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# ANALYTICS EMPOWERING AGRICULTURE: JAYALAXMI AGRO TECH

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> I grew up on the farm, however, with imminent rural migration, I travelled to cities and then abroad. When I went back to my village, after 15 years, I realized that the farmers' problems had remained same. Agriculture, being input intensive, needs constant information, which was fulfilled by pesticide shops in villages. Misinformation and biased information was rampant, which lead to increase in input costs. Accurate information was freely available on the internet; however, it couldn't reach the farmers. With the intention of bridging this critical information gap I decided to create an app for the farmers. This app aims to bridge this digital divide and empower farmers.
>
> - Anand Babu Chitav, Co-founder of Jayalaxmi Agro Tech

Anand Babu Chittavadigi, co-founder of Jayalaxmi Agro Tech (JAT), looked up from his laptop, seeking answers and insights from the data collected from their application about the plant diseases and crop varieties accessed by the farmers. The objective of JAT was to provide a farm advisory system to help farmers in making decisions related to farm management. JAT had so far developed 20 mobile applications (apps) for various crops and farm animals across three Indian languages that could be used by farmers to identify the affected crops and farm animals. In 2017, approximately 200,000 farmers had downloaded the app and were actively using it to seek information about their crops.

Farming in India has been a high stress profession due to high input costs and uncertain income. Anand was concerned about the high number of farmer suicides driven by a high level of stress. According to the Government of India, over 12,000 suicides were reported every year since 2013.[i] Anand was also worried about the increasing fertilizer subsidy and excessive usage of chemicals by the farmers. He wanted to analyze the data which he was collecting through his app and find out if he could gain some insights to understand some of these problems which could be further used to assist the farmers. JAT collected usage information of crops by farmers across the India through their application. The information included details of location, crop and number of clicks by farmer on crop-specific mobile application icons such as planting, harvesting, disease, variety, micronutrients, irrigation, fertilizer, possible cure to disease, and farming practices.

Anand realized that the farmer's data from JAT apps could provide him with invaluable inputs on cropping and disease patterns; however, he also realized that he should use additional data such as temperature, weather, rainfall, soil quality, irrigation as well as yield of the crops from other sources to obtain richer insights to solve farmers' problems. Anand was staring at his laptop. He had several MS Excel sheets with data about various crops open in front of him. He was wondering about how to analyze the data to gain meaningful insights that could be used to help the farmers. He decided to deep dive into the data collected on the chili crop first.

## AGRICULTURE IN INDIA

India has traditionally been an agrarian economy; owing to its fertile soil and river network. Agriculture, fishing and forestry were expected to contribute 15.1%[ii] to India's GDP in FY 2017 and this had increased by 4.4%[iii] over the previous year. Indian agricultural produce included grains, pulses, spices,

fruits and vegetables, oilseeds, sugarcane, coffee, tea, cotton, jute, and dry fruits. Food grain production was expected to be 272 million tonnes in 2016-17.[iv] Allied industries included produce such as milk, meat, eggs, silk, and honey. India's agriculture produces topped most of the countries in the world across several products. **Exhibit 1** shows a summary of world food grain production and where India features in the same.

### Green and White Revolutions

Agriculture has been prevalent in India since ancient times and the agricultural produce was in high demand in the international trade. After its independence in 1947, India depended on imports and food aid to feed its population. After the severe drought of 1965 and 1966, the Indian government reformed the agricultural policy and brought in "Green Revolution", which focused on seeds with superior yields and resistance to diseases, use of irrigation, fertilizers and pesticides along with dissemination of farming knowledge to increase the yields.

White revolution was initiated by National Dairy Development Board (NDDB) during the late1960s, since the milk production growth rate had declined to 1.15%. Milk production increased from 17 million tonnes in 1950-1951 to 86.6 million tonnes in 2001-2002 and India became one of the largest producers of milk.[v] White revolution was achieved through cooperative production and providing farmers with better breeds of cattle and training them in modern animal husbandry techniques.

## CONNECTED INDIA – THE MOBILE EXPLOSION

India had around 299.24 million smart phones users.[vi] In urban India, the Internet user base was expected to be 275-285 million in June 2017.[vii] In rural, India's Internet user base was forecasted to reach 170-180 million by June 2017 as shown in **Exhibit 2**. Mobile usage across urban and rural areas boomed significantly after the launch of the Prime Minister's Digital India Campaign. India added 15,000 new internet users everyday.[viii] As per the data from the Telecom Regulatory Authority of India (TRAI) in 2017, urban connectivity in India was showing a monthly growth rate of 1.6% and the monthly growth rate of rural connectivity was at 0.56.This mobile explosion in rural areas was an opportunity to reach the farmers and help them by providing timely and accurate information. They could use this information to grow the right crop varieties, manage crop diseases, and to initiate any timely corrective action.

## GENESIS AND JOURNEY OF JAYALAXMI AGRO TECH

### Genesis of JAT

Ever since farming was started by growing crops, raising livestock and catching fish, farmers have always sought information about the right crops, choice of fertilizers and insecticides and so on. However, in developing countries such as India, due to information gap (digital divide), agriculture became "input-

intensive" and not "knowledge-intensive". A few compelling problems that farmers faced (revealed from JAT field visits) due to information gap are as follows:

- Lack of awareness on disease/drought resistant varieties: More than 90% of the farmers were not aware of disease and drought resistant varieties.
- Inappropriate Irrigation resulting in water wastage: Indian farmers instead of watering the plant watered the soil. Farmers spend 5000 liters of water to grow 1 kg of rice, while it requires around only 1500[ix] liters of water.
- Disease and pesticide management: Indian farmers largely depended on pesticide shop owners for disease management, which led to irrational use of pesticides.
- Micronutrient management: Many farmers did not have the knowhow to differentiate disease from micronutrient deficiency.
- Mono-crop culture: Many farmers have been growing single crop for decades due to lack of knowledge to grow other crops.
- Fertilizer requirement calculation: Large proportion of farmers (almost 99%) in India were not aware of Nitrogen, Phosphorus, and Potassium (NPK) fertilizer calculations.[x]
- Lack of awareness on traditional/cultural aspects of farming: Young farmers were not aware of traditional practices in farming.

Agriculture is seen as not-profitable and hence youth have been losing interest in farming and started migrating to urban area in search of jobs. This kind of polarization leads to several social problems. Anand believed that this problem would persist until agriculture became "knowledge-intensive" for which information was the key. While smartphone penetration was growing even in rural areas, there was huge potential to use farmer's Android phones as a primary tool to deliver the knowledge/information in a constructive and simple manner.

Farmers needed several inputs on agriculture, starting from seeds, variety of crops, fertilizers, water, pesticides, micronutrients, irrigation, diseases, etc. Non-availability of agricultural inputs at reasonable costs and at the right time was a major concern for the farmers. Lack of proper, reliable, and independent information placed the farmers at the mercy of sales agents of companies (selling inputs such as pesticides and chemicals), who are motivated by profit rather than the interest of the farmers. Lack of credit also pushed farmers to purchase inputs from local suppliers who often provided substandard inputs. All this added to the cost of farming. This posed a need for independent and reliable information which was available freely at any time to the farmers.

To bridge this knowledge gap of the farmers and to prevent the farmers from getting exploited by local money lenders and pesticide dealers, JAT created a knowledge heavy mobile application for the farmers. They developed a suite of 25+ crop-specific mobile applications in regional languages with audio visuals. Their objective was to deliver the most happening technologies such as Mobility, Analytics, and Cloud into the hands of farmers even in the absence of Internet.

## JAT Journey: 200,000 Farmers and Ticking

The mobile apps developed by JAT were very easy to use and available in many Indian languages which even illiterate farmers could use. There was no charge for the information accessed by the farmers. The application could be downloaded by the farmers either from the Internet or through Bluetooth connection from their agri-pole devices. The ''agri-pole'' is a hardware device developed to address the connectivity gap. It enabled farmers to download the app in the absence of Internet. When the farmer went near the agri-pole, he had to switch on the Bluetooth, select the particular crop app, click option download, and the app was downloaded on his phone. Once the app was downloaded in one smart phone, it could be easily shared with others, and did not require download in every mobile. Internet connection was not needed by farmers to use the application. These agri-pole devices were installed in 300 Indian villages. Access data from the app was pushed to a central server in real-time basis if Internet connection was available on the phone or whenever the phone was connected to the Internet. The sections accessed by the farmers and frequency of access to specific section (plant, disease, etc.) were stored on a daily basis in the centralized database. This data gathered from the application provided information at individual phone number level on daily basis on the type of information accessed by the farmers. An analytics platform also part of this application created basic visualization of this captured data.

JAT has won many prestigious awards for their initiatives in the agriculture sector; a few of them are mentioned here.

- Jayalaxmi Agrotech is winner of "Digital India innovation challenge" in agriculture category.[xi]
- Jayalaxmi Agrotech's innovative solution received **Presidential award from Honorable President Sri. Pranab Mukherji.**[xii]
- Jayalaxmi Agrotech bagged prestigious awards such as '**mBillionth award**' from Digital empowerment foundation and '**Mobile for social good'** award from Vodaphone foundation for their efforts in bringing social transformation in the agriculture sector.[xiii]

## ANALYZING THE DATA COLLECTED THROUGH THE APP:

Over a period of two years since the JAT application was rolled out, there was a consistent increase in the download of the application by the farmers. There was an increase in the user base for the application as shown in **Exhibit 3**, where we see that overall number of users after October 16 was more than the earlier months. Much application usage data was collected on real-time basis. The data was collected on every application usage by the farmer and a new record was created in the Google Firebase database. This data mainly consisted of the place/location of the farmer, crop which was accessed, phone number from where the application was being used and also contained information on every section of the application used and provided the number of times the specific section was accessed. Structure and description of the data captured by the JAT app is provided in **Exhibits 4** and **5**, respectively.

JAT wanted to gain insights using the data and also test some claims about how the application could benefit the farmers. This would help them in further increasing the user base for the application. It would

also aid in reaching out to more and more organizations as well as the government to address the more pressing issues in the agriculture sector such as crop price volatility, and yield prediction. The app would also help to assess farmer distress in a specific area and could help in reducing the prevalent farmer suicides.

Having successfully created and distributed the app across Karnataka and other states in India, JAT wanted to understand the usage of their application in various states and districts. They wanted to understand not just from the perspective of the pattern of app usage but also to draw some inferences on the varieties and diseases prevalent in specific areas and their usage patterns. They wanted to understand if the app could help the farmers to take more informed decisions and reduce their distress by improving the yield in some way. Certain hypotheses were framed based on the application usage by the farmers and the kind of insights that it could give Anand and his team. This could help them to initiate some timely actions for the benefits of the farmers. Some of the key hypotheses that he wanted to test are as follows:

- Crop variety and disease accessed is not the same for different locations.
- Prevalence of a specific disease in a location causes an increase in access of that specific disease from that location.
- Is there any change in the access pattern of disease and variety over a period of time?
- Are access patterns of a specific disease different for favorable weather conditions for that disease?
- Is there a correlation between variety and disease access patterns?

The data which was collected by the app was used as a proxy for the actual varieties grown by the farmers and diseases prevalent in a specific area. These were few of the answers Anand was seeking from the daily app usage data they were collecting.

## ABOUT CHILLIES

Information about 25+ crops was accessed across India by the farmers through this app. JAT wanted to test claims and hypotheses using the collected app data mainly to understand the disease patterns for various crops, their relationship with the varieties grown, effect of weather conditions on the disease pattern, and any shift in the varieties or disease patterns. We cannot test claims made by Anand for all the crops together as the crop cultivation, areas of cultivation, crop features and needs as well as crop diseases, are different for all the crops. Hence, data for a specific crop was chosen to test the few claims made by JAT. The crop chosen was Chili (green, red, and dry).

According to the Spice Board of India, total chili production in India was 1.4 million tonnes in 2015-2016 and chilies worth INR 40 billion[1] were exported, which had increased by 12% over the previous year.[ix] India has been the largest producer, consumer, and exporter of chilies in the world. In India, chilies have been majorly grown in the states of Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Orissa, West Bengal, Rajasthan, and Tamil Nadu. Different varieties of chilies grown in India were Bird's Eye Chili (*Dhani*), *Byadagi, Ellachipur Sannam, Guntur Sannam, Hindpur, Jwala, Kanthari,* Kashmir *Chili*,

[1] 1 USD is approximately INR 71 during December 2018

and Madhya Pradesh *G.T.Sannam*. Major chili varieties in Karnataka were *Badagi Kaddi, Poosa Jawal, Arka, CH01,* etc.

In Karnataka, chili has been grown in districts of Dharwad, Mysore, Hassan, Bangalore, Bellary, Hubli, Gadag, and Byadagi.

Chili was chosen as a sample crop to analyze the data collected from the JAT application since it was more restricted to specific districts and the presence of JAT app in these districts was high. Hence, better data was available from these districts.

Exhibit 1

## World Food Grains Production Summary

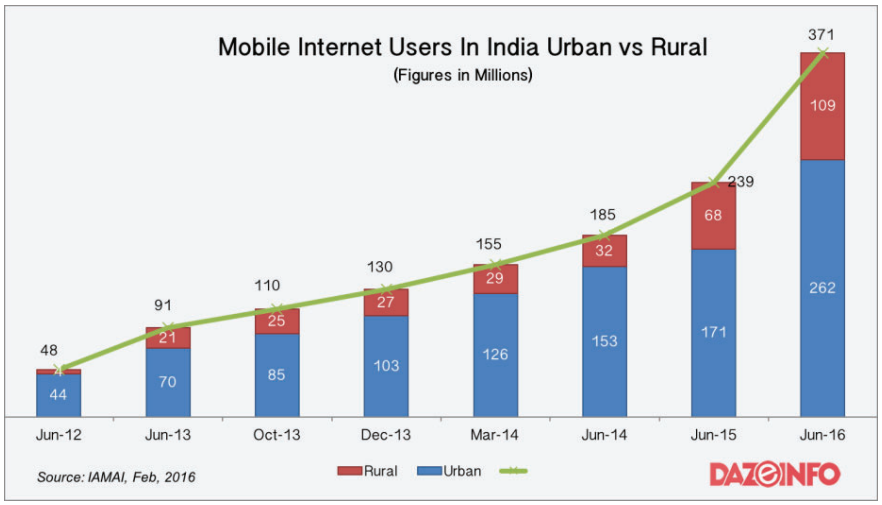
| MMT | Wheat | | | Coarse Grains | | | Rice Milled | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2014-15 | 2015-16[1] | 2016-17[2] | 2014-15 | 2015-16[1] | 2016-17[2] | 2014-15 | 2015-16[1] | 2016-17[2] |
| United States | 55.1 | 56.1 | 62.9 | 377.2 | 367.0 | 402.6 | 7.1 | 6.1 | 7.1 |
| Canada | 29.4 | 27.6 | 31.7 | 22.0 | 25.6 | 25.6 | 0.0 | 0.0 | 0.0 |
| Mexico | 3.7 | 3.8 | 3.9 | 32.7 | 32.4 | 33.2 | 0.2 | 0.2 | 0.2 |
| Russia | 59.1 | 61.0 | 72.5 | 40.4 | 37.4 | 40.8 | 0.7 | 0.7 | 0.7 |
| Ukraine | 24.8 | 27.3 | 26.8 | 39.4 | 33.4 | 39.2 | 0.0 | 0.0 | 0.0 |
| China | 126.2 | 130.2 | 128.9 | 222.8 | 231.8 | 227.9 | 144.6 | 145.8 | 144.9 |
| India | 95.9 | 86.5 | 87.0 | 43.1 | 38.5 | 44.2 | 105.5 | 104.4 | 106.5 |
| Indonesia | 0.0 | 0.0 | 0.0 | 9.0 | 10.5 | 10.9 | 35.6 | 36.2 | 37.2 |
| Pakistan | 26.0 | 25.1 | 25.6 | 5.3 | 5.7 | 6.1 | 6.9 | 6.8 | 6.8 |
| Thailand | 0.0 | 0.0 | 0.0 | 4.9 | 4.8 | 5.3 | 18.8 | 15.8 | 18.6 |
| Argentina | 13.9 | 11.3 | 16.0 | 36.8 | 37.9 | 46.2 | 1.0 | 0.9 | 0.9 |
| Brazil | 6.0 | 5.5 | 6.7 | 87.7 | 69.1 | 96.0 | 8.5 | 7.2 | 8.2 |
| Australia | 23.7 | 24.2 | 35.0 | 12.6 | 12.4 | 16.6 | 0.5 | 0.2 | 0.6 |
| South Africa | 1.8 | 1.4 | 1.9 | 11.1 | 8.7 | 15.6 | 0.0 | 0.0 | 0.0 |
| Turkey | 15.3 | 19.5 | 17.3 | 9.4 | 14.3 | 10.9 | 0.5 | 0.5 | 0.5 |
| Other | 247.3 | 255.7 | 235.3 | 353.7 | 321.5 | 325.0 | 148.9 | 147.4 | 149.0 |
| World | 728.1 | 735.2 | 751.4 | 1308.0 | 1251.1 | 1346.1 | 478.6 | 472.2 | 481.1 |

MMT – Million Metric Tonnes, 1 – Preliminary Estimates, 2 – Projections

**Source:** Compiled by authors from World Agricultural Production, Circular Series WAP 04-17, April 2017, United States Department of Agriculture

Exhibit 2

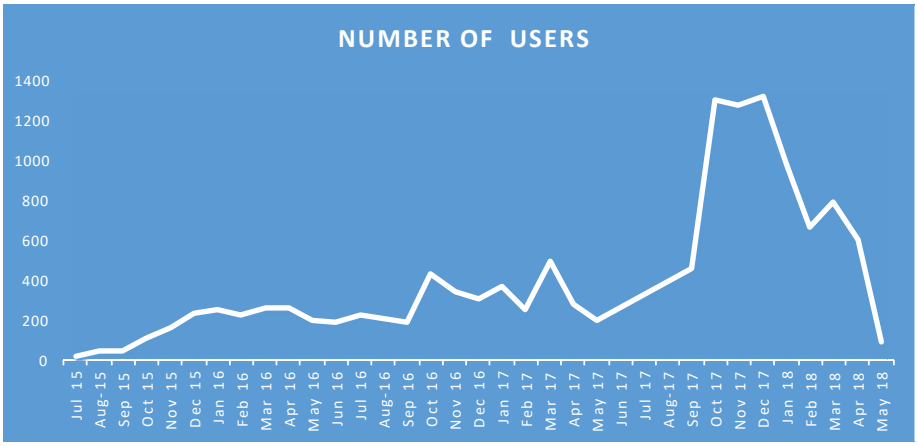
**Mobile Internet Users in India Urban vs. Rural**




**Source:** https://dazeinfo.com/2016/02/08/mobile-internet-users-in-india-2016-smartphone-adoption-2015/

Exhibit 3

Number of users since 2015




**Source: Jayalaxmi Agro Tech**

Exhibit 4

**Variable Description of Data from Agro-Case data file**

| Variable | Description |
|---|---|
| Month-Year | Month and year of data collected |
| Week | Week of the month |
| Number of users | Number of users using the app in that month-year |
| Usage | Number of times app used in that month-year |
| D1-D11 | Number of times a specific disease is accessed (disease name in **Exhibit 5**) |
| V1-V10 | Number of times a specific variety is accessed (Variety name in **Exhibit 5**) |
| Micronutrient | Number of times micronutrient section of app is accessed |

"Belagavi_Weather" and "Dharwad_Weather" data sheet contains the month-on-month disease access data from Belagavi and Dharwad districts of Karnataka along with the average temperature and humidity in that specific month. "Disease index" sheet contains favorable temperature and humidity conditions for the diseases mentioned.

**Source: Jayalaxmi Agro Tech**

Exhibit 5

| Code | Description |
|---|---|
| P | Plantation |
| F | Fertilizer |
| I | Irrigation |
| M | Micronutrient |
| D1 | Dumping-off |
| D2 | Fruit Rot |
| D3 | Powdery Mildew |
| D4 | Bacterial Leaf Spot |
| D5 | Cercospora Leaf Spot |
| D6 | Leaf Curl |
| D7 | Fusarium Wilt |
| D8 | Fruit Borer |
| D9 | Thrips |
| D10 | Mites |
| D11 | Aphids |

Exhibit 5 (Contd.)

| | |
|---|---|
| V1 | Badagi Kaddi |
| V2 | Poosa Jawal |
| V3 | Arka Lohith |
| V4 | Arka Supal |
| V5 | Arka Meghana |
| V6 | Arkeshwar |
| V7 | Arka Hareeth |
| V8 | Arka Abhir |
| V9 | Bhagya Laxmi |
| V10 | C H 01 |
| G | Growth hormone |
| H | Harvesting |
| DT | Decision tree |
| W | Weather |

**Source: Jayalaxmi Agro Tech**

## ENDNOTES

[i] Source: http://timesofindia.indiatimes.com/india/over-12000-farmer-suicides-per-year-centre-tells-supreme-court/articleshow/58486441.cms, retrieved on May 3, 2017

[ii] Source: Monthly Economic Report, March 2017, Economy Division, Department of Economic Affairs, Ministry of Finance, page (http://dea.gov.in/sites/default/files/MER_March%202017.pdf), page 8, Table 1

[iii] *ibid*

[iv] Second Advanced Estimates of Production of Foodgrains for 2016-17, Department of Agriculture, Cooperation and Farmers welfare, Directorate of Economics & Statistics, page 1

[v] Source: http://www.fao.org/wairdocs/lead/x6170e/x6170e2z.htm

[vi] Source : (https://www.statista.com/statistics/467163/forecast-of-smartphone-users-in-india/)

[vii] Source : (http://www.livemint.com/Industry/QWzIOYEsfQJknXhC3HiuVI/Number-of-Internet-users-in-India-could-cross-450-million-by.html)

[viii] Source : http://www.hindustantimes.com/business-news/reliance-jio-s-fight-with-other-telcos-could-be-rural-india-s-gain/story-i7sPEGyuHk0GpODKfljJ6N.html

[ix] Source :http://www.thehindu.com/todays-paper/tp-national/tp-karnataka/5000-litres-of-water-to-grow-1-kg-of-rice/article2613414.ece

[x] Source :http://164.100.47.193/lsscommittee/Agriculture/16_Agriculture_29.pdf

[xi] Source : https://innovate.mygov.in/ifdic1/

[xii] Source : https://www.youtube.com/watch?v=QXBUVOqPygI

[xiii] Source : http://www.millenniumalliance.in/imgs/Final_Award_Round_1-4.pdf)