

Use of Artificial Intelligence in Market Intelligence System

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Implementation of GPS enabled new signals to enhance the quality, as well as efficiency of agricultural operations, and thereby, increase the overall productivity in future. The major problem is that the environment of Artificial Intelligence (AI) is not exactly the same as farmers' field which makes the testing, validation and successful rollout of AI and other related (Industry 4.0 revolution) technologies much more riskier and laborious than in other industries. Sometimes the cost associated with implementation of AI in agriculture becomes so high and unaffordable due to unpredictability associated with each and every aspect of agriculture such as weather, pests, soil, etc. Increasing consumption and rising requirement of better yield are estimated to be one of the major factors that is fueling the demand of automating farming operations. The farmers want to shift more towards automation to enhance yield and improve the product quality. This technology assists farmers in enhancing their crop yield and product quality by analyzing and correlating large amounts of structured and unstructured data from multiple sources to extract actionable insights to enhance yield.

Key words: Agriculture, Artificial Intelligence, Automation, Market Intelligence

Prevailing market intelligence system

A remunerative and stable price environment is considered to be important for providing incentives to farmers for increasing agricultural production and productivity. Price rise of agricultural commodities has become a major concern for policy makers in India. The volatility in the agricultural prices has a catastrophic effect on farmers and other stakeholders involved in the production, marketing and consumption of the food commodities. This has increased the risk faced by the farming community. Considering the fluctuations in the agricultural price scenario, proper understanding of the agricultural price mechanism and their forecasts would help farmers to plan and decide about the production portfolio and marketing for improved farm profit, traders to understand the market trend and Government to augment economic development in the nation.

The sufficient information about the prices would strengthen the otherwise weak linkage between production and marketing in the country. Market Intelligence is the process of collecting relevant information related to the existing market prices, domestic and global agricultural supply and demand conditions, policy environment and other relevant factors. Converting those data into a usable form through scientific modelling and stakeholders' perceptions; and disseminating through effective means so that informed and effective decisions can be taken by the farmers and other stakeholders. This process requires that the market data is converted to usable information and then to market intelligence.

The development of a Decision Support System on Market Intelligence would initiate to provide reliable and timely price forecasts to farmers for selected agricultural

commodities in order to enable them to make informed production and marketing decisions, which in turn could lead to higher profitability. Regionally important commodities were selected based on a number of parameters like supply conditions, arrival pattern, global linkages, etc. which could influence on prices. Appropriate forecast models were developed to capture the unique behaviour of each commodity; forecasts are developed based on a modelling framework along with the consideration of qualitative expectations of farmers and traders. The forecasts were disseminated to farmers and other stakeholders through newspapers, websites, television, radio, information bulletins, social media, etc. Both long-term or annual and short-term price and other forecasts are important for policy makers, and farmers. As indicated above, some efforts have been made by ICAR

institutes in the past and it is time to consolidate these efforts that methodological refinement and building capacity in the states.

Reliable forecasting is extremely important for efficient planning and decision making. It is imperative to study the price trends of different commodities by employing sound statistical modelling techniques that, in turn, will be beneficial to the farmers and planners in formulating suitable policies to face the challenges ahead. Time series models have become increasingly popular as a tool to describe such economic phenomena. The most popular and widely used time-series model has been the Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) model. Univariate ARIMA models use only the information contained in the series itself. Thus, models are constructed as linear functions of past values of the series and/or previous random shocks (or errors). Forecasts were generated under the assumption that the past history could be translated into predictions for the future.

Later, it was observed that ARIMA family has serious limitations and is not capable of modelling the datasets that depict volatility. Considering this, Engle (1982) proposed the Autoregressive Conditional Heteroscedastic (ARCH) families of parametric nonlinear time-series models. It captures the volatility in prices through inbuilt modelling mechanisms. More recently, Artificial Neural Networks (ANN) have been studied as an alternative to these non-linear model driven approaches. ANN belongs to the data-driven approach, i.e. the analysis depends on the available data, with little a priori rationalization about relationships between variables and about the models.

Forecasts developed based on modelling framework must consider price expectations of farmers and traders to provide short term forecasts to farmers at an appropriate time period for effective decision making. Price forecasting for the commodities needs to be done in the preceding month of sowing and

harvesting of the crop so that it could provide sufficient time for production and marketing decisions of the farmers. In case of perishable commodities, the forecast needs to be done weekly. The different price forecast models are available and also are attempted by researchers depending upon the nature of commodities, quality of data, and degree of price forecast accuracy etc. The estimates of parameters along with corresponding standard error and p-value of selected model needs to be worked out to ascertain the suitability of model. For instance ARIMA model for price forecasting in case of pulse crops is considered good provided price remains somewhat stable. Whenever, there is price volatility in prices of pulse crops, GARCH models is found better fit. SARIMA models in price forecast are considered good when it becomes essential capturing the seasonal effects. In case of extremely volatile price situation, E-GARCH model is considered better for price forecasting due to its intrinsic capability to capture the leverage effects and symmetric and asymmetric price patterns. In general, pre-harvest forecasts are more precise than pre-sowing forecasts.

The forecasts were disseminated to farmers through regional newspapers, websites of the regional academic institutes, information bulletins, personal meetings and interactions, social media and mass media. To ascertain the effects of price effect on farmers, traders, and warehouse/storage owners, there is a need to capture the longitudinal data of each stakeholder (around 25) for each commodity in each state in order to regularly disseminate the forecasts and monitor the impacts of the price information provided to them. Mass media including print and electronic media would be preferred mode of dissemination across states for wider dissemination. Other modes comprised of voice SMS, text SMS etc for portals developed by public and private institutes engaged in agriculture.

The core problem of Indian marketing is high price volatility in agricultural commodities in the

markets. Durable nature of commodities reveals less price volatility as compared to other crop categories. Aberrant climatic shocks and adhoc-ism in government market and trade policies, market sentiments are considered responsible for quite violent price shocks during the recent years. At policy parlance, it is considered that the length of price stability phases has reduced overtime and shorter phases with greater instability are becoming pronounced.

Strenuous efforts need to be made in terms of improving the forecast accuracy through modelling and its dissemination through institutional interventions. Quality and granularity of data, modelling innovations etc needs to be refined and must be brought in automation mode. Once the MI system is robust and reliable, then arises necessity of institutionalization of market intelligence (basically aiming at generating short term price forecasts).

Besides its own volatility, the prices of agricultural commodities are affected by many climatic, technology, institutions and policy variables. Therefore, the methodological improvements for incorporating the effects of extraneous variables are the need of the hour. The multi-variate modeling framework needs to capture the variables which emanate from extraneous shocks. Thus, the real time data on extraneous variables must be available to capture the external shocks. Besides, the use of remote sensing and artificial intelligence need to be promoted in order to get the advanced information about the crop conditions at field level.

In the long run, to create longer and larger impact and acceptability in the system, e-solution for market intelligence can be developed by combining various algorithms of suitable techniques and models in single software package, which would be easy to use even by the line departments.

The results emanating from focused regional and commodity analysis are required to provide the updated market dynamics to appraise the policy makers to take any

preventive or corrective actions. Proper emphasis on smooth supply in domestic market along with international trade coupled with strong market surveillance and intelligence efforts with good state governance would help control the price distortions.

Application of industry 4.0 revolution in market intelligence

Location based services: Global positioning system (GPS) enabled smartphones have put mapping technology in the pockets of billions of users. End consumers are capturing the lion's share of the benefits, mostly through time and fuel savings as well as new types of mobile services. Beyond this value, there are growing opportunities for businesses to use geospatial data to track assets, teams, and customers across dispersed locations in order to generate new insights and improve efficiency.

Retailers can mine a trove of transaction-based and behavioral data from their customers. Thin margins (especially in the grocery sector) and pressure from industry-leading early adopters have created strong incentives to put that data to work in everything from cross-selling additional products to reducing costs throughout the entire value chain. This retail sector has high potential margin improvements and productivity growth, but again, a great deal of value has gone to consumers.

Within research and design of production, design-to-value applications have seen the greatest uptick in adoption. Developments of such digital factories have integrated sensor data-driven operations analytics, often reducing operating costs. After-sales servicing offers are beginning to be based on real-time surveillance and predictive maintenance.

Use of data analytics could be of immense use to make government services more efficient, reduce fraud and errors in transfer payments, and improve tax collection and have potential of huge annual savings. Wider potential is envisioned today for societies to use analytics to make

more evidence-based decisions in many aspects of government.

Transformation strategy for market intelligence

An effective transformation strategy in market intelligence could be of several components:

- One must ask some fundamental questions to shape the strategic vision: What will data and analytics be used for? How will the insights drive value? How will the value be measured? The second element is building out the underlying data architecture as well as data collection or generation capabilities. A need is felt to switch from legacy data systems to a more nimble and flexible architecture to store and harness big data. They may also need to digitize their operations more fully in order to capture more data from their customer interactions, supply chains, equipment, and internal processes.
- One should acquire the analytics capabilities needed to derive insights from data. The organizations may choose to add in-house capabilities or outsource to specialists.
- A common stumbling block is changing business processes to incorporate data insights into the actual workflow. This requires getting the right data insights into the hands of the right personnel.
- Organizations need to build the capabilities of personnel at appropriate levels to understand how to use data-driven insights—and to begin to rely on them as the basis for making decisions.

Another equally vital role is that of the business translator who serves as the link between analytical talent and practical applications to business questions. In addition to being data savvy, business translators need to have deep organizational knowledge and industry or functional expertise. This enables them to ask the data science team the right questions and to derive the right insights from their findings. It may be possible to outsource analytics activities, but business translator roles require proprietary knowledge and should be more deeply embedded into the

organization. Such capabilities need to be built in the organization from within.

National efforts for data integration

The early efforts on market intelligence started in India, as early as 1954, when on the recommendation of the Agricultural Prices Enquiry Committee, (1954), the Directorate of Economics and Statistics, Ministry of Agriculture (DESMOA) set up 14 Market Intelligence Units (MIU) in the capitals of states. The market intelligence units helped the DESMOA in the formulation, implementation and review of the agricultural price policy relating to procurement, marketing, storage, transportation, import, export and credit, etc; the units gave their appraisal of production of various *kharif* and *rabi* crops at regular intervals to help preparation of crop forecasts.

AGMARKNET was a mega initiative launched by Government of India through a network of Directorate of Marketing and Inspection, Department of Agriculture and Cooperation and National Informatics Centre. The initiative connected all major agricultural markets of the country and provided the current price information to the beneficiaries. The daily information is compiled by the regulated markets and provided to NIC for sharing on the web portal. Besides the commodity wise price and arrival information, the portal has been enriched over a period of time in terms of providing other useful information related to Government policies, regulations, subsidies etc. Based on the temporal trends, the information is useful for the academic and research organizations for making future predictions regarding the price behavior.

Organizations now have troves of raw data combined with powerful and sophisticated analytics tools to gain insights that can improve operational performance and create new market opportunities. Most profoundly, their decisions no longer have to be made in the dark or based

on gut instinct; they can be based on evidence, experiments, and more accurate forecasts.

Machine learning and deep learning capabilities have an enormous variety of applications that stretch deep into sectors of the economy that have largely stayed on the sidelines thus far.

It aims to help organizational leaders understand the potential impact of data and analytics, providing greater clarity on what the technology can do and the opportunities at stake.

Data scientists now have unprecedented computing power at their disposal, and they are devising ever more sophisticated algorithms.

In an environment of increasing volatility, the organizations have to adapt according to spontaneous changes. They have to decide whether to enter new markets or changing their business models. At the same time, they have to apply analytics to improve their core operations besides enabling continuous learning and feedback. There will be enormous new opportunities as well as significant risks—not only for individual companies but for society as a whole.

Emerging data ecosystem

Data is considered as critical corporate asset. Business leaders and policy analysts want to know what the information they hold is worth. The value emanating from data is tied to how it will be used and by whom. Value of data is generated when supply of data matches demand of data (users of data). Interestingly, not all data are created equal and challenge lies in valuing data are its sheer diversity. These are several broad categories of data supply like behavioural data (capturing actions in both digital and physical environments), transactional data (records of business dealings), ambient or environmental data (conditions in the physical world monitored and captured by sensors), geospatial data, reference material or knowledge (news stories, textbooks, reference works, literature, and the like), and public records. Some data are structured (easily expressed in

rows and columns), while images, audio, and video are unstructured. On the demand side, after analysis of data based on research question can provide insights for diverse uses, some of which are more valuable than others.

An important case in which value can accrue to data generation and collection involves market-making with strong network effects. In certain arenas, a small number of players establish such critical mass that they are in a position to collect and own the vast majority of data generated in these ecosystems. But in the absence of these types of exceptional supply constraints, simply selling raw data is likely to generate diminishing returns over time.

Another role in the data ecosystem involves aggregating information from different sources. In general, this capability is becoming more accessible and less expensive. Data aggregation adds value when combining, processing, and aggregating data is technically difficult.

Analytics in data ecosystem see the biggest opportunities in the future. The provider of analytics understands the value being generated by those insights and is thus best positioned to capture a portion of that value. Combining analytical tools with business insights for decision makers is likely to multiply the value even further. Bad analysis can destroy the potential value of high-quality data, while great analysis can squeeze insights from even mediocre data. Data aggregators are offering to integrate clients' data and perform analysis as a service.

Emerging data-driven models and capabilities are reshaping agri-marketing

There are Indicators of potential for agricultural market disruption: assets are underutilized due to inefficient signalling, supply/demand mismatch, dependence on large amounts of personalized data/ data is siloed or fragmented, large value in combining data from multiple sources, R&D is core to the business model, decision making is subject to human biases, speed of decision

making limited by human constraints and large value associated with improving accuracy of prediction etc. All these open the door to disruption.

Hyperscale platforms can match supply and demand in real time. Digital platforms provide marketplaces that connect sellers and buyers for many products and services. Some platform operators using data and analytics to do this in real time and on an unprecedented scale—and this can be transformative in markets where supply and demand matching has been inefficient.

In transportation of agri-produce, goods shipment -sharing services use geospatial mapping technology to collect crucial data about the precise location of producers and available transporters with demand of consumers/retailers in real time. The introduction of this new type of data would enable efficient and instant matching, a crucial innovation in this market. In addition, the data can be analyzed at the aggregate level for dynamic pricing adjustments to help supply and demand adjust. The typical personally owned transport like tractor/truck is estimated to sit idle more than 50 percent of the time, making it a hugely underutilized asset. Developing virtual platform (connecting producers, transporters, traders and consumers)goods shipment -sharing mechanism have been able to expand rapidly without acquiring huge fleets of transportation, making it easy for new drivers to put their own underutilized assets to work.

Imminently mobility services, such as goods shipment sharing and transport sharing, could add more of total load vehicle miles in the economy. This would not only boost agri-sales in absolute numbers but also shift toward mobility services through more vehicle sales. Consumers could save on shipment purchases, fuel, and parking. Some of this value will surely go to consumer surplus, while some will go to the providers of these platforms and mobility services.

Data and analytics can reveal finer levels of distinctions, and one of the most powerful uses is micro-segmenting a population based on

the characteristics of individuals. Using the resulting insights to personalize products and services on a wide scale is changing the fundamentals of competition in agriculture sector. This capability could have profound implications for the way agri care is delivered if the sector can incorporate the behavioral, genetic, and molecular data connected with many individual farmers. The declining costs of genome sequencing, the advent of proteomics, and the growth of real-time monitoring technologies make it possible to generate this kind of new, ultra-granular data. These data can reshape agri care in two profound ways. First, they can help address information asymmetries and incentive problems in the agri-care system. Now that a more complete view of the farmer's farm is available, incentives could be changed for agri-clinics and other providers to shift their focus from disease treatment to wellness and prevention, saving huge sums on pesticide expenditures and improving the quality of produce. Second, having more granular and complete data on individual farmers' farm can make treatments more precise. Treatments, dosages, and plant care settings can be personalized to farmers (groups of farmers' farm), leading to more effective outcomes with fewer side effects and reduced costs. The wide range depends on the many uncertainties involved, including how rapidly the plant health-care system can adapt and whether R&D applications produce breakthrough treatments.

Data integration and sharing/networking

Massive data integration capabilities can break down organizational silos. The first step in creating value from data and analytics is accessing all the information that is relevant to a given problem. This may involve generating the data, accessing it from new sources, breaking silos within an organization to link existing data. Combining and integrating large stores of data from all of these varied sources has incredible potential to yield insights, but many organizations have

struggled with creating the right structure for that synthesis to take place.

Data and analytics can fuel discovery and innovation. One of the main components of productivity growth, innovation can be applied to both processes and products. Throughout history, innovative ideas have sprung from human ingenuity and creativity—but now data and algorithms can support, enhance, or even replace human ingenuity in some instances. In the realm of process innovation, data and analytics are helping organizations determine how to structure teams, resources, and workflows. High-performing teams can be many times more productive than low-performing teams, so understanding this variance and how to build more effective collaboration is a huge opportunity for agri-business organizations. This involves looking at issues such as the complementarities of skills, optimal team sizes, whether teams need to work together in person, what past experience or training is important, and even how their personalities may mesh. Data and analytics can test hypotheses and find new patterns that may not have even occurred to managers.

Algorithms can support and enhance human decision making. When humans make decisions, the process is often muddy, biased, or limited by our inability to process information overload. Data and analytics can change all that by bringing in more data points from new sources, breaking down information asymmetries, and adding automated algorithms to make the process instantaneous. As the sources of data grow richer and more diverse, there are many ways to use the resulting insights to make decisions faster, more accurate, more consistent, and more transparent.

AI in agricultural market intelligence system

Transformation of agriculture and Industry 4.0 revolution are taking place side by side in the economy. The pace of Indian agricultural transformation was very slow compared to Industry 4.0 revolution.

Now Industry 4.0 has taken the driving seat of Indian economy. The paradigm shift from IT phase to Industry 4.0 revolution led to opening new vistas of economic opportunities. The constructive destruction process discerned mainly three important avenues for joining higher income earners' club in the economy are, viz. (1) big data analytics, (2) networking business and sharing/connecting the economic agents, and (3) use of AI to automate the process.

Combination of human ingenuity and data analytics

Conventional software programs are hard-coded by humans with specific instructions on the tasks they need to execute. By contrast, it is possible to create algorithms that "learn" from data without being explicitly programmed. The concept underpinning machine learning is to give the algorithm a massive number of experiences (training data) and a generalized strategy for learning, then let it identify patterns, associations, and insights from the data. In short, these systems are trained rather than programmed. Through BigData and IoTs use of AI has become viable only now as vast quantities of data and unprecedented processing power are available. The work activities currently performed by people in agri-market could potentially be automated through machine learning.

Machine learning capabilities are best suited for solving three broad categories of problems: classification, prediction/estimation, and generation. Classification problems are about observing the world and also involves finding associations in data or segmenting it into clusters, which is useful in tasks such as customer segmentation. Machine learning can also be used to predict the likelihood of events and forecast outcomes. Advances in deep learning could greatly expand the scope of automation. There are ethical questions surrounding machine intelligence. One set of ethical concerns relates to real-world biases that might be embedded into training data. Another question involves deciding whose ethical guidelines will

be encoded in the decision making of intelligence and who is responsible for the algorithm's conclusions.

Artificial Intelligence is a program that can adapt itself to execute tasks in real time situations using cognitive processing as the human mind. Interestingly, it does not require constant supervision. In this process an installed application guides farmers through the process of growing, sowing, harvesting and sale of produce. Recent technological advancements and the modernization of GPS are making farmers and the agriculture service providers expect further improvements to increase not only the productivity and quality but also in tacking the post harvest operations in a desired manner. This implementation of new signals will enhance the quality, as well as efficiency of agricultural operations, and thereby, increase the overall productivity in the future. Henceforth, man-made reasoning (AI) is one such critical innovation in the present advanced agriculture that is being actualized and conveyed for more sustainable utilization of available assets. The farmers and other stakeholders in domestic and international markets would sell agricultural commodities on a certain date due to inbuilt advance warning system because that particular date typically aligned with above average product prices. Algorithmic models composing of participants and market behavior to price movements of various years tell their likely price in near future which avoids distress in farmers. Doing predictive analysis on

commodity prices to time the sale was practically impossible because the stakeholders in market were neither equipped with the right tools or data to make this type of decision. These are the types of decisions that AI is uniquely capable of helping especially farming community besides making predictions on the right time to crop production and its management. This can improve the return on investment for all farms. Further, the AI technology can process analytics that helps farmers to minimize losses in the production supply chain of their farms. This technology assist farmers in enhancing their crop yield and product quality by analyzing and correlating large amount of structured and unstructured data from multiple sources to extract actionable insights to enhance yield. Adoption of such smart technology would provide virtual assistants to farmers. Techniques such as machine learning and deep learning can create chatbots that will answer all questions of the farmers instantly as well as give recommendations and advice over specific problems. Thus initiatives to increase digital literacy in rural landscape can be seen as a weapon in doubling farmer income in near future. Moreover, IA would automate development, validation and application of price forecasts for major commodities in major markets/ States and devise/ develop mechanism for dissemination of price forecast through electronic and print media and other ICT tools on click of mouse. This would substantially

reduce cost and increase efficiency of the market intelligence system provided continuous development of capacity and mechanism for institutionalization of market intelligence in the country.

CONCLUSION

With the support of AI, the purpose of the government is to make government data and information related to market more available to people and make services more accessible to the public. This move is seen as an attempt to ensure transparency at the government's end and address price volatility issues with the help of online information. It can help us save expenditure and also innovate. Through AI, how the government created different data sets for the public so that AI-based solutions could be applied on the data to find solutions to various problems. In order to deliver effective service for the public, focus should be on streaming processes and generating meaningful data for better AI systems to function better. It is realized the opportunities of newer technologies present and laid the foundation to tap innovation and employment opportunities in Industry 4.0 revolution. Hence it becomes essential to use AI in market intelligence system to automate the processes.

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