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Artificial Intelligence in Farming: A Journey from Sustainable Agriculture to Profitable Agriculture

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Introduction

'Agriculture', a term derived from the Latin terms *ager* meaning land or field and *cultura* meaning cultivation. Therefore, Agriculture, or as we know commonly as farming, is a derivative of a blanket of cultivation practices initiating with land preparation and terminating with marketing or reaching the target customer. According to a report by Food and Agriculture Organization (2016), 'Economic losses from natural disasters have reached a staggering average of USD 250 - 300 billion a year' owing to flood, droughts, storms and other such natural calamities. Now, this can only suggest that we need to put in place strategies which will reduce the impact of such natural calamities on agricultural production. In today's scenario with the 4th revolution in Agriculture onto us, verified and technical information related to the farm activities can be readily sent across from the scientists to the farms. AgriTech startups such as *Fasal*, *Cropin*, *Intello Labs* are working in the same direction. This has made profession go from being the one to support one's own family to a profitable venture. And the most important factor that brought about this much appreciated change is the use of Artificial Intelligence (AI) in Agriculture.

Artificial intelligence is not a new concept, through the years it has been utilized in various field across the world with its discovery somewhere in the 1950s. Its application has recently been recognized in agriculture with the use of agribots, UAVs or drones, and simulation based models. "Artificial Intelligence (AI) has begun to play a major role in daily lives, extending our perceptions and ability to modify the environment around us" (Kundalia *et al.*, 2020; Gandhi *et al.*, 2020; Ahir *et al.*, 2020 c.f. Talaviya, 2020). AI is a technology which functions by following patterns and acquiring decision making ability in parallel to how a human brain functions and this helps to bridge the gap between unavailable skilled

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labor and a large population to feed. "AI in farming has many benefits such as enhanced crop production and improved real-time monitoring, harvesting, processing and marketing" (Yanh *et al.*, 2007 c.f. Talaviya, 2020). Therefore, amalgamation of agriculture and technology is the need of the hour to take agriculture from sustainability to profitability. The article discusses this aspect at length with the help of success stories from AgriTech ventures and their role in uplifting the Indian Economy and the standard of living of the farmers.

According to FICCI, 'there are nearly 450 agritech startups in India, and these startups are growing at the rate of 25 percent. With the budding startup culture in India supported by the government incentives and incubation through the Startup India Mission, many promising startups have appeared in the field of agriculture. The startups are working towards mechanization of Indian farms and their thrust areas are as mentioned below:

- **Geo-informatics:** The use of image recognition and processing in Agriculture has gained much acclaim in the recent years. With the help of remote sensing (the technique of using geospatial satellites to obtain an image of landmasses, water bodies, agricultural areas and other physical attributes of earth), warnings related to natural calamities, pest & disease infestation and crop failure can be determined early enough to prevent them. Many startups in India and abroad are working on this concept to provide agro-advisory services and prescription maps. One of such startups is **Dimension I GIS** which functions by providing Geographical Information System (GIS) service by deriving useful information from spatial data in the form of prescription maps which help to identify similar or dissimilar areas with respect to cropped area, nutrient content, slope and other attributes.
- **Big Data and Analytics:** There is a huge amount of data available freely on different sources on the internet currently in the era of technology and this is referred to as big data. As stated by one of the famous mathematician and data science entrepreneur, '**data is the new oil'** especially in the 21st century with a large amount of data freely available at an ease of a click. The process to manipulate this

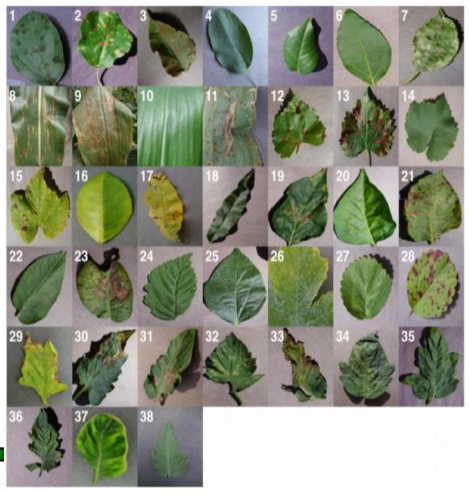

Fig 1. 14 Crops & 26 Diseases included under Plant-Village Dataset Source: Kaggle website

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data and club it with other data to obtain information required to make decisions is called Data Analytics and the science dealing with it is called Data Science or Analytics.

- Startups such as **Cropin** and **Exabit** are working in this direction to allow farmers to receive the right information at the right time for risk mitigation and better yield. The information includes but is not limited to the right time of sowing, choice of crop and variety, market analysis and yield estimation along with warnings of any upcoming calamity. **Plant Village Dataset** (https://www.kaggle.com/emmarex/plantdisease) is an open source data containing the images of around 54303 healthy and diseased leaf images categorized into 38 categories. It unlocks a potential for plant pathologists and crop physiologists to identify a particular disease based on the picture of its major symptom. The overall accuracy obtained on the Plant Village dataset varied from 85.53% to 99.34% in using deep learning for image-based plant detection, and hence showing strong promise of the deep learning approach for similar prediction problems.

- **Strengthened Supply Chain:** This refers to establishment of proper market channels to estimate the demand and supply of any agricultural commodity, and ensuring its quality during the entire process from the 'farm to the fork'. As agricultural commodities are majorly perishable, it becomes a pain point for the farmers to avoid any losses while transportation. According to a report by Federation of Indian Chambers of Commerce and Industry (**FICCI, 2019**), "the level of wastage of agri produce is very high and is estimated at over 15 billion annually due to the dilapidated supply chain network". Startups such as **Ninjacart**, **Crofarm** and **Krishi Star** reach the consumers with the help of different platforms such as mobile applications, websites, and digital marketing to collect their orders and supply quality agriculture produce at their doorstep.

- **Farm Services:** Use of Unmanned Aerial Vehicle (UAVs) or drones is becoming a common practice among the marginal and large farmers of the country. Using this technology to map their farm areas to get appropriate prescription, and also to apply

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location specific dose of agrochemicals. Startups are providing farm solutions in the form of leasing or consultancy services such as **V Drone Agro**, a Bengaluru based startup providing services like crop health, data analysis and mapping. In this way, the services are easily and cheaply obtained by the small and marginal farmers, making them affordable to them. Other such startups providing farm equipment for rent include **Far Mart, Fasal, Oxen, Goldfarm** and **Ravgo**.

- **IOT-enabled Technology:** IOT or Internet of Things helps to connect any inanimate object to the internet and give command to the machinery or equipment through any device, sensors are more generally used. This is technology is used to automate mechanical processes and cut down any inefficiency or lack of manpower. According to a background paper by the Ministry of Agriculture and Farmer Welfare, "Information on crop yields, rainfall patterns, pest infestation and soil nutrition can be used to improve farming techniques over time" (Promoting Startups in Agriculture, 2021). Example of this type of startups includes **Stellapps Technologies**, **Drip, Kamal Kisan** and **Nanopix.**

Table 1: Information about 20 AgriTech Startups in India

S.No.	Startup	Model	Funding Till Date (January 13th, 2021) (US$ million)
1.	**Arya Collateral**	Warehousing and Supply Chain	9.3
2.	**Bijak**	B2B Marketplace	14.6
3.	**Clover**	Warehousing and Supply Chain	6.9
4.	**Crofarm**	B2B E-commerce	4.9
5.	**DeHaat**	Full Stack	16.5
6.	**Ergos**	Warehousing and Supply Chain	6.3

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7.	**IntelloLabs**	Image recognition (Agronomy)	8.8
8.	**Jai Kisan**	Full Stack	6
9.	**Kisan Network**	B2B Marketplace	3.5
10.	**Procol**	SaaS – Cloud based procurement software	4.8
11.	**Vegrow**	Big Data & Farmer Analytics	2.5
12.	**WayCool**	E-Distributor (B2B)	65.7

Source: Indian Brand Equity Foundation, 'Agritech Start-Ups: The Ray of Hope in Indian Agriculture', 2021 (https://www.ibef.org/blogs/agritech-start-ups-the-ray-of-hope-in-indian-agriculture).

Artificial Intelligence has made its way into agriculture and it has been facilitated by the budding AgriTech startups in the country. More than 70% of the Indian population hail from the rural area and 58% out of the total 1.39 billion, devote their life to farming as a profession (Deshmukh and Babur, 2015). Therefore, it becomes the role of entrepreneurs of these startups to sensitize the farmers from rural background about the use of AI in agriculture and its benefit to enhance both the production and productivity of crops. Further, AI-based startups also come with the promise of employment generation as according to a report by FICCI, "by 2020, the number of start-ups in India is projected to increase to more than 11,500, with job creation from these entrepreneurs reaching 250–300 K by 2020." And in view of current pandemic where there is a lack of labor due to migration, Artificial intelligence proposes an easier way of farming; as it is famously said by Pt. Jawaharlal Nehru, "Everything can **wait**, but not **agriculture**".

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