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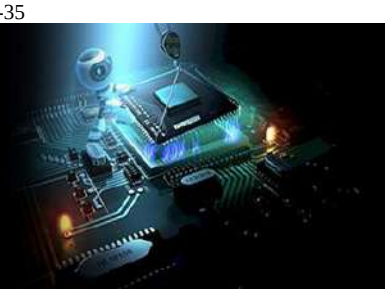

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Smart farming with e: Technology

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Abstract
Agriculture is both a major industry and foundation of the economy. In 2016, the estimated value added by the agricultural industry was estimated at just under 1 percent of the US GDP. Factors such as climate change, population growth and food security concerns have propelled the industry into seeking more innovative approaches to protecting and improving crop yield. As a result, AI is steadily emerging as part of the industry's technological evolution. This paper presents ideas for a new generation of agricultural system models that could meet the needs of growing community of end-users exemplified by a set of Use Cases. We envision new data, models and knowledge products that could accelerate the innovation process that is needed to achieve the goal of achieving sustainable local, regional and global food security. We identify desirable features for models, and describe some of the potential advances that we envisage for model components and their integration. We propose an implementation strategy that would link a "pre-competitive" space for model development to a "competitive space" for knowledge product development and through private-public partnerships for new data infrastructure. Specific model improvements would be based on further testing and evaluation of existing models, the development and testing of modular model components and integration, and linkages of model integration platforms to new data management and visualization tools.

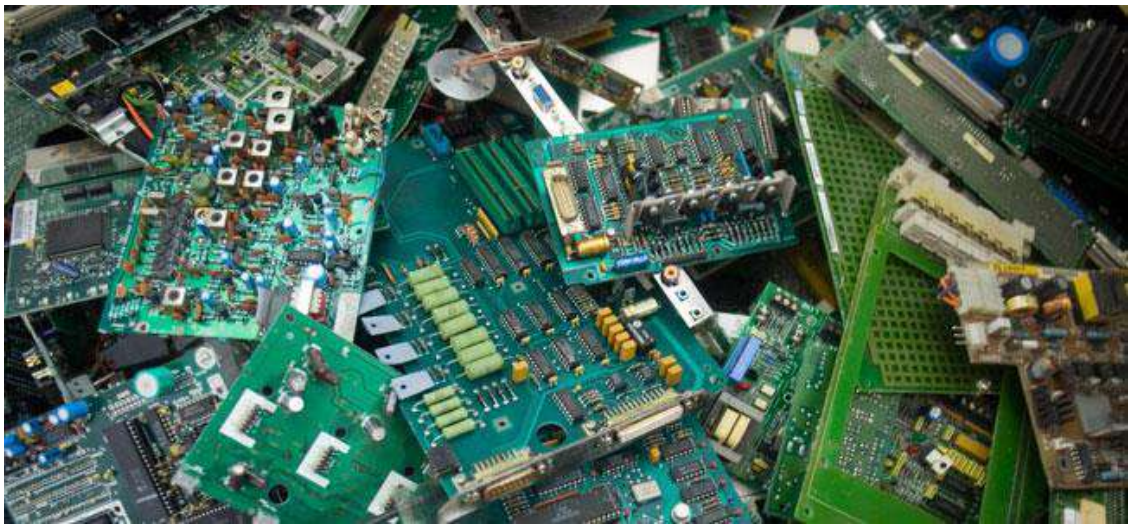
Keywords: Agriculture, systems. models, data, knowledge products, next generation

1. Introduction
The first people to turn from the hunting and gathering lifestyle to farming probably relied on their bare hands, perhaps aided by sticks and stones. Once tools such as knives, scythes, and plowswere developed, they dominated agriculture for thousands of years. During this time, most people worked in agriculture, because each family could barely raise enough food for themselves with the limited technology of the day. With the coming of the Industrial Revolution and the development of more complicated machines, farming methods took a great leap forward. Instead of harvesting grain by hand with a sharp blade, wheeled machines cut a continuous swath. Instead of threshing the grain by beating it with sticks, threshing machines separated the seeds from the heads and stalks. These machines required a lot of power, which was originally supplied by horses or other domesticated animals. With the invention of steam power came the steam-powered tractor, a multipurpose, mobile energy source that was the ground-crawling cousin of the steam locomotive. Agricultural steam engines took over the heavy pulling work of horses. They were also equipped with a pulley that could power stationary machines via the use of a long belt. The steam-powered behemoths could provide a tremendous amount of power, because of both their size and their low gear ratios.
The next generation of tractors was powered by gasoline (and later) diesel engines. These engines also contributed to the development of the self-propelled, combined harvester and thresher—or combine, for short. Instead of cutting the grain stalks and transporting them to a stationary threshing machine, these combines could cut, thresh, and separate the grain while moving continuously through the field. And the future Generation will depend on Artificial Intelligence which is nothing but the E-Technology.

2. Artificial Intelligence in the Agricultural Industry
Based on our research, the most popular applications of AI in agriculture appear to fall into three major categories:

- **Agricultural Robots:** Companies are developing and programming autonomous robots to handle essential agricultural tasks such as harvesting crops at a higher volume and faster pace than human laborers.

- **Crop and Soil Monitoring:** Companies are leveraging computer vision and deep-learning algorithms to process data captured by drones and/or software-based technology to monitor crop and soil health.
- **Predictive Analytics:** Machine learning models are being developed to track and predict various environmental impacts on crop yield such as weather changes.



Transforming agriculture with e-technology

Agricultural practices and advancements differ globally-since plants have their own differences and the location plays a role on their development as well. But through the exchange of knowledge from different agriculturally-involved individuals from all over the world, improvement of techniques can be experienced as well. It has made an impact on how information is shared, and being able to use this information for the advancement of the agricultural sector gives a great positive impact that is beneficial for everyone. IT has become a bridge for people from all over the world. Agriculture in India is the core sector for food security, nutritional security, and sustainable development & for poverty alleviation. It contributes approx. 18 % of GDP. Milestones in agriculture development in India includes: Green revolution, Evergreen revolution, Blue revolution, White revolution, yellow revolution, Bio technology revolution and the most recent one is Information and communication technology revolution.

IT supports new methods for precision agriculture like computerized farm machinery that applies for fertilizers and pesticides. Farm animals are fed and monitored by electronic sensors and identification systems. Selling or buying online began to become popular in the world. However, it's most important role remains communication, and the Internet has provided us with an ideal opportunity to do so. Central, state governments and private organisations have taken ICT measures for agriculture extension which include ITC- e-choupal, Kisan Kerala, Aaqua, Rice knowledge management portal, e-krishi, Mahindra Kisan Mitra, IFFCO Agri-portal, Village knowledge centers (VKCs)- M.S Swaminathan research foundation (MSSRF), village resource centres (VRCs)- Indian Space research organisation, etc. We cannot go into the detail of each one, we will focus the important and recent ones, may be not given in the above list.

3. Transforming rural India with the help of digital technologies

ICT is becoming the facilitator of socio-economic development in rural India with its obvious facilities by way of health, education, financial services and employment avenues, etc. It can help the bridge gaps by providing 'e' and 'm' services. ICT offering meant for rural sector can be classified into three categories:

1. Those solutions which aim are aimed at empowerment.
2. Those which would do enablement.
3. Those for market expansion.

With respect to empowerment- e-choupal comes up as fine example. This is example of efficient supply chain system empowering the farmers with timely and relevant information enabling them to get better returns for their produce. And due to its community centric approach, it gives other offerings also to the farmers' like- insurance and farm management practise, etc. The practise of e-governance, which creates transparency and governance through IT has enabled the citizens. Successful implementation of e-governance in the areas like- maintain land records is a great step in removing the malpractices and creating assurance of rightful ownership. Aadhar is another such tool, which has empowered the masses by confirming their identities and is good example of ICT solution attempting to provide access to monetary benefits by establishing the correct identity and this way rural economy is also expanding. Market expansion with the help of ICT can be seen through various examples, such as – In recent years the village and heritage tourism in remote areas of the country has picked up a huge momentum and this has been done on account of awareness being created by the online portals, attracting more visitors compared to past. Direct connect through e-commerce has facilitated large number of artisans agro-based small enterprises in rural areas. Women's livelihood is being facilitated amongst the weavers' community in the north eastern states by marketing their product through the internet medium. Indian rural market is going under transformation with better access to information. With the help of IT, farmers can use the services of FMC and can get better value for their product. As we know development is a process which takes couple of years to change the rural life. Thus information

technology will definitely be in a position to change the scenario of rural life and create a better path for rural development. Among the major States, Maharashtra was on top with the 104 out of 1,000 families had Internet in cities, followed by Kerala and Himachal Pradesh at 95 each and Haryana at 81.5.

4. ICT and agriculture

Farming and Information Technology seems to be the most distantly placed knowledge sets in the world. Farming being the most primitive and most basic of the jobs and IT related being the most advanced and most modern.

However we know the importance of farming as it is essential for life maintenance on the surface of mother earth and it is important for the developments in IT to aid for the betterment of farming to produce better. The information related to policies and programs of government, schemes for farmers, institutions through which these schemes are implemented, new innovations in agriculture, Good Agricultural Practices (GAPs), Institutions providing new agricultural inputs(high yielding seeds, new fertilizers etc) and training in new techniques are disseminated to farmers through use of Information technology to ensure inclusiveness and to avoid digital divide. Access to price information, access to agriculture information, access to national and international markets, increasing production efficiency and creating a 'conducive policy environment' are the beneficial outcomes of e-Agriculture which enhance quality of life of farmers. Soil Management, Water Management, Seed Management, Fertilizer Management, Pest Management, Harvest Management and Post-Harvest Management are the important components of e-Agriculture where technology aids farmers with better information and alternatives. It uses a host of technologies like Remote Sensing, Computer Simulation, and Assessment of speed and direction of Wind, Soil quality assays, Crop Yield predictions and Marketing using IT. In India, there have been several initiatives by State and Central Governments to meet the various challenges facing the agriculture sector in the country. The E-Agriculture is part of Mission Mode Project, which has been included in NeGP (under National E-governance Plan) in an effort to consolidate the various learnings from the past, integrate all the diverse and disparate efforts currently underway, and upscale them to cover the entire country.

5. Emerging Agriculture Technologies

Venture capitalists invested more than $2 billion in agriculture technology startups in 2014 and again in 2015. That trend is expected to continue in 2016 because the demand for innovative farm technology is high, and when inventors show results, modern farmers have demonstrated a willingness to embrace those inventions and new techniques. With that in mind, here are seven emerging technologies that can literally change the agricultural landscape in the years ahead.

5.1 Soil and Water Sensors

Perhaps the equipment having the most immediate effect are soil and water sensors. These sensors are durable, unobtrusive and relatively inexpensive. Even family farms are finding it affordable to distribute them throughout their land, and they provide numerous benefits. For instance, these sensors can detect moisture and nitrogen levels, and the farm can use this information to determine when to water and fertilize rather than rely on a predetermined schedule. That results in more efficient use of resources and therefore lowered costs, but it also helps the farm be more environmentally friendly by conserving water, limiting erosion and reducing fertilizer levels in local rivers and lakes.

5.2 Weather Tracking

Although we still make jokes about our local meteorologists, the truth is that computerized weather modeling is becoming increasingly sophisticated. There are online weather services that focus exclusively on agriculture, and farmers can access these services on dedicated onboard and handheld farm technology but also via mobile apps that run on just about any consumer smartphone. This technology can give farmers enough advanced notice of frost, hail and other weather that they can take precautions to protect the crops or at least mitigate losses to a significant degree.

5.3 Satellite Imaging

As remote satellite imaging has become more sophisticated, it's allowed for real-time crop imagery. This isn't just bird's-eye-view snapshots but images in resolutions of 5-meter-pixels and even greater. Crop imagery lets a farmer examine crops as if he or she were standing there without actually standing there. Even reviewing images on a weekly basis can save a farm a considerable amount of time and money. Additionally, this technology can be integrated with crop, soil and water sensors so that the farmers can receive notifications along with appropriate satellite images when danger thresholds are met.

5.4 Pervasive Automation

Pervasive automation is a buzz term in the agriculture technology industry, and it can refer to any technology that reduces operator workload. Examples include autonomous vehicles controlled by robotics or remotely through terminals and hyper precision, such as RTK navigation systems that make seeding and fertilization routes as optimal as possible. Most farming equipment already adopts the ISOBUS standard, and that puts on the precipice of a farming reality where balers, combines, tractors and other farming equipment communicate and even operate in a plug-and-play manner.

5.5 Minichromosomal Technology

Perhaps one of the most exciting advents in agriculture technology is coming in a very tiny package. A minichromosome is a small structure within a cell that includes very little genetic material but can, in layman's terms, hold a lot of information. Using minichromosomes, agricultural geneticists can add dozens and perhaps even hundreds of traits to a plant. These traits can be quite complex, such as drought tolerance and nitrogen use. However, what is most intriguing about minichromosomal technology is that a plant's original chromosomes are not altered in any way. That results in faster regulatory approval and wider, faster acceptance from consumers.

5.6 RFID Technology

The soil and water sensors mentioned earlier have set a foundation for traceability. The industry has only begun to

realize this infrastructure, but it's taking shape quickly. These sensors provide information that can be associated with farming yields. It may seem like science fiction, but we're living in a world where a bag of potatoes can have a barcode that you can scan with your smartphone in order to access information about the soil that yielded them. A future where farms can market themselves and have loyal consumers track their yields for purchase is not far-fetched.

5.7 Vertical Farming

Vertical farming has been a science fiction topic as far back as the 1950s and perhaps further, and now it's not only scientifically viable but will be financially viable within the decade. Vertical farm technology Vertical farming a component of urban agriculture is the practice of producing food in vertically stacked layers. This offers many advantages. Perhaps the most obvious is the ability to grow within urban environments and thus have fresher foods available faster and at lower costs. However, vertical farming won't be limited to just urban environments like initially expected. Farmers in all areas can use it to make better use of available land and to grow crops that wouldn't normally be viable in those locations.

6. Conclusion

Technology is transforming nearly every aspect of our modern lives, and farming is no exception. The produce on your table tonight will have gotten there faster, fresher and more cost-effectively thanks to leading-edge technology in agriculture. Agriculture technology will become ever more computerized in the decades ahead!

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