suggestions | 4 | 12 | 31 | 67 | 28 | 142 | 3.73 | 4 |
| 5 | Competitive price | 6 | 20 | 42 | 58 | 16 | 142 | 3.41 | 5 |
| 6 | Ease of application | 7 | 38 | 60 | 23 | 14 | 142 | 2.99 | 6 |
| 7 | Brand | 6 | 36 | 80 | 12 | 8 | 142 | 2.86 | 7 |
| 8 | Environmental safety/ Organic certification | 25 | 46 | 50 | 17 | 4 | 142 | 2.50 | 8 |

(SD- Strongly disagree, D- Disagree, N-Neutral, A-Agree, SA-Strongly agree)(Nemoto and Beglar, 2014 & Guh *et al*. 2008)

Study highlights the factors influencing farmers' preference towards biostimulants. Responses were grouped into five categories: Strongly disagree, Disagree,Neutral,Agree,and Strongly agree. Key factors considered include Dealers/Distributors recommendation, Quality, Co-farmers’ suggestions, Competitive price and other. The importance of each factor was determined using the WeightedAverage Mean (WAM).

The analysis revealed that Dealers/Distributors recommendation ranked as the top influencing factor (WAM 4.31), followed by Effectiveness/ Yield improvement (4.13), Quality (3.94), and Co-farmers’ suggestions (3.73). Competitive price and Ease of application also played significant roles. However, Brand and Environmental safety/Organic certificationwere rated the least influential.

**3.3 To study the problems faced by farmers in adoption of biostimulants**

**Problems faced by farmers in adoption of biostimulants:**

Table 14.Problems faced by farmers in adoption of biostimulants

|  |  |  |  |
| --- | --- | --- | --- |
| F | Factor | Garrett’s Mean Score | Rank |
| F1 | Lack of proper technical knowledge | 74.93 | 1 |
| F2 | Delayed effect | 63.87 | 2 |
| F3 | Poor efficiency | 56.16 | 3 |
| F4 | Fear of crop failure or adverse effects | 50.53 | 4 |
| F5 | High cost | 43.87 | 5 |
| F6 | Limited awareness about the benefits | 36.62 | 6 |
| F7 | Less product range | 25.02 | 7 |

(Christy,2014)

Third objective highlight the problems that faced by farmers and provide insights for adoption of biostimulants in study area.

Seven different problems were ranked based on how farmers rated their severity, from Rank 1 (most significant problem) to Rank 7 (least significant problem).

It further analyzes these responses using Garrett’s mean score ranking. The findings show thatlack of proper technical knowledgearethemostcritical barrier(meanscore:74.93),followedby delayed effect (63.87) and poor efficiency of biostimulants (56.16).Concerns such as fear of crop failure (50.53) and high cost (43.87) were also noted but had comparatively lower impact. Factors like limited awareness about benefits (36.62) and less product range (25.02) were ranked lower.

**3.4To find out the market potential of biostimulants**

The market potential is the number of potential buyers, an average selling price, and estimate of usage for a specific period of time.

Q = n \* q \* p

Where,

Q = total market demand of a Bio stimulant

n = number of farmers in the market

q = quantity purchased by an average farmer per year/month/season/land size and dosage

p = price of an average unit according to the quantity

(Vahoniya & Rajwadi, 2023)

Here took an market potential for example X company’s Biostimulant product “A” in the dantiwada taluka of Banaskantha district was estimated by the information collected from the study and district agriculture office, it is presented in Table 15.

Table 15.market potential for biostimulant product “A”

|  |  |
| --- | --- |
|  | Dantiwada |
| n  | 14977 |
| p  | ₹1,300 |
| q (Quantity used per farmer per season) | 2.7 liters |
| Potential market (liters) | 40,437.9 liters |
| Potential market (Rs.) | **₹5.25 Crore** |

(n = Total number of potential farmers, p = Average selling price, q = Average consumption per season)

The market potential of “A” was calculated using the formula Q = n × q × p, where Q represents the total market demand, n is the number of potential users, q is the quantity used by each farmer per crop season, and p is the price per litre. The price per litre of “A” was taken as ₹1,300 based on current average retail prices for biostimulants products in market. On average, each farmer uses 2.7 liters per season, applying 300 ml per acre across 3 acres with 3 applications per crop season. To determine the number of farmers (n), data from a government census in Dantiwada Taluka was used. By multiplying the number of potential users by the quantity used and the price per unit, the market potential of product “A” in Dantiwada Taluka was estimated to be ₹5.25 crore per crop season.

**4. Conclusion**

The study on factors influencing and problems faced by farmers in the adoption of biostimulants in Gujarat's Dantiwada taluka of Banaskantha districtprovided several findings. According to the survey, results show that majority of farmers were 36 to 50 years old, with 78.00 percent. 79.00 percent of them having 3 to 5 family members. Most farmers occupation is farming plus animal husbandrty and the income of majority farmer is between 1 lakh to 5 lakh. Also, Total land holding of farmers is between 2 to 5acre. The main crop in kharif season was Groundnut with 100 percent. The main crop in rabi season was potato followed by wheat, mustard, amaranth. And in zayad season Groundnut was main crop followed by Pearlmillet, Muskmelon, Watermelon. In the survey, it was observed that 82.50 percent farmers were aware about biostimulants and among them 86 percent have used biostimulant in field. Also, they strongly believed that application of biostimulant helps in bloom more flower of and increase crop yield. Acording to study most of farmers were influencing with a dealers/distributors recommendation. In the problems of adoption of biostimulants was lack of proper technical knowledge followed by delayed effect.Furthermore, the market potential analysis for biostimulant reveals promising prospects within the Dantiwada area, with a sizable market share and considerable demand for biostimulants.

**References**

1. Ameen, A., & Raza, S. (2017). Green revolution: a review. *International Journal of Advances in Scientific Research*, 3(12), 129-137.
2. Chojnacka, K. (2015). Innovative bio-products for agriculture. *Open Chemistry, 13*(1), 932-937. [doi.org/10.1515/chem-2015-0111](https://doi.org/10.1515/chem-2015-0111)
3. Christy, R. J. (2014). Garrett’s ranking analysis of various clinical bovine mastitis control constraints in Villupuram district of Tamil Nadu.*Journal of Agriculture and Veterinary Science*, *7*(4), 62-64.
4. Deshmukh, M. S., Ghagare, T. N., Nanaware, D. R., Vadrale, K. S., & Sutar, S. S. (2023). *Synthetic agricultural inputs and its impact on foodgrains and human health* (Preprint). Research Square. <https://doi.org/10.21203/rs.3.rs-3046136/v1>
5. Giraldo, J. D., Garrido-Miranda, K. A., & Schoebitz, M. (2023). Chitin and its derivatives: Functional biopolymers for developing bioproducts for sustainable agriculture-A reality, *Carbohydrate Polymers, 299*, 120196.
6. Guh,Y.Y.,Po,R.W.,&Lee,E.S.(2008).Thefuzzyweightedaveragewithinageneralized means function. *Computers & Mathematics with Applications*, *55*(12), 2699-2706.
7. Gyeltshen, K. (2021). Agricultural chemical inputs and their impact on South Asian agriculture. In K. Gyeltshen, S. Attaluri, & M. B. Hossain (Eds.), *Impact of Agricultural Chemical Inputs on Human Health and Environment in South Asia* (pp. 1-21). SAARC Agriculture Centre.
8. Markets and Markets. (2023). Global biostimulants market: Industry trends, share, size, growth, opportunity and forecast 2023-2030. Retrieved from <https://www.marketsandmarkets.com/Market-Reports/biostimulant-market-1081.html>
9. Nelson, A. R. L. E., Ravichandran, K., & Antony, U. (2019). The impact of the green revolution on indigenous crops of India. *Journal of Ethnic Foods, 6*(1), 1-10. <https://doi.org/10.1186/s42779-019-0011-9>
10. Nemoto, T., & Beglar, D. (2014). Developing Likert-scale questionnaires. In N. Sonda & A. Krause (Eds.), JALT2013 Conference Proceedings (pp. 1–8). Tokyo: Japan Association for Language Teaching.
11. Papnai, N., Chaurasiya, D. K., & Sahni, S. (2022). Biostimulants: concept, types and way to enhance soil health. *International Journal of Plant & Soil Science*, *34*(20), 24-40.
12. Patel, N., Sharma, D., & Kumar, V. (2022). Role of biostimulants in mitigating abiotic stress in Indian crops. *Indian Journal of Plant Science*, 19(4), 89-102.
13. Sharma, N., & Singhvi, R. (2017). Effects of chemical fertilizers and pesticides on human health and environment: A review. *International Journal of Agriculture, Environment and Biotechnology,* 10(6), 675-679. <http://dx.doi.org/10.5958/2230-732X.2017.00083.3>
14. Sharma, R., & Kumar, S. (2020). Impact of biostimulant application on yield and quality of vegetable crops in India. *Asian Journal of Agricultural Science*, 32(1), 67-80.
15. Singh, J., & Yadav, A. N. (Eds.). (2020). *Natural bioactive products in sustainable agriculture*. Springer. <https://doi.org/10.1007/978-981-15-3024-1>
16. Swaminathan, M. S., & Kesavan, P. C. (2015). The transition from Green to Evergreen Revolution. *EC Agriculture*, *2*(1), 271–276.
17. Unger, C. R. (2014). India’s Green Revolution: Towards a New Historical Perspective. *Südasien-Chronik-South Asia Chronicle*, (4)254-270.
18. Vahoniya D. R. and Rajwadi A. (2023). Market and market potential: A conceptual paper. Theoretical Biology Forum, 12(2), 341-349. DOI: <https://doi.org/10.61739/TBF.2023.12.2.341>
19. Verma, P., Singh, D., Pathania, I. P., Aggarwal, K. (2019). Strategies to improve agriculture sustainability, soil fertility and enhancement of farmers income for the economic development. In P. S. Panwar, M. Bhardwaj, & R. Prasad (Eds.), *Soil fertility management for sustainable development* (pp. 43–70). Springer.