

# Indian Agriculture Analysis

by Group 14

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## India's agriculture overview

- ▶ Agriculture in India largest economic sector
- ▶ Important in development of nation and economy due to enormous size.
- ▶ Rice and wheat among the most important crops
- ▶ Agriculture has major portion of the Indian economy and employs a large section of society.
- ▶ It is highly inefficient and unscientific.
- ▶ Problems can be solved by proper analysis of the agricultural data

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1. Finding trends in crops in terms of production, area, etc. over the years and studying the reasons behind the changing trends.

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1. Finding trends in crops in terms of production, area, etc. over the years and studying the reasons behind the changing trends.
2. Finding how different factors that affect production are related to each other.

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1. Finding trends in crops in terms of production, area, etc. over the years and studying the reasons behind the changing trends.
2. Finding how different factors that affect production are related to each other.
3. Prediction of suicide rate of the farmers.

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1. Finding trends in crops in terms of production, area, etc. over the years and studying the reasons behind the changing trends.
2. Finding how different factors that affect production are related to each other.
3. Prediction of suicide rate of the farmers.
4. Study of crops that do not follow the general trends and show an abnormal trend such as reduction in production.

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1. Finding trends in crops in terms of production, area, etc. over the years and studying the reasons behind the changing trends.
2. Finding how different factors that affect production are related to each other.
3. Prediction of suicide rate of the farmers.
4. Study of crops that do not follow the general trends and show an abnormal trend such as reduction in production.
5. Finding similar crops and similar states based on various factors.



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1. Finding trends in crops in terms of production, area, etc. over the years and studying the reasons behind the changing trends.
2. Finding how different factors that affect production are related to each other.
3. Prediction of suicide rate of the farmers.
4. Study of crops that do not follow the general trends and show an abnormal trend such as reduction in production.
5. Finding similar crops and similar states based on various factors.
6. Predictions of crops that might be rarely produced

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2. Finding how different factors that affect production are related to each other.
3. Prediction of suicide rate of the farmers.
4. Study of crops that do not follow the general trends and show an abnormal trend such as reduction in production.
5. Finding similar crops and similar states based on various factors.
6. Predictions of crops that might be rarely produced
7. Crops that might be preferred by the farmers.

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## Sources for data

- ▶ <https://www.kaggle.com/>
- ▶ <https://data.gov.in/search/site?query=crops>
- ▶ Indian exports website

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# Data Collection

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No.	Data	Details
1	Crop Production Statistics	Has crop production info from 2000 to 2014. For different district of each State it includes, various crops produced, area of cultivation, production and type of crop. (Kharif, Rabi)
2	Crop prices	Prices of some crops year wise change till 2013 (price in rupees per quintal).
3	Cultivation area	Area of land crop is produced on year by year for major crops from 2000 to 2009.
4	Cultivation cost	State wise cost of cultivation of crops per hectare and per quintal. Three variants : (actual paid out cost plus imputed value of family labour (A2+FL), comprehensive cost imputed rent and interest on land and capital (C2) and cost/quintal)

# Data Collection

No.	Data	Details
5	Mean Temperatures	Data of mean temperature from 2000-2012 for whole year and over interval of two months. This is used to determine effect of temperature on various crops
6	Rainfall Statistics	State wise rainfall statics from year 2000-2015 annually and monthly in millimeter per square meter(area)
7	Crops Growth rate	Growth rate of various crops from 1997 to 2012 over a interval of five years.Growth rate represent increase in size, mass or number of crops over a period of time. It is used in analysis of preference of one crop over other.

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No.	Data	Details
9	Exports data	Data regarding the amount of export of various materials and its price from 2003 to 2015.
10	Data	Combined data of various states from 2000 to 2014. This is combined representation of all data in one table. All other tables mentioned above are combine using the common features and merged.

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## Data Cleaning

The data needed to be cleaned in the beginning. The challenges faced while cleaning the data are-

1. The databases obtained composed of data of different years, which were not same across databases.
2. The names of some crops were not present in all the databases.
3. The database also contained a lot of missing data.
4. The data was of varying formats.
5. The naming conventions of crops and states were not the same across databases.
6. The units of measurements were different in different databases.

# Data Plots

## Crop Prices

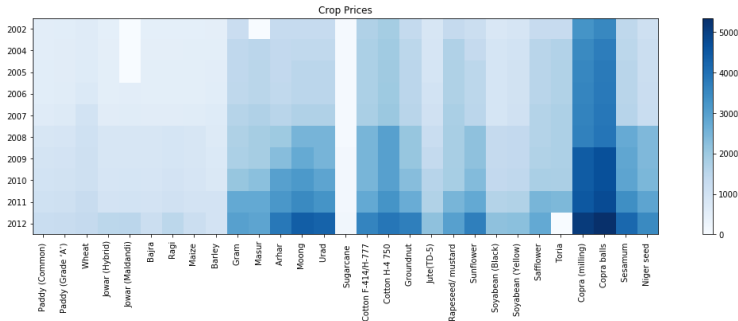


Figure: Crop price of various crops in different year in Rs/quintal

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# Data Plots

## Area under Cultivation

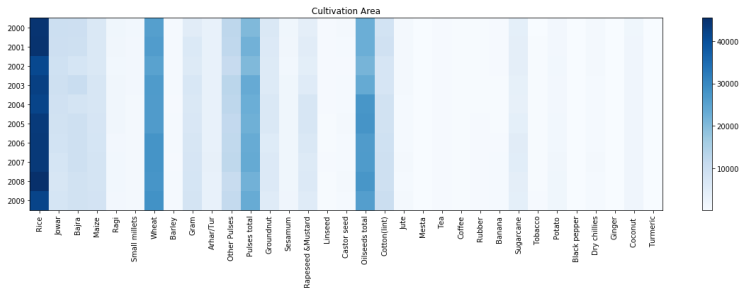


Figure: Cultivation area of various crops in hectares

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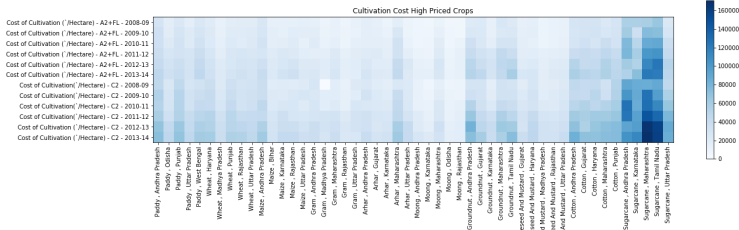
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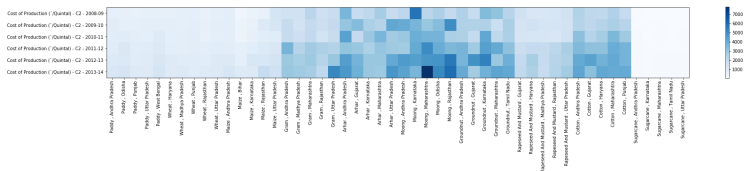
References

Cultivation Cost  $A2+FL$  and  $C2$



**Figure:** Cultivation cost by area of major crops in respective states in Rs/hectare

### Cultivation Cost by Quintal



**Figure:** Cultivation cost by quintal of major crops in respective states

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## Farmer Suicides

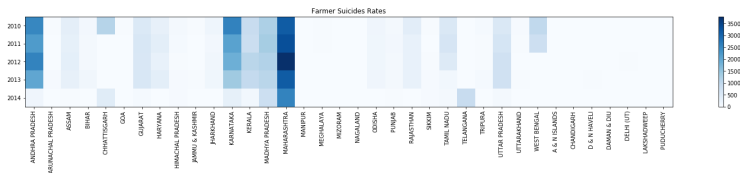


Figure: Farmer suicide rate

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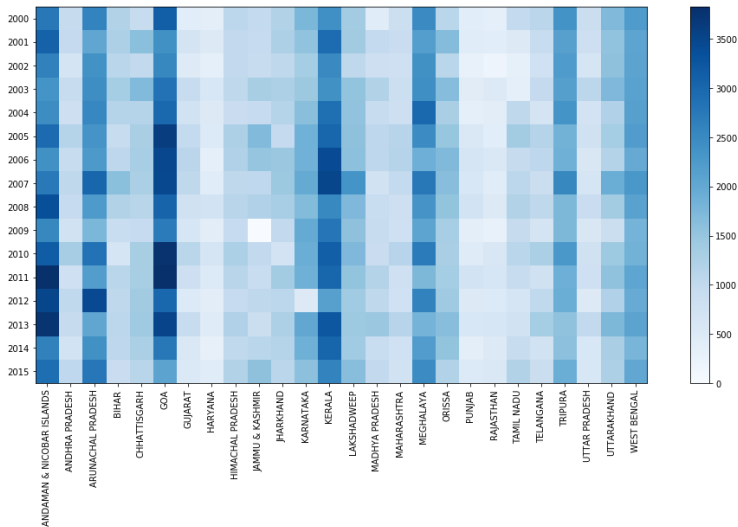
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## Annual rainfall



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Figure: Annual rainfall

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## Growth rate of Major Crops

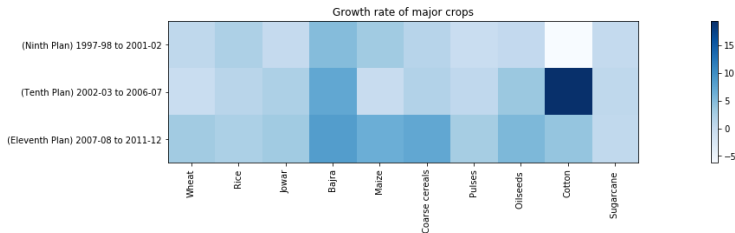


Figure: Growth rate of major crops

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## Temperature Variations of various year in Centigrade

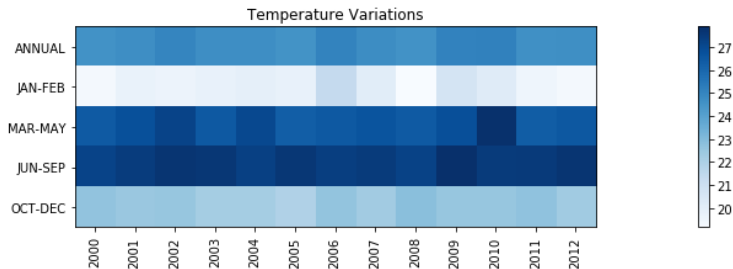


Figure: Temperature Variations of various year in Centigrade

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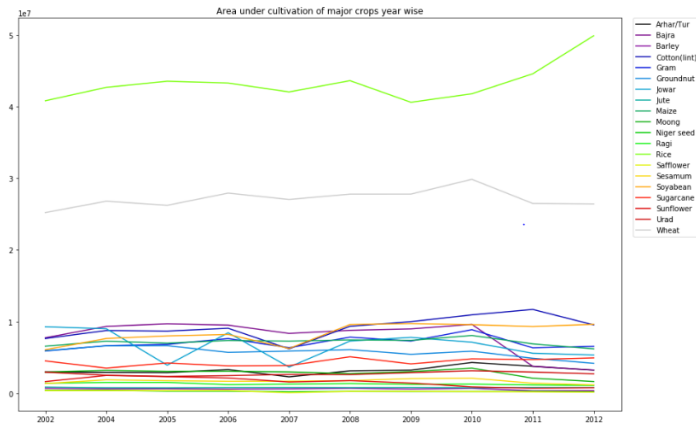
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## Area under Cultivation



**Figure:** Area under Cultivation of Major Crops in various years in hectares

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## Area under Cultivation

- ▶ In the chart above, we see the area under cultivation of particular crops from 2002 to 2012.
- ▶ Area under cultivation of Rice and Wheat takes the maximum proportions
- ▶ Wheat and rice accounted for 75% of the food grains production in the country
- ▶ Area under cultivation of rice has increased significantly but for wheat it is relatively uniform.
- ▶ The countrys increasing requirement for these food grains is attributed to its population increase over the decade

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## Production of Major Crops in various years

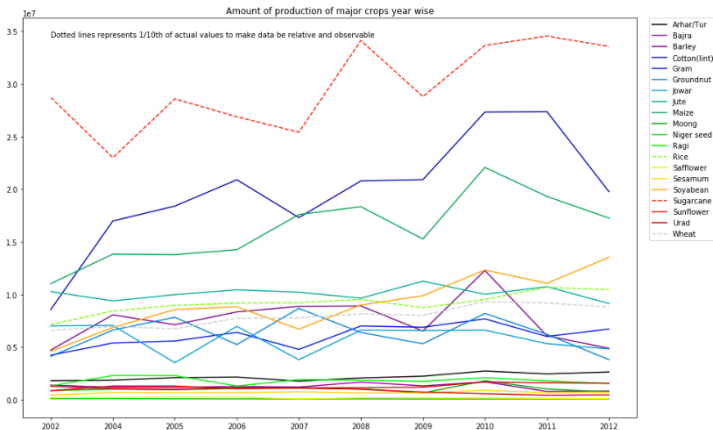


Figure: Production of Major Crops in various years

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## Production of Major Crops in various years

- ▶ Figure shows the production of different crops over the years
- ▶ The highly produced crop in India is Sugarcane
- ▶ India is the second largest producer of this popular cash crop
- ▶ Other crops which are highly produced over the country includes rice,wheat,cotton etc

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## Price per quintal of Major Crops by year in various years

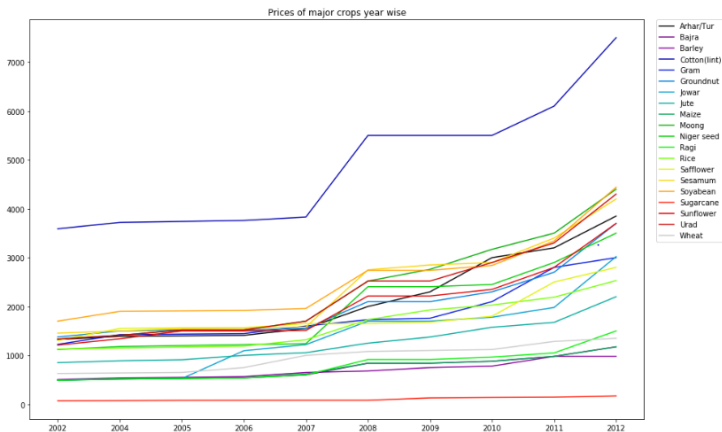


Figure: Price per quintal of Major Crops by year in various years

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Price per quintal of Major Crops by year in various years

- ▶ Over the years, the price of all major crops have increased slightly considering the increased demand due to the population
- ▶ There are some exceptions with a sudden increase in 2008 due to 2007-08
- ▶ Cotton prices have seen a huge rise in prices.

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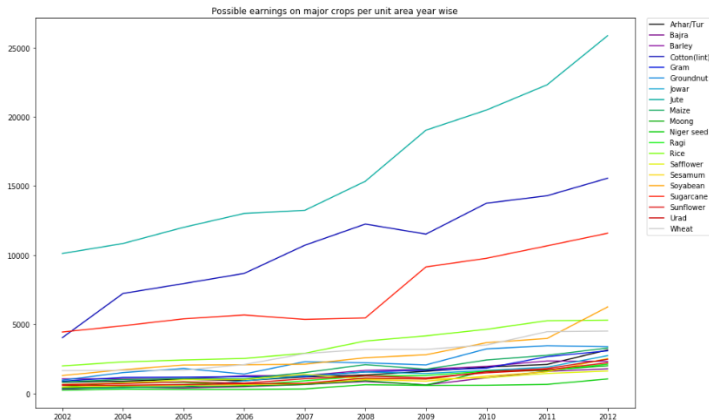
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Possible earnings on major crops per unit area in various years



**Figure:** Possible earnings on major crops per unit area in various years

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Possible earnings on major crops per unit area in various years

- ▶ From figure we can find that most of the possible earnings per unit area is contributed by Groundnut, Gram and Sugarcane
- ▶ The earnings have increased over the years because of the increase in price of the crops

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## Relationship between Avg Rainfall and Area in different states

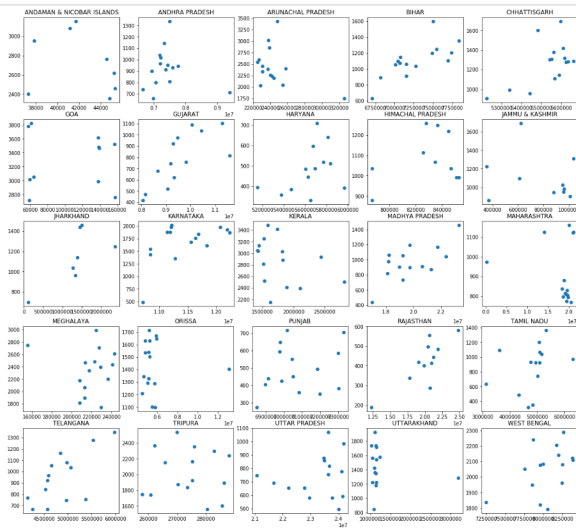


Figure: Relationship between Avg Rainfall and Area in states

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# Observations

## Relationship between Avg Rainfall and Area in different states

- ▶ In above figure influence of rainfall on the area under cultivation for different states is shown
- ▶ We can observe that most of the agricultural area in India is still depending on monsoon rainfall
- ▶ Rainfall can have direct or indirect impact on the area
- ▶ From plots we can see dependence between area and rainfall in the states like Bihar, Haryana, Madhya Pradesh, Rajasthan and Telangana.

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## Relationship between Avg Rainfall and Production in different states

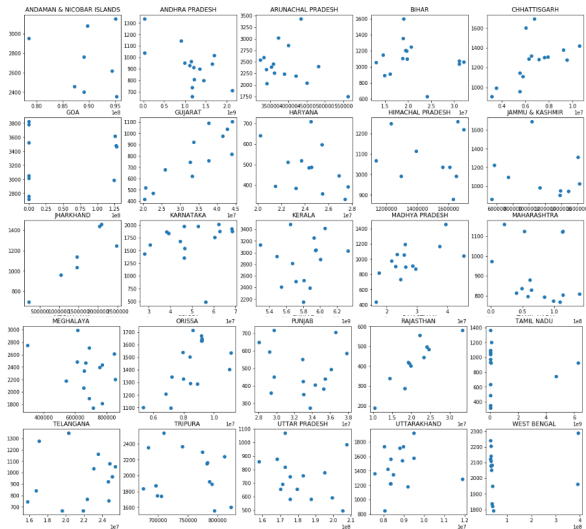


Figure: Relationship between Avg Rainfall and Production in states

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## Relationship between Avg Rainfall and Production in different states

- ▶ In above figure influence of rainfall on the production for different states is shown.
- ▶ Rainfall can affect the production of crops in a great way
- ▶ From plots we can see in states like Chhattisgarh, Gujarat, Jharkhand, Karnataka etc(where major crop is rice and sugarcane) increased rainfall is leading to increased production
- ▶ In Haryana,Uttar Pradesh,Rajasthan(major crop is wheat) increased rainfall is showing to have negative impact on production

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## Relationship between Avg Rainfall and Yield in different states

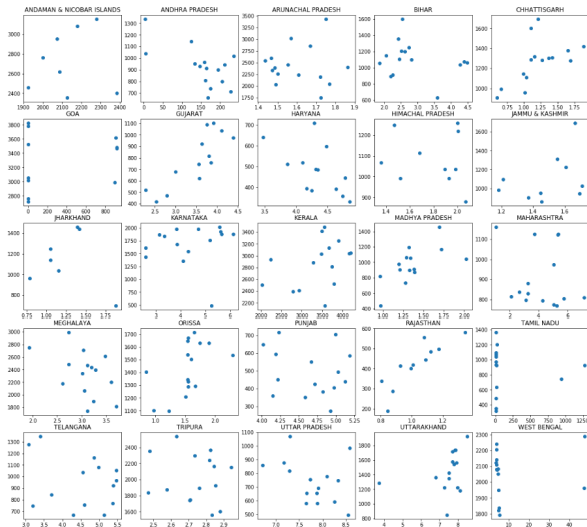


Figure: Relationship between Avg Rainfall and Yield in states

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## Relationship between Avg Rainfall and Production in different states

- ▶ In above figure influence of rainfall on the yield for different states is shown.
- ▶ While investigating the impacts of rainfall variability, it is important to consider yield (Production/Area) as well, as high area under cultivation can be affected by the produce to rare events such as recent snowfall (not in normal snowfall season) in Kashmir that destroyed the Apple crops.
- ▶ it can be observed that rainfall has positive impact on yield in states like Gujarat, Chhattisgarh, Rajasthan, Himachal Pradesh, Madhya Pradesh (major crop is rice and sugarcane).

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## Correlation Analysis

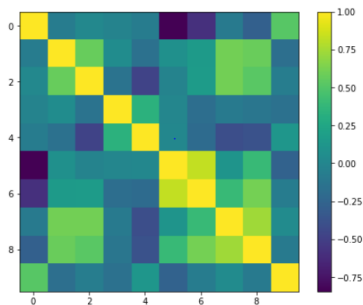


Figure: Correlation between different features

- This plot helps us to visualize the correlation between different features of the table created after merging all data related to Area, Production, Rain, Suicides etc.

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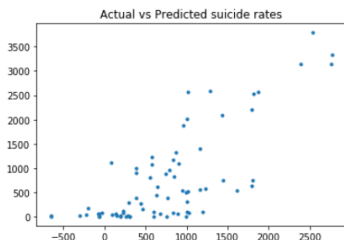
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## Suicide rate Analysis

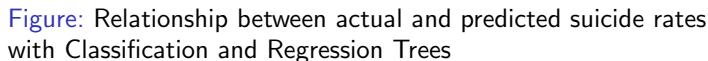
### Linear Regression



**Figure:** Relationship between actual and predicted suicide rates with Linear Regression

- ▶ Accuracy achieved : 62.07%
- ▶ Not a very good estimate as well as not explainable. But it does say that there is some relation.
- ▶ Similar trend follow for ridge, lasso models.

## Decision Tree Regression



- ▶ Accuracy achieved : 83.87%
- ▶ Performs very good on increasing the tree size.
- ▶ It's Explainable



# Results

## Suicide rate Analysis

### Decision Tree Regression

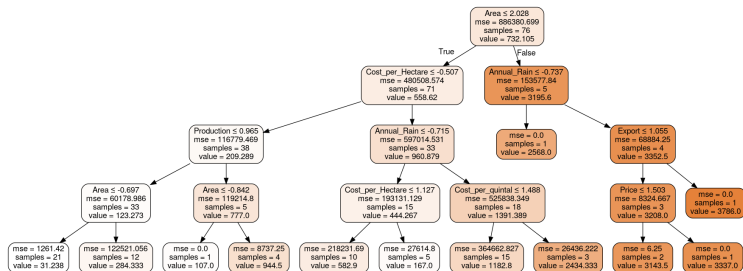
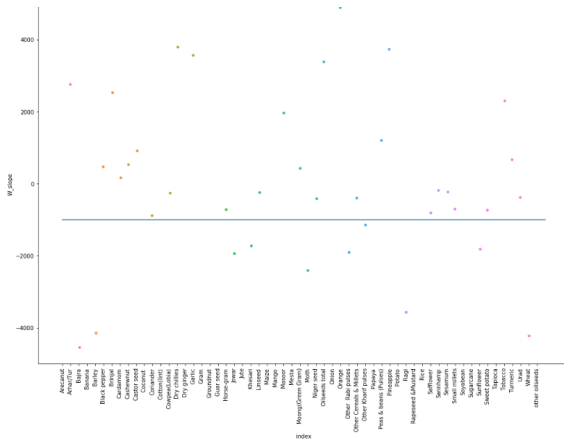


Figure: Decision Tree for Suicide Prediction

- Shows that high area under cultivation, Lower annual rainfall, Less Exports and Increase in cost per hectares are reasons for increase in number of suicides.

# Results

## Crops with reduction in production over the years



**Figure:** Plot for crops that have more reduction in production over the years

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Crops with reduction in production over the years

- ▶ From the above graph, it can be concluded that for some of the crops like Bajra, Groundnut, Jowar etc production is reducing over the years as the slope of the production vs year is negative.
- ▶ We have considered threshold as -1000 for the slope.

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## Clustering

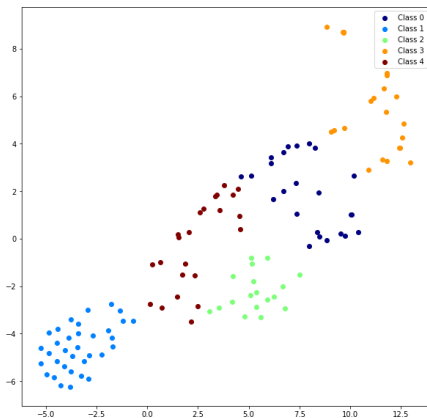


Figure: Clustering of similar crops

# Results

## Clustering

- ▶ Clustering the crops in this figure on the basis of data available except for export.
- ▶ Data was converted to 2 dimensions using tSNE as it keeps the neighbours in original space closer in lower dimensions as well.
- ▶ Total number of clusters was chosen by plotting the data first. K-means clustering is used for this as even number of points in each cluster can be observed.
- ▶ Many of the Fruits lie in cluster 0.
- ▶ Sugarcane, Wheat, Rapeseed & Mustard, Maize, Rice like crops lie in cluster 1.
- ▶ Many of dry crops and oil seeds lie in cluster 2.
- ▶ Many of pulses lie in cluster 3 along with some fruits.
- ▶ Final cluster has mix of vegetables and some root crops.

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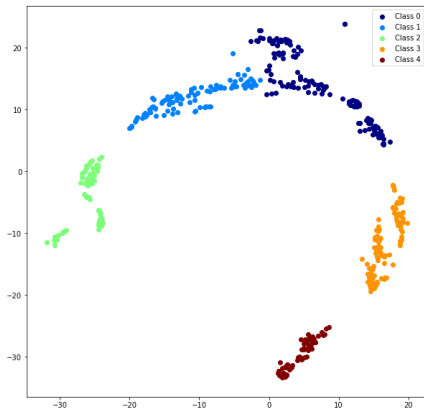


Figure: Clustering of similar states

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## Clustering

- ▶ In this we tried to cluster the states with similarities over all data in different years i.e. state and year as class.
- ▶ Data was converted to 2 dimensions using tSNE due to reasons mentioned earlier.
- ▶ The clustering used in this was Agglomerative clustering as cluster can be seen as uneven and separated. It captures this keeping the clusters uneven. Used 5 clusters as it can be visually observed.
- ▶ Cluster 0, 1 and 2 had most of the states in north, middle and south India.
- ▶ Cluster 2 has most states from south India.
- ▶ Cluster 3 and 4 has most of the states from north east states.

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# Results

Crops with reducing productions over the years

Bajra	-4537.162480
Barley	-4141.496114
Groundnut	-12034.886469
Guar seed	-12780.917262
Jowar	-1927.821737
Jute	-54720.777614
Khesari	-1717.234226
Mesta	-5094.770567
Moth	-2411.072500
Other Rabi pulses	-1908.905869
Other Kharif pulses	-1140.953895
Ragi	-3564.839019
Rapeseed & Mustard	-6685.204140
Sunflower	-1812.156509
Tapioca	-11008.462271
Wheat	-4216.058051

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# Results

Crops with reducing productions over the years

The above table shows the crops that have negative overall slope or in other words have seen decrease in production over the years. The Threshold we used is -1000

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Crops with Reducing productions and Increasing prices

Crop	Production variation	Prices variation
Barley	-129.610556	51.277056
Jute	-43011.146430	125.248918
Niger seed	-144.009443	249.534632
Safflower	-1031.251935	122.445887
Sunflower	-4511.467222	223.906926

In this we tried to find the crops that have reduction in production of the crop but there is still increase in price of the crop. This shows that the production has been decreasing but the demand for the same crops is not. As it can be observed by the positive value of slope.

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# Results

Crops with slow increase in productions but high increase in prices

Crop	Production variance	Price variance
Arhar/Tur	5237.572915	260.551948
Groundnut	1758.235163	199.339827
Jowar	3648.323679	234.956710
Jute	-43011.146430	125.248918
Moong	941.797058	308.993506
Niger seed	-144.009443	249.534632
Safflower	-1031.251935	122.445887
Sesamum	1494.291172	279.404762
Sunflower	-4511.467222	223.906926
Urad	2670.533797	284.469697

This shows that the increase in production of that crop is not as much as demand. These crops will be more profitable to produce.

# Results

Crops with lower rate of increase in cost per hectare than price

Crop	Cost/Hect.	Price	Ratio
Moong	571.901298	308.993506	0.540292
Arhar/Tur	1155.433382	260.551948	0.225501
Gram	865.233108	169.123377	0.195466
Cotton(lint)	2477.784265	379.372294	0.153109
Groundnut	1623.278151	199.339827	0.122801
Rice	1253.114850	150.562771	0.120151
Maize	868.141613	68.593074	0.079011
Wheat	1122.494264	81.904762	0.072967
Sugarcane	3281.720563	10.367338	0.003159

We tried to find out the crops that has lower rate of increase in cost per hectare but has increased in price of that crop more. This shows that these crops can give more returns.

# Results

## Recommendations based on production values

STATE	Maxm. 1	Maxm. 2	Maxm. 3	Maxm. 4
ASSAM	Coconut	Rice	Sugarcane	Banana
BIHAR	Sugarcane	Rice	Wheat	Maize
CHANDIGARH	Wheat	Potato	Rice	Maize
CHHATTISGARH	Rice	Khesari	Gram	Sugarcane

We assumed each state as a user and each crop as a item and based on production values as rating we did matrix factorization to recommend other crops that are likely to be grown in those states if soil supports it.

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STATE	Rec 1	Rec 2	Rec 3	Rec 4
CHHATTISGARH	Sugarcane	Wheat	Rice	Potato
DNH	Sugarcane	Wheat	Rice	Potato
GOA	Coconut	Sugarcane	Rice	Tapioca

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<b>STATES</b>	<b>Crop</b>
ANDHRA PRADESH	Coconut
BIHAR	Sugarcane
KARNATAKA	Sugarcane
CHHATTISGARH	Rice
ARUNACHAL PRADESH	Rice
JAMMU & KASHMIR	Maize
MADHYA PRADESH	Wheat
PUNJAB	Wheat

**Table:** State Wise Maximum Producing Crops for some states

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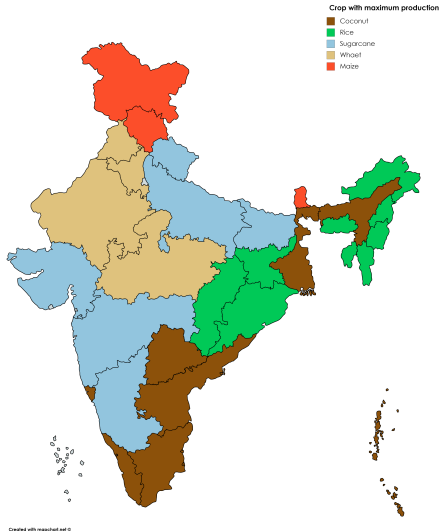
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## State wise maximum producing crops



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Figure: State wise maximum producing crops.



### Maximum produced crops in states year wise

STATES	2000	2001	2002	2003
ANDHRA PRADESH	Coconut	Coconut	Coconut	Coconut
BIHAR	Rice	Sugarcane	Rice	Rice
KARNATAKA	Sugarcane	Sugarcane	Sugarcane	Sugarcane
CHHATTISGARH	Rice	Rice	Rice	Rice
ARUNACHAL PRADESH	Rice	Rice	Rice	Rice
JAMMU & KASHMIR	Maize	Maize	Maize	Maize
MADHYA PRADESH	Wheat	Wheat	Wheat	Wheat
PUNJAB	Wheat	Wheat	Wheat	Wheat

**Table:** Maximum produced crops in states year wise

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# Conclusion

- ▶ Agriculture depends on several factors and its proper study is immensely useful.
- ▶ We tried to obtain and organize agricultural data in a way in which it can be used for analysis
- ▶ Datasets are merged and studied regarding various factors that affect crop production

# Conclusion

- ▶ Agriculture depends on several factors and its proper study is immensely useful.
- ▶ We tried to obtain and organize agricultural data in a way in which it can be used for analysis
- ▶ Datasets are merged and studied regarding various factors that affect crop production
- ▶ Changing patterns motivates us to find reasons behind these changes

# Conclusion

- ▶ Agriculture depends on several factors and its proper study is immensely useful.
- ▶ We tried to obtain and organize agricultural data in a way in which it can be used for analysis
- ▶ Datasets are merged and studied regarding various factors that affect crop production
- ▶ Changing patterns motivates us to find reasons behind these changes
- ▶ Factors that affect crop production are not always independent

# Conclusion

- ▶ Agriculture depends on several factors and its proper study is immensely useful.
- ▶ We tried to obtain and organize agricultural data in a way in which it can be used for analysis
- ▶ Datasets are merged and studied regarding various factors that affect crop production
- ▶ Changing patterns motivates us to find reasons behind these changes
- ▶ Factors that affect crop production are not always independent
- ▶ Using data something as significant as suicide rates can also be predicted with a good accuracy, this helps in better planning and taking preventive measures

# Conclusion

- ▶ Agriculture depends on several factors and its proper study is immensely useful.
- ▶ We tried to obtain and organize agricultural data in a way in which it can be used for analysis
- ▶ Datasets are merged and studied regarding various factors that affect crop production
- ▶ Changing patterns motivates us to find reasons behind these changes
- ▶ Factors that affect crop production are not always independent
- ▶ Using data something as significant as suicide rates can also be predicted with a good accuracy, this helps in better planning and taking preventive measures
- ▶ Decision trees makes the prediction more intuitive to understand, highlighting how each of the factors affect
- ▶ Accuracy with decision trees is 83%

# Conclusion

- ▶ Finding crops that have special changing patterns over the years like decrease in production can help us understand the reasons behind them in a more specific way

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# Conclusion

- ▶ Finding crops that have special changing patterns over the years like decrease in production can help us understand the reasons behind them in a more specific way
- ▶ We can also use these data to recommend new crops that can be grown in places which has the suitable weather and economy conditions



# Conclusion

- ▶ Finding crops that have special changing patterns over the years like decrease in production can help us understand the reasons behind them in a more specific way
- ▶ We can also use these data to recommend new crops that can be grown in places which has the suitable weather and economy conditions
- ▶ The above results can be combined to help farmers decide their crops on more monetary gain and with little risk.

# Conclusion

- ▶ Finding crops that have special changing patterns over the years like decrease in production can help us understand the reasons behind them in a more specific way
- ▶ We can also use these data to recommend new crops that can be grown in places which has the suitable weather and economy conditions
- ▶ The above results can be combined to help farmers decide their crops on more monetary gain and with little risk.
- ▶ Government can be better prepared for anomalies with better resource arrangements such as insurances, logistics and resources.

# Conclusion

- ▶ Finding crops that have special changing patterns over the years like decrease in production can help us understand the reasons behind them in a more specific way
- ▶ We can also use these data to recommend new crops that can be grown in places which has the suitable weather and economy conditions
- ▶ The above results can be combined to help farmers decide their crops on more monetary gain and with little risk.
- ▶ Government can be better prepared for anomalies with better resource arrangements such as insurances, logistics and resources.
- ▶ From recommend data the effect of reduce in whole sale price for the crops can be regulated.(eg.: Tomato season)

# Future Work

- ▶ The study can be extended to large data sets with large number of attributes.
- ▶ Data can be taken more locally to study the various regions within the states
- ▶ More features can also affect the production of crops like Soil data (soil type, PH value), Weather data (winds, humidity) , fertilizers used, can also be taken into account for more detailed results.
- ▶ Apart from these, predictions of various other factors can be made, like crop production in the following year, but this is more involved as this depends on many parameters and it is very highly unpredictable.

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Kaggle

<https://www.kaggle.com/>



Indian Government Data

<https://data.gov.in/>

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