DIGITAL TRANSFORMATION OF AGRICULTURE - SEEDS IN THE WOMB OF TIME

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Background

The first green revolution of India started from mid 1960s mainly because the rate of growth in agricultural harvests could not keep pace with population growth. The revolution was predominantly driven by the ultimate objective of achieving self-sufficiency in food and contributing to mitigate shortage elsewhere in the world. India adopted high-yielding varieties of seeds. Government's initiatives gradually helped farmers with improved availability of irrigation facilities, fertilisers, and insecticides. This was followed by limited mechanisation of cultivation using tractors, pumps, deep tube wells, and other low-end devices for harvesting, etc.

The process of green revolution continued with contributions from various research work for cross breeding of plants and seeds, all weather farming of erstwhile seasonal crops and vegetables, improving soil testing, manure applications farming techniques, etc. Farmers now grow many crops, vegetables and fruits of western origin which were never grown in India just about two decades

before. Another revolution joined the march, and that was white revolution.

But even after seventy-three years of independence, Indian farmers are deprived of the rightful price for their harvests, because of too many intermediaries. Their produces are subjected to adulteration, contamination, wastage, and spoilage due to unscrupulous traders and non-availability of affordable storage, supply chain and cold chain facilities. Reliability of harvest cannot be established due to lack of quality-based gradation and traceability to the origin of farmland and farmers.

Farmers in India do not have easy access to technical advisories and services related to weather conditions, soil testing, crop scouting, etc. They do not get right quality and quantities of inputs such as seeds, fertilisers, etc. at the right prices and at the right time. Last but not the least crop loans from banks and insurance for coverage against perils of nature are also not available without pains and hurdles. These situation for agriculture and agriculturists may not be much different in many underdeveloped and developing countries.

Objective

The predominant objective of this paper is to ideate a comprehensive digital solution which can address the above issues and mitigate miseries of farmers who grow food for all but do not get rightful rewards for their hard work. The author would like to contribute in his limited way towards making this journey for digital transformation joyful and rewarding from the perspectives of all stakeholders and particularly for marginal farmers. The proposed solution with limited modifications would also be able to mitigate similar miseries in areas of horticulture, animal husbandry, fruit orchards, sericulture, etc.

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Industry 4.0 and Agriculture

Agriculture contributes about 15% to Indian GDP. According to a recent estimate of ILO around 42% of Indian working population is engaged in agriculture. Most of these farmers belong to lower middle and marginal category. They do not get the rightful return against their hard labour.

But the present scenario is different in industry and service sectors. The entire world has entered the era of fourth industrial revolution which is essentially driven by digital transformation. In about a decade's period many Goliaths have been disrupted and 'destrupted' by 'startupian' Davids powered by digital tools and applications. India is no exception to that, albeit at a slower pace. According to Venture Intelligence[W1] presently there are about 30 Unicorn in India and many more 'Soonicorns' are in the race. The bigger question is whether digital transformation of agricultural activities is possible? Can agriculture, manufacturing and service sectors of the economy collaborate and integrate their platforms to ensure for farmers the rewards they rightfully deserve?

Economic Times[W2] reported in July 2020 that, *"Surprisingly, tech companies and startups see an opportunity to upgrade around $400 billion Indian agriculture sector. There are 896 agri-tech startups providing tech tools for pre-harvest, post-harvest and during plant growing periods, according to Tracxn data as on July 1. They have attracted $560 million of venture funding, most of it in the last three years. In two years, according to Maple Capital Advisors, agri-tech ventures will attract another $500 million*." This report indicates that the process of collaboration for digital transformation of Indian agricultural sector has already started and is gaining momentum with considerable quantum of money being invested. However, there is a need for an integrated approach.

ICT and Agriculture

The process flow of agricultural activities from sowing seeds to reaching harvests to ultimate consumers generates considerable volume of multi-faceted data by different stakeholders from different locations. Successful digital transformation involves a great deal of automated processes for timely collection of relevant data, safe storing, and meaningful analyses. The imperatives are to draw inferences from the outcomes of data analytics, strategize plans, and initiate timely actions for maximisation of value creation and minimisation of value destruction with due transparency. Therefore, use of Information and Communication Technology (ICT) is foundational requirement for solving problems for all stakeholders directly or indirectly engaged in agricultural activities.

This has been observed and concluded by many research scholars. Walter et al. (2017)[B1] concluded that, *"The use of data and information becomes increasingly crucial for the agriculture sector to improve productivity and sustainability. ICT substantially increases the effectiveness and efficiency of collecting, storing, analyzing and using data in agriculture."* Kaddu and Haumba (2016)[B2] observed that, *"ICT allows agricultural practitioners and farming communities to easily obtain update-to-date information and thus make better decisions in their daily farming."*

Post the above two research-based conclusions, digital technologies have brought in manifold improvements in automated processes for data collection, analytics and problem-solving capabilities. This is more so when there are simultaneous applications of Blockchain, IoT, Drone, AI, ML, Edge Computing, etc. in different combination(s) befitting the problem(s) to be solved in isolation or combinations.

The following part of this paper has been written in the form of an ideated use case for designing comprehensive solutions of those problems, as briefly delineated above, faced by various stakeholders in the life cycle of a crop. Efforts would be for further orchestrating splintered efforts by stakeholders in the value chain and improve collaboration with trust, transparency, privacy, information safety and security.

Kishan Blockchain for Digital Transformation of Agriculture

Blockchain has already been established as one of the most safe, immutable, transparent, and reliable technologies

for conducting commercial and non-commercial transactions. The Author in some of his previous columns in this Journal has written about Blockchain which is also synonymously known as Distributed Ledger Technology (DLT). Additionally, readers can also refer one of his published papers[B3] or watch his video recorded Master Class[W3] for gathering brief application-oriented knowledge on Blockchain.

While ideating structural design, operating propositions, and applications of Kishan Blockchain Platform, hereinafter referred as KBP, for digital transformation of agriculture the author has made efforts to plug in certain other digital tools and devices to render the solution comprehensive. At the user end KBP is to be positioned as a simple 'App' that can be handheld using a smart phone, iPad, or laptop / desktop computer, etc. The front-end can be presented in any vernacular and user-friendly icons, with toggle switch for change of language. The administrator for the KBP should arrange training for farmers and other participants

Stakeholder Participants for KBP

The very first of objectives for digital transformation of agriculture should be to bring the following stakeholders under one umbrella of a KBP:

1. Cultivators - Farmers and their associates, who in course of time may be assignees for all rights, assets, and liabilities of the farmers.
2. Government Agencies - Officials of Land Registry, *Jila Parishad* to *Gram Panchayet* (Local self-government from district to village level), Block Development Office, irrigation, and meteorological departments.
3. Input Vendors - Seed processors, manufacturers of farming equipment, pumps, fertilisers, pesticides, and insecticides, digital devices like drones, IoTs, sensors, etc.
4. BFSI Players - Banks, financial institutes, insurance companies, factors, etc.
5. Service Providers - Agricultural scientists, supply chain and cold storage operators, soil scientists, etc.
6. Customers: Government, organised retail chains, food processors, hotel chains, eCommerce players and co-operative marketing federations

It will be a challenge to incorporate all narratives for systems architecture and business requirements (BR) for designing and writing software for KBP. However, some of the new and critical aspects, which are unique requirements for a KBP has briefly been narrated in the following sections.

Administrator for KBP

KBP, being a nation-wide initiative for digital transformation of agriculture, can be administered and oversighted by a National Council like GST Council. Digital scientists can be co-opted as members of this Council. While discharging its roles and responsibilities for policy decisions and oversight, the National Council may decide to handover responsibilities to a professional IT organisation for developing, scaling up and maintaining the KBP on its behalf.

Nodal Structure for KBP

Scaling up of any blockchain platform is one of the major challenges for software architecting, designing, and coding team. Accordingly, several options can be considered for structuring one or more KBPs bearing in mind that data collection, analytics and oversighting can be performed both at state and national levels. This is necessary for framing strategies and policy decisions for agriculture sector, and timely dissemination of technical and commercial advisories to farmers. The following options and operating features may be considered:

1. Blockchain with DTL Nodes for the following stakeholders:
   - District > Jila Panchayet > Block > Gram Panchayet > Farmers' Cooperative > Farmers and other stakeholders

     Or
   - State > District > Jila Panchayet > Block > Gram Panchayet > Farmers' Cooperative > Farmers and other stakeholders
2. Administrative authorities for above platforms can be at the supervisory node of respective Ministry of Agriculture at state and / or central government levels simultaneously with decentralisation and delegation of authorities to officials at District, Zila Parishad and Gram Panchayet levels depending upon transactional need and ease of operation.

   One or more such KBPs can also be operated by any corporate house in private sector. Government officials can also join as participants. However, it should be ensured that a common farmer at the lowest village level is not put into a dilemma of selecting the right KBP to join and for this too much of competition may be avoided
3. Recommendation and approval of transactions should be kept at one or more nodes depending upon guiding policies, SOP for operating the KBP, roles and responsibilities of each participant and nature of each transaction.
4. Integration and interoperability of the above DTL platforms across district, state and central government levels should be ensured for more collaboration and coordination for the ultimate objective of value creation for farmers.

KYP – Pre-entry Identification and Authentication Participants

The proposed KBP platform would first provide facilities to 'Know Your Participant'. It would capture all details and credentials for identification, recognition, and registration of every singly participant, irrespective of being an individual, incorporated entity or government agency. Uploaded

supporting documents, towards proof of authenticity and credentials, would securely be stacked by the KBP in a digital document library. This KYP facility would be configured in compliance with all regulatory requirements which the respective participants are subordinated to.

Enforceability of transactions - Super Smart Contract

Every single commercial transaction that will be entered and executed by and between two or more of participants must have to be backed by a legally enforceable contract in compliance with respective laws and regulations. The KBP would facilitate the process by hosting templates for all possible types of contracts which two or more of the participants under a contract would have to digitally sign-off. Such transactions could be in the nature purchase of farming equipment, fertilisers, technical services, etc, loan to farmers by banks, crop insurance contract, sell of crops to buyers, and so on.

Such underlying contracts will be father-hooded by the Super Smart Contract. All such contracts will initially be drafted by legal eagles, and then codified and embedded in the Smart Contract library hosted in the KBP. It will have facilities for change of clauses and sub-clauses as mutually agreed by and between the concerned participants through offer for modifications and acceptance recorded through the platform. All these will be linked and grafted to the concerned smart contract hosted by KBP and guide all subsequent transactions.

Digital Platforms Tools and Devices for KBP

Success of any KBP will to a large extent depend upon simultaneous and integrated use of many other digital tools and devices for conducting various primary and auxiliary activities:

Integration with other Digital Platforms

- Government Blockchain for Land Records: Integration of any KBPs with such state government level land records will facilitate the process of, establishing ownership of crops, collateralisation for bank loans, contract management for selling of harvests, etc.
- Fintech and Banking Platforms: Introduction of Central Bank Digital Currency or permission for use of Stable Coins in India may take time. Therefore, seamless integration of a KBP with one or more FinTech Platforms would be necessary for financial transactions.

Use of Digital Tools and Devices

- **Internet of Things and Sensors** - IoTs can be used for multiple purposes, when integrated with the concerned KBP. The following could be some of those purposes:
  - Soil Surveillance: Sensors and IoTs can be placed reasonably deep into the land for monitoring moisture content. This will help estimating irrigation need based on advisories for no or scanty rain by meteorology department.
  - Deep Tube-wells and Pumps: IoTs can be affixed to water flow meters from deep tube-wells and / or pumps for automatic generation and collection of data regarding volume of water used by a farmer. Such data can be used for charging him, and /or government monitoring depletion in levels of underground water.
  - Farming Equipment: If a farmer hires equipment such as tractors, harvesting machines etc., an IoT can be fixed for multiple purposes, e.g. intimating days and hours of use for charging the farmer, health condition of the equipment and need for maintenance depending upon say period of use, heat, sound, speed, etc.
- **Drones** - These flying machines can be fitted with sensors, IoTs, digital cameras and computers having abilities for videography and geo-physical positioning. These can be integrated with the KBP and used for the following purposes:
  - Spreading of pre-measured insecticides and pesticides with reference to type of crop, field area and advisory issued by agricultural scientists.
  - Crop scouting to monitor growth, colour and physical state of standing plants, visual status of yield, time for harvesting and surveillance against pilferage.
  - Imaging of cultivated field in an unfortunate event of natural calamities to assess the extent of crop damages and insurance claim amount to be paid to farmers.
  - Pictures from drones linked to geophysical position will enable government agencies to assess areas of land cultivated for a type of crop in a given season.
- **Immersive Technology (AR, VR and MR)** - These can be used for virtually real image management of standing crop. Such video images can help farmers to realise physical condition of crop and actions needed to ensure rightful treatment for ensuring growth free from risks of insects and pests.
- **Edge Computing** - To reduce load at the central cloud computing level, various digital devices, e. g., Drones and IoTs may be powered with in-built computing devices for processing of local data before passing processed information to the central cloud storage.

RPA and Robots - Robotic process automation and deployment of robots in India would be possible in course of time. The author feels that these may be introduced in the second or third phase, bearing in mind that large number of people earn livelihood from agricultural activities.

All the above digital devices may be provided by the

service vendors on rent to the farmers and / or the Central KBP administrator, except for certain IoTs and Sensors, costs for which can be borne farmers.

Artificial Intelligence and Machine Learning – Extensive data will be generated and captured by a KBP through various commercial and non-commercial transactions. Such data will never be stale for future reference and will always be updated for every crop growing season. KBP should be designed in such a manner that those data can easily be retrieved, collated, and safely stored in such a manner that will facilitate the process of using tools from the stable of AI and ML

The predominant objective is to conduct region-wise analyses of various related variables, price movements of outputs in relation to inputs, farming techniques, variation in weather conditions, type of soil, etc. It will also generate how the vendors and customers commercially conduct themselves and behavioural data of farmers. When inferences are drawn after analyses, various stakeholders, including governmental agencies, banks, insurance companies, vendors, and buyers, will be able to strategize their respective plans, initiate actions with a win-win motive for all.

Podcast Facility

All services to farmers need not be rendered through a transaction in a KBP, e. g, informing farmers and insurers about attack of pests and insects, forecast for natural perils, rain in a monsoon season when saplings are sown, and crops are grown etc. Objectives could be to help farmers to decide timing for sowing seeds and drawing water from underground or from canal. Hence, a KBP would have a configured facility to podcast such advisories as messages to all farmers. However, records for such podcasts can be kept in the concerned KBP.

Escrow Bank Account - Comfort for Stakeholders

One of the overriding objectives of a KBP is to ensure transparency and reliability for all transactions and to commit that all participants get their dues on time as per contractual terms. For this a KBP can open and auto-operate an Escrow Bank Account on behalf of each farmer. The farmer would have a lien on the balance of the account. All collection and payment transactions processed in KBP will auto trigger instructions for processing and settlement by Banks. If money is required for subsistence of the farmer, the bank will directly credit the farmer's savings account in accordance with the loan agreement.

The chosen bank should be the one which would sanction loan to the farmer against future receivables from sale of crops and / or the farmer's land as collateral(s). The farmer's personal money, drawing funds against loans, collections against approved government grants and insurance claims, if any, will be deposited to this account. Payments to all vendors and service providers will be released from this escrow account on behalf of the farmer while crops grow on the field.

The bank loan will be paid-off from collections against sale of crops. The residual positive balance will be credited to the farmer's savings account after the transaction of the season is completed for settlement of the last liability on behalf of the farmer. Any negative balance will have to be settled by the farmer or though waiver of loan by Government. In any unlikely and unfortunate event of crop failure, collection will be there against insurance claim for meeting the bank loan, the entire process of which will be managed by the KBP in sequence of auto-triggered transactions or the ones initiated by the concerned stakeholders.

Crypto Currency

Ideally all transactions for this Escrow Account should be handled using a Cryptocurrency. The author is of the view that in course of time when India will introduce Central Bank Digital Currency (CBDC) that should be the valid medium for settlement to be handled through a KBP, which every participant will be able to encash into fiat currency, i. e., INR. Till that time one can adopt any other cryptocurrency such as Stable Coins subject to Indian financial regulators approving such use.

Sequence of Events and Transactions

Design and codification of a KBP as a blockchain platform should be pervasive, versatile, and flexible enough to allow initiation and processing of all commercial and non-commercial transactions by and between the stakeholders. It should configure all transactions right from a farmer ideating to grow a crop say paddy to its selling to government, organised retailers and / or hotel chains. The concerned KBP should enable floating of tenders among and beyond the participant vendors by a farmer or a group of participating farmers for equipment, seed fertiliser, and / or any services that they may require. If any vendor wants to participate in such tenders, must first register as a participant. Similar facility should be there for exploration of price of harvests through request for quotation (RFQ) from prospective buyers.

KBP - A Virtual B2C Market Place for Vendors

From the perspective of vendors, KBP provides a tailor-made virtual marketplace that will save considerable marketing expenses for those product sellers and service providers. They will also be assured of getting paid because of funds form bank loans being available in the Escrow Account. And for these facilities all those organisations would be happy to pay participation fees. This in turn will be a source of earnings for the Administrator of any KBP to meet expenses for maintenance and scaling up as and when needed to accommodate larger participation.

Banks also will find comfort for participating in a KBP as lenders because the escrow bank account which will be operated as an integrated part of the KBP for end to end handling of transactions in a crop season from sowing seeds to realisation from sales.

KBP - A Virtual eMandi for Farmers and Buyers

KBP will also serve as a virtual marketplace for buyers in the form of an eMandi of agricultural produce. Accredited

technical agency(ies) for providing services for quality inspection and gradation of crops will also be a participant(s) of a KBP. Objective is to ensure that the farmers get the most deserving price for their crop befitting its quality as graded by that agency.

Even before the Crop is harvested farmers per design can initiate reverse tendering process among the participating buyers through the KBP for exploring and discovering the right price. Exception to this could be for 'Minimum Support Price' announced by Government for procurement from farmers for harvest like paddy and wheat. All these will make the role of any intermediary redundant and ensure that farmers get their due reward. Again, because the product will be sold directly by the farmer to the buyer no scope of adulteration and contamination would be there. Such buyers can be charged a fee for providing sourcing services by the KBP.

Supply Chain Management Back Tracing

Supply chain management service providers, including packaging of harvests, will also be participants of a KBP. One critical requirement that needs to be taken care of by them is to introduce RFID or QR Codes on every primary, secondary and tertiary level packaging for the products of each farmer. Such codes are also to be inserted in case there are instances of break bulk and repackaging. Structure for such codes is to be logically designed to identify farmer's name, if allowed, GPS position of the land where the crop was grown, type of farming done, e. g., organic or inorganic, and universal product tariff code. The package should also contain all other disclosures and declaration in compliance with related regulatory requirements.

Software for the supply chain portion of a KBP are to be coded at the back end in such a manner that would facilitate the process of tracking and tracing back the product till the ultimate farmer and his land where the same was produced. Readers may be aware that wineries prefer to know and quote the place where the grapes were produced first on the label of a wine bottle. In developed countries consumers are increasingly demanding to know details of the farm, location, type of farming done whenever the buy agricultural products.

Instructional Transactions

KBP will have to record certain transactions which will be in the form of advisories and instructions to farmers by Government agencies, agricultural scientists, vendors for manures and pesticides, meteorological authorities regarding onset of monsoon and commencement of sowing seeds, etc. Such advisories / instructions may or may not be rendered on a commercial basis against payment of fees but have important bearing in farmers' ultimate success for growing crops of the desired quality and quantity per square unit of land cultivated. Such transactions should also be recorded in Blockchain for every node of the DTL to take note of.

Conclusion

Kishan Blockchain Platform has been ideated by the author as a seed in the womb of time with the objective to generate and ensure rightful rewards for hard labour and sacrifice of Indian farmers. He will look forward to seeing that day when KBP will meet reality and be regarded as a friend of millions of farmers under the sun. The author will be happy to collaborate with any organisation who may be interested in the proposed KBP. MA

Note:

Contents of this paper are of proprietary nature. The author reserves all rights of the ideated method for digital transformation of agriculture through the 'Kishan Blockchain Platform (KBP)' as delineated above. He may be contacted at paritosh.basu@sbm.nmims.edu or @ paritoshbasu.

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Bibliography

1. *B1. Walter, A., Finger, R., Huber, R., and Buchmann, N., Opinion: Smart farming is key to developing sustainable agriculture, Proc. Natl. Acad. Sci. U. S. A. 114, 6148–6150. doi: 10.1073/pnas.1707462114, 2017*
2. *B2. Kaddu, S., and Haumba, E. N. (2016). "Promoting ICT based agricultural knowledge management for increased production by smallholder rural farmers in Uganda: a case of Communication and Information Technology for Agriculture and Rural Development (CITARD), Butaleja," in Proceedings of the 22nd Standing Conference of Eastern, Central and Southern Africa Library and Information Associations (SCECSAL XXII), Butaleja, 243–252.*
3. *B3. Basu Paritosh, Emerging Dimensions of Blockchain Technology, AIMA Journal of Management & Research, February 2019, Volume 13 Issue 1/4, ISSN 10974 – 497, pp 1-21*

Webliography

1. *W1.https://www.ventureintelligence.com/Indian-Unicorn-Tracker.php*
2. *W2.https://economictimes.indiatimes.com/news/economy/agriculture/can-high-tech-firms-with-actionable-inputs-eliminate-uncertainties-in-agriculture/articleshow/77040874.cms*
3. *W3. https://www.youtube.com/watch?v=_bC6-0QlJNQ*

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