

# Enabling Smart Farming in India: Application of Data Science and Analytics

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**Abstract:** The availability of agricultural land in India is declining due to emerging constructional projects held to satisfy the population of country. This condition affects the agricultural activities and decreases the interest and efforts put by farmers and reduce the agricultural marketing. The present agricultural scenario puts a challenge of repeatedly growing same crops on the field which degrades the soil fertility and threatens the scope of growing different crops, hence leaving the farmer with minimum profit and ultimately under heavy debt. In such case the farming should be carried out optimally so that it fulfils the need of the hour without degrading the available resources. This paper inculcates data science in agricultural sector and highlights some major anomalies in present agriculture scenario and provides some effective solutions to the problems faced during the process of farming.

**Keywords:** Agriculture, Agricultural Marketing, Smart Farming, Soil Fertility, Data Science, Farming.

## 1. INTRODUCTION

India is counted amongst the leading nations of the world. India's economy is ranked 6<sup>th</sup> in the world's largest economy with a value of \$2.848 trillion as recorded by the International Monetary Fund (IMF) in the year 2017-18 [1]. India's economy is classified into three sectors – Agriculture, industry and services. These three sectors together build the total economic value of the nation. Among these sectors the Agriculture sector has shown a very non-uniform growth in terms of GDP since the year 1950, mostly in the declining phase (Fig-1.1).

Agricultural sector is one of the major contributors in strengthening the GDP of India. The agricultural sector accounts 18% of India's gross domestic product (GDP) and provides employment to 50% of the countries workforce [2]. Since agricultural sector has such a great impact on the overall growth of the nation therefore any drawback in this aspect cannot be overlooked.

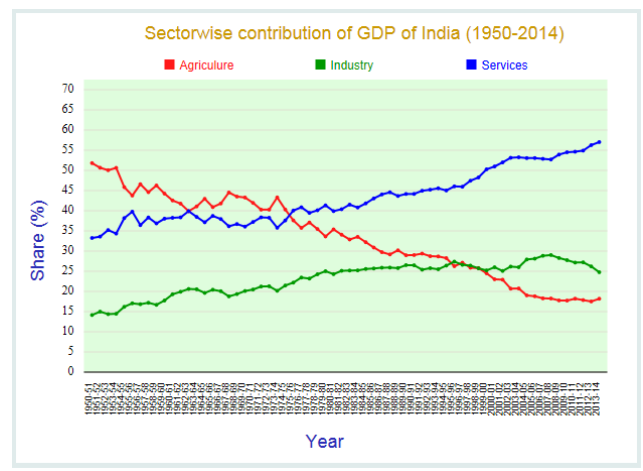


Fig 1.1: Impact of three sectors in GDP of India [3].

Every year food of around 50,000 crore INR value is wasted in India [4]. This happens due to many reasons such as calamity, transportation, bad storage, weather destruction, less demand etc. Crop selection can also be considered as one of the main reason of food wastage in India. Crop selection should be directly linked with the demand in the market. Farmers are facing a lot of problems due to ignorance of these factors. Sometimes, farmer grows the crops which are not much popular in the market and at the end the farmers earn mere profit for the season and remaining food with them is wasted. The problem of food wastage in India can be solved using the effective methods of crop selection. This paper includes some pre-harvesting research that will increase the efficiency of the crop selection method. Using this information the smart farming techniques can be enabled in India from the very beginning of the process of farming.

## 2. ADVANTAGES OF DATA SCIENCE IN AGRICULTURE

The slow-paced agriculture industry of India presents a threatened scope for its future. These days, other industries are growing at ten-fold and the agriculture industry of India has marked very less growth as compared to the service and the tertiary sectors of India (Fig – 2.1). Therefore, emerging technologies like Internet of thing (IoT), Data

Science, Data Analytics etc. should be used for the development of the agricultural sector. This paper focuses on the data science and analytics technique that will project a different angle of looking at the agricultural activities and thereafter simplify the agricultural process and increasing the efficiency. Following are long term benefits of inculcating data science and analytics to agriculture:

- i. Empowering management.
- ii. Defining goals.
- iii. Identifying opportunities.
- iv. Decision making with quantifiable, data-driven evidence.
- v. Testing these decisions.
- vi. Identification and refining of target audiences.

Sectors	Growth Rate (%)			Share in GVA or GDP (%)		
	15	16	17 PE	15	16	17 PE
Agriculture, forestry & fishing	-0.2	0.7	4.9	16.5	15.4	15.2
Industry	7.5	8.8	5.6	31.2	31.5	31.2
Mining & quarrying	11.7	10.5	1.8	3.0	3.1	3.0
Manufacturing	8.3	10.8	7.9	17.4	17.8	18.1
Electricity, gas, water supply & other utility services	7.1	5.0	7.2	2.2	2.1	2.2
Construction	4.7	5.0	1.7	8.6	8.4	8.0
Services	9.7	9.7	7.7	52.2	53.1	53.7
Trade, Hotel, Transport Storage	9.0	10.5	7.8	18.5	19.0	19.2
Financial , real estate & prof services	11.1	10.8	5.7	21.4	21.9	21.7
Public Administration, defence and other services	8.1	6.9	11.3	12.4	12.2	12.8
GVA at basic prices	7.2	7.9	6.6	100.0	100.0	100.0
GDP at market prices	7.5	8.0	7.1			

Fig 2.1: Growth rate of different sectors [5].

### 3. THE PROPOSED MECHANISM

The selection of crop is very important point that is to be considered for the efficient agricultural output. The agricultural activity of farming is very important in terms of growth because it requires a lot of resources (human labour, water, land, fertilizers etc.) and time to grow a crop. When a crop is wasted it means all these resources along with the investment in terms of time and money all goes in vain. There are various important points that need to be taken into consideration during the process of crop selection for the season. Properly selected crop will result in low food wastage rate, increased profit of farmers and crops with high nutrients. Therefore, this paper presents a different angle of crop selection which will consider the important factors for efficient farming.

#### 3.1 DEMAND

Demand of a certain crop in a particular area plays an import role in deciding the scope of the survival of that crop in the area. The demand for different crops may vary from place to place which makes it important for deciding the scope of the crop. On the basis of demand the price of a commodity also ranges. Therefore, it is important to mark the demand of the market for which the farmer is targeting. There can be 3 forms of market:-

- i. Local Market.
- ii. National Market.
- iii. International Market.

It is possible that the demand of a crop is very high at local market but very low at international or national market and vice-versa. So, farmers should know the demand of the crop that they are planning to grow. Crop with high demand and practically reachable market should be grown.

#### 3.2 CONNECTIVITY

The connectivity in this context is referred as to how well the farm land is connected to the market or consumer. Farmland that can directly connect to the consumer (farmland near to cities and populated areas) should grow those crops which have short shelf life and less irrigation time. This will not only save the transportation cost to the farmers, but it will also provide fresh vegetables to the consumers (Fig – 3.2.1). Farmland that is far away from the consumers should grow crops of longer shelf life (Fig – 3.2.2).

Commodity	Recommended Temperature for Handling and Storage (max post-harvest life)	Post-harvest Life at 35°C* (ambient temperature)	Post-harvest Life at 25°C	Post-harvest Life at 15°C	Increased Marketing Time Available at 15°C
Cabbage	0°C (6 months)	2 weeks	4 weeks	8 weeks	4X
Carrots	0°C (6 months)	2 weeks	4 weeks	8 weeks	4X
Tomatoes	15°C (14 days)	3 days	6 days	14 days	5X
Peppers	12°C (20 days)	3 days	7 days	15 days	5X
Potatoes	5° to 7°C (5 to 10 months)	2 weeks	4 weeks	8 to 10 weeks	4X
Spinach	0°C (14 days)	1 day	2 days	5 days	5X
Sweet potatoes	15°C (4 to 6 months)	1 month	2 months	4 to 6 months	4X

Fig 3.2.1: Popular vegetables and suitable temperature [6].

**Printable PRODUCE SHELF LIFE GUIDE**

**USE ASAP 3-5 DAYS**

- Asparagus
- Basil
- Bok Choy
- Chard
- Chives
- Cilantro
- Escarole
- Kale
- Okra
- Onions, Cut
- Radicchio
- Snow Peas
- Spinach
- Tomatoes (Countertop)

**USE SOON 5-7 DAYS**

- Artichokes
- Arugula
- Bell Peppers
- Broccoli
- Broccoli Rabe
- Brussels Sprouts
- Cabbage, Savoy & Napa
- Cauliflower
- Eggplant
- Endive
- Fennel
- Green Beans
- Jicama
- Leeks
- Lettuce/Mixed Greens
- Mint
- Mushrooms (Paper bag in fridge)
- Potatoes, Baby (Cool dark place away from onions)
- Radishes
- Scallions/Green Onions
- Winter Squash, Cut
- Zucchini & Summer Squash

**NO RUSH 2+ WEEKS**

- Cabbage, Green & Red
- Carrots
- Celery
- Rosemary
- Sweet Potatoes (Countertop)
- Thyme
- Turnips
- Beets
- Ginger
- Lemons
- Limes
- Potatoes, Large (Cool dark place away from onions)
- Parsnips
- Onions, Whole (Cool dark place away from potatoes)
- Winter Squashes (Countertop)

**COOKSMARTS**

Store in fridge unless otherwise noted. Store more perishable ingredients in more visible places, so you'll remember to use them sooner.

Fig 3.2.2: Produce shelf life guide [7].

#### 3.3 SOIL TYPE

It is very essential for the farmer to know the soil type as it determines what type of crops can be grown on the field. A crop is dependent on the soil as it provides basic nutrients

to the plant to grow. A soil with high concentration of minerals can yield good quality of crops with high nutrients demand (such as Sugarcane) and vice-versa.

Soil type	Properties
Clay soil	Full of minerals, this soil is fertile but quickly gets cold and waterlogged in winter, and during the summer, bakes to a crust. Sticky mud you can roll into a sausage is a clay soil.
Silt soil	Like clay, silt is fertile, holds water and is easy to compact. Unlike sticky clay, silt soils have a silky consistency.
Sandy soil	Sandy soil has much larger mineral grains than clays and silts. It's free draining and thanks to the air trapped within it, sandy soil is also warmer than either clay or silt. However, it tends to be low in nutrients, dries quickly, and is often acidic. Sandy soil is gritty and crumbly in texture.
Chalky soil	The consistency of this soil varies considerably depending on its precise makeup - some are heavy, some quite light, but all chalky soils tend towards alkalinity.
Peat soil	Full of dark organic matter, peat soils hold a lot of water.
Loam	Combines elements of sandy, clay, and silt soils to produce the best of all worlds, a soil that's moist, fertile and drains well.

Fig 3.3.1: Different types of soil [8].

### 3.4 WEATHER FORECAST

The weather of India affects the agricultural activities in the form of rainfall dramatically. The plants need at least some water for their survival; therefore rain (being the most effective means of watering in India) is important to agriculture. The regular rain pattern could be a boon to the farming but too much of rain causes serious problems like sweeping away the entire cropping land. Droughts in certain areas cause the halt in the growth of the crops, on the other hand overly wet weather causes harmful fungus growth. The survivals of the plants depend on varying amounts of rainfall. For example, the production of wheat requires 62.5 to 82cms of rain whereas the production of rice needs hundreds of inches of the rainfall to survive [9]. In areas with wet and dry seasons, soil nutrients diminish and erosion increases during the wet season. The previous dry season leads to food shortages into the wet season, as the crops have yet to mature. Developing countries have noted that their populations show seasonal weight fluctuations due to food shortages seen before the first harvest, which occurs late in the wet season. Rain may be harvested through the use of rainwater tanks; treated to potable use or for non-potable use indoors or for irrigation; excessive rain during short periods of time can cause flash floods. It is also important to see the water requirement of the crop. Inadequate amount of rainfall the farming process as shown below in Fig 3.4.1- Fig 3.4.3.

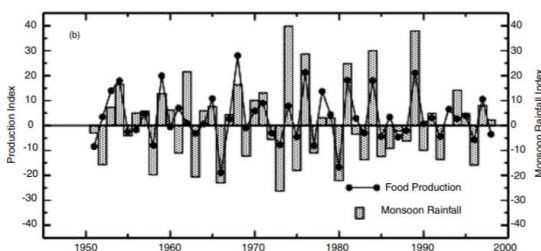


Fig 3.4.1: Rainfall effect on food production [10].

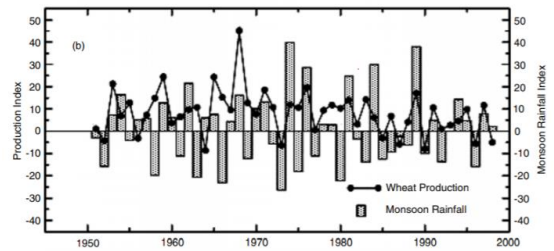


Fig 3.4.2: Rainfall effect on wheat production [10].

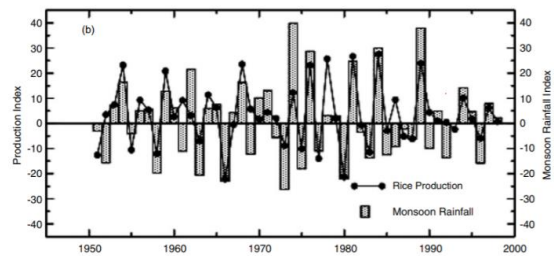


Fig 3.4.3: Effect of rainfall on rice production [10].

### 3.5 INVESTMENT

The investment in this context refers to the amount of money invested by the farmer for the overall development of the farm during a particular season. There are varieties of crops, each crop has different requirements like preparation of fields, sowing of crops, harvesting, packaging, and delivery. Each process requires some form of capital ranging from the time invested to the capital investment. A farmer has to pay for the seeds, fertilizers, packaging, labour, transportation etc. All these cost vary from crop to crop. Therefore this point marks its own importance in the process of crop selection where farmer should look at this too.

## 4. CHALLENGES IN THE CURRENT AGRICULTURAL SCENARIO

- Initial acceptance of the idea in the society will be a major challenge for this idea to lay down its roots.
- The inability of the farmer to access the data science tools will be a big challenge. Although it can be overcome using the campaigns and tutorials helping to update the farmer with latest technologies.
- The government policies are not communicated to the farmers which create unawareness of those policies and the actual implementation of these becomes difficult.
- The increasing population lead to the higher demand which enforces the farmers to use the fertilizers which ultimately degrade the fertility of the land making it incapable of producing the expected agricultural output.
- The absence of proper equipment with the farmers presents a major challenge for the farming. The farmers have to work overnight in the farms and

the lack of proper equipment like proper electricity, effective footwear causes difficulties.

- The agricultural inspectors employed by the government shows their inability to properly communicate the government policies to the farmers.
- In parts of India, the over-pumping of water for agricultural use is leading to falling groundwater levels. Conversely, water-logging is leading to the build-up of salts in the soils of some irrigated areas. In rain-fed areas on the other hand, where the majority of the rural population live, agricultural practices need adapting to reduce soil erosion and increase the absorption of rainfall. Overexploited and degrading forest land needs mitigation measures [11].

## 5. CONCLUSION

This paper will ensure good scope of the agricultural activities. The life threatening problems of farmers due to their inability to levy the heavy debts taken for the farming purposes will also be targeted and finally removed with the use of the techniques covered in this paper. The challenges to the development of the agriculture sector in India need a special concern of the higher authorities. India is known in the world as the Agro-Prime nation therefore, we need to enhance our current agricultural practises and inculcate latest technologies in it. Agriculture in India is also not considered as a business therefore, the number of young farmers stepping in the agricultural market is decreasing and the adult farmers are retiring from agriculture and opting for the services due to the complexities in this sector. This paper presents a different angle of looking at the farming practises and the techniques introduced in the paper will decrease the complexities of the current agricultural sector.

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