

Market Segmentation Analysis for a Biopesticide Start-up

By: Team 4

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Abstract

Market Segmentation analysis was done on Indian agricultural datasets to identify the best region and state for a Biopesticide startup to enter into the market in regards to their first release. Different factors were analysed through data visualisation and clustering for the company to make a choice based on their products.

Introduction

Biopesticides are crop protection products derived from natural sources that are used to control pests, pathogens and weeds by a variety of means. Biopesticides are generally grouped into two major categories: microbial and biochemical.

- Microbial pesticides use living organisms such as bacteria, fungi, viruses, protozoans and yeasts.
- Biochemical pesticides use naturally occurring, bioactive compounds that control pests by non-toxic mechanisms. These include plant extracts, semiochemicals/pheromones (organic compounds that organisms use to transmit chemical messages) and organic acids.

One of the main differences between bioactive crop protection products and conventional agrochemicals is selectivity. Conventional agrochemicals tend to be broad-spectrum products that impact many different kinds of organisms. These products allow farmers to control numerous pests with one agrochemical, but can also negatively impact other non-harmful species in the environment.

Biopesticides tend to be highly targeted to specific pests. Because they are so targeted, they are generally considered to be more environmentally friendly than synthetic agrochemicals. For example, *Bacillus thuringiensis* (Bt), a bacterium commonly used as a microbial pesticide, comes in many different strains and subspecies, each of which kills one specific insect or a few closely related insect species. The protein each strain of Bt produces is highly specific to the target insect species, and harmless to other organisms (including humans and animals).

Overview

With an ever growing population, the need of the hour in India is its extreme food necessity. The primary hindrance towards these needs is crop failure and pest infestation. Pesticides are substances that kill, repel, control or prevent pests from harming the crops. There are several categories of pesticides. They include herbicides for reducing the effects of weeds, insecticides for controlling insects that feed on the crops, fungicides to refrain any detrimental fungal growth and mildew, disinfectants for preventing bacterial infestation, and chemical compounds used to control mice and rats.

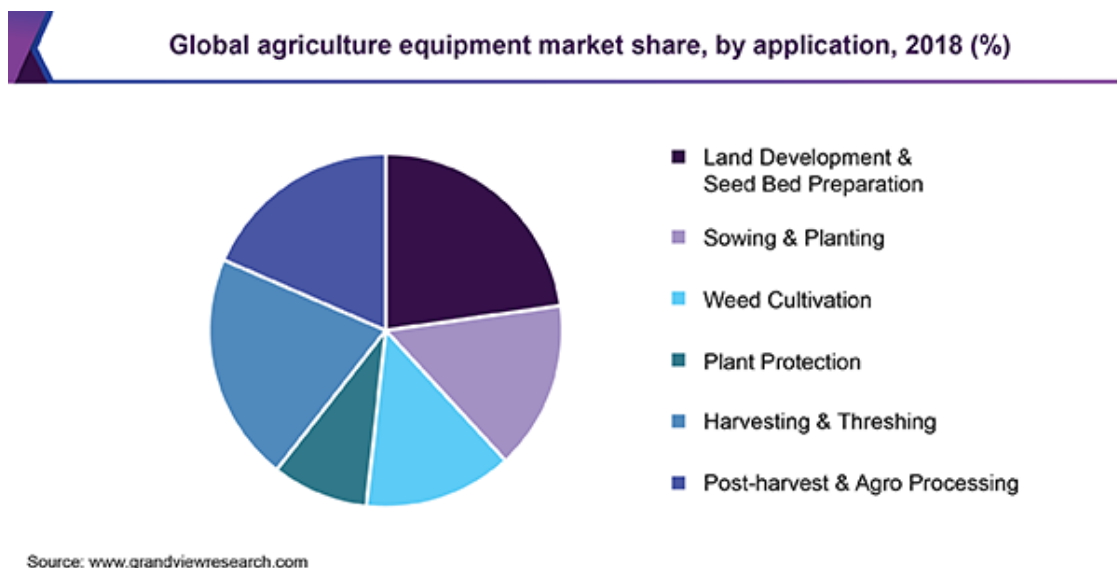
The Indian pesticides market reached a value of INR 232 Billion in 2020. It is estimated that in the past few years, pests have eaten away approximately 20-25% of the total crops being grown. This requires severe measures to be taken in order to limit the amount of damage on the yield. Pesticides play a crucial role in protecting the crops and their importance has risen noticeably in the last few decades and is expected to grow moderately in the next five years.

As mentioned previously, India's increasing population needs to be supplied with an adequate amount of food. This is less likely to happen as the amount of cultivable land has been reducing due to climate change, urbanization, and bad agricultural practices. This area is expected to go down further. This puts us in a difficult situation if the pest infestation losses are not taken care of, keeping in mind the rising food demand.

Synthetic pesticide role in market and how is biopesticide doing in the market

The global pesticides market size reached a value of nearly \$84.5 billion in 2019, having grown at a compound annual growth rate (CAGR) of 4.2% since 2015, and is expected to grow at a CAGR of 11.5% to nearly \$130.7 billion by 2023. Chemical pesticide products have a major chunk of the market under their control. However, the Biopesticide market is projected to grow at a CAGR of 14.7% from an estimated value of USD 4.3 billion in 2020 to reach USD 8.5 billion by 2025. Due to the pollution, soil degradation and bioaccumulation of synthetic pesticides, Biopesticides are now being chosen by a significant amount of the population. Biopesticide products are mainly used for fruits & vegetables, cereals & grains, and oilseeds & pulses. In most recent times, there is also an increase in demand for biopesticides from recreational parks, theme parks, and golf courses to control pests

The development of synthetic crop protection products is expensive. A typical synthetic product manufacturing process requires extensive R&D activities and has to go through regulatory approvals as opposed to biopesticides that are relatively less expensive and have quick development processes. Due to its cost-effectiveness, smaller companies/start-ups are venturing into this market with limited research budgets. This has led to intense competition for the major players in the agricultural biologicals market. According to secondary sources, since 1960, there has been a steady increase in demand for chemical active ingredients as a consequence of the rise in R&D investments, due to which there was a surge in the introduction of active ingredients between the 1980s and 1990s. However, the same has reduced over the last two decades. The lengthy timeline for the introduction has a clear indication that key companies are moving toward alternative sustainable solutions to control pests. Thus, the demand for biopesticides is projected to increase during the study period.



Market Overview

Agriculture is the primary source of livelihood for about 58% of India's population. Gross Value Added by agriculture, forestry, and fishing was estimated at Rs. 19.48 lakh crore (US\$ 276.37 billion) in Fiscal Year (FY) 20. Share of agriculture and allied sectors in gross value added (GVA) of India at current prices stood at 17.8 % in FY20. Consumer spending in India will return to growth in 2021 post the pandemic-led contraction, expanding by as much as 6.6%.

The Economic Survey of India 2020-21 report stated that in FY20, the total food grain production in the country was recorded at 296.65 million tonnes—up by 11.44 million tonnes compared with 285.21 million tonnes in FY19. The government has set a target to buy 42.74 million tonnes from the central pool in FY21; this is 10% more than the quantity purchased in FY20. For FY22, the government has set a record target for farmers to raise food grain production by 2% with 307.31 million tonnes of food grains. In FY21, production was recorded at 303.34 million tonnes against a target of 301 million tonnes. The organic food segment in India is expected to grow at a CAGR of 10% during 2015-25 and is estimated to reach Rs. 75,000 crore (US\$ 10.73 billion) by 2025 from Rs. 2,700 crore (US\$ 386.32 million) in 2015.

India is expected to achieve the ambitious goal of doubling farm income by 2022. The agriculture sector in India is expected to generate better momentum in the next few years due to increased investment in agricultural infrastructure such as irrigation facilities, warehousing and cold storage. Furthermore, the growing use of genetically modified crops will likely improve the yield for Indian farmers. India is expected to be self-sufficient in pulses in the coming few years due to concerted effort of scientists to get early maturing varieties of pulses and the increase in minimum support price.

Agricultural Marketing continues to be the mainstay of life for the majority of the Indian population. It contributes around 25% of the GDP and employs 65% of the workforce in the country. The Government of India under the ministry of agriculture has also set up specific commodity Boards and export promotion councils for monitoring and boosting the production, consumption, marketing and export of various agricultural commodities. Some of these organisations /boards are Cotton Corporation of India (CCI), Jute Corporation of India (JCI), Tea Board, Coffee Board, Spice Board, National Horticulture Board (NHB), National Agricultural Marketing Federation (NAFED), Agricultural Products Export Development Authority (APEDA), etc. Most agricultural commodity markets generally operate under the normal forces of demand and supply. However, with a view to protect farmer's interest and to encourage increased production, the government also fixes minimum support price (MSP) for some crops like Paddy, Wheat, Jute etc. as public policy instruments. The government also promotes organised marketing of agricultural commodities in the country through a network of regulated markets. There are 7161 Wholesale Regulated Markets in the country as on 31.3.2001. Besides, there are also 7293 Wholesale Markets and 27,294 Rural Periodic.

Increasing the adoption rate of organic cultivation in India is a major driving factor for biopesticides in the country. According to the Research Institute of Organic Agriculture, the area under organic cultivation in India was 1.5 million hectare in 2016, which increased to 1.9 million hectare in 2018. According to the Government of India, the area under organic farming covered across the country under the schemes Paramparagat Krishi Vikas Yojana (PKVY), Mission

Organic Value Chain Development for North Eastern Region (MOVCDNER) and National Programme of Organic Production (NPOP) is 23.02 lakh hectares.

The advent of regulated markets Regulated markets have helped in mitigating the market handicaps of producers/sellers at the wholesale assembling level. But, the rural periodic markets in general, and the tribal markets in particular, remained out of its developmental ambit. It was envisaged that physical markets with facilities and services would attract the farmers and the buyers creating a competitive trade environment thereby offering best of the prices to the producers/sellers. Presently, about 23 Agricultural Produce Market Acts are in force in various States and UT in the country for enforcing and facilitating organised agricultural marketing functions. In most States, there are a number of rural primary markets which serve, on an average, an area within a radius of 8-16 KM. The secondary assembling market serves, on an average, about 500 Sq.Km.

Market segmentation

Market segmentation is a decision-making tool for the marketing manager in the crucial task of selecting a target market for a given product and designing an appropriate marketing mix. It is one of the key building blocks of strategic marketing. Market segmentation is essential for marketing success, the most successful firms drive their businesses based on segmentation of market strategically and targeting the market spaces by identifying the differences in demands of different types of markets. It lies at the heart of successful marketing.

At its core, market segmentation is the practice of dividing your target market into approachable groups. Market segmentation creates subsets of a market based on demographics, needs, priorities, common interests, and other psychographic or behavioural criteria used to better understand the target audience.

Market segmentation means cutting markets into slices. Ideally, consumers belonging to the same market segments or sets of buyers are very similar to one another with respect to the consumer characteristics deemed critical by management. At the same time, optimally, consumers belonging to different market segments are very different from one another with respect to those consumer characteristics deemed critical to market segmentation by management are referred to as segmentation criteria.

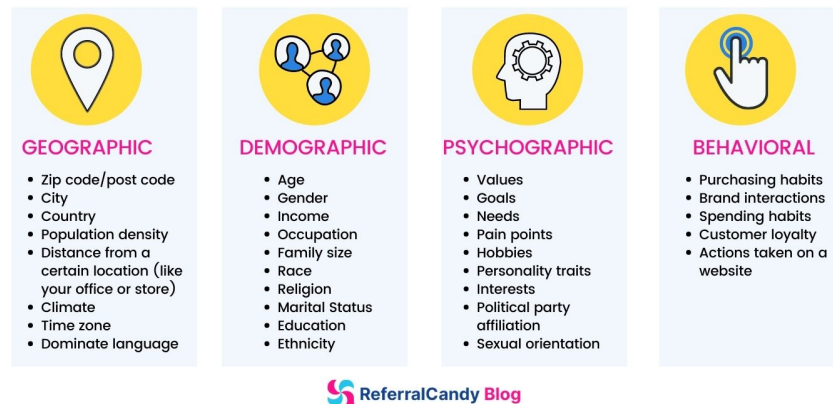
The goal of market segmentation is to develop detailed profiles of each market segment. Once these segments are clearly defined, we choose the segments with the highest potential of buying their products and services. To achieve that goal, we go through a three-step process that clarifies who people are and why they buy products.

1. Segment. We divide the market into categories based on shared traits.
2. Target. They choose the market or target, who are most likely to buy their products.
3. Position. We research what product, price, promotion, and place combinations will attract customers to buy their products.

Once we isolate their target audience, they must define what is different about their product? Is it better, faster, cheaper, or more advanced than competitive products? To answer

that question, it should be understood that the target audience's problems and how they can creatively solve those problems. Companies create a competitive advantage for themselves through product differentiation, helping their products and services stand out as solutions for buyers' issues.

THE 4 TYPES OF MARKET SEGMENTATION



There are many ways to segment markets to find the right target audience. Five ways to segment markets include **demographic**, **psychographic**, **behavioural**, **geographic**, and **firmographic** segmentation.

Demographic segmentation assumes that people with common characteristics will have similar lifestyle patterns, tastes, and interests that will influence their purchasing habits. Demographics are often combined with other segmentation approaches to develop target markets with the greatest likelihood of buying their products. Demographics include factors like age, gender, occupation, income, and education. Surveys are one way to collect demographic information.

The advantage of demographic segmentation is that it is easy to collect. Government sources provide household, income, education, and health data for marketing strategy and business goals. Companies have also developed apps that track more granular demographic data for contact tracing and travel patterns. Surveys also reveal the specific demographics of a target market instead of available research data sources and uncover actionable insights. When combined with behaviour traits and other variables, demographic segmentation provides valuable insights to understand which specific customers within their target market will buy products and better understand how to reach them with the right marketing messages.

Using demographics and behaviours, they can identify:

- How big the market opportunity is for their product.
- How their brand compares to the competition.
- Which demographics are most likely to buy our product or service.
- Which advertising campaigns will resonate best with their target market.

Psychographic segmentation divides people into groups based on their personality, lifestyle, social status, activities, interests, opinions, and attitudes. Psychographics are an excellent complement to demographics because they identify the motivations behind why people make particular choices. Psychographics for market segmentation can be used to understand :

- How consumers perceive their products and services
- What consumers really want—and why
- Gaps or pain points with their current products or services
- Opportunities for future engagement
- How to better communicate with their target audience

We can collect the psychographic information using three types of survey questions.

1. Open-ended questions that use a qualitative approach include a question like, “What is your biggest challenge with...” will provide a deeper understanding of the respondent's problems.
2. Likert scale questions show how much the respondent agrees or disagrees with a statement, like “strongly agree” to “strongly disagree,” letting us know how important the topic is to them.
3. Semantic differential scale questions ask people to rate a product, brand, company, or other attributes, helping us understand their attitude.

Behavioural segmentation describes specific steps in their ideal customer's buying process, including what their ideal customers want, why they want it, the benefits sought, and how they go about getting their needs met. It is used to study B2C and B2B market segments. When companies understand why people buy, they can better target their marketing messaging. behaviours can include:

- **Purchasing reason** : Are buyers searching for the best price, excellent ratings, safety considerations, or other criteria? What problem are they trying to solve?
- **Occasion or event** : Are consumers buying for a holiday or anniversary? Are B2B buyers trying to use up their budget before year-end?
- **Product benefits** : Is the buyer looking to purchase the latest technology, safest product, or be the first to buy the newest product?
- **Buyer's journey stage** : Does the buyer want information for a future purchase? Or are they looking to try out the brand for the first time?
- **Engagement level** : Is the buyer a die-hard fan looking for the latest product?

Geographic segmentation allows us to group people based on where they live, work, or travel. The location has a significant influence on buying habits that we can use to develop their marketing messages.

We can use various geographic segmentation variables that include the country, region, state, province, town, climate zone, or zip code. Culture and population density (urban or rural)

are also crucial variables to include in their market research. These location variables will influence what problems people have in that region and how we can solve it.

Where a person lives can influence everything from their food choices to the car they drive. Cultural norms of the area influence their beliefs, causing them to choose one product over another. For instance, working in an office in a big city versus working from home will affect what they wear and what technology they use. Travel destinations also use geographic marketing to promote hotels, activities, and restaurants in the area.

The benefit of geographic segmentation is that the data is relatively easy to collect through online data sources. Marketers can also hone their messaging to the target audience of a specific location or combine it with other segmentation variables, like demographics, to build a complete profile of their target market.

Firmographic segmentation is to B2B marketers what demographics is for B2C marketers. Firmographics explain their business target market characteristics and include their industry, number of employees, legal status, company size, financial standing, and other business-related variables.

A B2C market may have thousands of customers, but a B2B target market may have only a few large commercial companies in their target market. Firmographics provide information for marketers who want to understand companies' strengths and viability within their target market. They focus on their financial performance and growth trends to see if the market segment is growing or experiencing a decline.

Firmographic data is available through online sources like federal and state government websites, trade journals, and other industry sources. Marketers also use surveys to collect specific data about their B2B target market.

Benefits of market segmentation

Market segmentation is the basis for successful product concepts, launches, marketing messages, advertising, and other critical marketing activities. Companies invest crucial resources into understanding their ideal customer's problems to solve those challenges with valuable products and services.

- Better advertising campaigns
- Develop on-target products
- Identify new trends and opportunities
- Provide input to business operations
- Establish brand trust



Target market

The ideal target segment for any Agri-Tech startup based on geographics, demographics, psychographics and behaviour will be an Area that is highly active in agricultural practises, has a good mean income from agricultural sales, is composed of well-educated and has an eco-friendly population. Due to boundless advances in agricultural practices and an integration of modern technology into harvesting, seed design and irrigation, many states in India have gone on to be the leading producers of food crops. These areas would be focussed on primarily. Regions with an extensive demand and low supply of biopesticides, regions with high chemical pesticide consumption must be kept in mind while segmenting the region. This is because a high amount of unconverted chemical pesticide users can be targeted with an effective marketing plan to persuade them to use biopesticides. Regions where the local government provides incentives for organic farming must also be considered while choosing a segment.

Process of implementation

The procedure involved in this analysis requires us to narrow down on the states with the highest amount of agricultural crop production. The analysis can be done through various exploratory data analysis and data visualisation tools.

Loading Dataset

The data contains details about each state's Area under cultivation in different agricultural seasons, and also the unit production in each area.

```
[ ] df = pd.read_csv("/content/drive/MyDrive/Colab Notebooks/crop_production.csv")
df.head()
```

	State_Name	District_Name	Crop_Year	Season	Crop	Area	Production
0	Andaman and Nicobar Islands	NICOBARS	2000	Kharif	Arecanut	1254.0	2000.0
1	Andaman and Nicobar Islands	NICOBARS	2000	Kharif	Other Kharif pulses	2.0	1.0
2	Andaman and Nicobar Islands	NICOBARS	2000	Kharif	Rice	102.0	321.0
3	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Banana	176.0	641.0
4	Andaman and Nicobar Islands	NICOBARS	2000	Whole Year	Cashewnut	720.0	165.0

```
[ ] df.isna().sum()
```

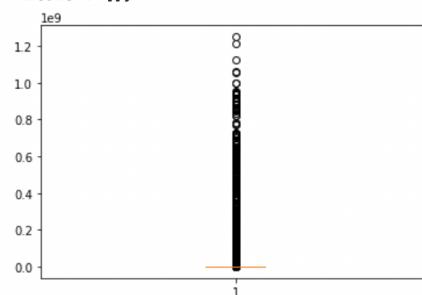
```
State_Name      0
District_Name   0
Crop_Year       0
Season          0
Crop            0
Area            0
Production      3730
dtype: int64
```

Exploratory Data Analysis

The distribution of production in each state is expressed through this box-plot:

```
[ ] plt.boxplot(df.Production)
```

```
{'whiskers': [<matplotlib.lines.Line2D at 0x17362c4ff08>,
<matplotlib.lines.Line2D at 0x17362cae088>],
'caps': [<matplotlib.lines.Line2D at 0x17362e39f48>,
<matplotlib.lines.Line2D at 0x17362e605c8>],
'boxes': [<matplotlib.lines.Line2D at 0x17362ce3e88>],
'medians': [<matplotlib.lines.Line2D at 0x17362e69dc8>],
'fliers': [<matplotlib.lines.Line2D at 0x17362e7bf48>],
'means': []}
```



A sorted list of the top 10 states whose production value was high from the years 1997 to 2014 was found in the block below:

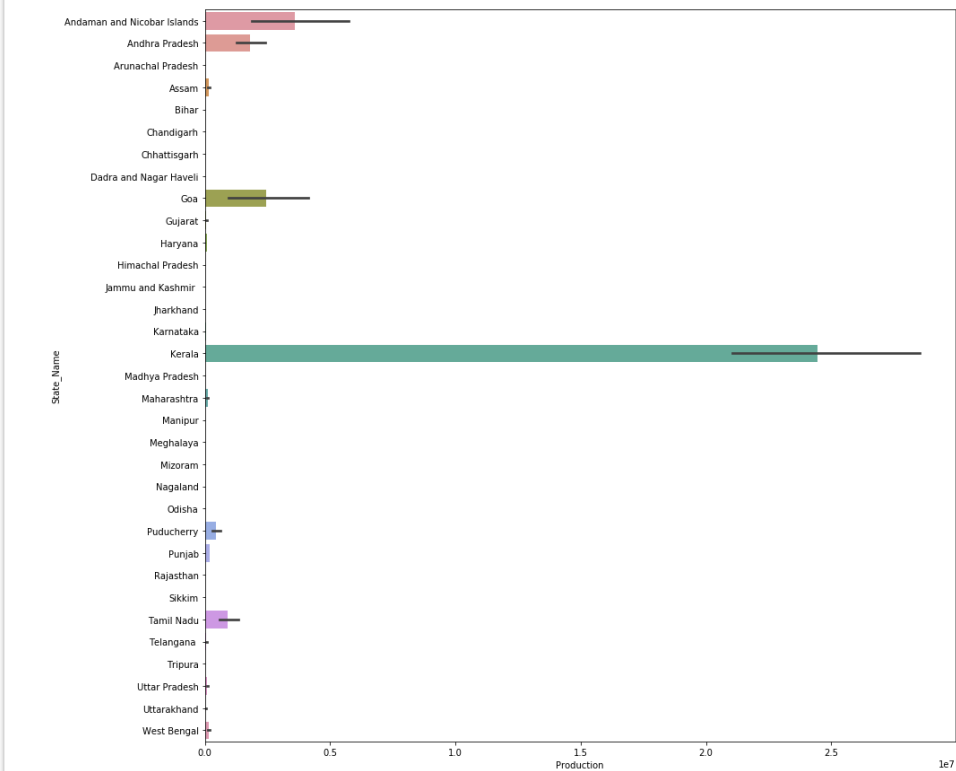
```
[ ] Prod = df.groupby(by = df.State_Name)['Production','State_Name'].sum().reset_index().sort_values(by = 'Production',
Prod
```

C:\Users\SAI TEJA\miniconda3\lib\site-packages\ipykernel_launcher.py:1: FutureWarning: Indexing with multiple keys (i
 """Entry point for launching an IPython kernel.

	State_Name	Production
15	Kerala	9.788005e+10
1	Andhra Pradesh	1.732459e+10
27	Tamil Nadu	1.207644e+10
30	Uttar Pradesh	3.234493e+09
3	Assam	2.111752e+09
32	West Bengal	1.397904e+09
17	Maharashtra	1.263641e+09
14	Karnataka	8.634298e+08
0	Andaman and Nicobar Islands	7.182232e+08
24	Punjab	5.863850e+08

Using the above data, a bar plot was made:

```
plt.figure(figsize= (15,15))
sn.barplot(x=df['Production'],y= df["State_Name"], orient='h');
```

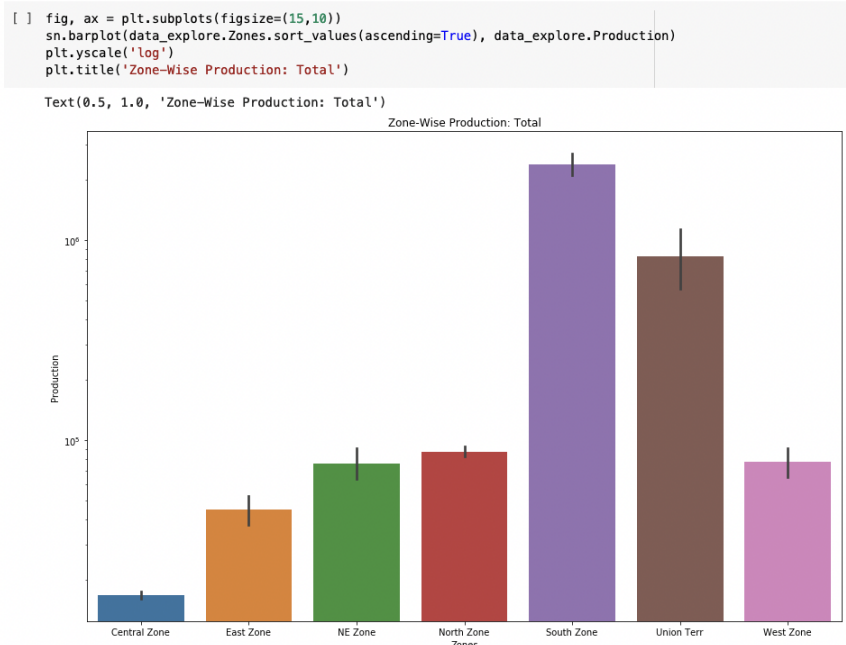


From the graph, it is quite evident that Kerala is one of the few states that has the highest crop production which is followed by A&N islands.

Comparing this with the data we have curated by gathering several datasets from <http://ppqs.gov.in/statistical-database> we will be able to narrow down on several high production states that also happen to be using pesticides in a huge quantity. The data is as follows:

S. No.	States/UTs	Average Consumption of Chemical pesticide between 2016-2021	Average Demand for Chemical pesticide between 2016-2021	Average Consumption of Biopesticide between 2016-2021	Average Demand for Biopesticide between 2016-2021	Number of Pesticide sale points
1	Maharashtra	13367	15165	1168	3294	35739
2	West Bengal	3211	4080	962	1243	15741
3	Kerala	840	837	753	792	1476
4	Chhattisgarh	1685	3002	491	631	5604
5	Karnataka	1562	1900	536	630	9600
6	Tamil Nadu	1996	2070	580	606	8148
7	Madhya Pradesh	593	718	416	468	19114
8	Bihar	865	1197	340	448	3054
9	Haryana*	4068	4240	402	421	11901
10	Gujarat	1674	1977	318	334	19946
11	Orissa	1313	1134	277	306	2970
12	Tripura*	335	427	147	281	81
13	Assam	326	354	225	235	4370
14	Punjab	5482	5996	208	225	11597
15	Telangana	4619	5854	155	187	8972
16	Rajasthan	2257	2336	66	95	17030
17	Uttar Pradesh	11252	11068	47	47	43660
18	Andhra Pradesh	1712	3960	8	46	12057
19	Jammu & Kashmir*	2525	2780	2	2	4555
20	Himachal Pradesh	414	827	3	2	2539

This data is sorted in a descending order in terms of Average demand for biopesticides from years 2016-2021. This provides us with some insights regarding states that are actively seeking biopesticides but also have a good amount of population for us to convert into customers.

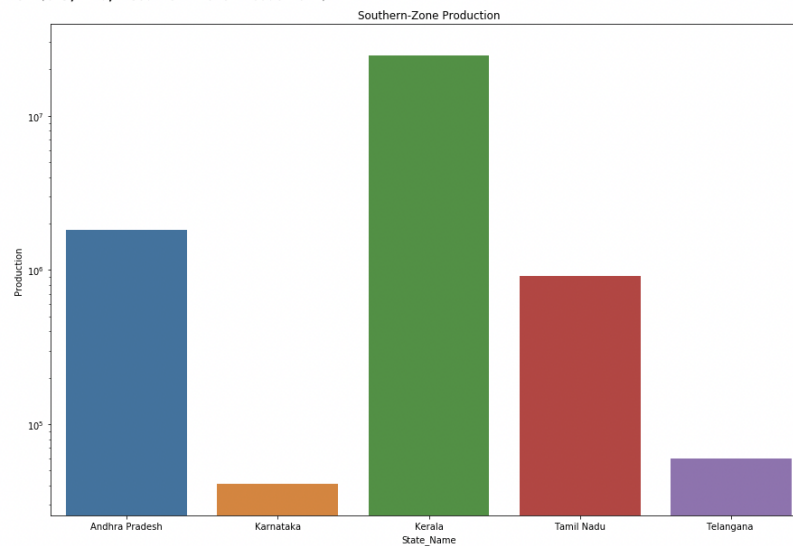


Data was further explored after dividing states to zones for us to narrow down on regions with most production. From the above plot, we can observe that the Southern Zone states have a higher production overall.

The below plot explores the contribution of each state to the overall production.

```
[ ] south_zone = data_explore[(data_explore["Zones"] == 'South Zone')]  
fig, ax = plt.subplots(figsize=(15,10))  
sn.barplot(south_zone.State_Name, south_zone.Production, errwidth=0)  
plt.yscale('log')  
plt.title('Southern-Zone Production')
```

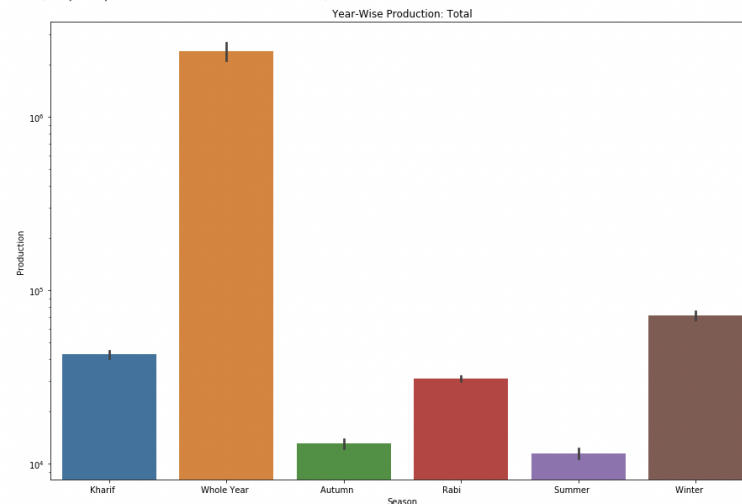
Text(0.5, 1.0, 'Southern-Zone Production')



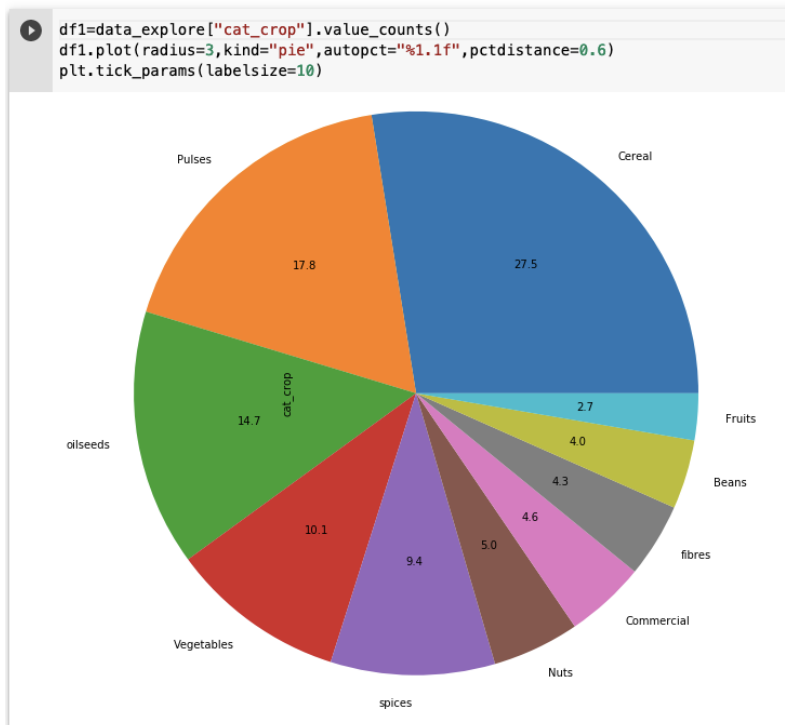
Further analysis to reveal the distribution of production in different times of a year reveals that crop production is the highest in Winter and Kharif.

```
[ ] fig, ax = plt.subplots(figsize=(15,10))  
sn.barplot(data_explore.Season, data_explore.Production)  
plt.yscale('log')  
plt.title('Year-Wise Production: Total')
```

Text(0.5, 1.0, 'Year-Wise Production: Total')

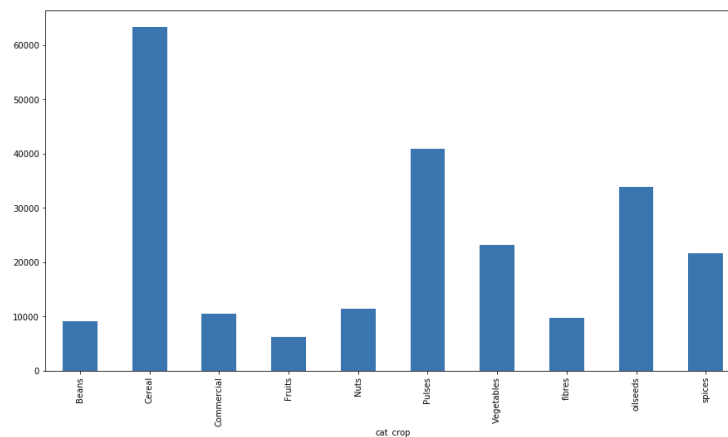


A plot was obtained to understand different categories of crop produced and this analysis reveals that Cereals, Pulses and Oilseeds are the crops that are most cultivated.



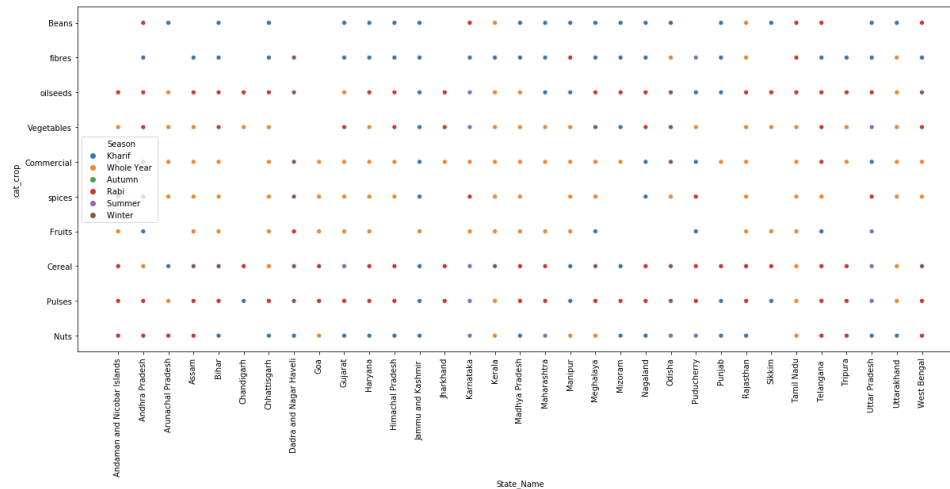
An in depth analysis to understand which season is the most feasible for southern and northern states to produce crops helped us understand that States in the south zone produced a variety of crops throughout the year. Whereas the northern states showed better activity in Kharif, Rabi and Summer.

```
[ ] plt.figure(figsize=(15,8))
plt.tick_params(labelsize=10)
data_explore.groupby("cat_crop")["Production"].agg("count").plot.bar()
plt.show()
```



Top crop categories are Cereal, Pulses and Oilseeds.

```
[ ] plt.figure(figsize=(20,8))
sn.scatterplot(data=data_explore,x="State_Name",y="cat_crop",hue="Season")
plt.xticks(rotation=90)
plt.show()
```



South zone: i. Top producing state Kerala shows a abundance of whole year seasonal crops

North Zone: ii. Top producing state Uttar Pradesh shows abundance of Kharif, Rabi and Summer crops

K-means Clustering:

1. Introduction:

K-Means Clustering is one of the Unsupervised learning algorithms that involves grouping the entries into K different clusters. Each cluster consists of a group of entries that have very close input values.

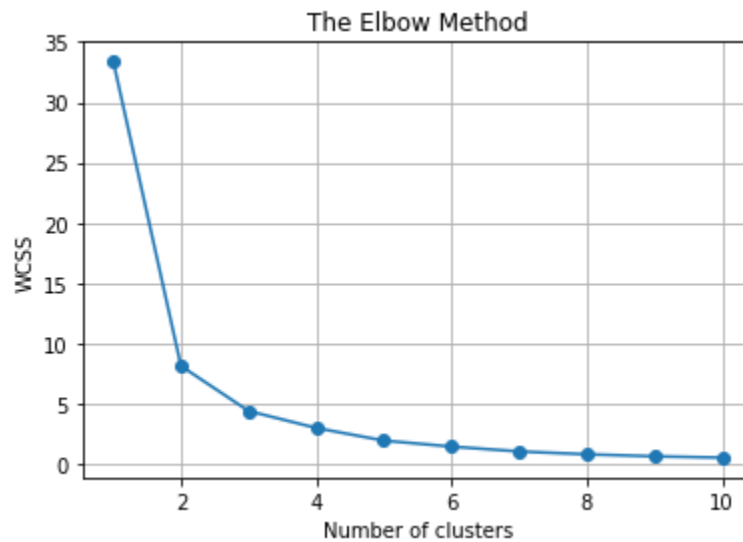
It helps us discover clusters of similar data points that are hard to view through a tabular form without any training. The centroid-based algorithm employed in K-Means clustering minimises the distance between the centroid of the cluster and its corresponding elements. The centroid of the cluster keeps changing as more and more elements are added to the group.

As input, we enter the dataset with state names and respective factor values. The algorithm goes through each entry and separates them into K-number of clusters. The value of K must be determined through the elbow method.

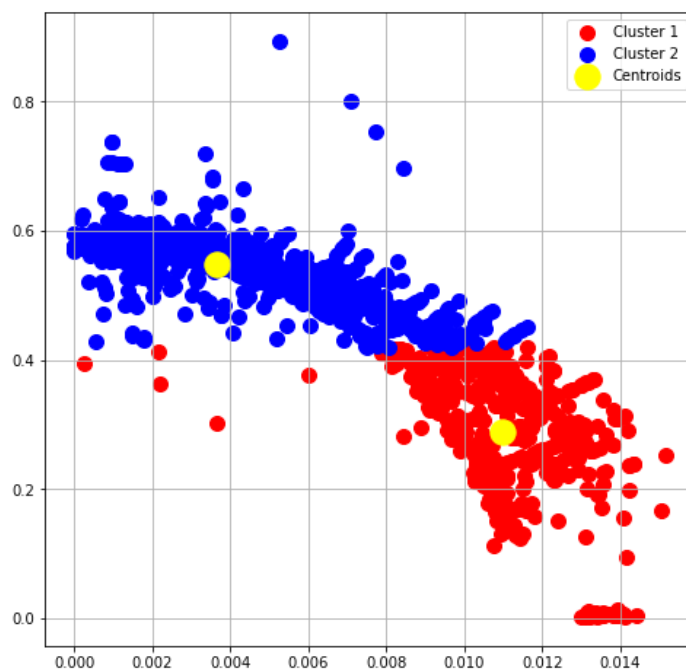
2. Elbow Method:

The Elbow method involves changing the number of clusters (K) from 1 to 10. For each value of K, the Within-Cluster Sum of Squares (WCSS) is calculated. WCSS is the summation of squared distance for each point from the centroid in a cluster. An elbow shape is obtained after plotting the WCSS values against each K value. When the number of clusters increase, the WCSS value decreases.

WCSS value is largest when $K = 1$. When we analyze the graph we can see that the graph will rapidly change at a point and thus creating an elbow shape. From this point, the graph starts to move almost parallel to the X-axis. The K value corresponding to this point is the optimal K value or an optimal number of clusters.



From the above graph, it is clear that the elbow point is at $K = 2$. Hence there are two major clusters in the data set. Now we can plot a graph and identify those two clusters.



From the plot, we can clearly identify two clusters and the centroids of those clusters are indicated with Yellow Dots. These yellow dots represent the center of each cluster formed in the data. These clusters are reasonably far from each other and are easily separable indicating the

diversity among the customers. Hence the company can easily choose their target customers from the clusters.

Conclusion

In conclusion, to be able to segment the market properly and obtain a suitable region to establish the startup in, it is imperative for the company to consider the area of production, production efficiency, seasons in which the regional farmers are active, what crops are the most popular among the given region, which regions are aware about organic farming, which regions are willing to convert to biopesticide users, chemical pesticide consumption and demand along with biopesticide consumption and demand. Although it is quite difficult to narrow down onto one or two areas, It would be a safer step to take the business forward in the Southern region as a variety of crops are produced throughout the year and a majority of crop production occurs in Kerala. But Uttar Pradesh is also a good place to start since it is one of the leading crop producers in India. Uttar Pradesh is also one of the top states in India which has a huge market for chemical pesticides. With appropriate advertising and help from the government policies, it is possible to carve a niche for ourselves as pioneers in the north Indian agricultural market.

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2. <https://www.businesswire.com/news/home/20210921005919/en/Indian-Pesticides-Market-Report-2021-Trends-Share-Size-Growth-Opportunity-and-Forecast-Report-2020-2026---ResearchAndMarkets.com>
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4. <https://inside.battelle.org/blog-details/biopesticides-vs.-conventional-pesticides>
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