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How ICT Interfaces with Structural Issues in Indian Agriculture

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Executive Summary

Governments across the globe and more so in the developing country context, have a primary responsibility of ensuring food security for their population and India is no exception. The Indian government is also responsible for the well-being of its farmers because approx half the population depends on agriculture for their livelihood. Given this background, our colonial experience and the environment of deficit and food insecurity in the decades even after our independence in 1947, Indian agriculture is inextricably tied to the state and its institutions particularly the governments both at the state and federal levels. The government is the sole entity responsible for maintenance of land records, and the primary entity responsible for comprehensive collection and collation of agricultural data and ensuring marketing of agricultural produce. Thus it is also the repository and custodian of all such data.

Governments in India, through mechanisms like the essential commodities act and the control over export and import decisions exercise a dominant say in pricing and inflation of agricultural goods. It is the primary agency for weather forecasts and provides relief in times of natural disasters which adversely affect agriculture. Agriculture credit is also facilitated by government policies. The federal government and the state governments carry out all these activities through their various ministries/departments/agencies and policies for the agricultural sector.

The entire Agricultural sector in India stand to benefit by leveraging Information and Communication Technologies (ICTs), which are now ubiquitous, priced reasonably and almost universal in access. Further, hardware costs have also gone down and size has been diminishing. Both these developments open up excellent avenues to generate credible data at the most granular levels of agriculture. These can be leveraged by the government to cut on its manual data gathering and processing protocols thereby improving efficiency, accuracy and associated costs. Due to digitization, transaction costs and time both stand to improve for end users (farmers) and thus their welfare would be enhanced. Recent trends in policy have established the virtue in evidence based, data driven policy formulation and action. Hence agricultural policies in India should be linked to credible data and decisions taken in a timely fashion to ensure smooth functioning of market.

Specifically, governments can prioritise digitising and geo-tagging land/revenue records and maps and linking them to the unique id for Indian residents (Aadhaar). Annual expenditure, which the government undertakes towards the agriculture sector such as those towards input subsidies, food subsidies exceeds a staggering Rs. 3.3 trillion. Rationalisation of these expenditures, based on such robust databases generated through digitisation would broad base the pool of genuinely eligible beneficiaries and enhance farmer welfare. Such an exercise would further have the snowballing effect of enhancing productivity, optimizing investments leading to the betterment of overall health of Indian Agriculture.

Introduction:

Indian agriculture has been poised for a take off, for almost two decades now. The sector has been beleaguered by fragmented landholdings that don't allow for sustainable incomes, opaque market practices that lead to low farm gate prices and a growth that is far below industrial and service sectors while the share of GDP is falling faster than the rate of absorption of labour from the sector by others. The Gross Value Added (GVA) in agriculture averaged an annual growth rate of 3.1% in the period 2012-13 to 2018-19 with wide ranging fluctuations from a negative 0.2 per cent in 2014-15 to 6.3 per cent in 2016-17 only to decelerate to 2.9 per cent in 2018-19 (Economic Survey 2018-19). The issues are known, even the solutions are known and attempts have been made to take it to the tipping point but not too many changes on the ground to make material difference to the sector or the farmer. Such state of affairs is generally referred to as the structural issues in Indian Agriculture by all concerned stakeholders. Due to recent advancements in mobile telephony/internet and related/IT hardware getting cheaper and miniaturized, new solutions are emerging that allow for more information to be collected and/or disseminated with minimum human intervention. ICT in agriculture has become the focus of the government, private and start up ecosystems, to try and bring in the revolution that is truly required. This paper outlines some of these structural issues and looks at the possible solutions that ICT can provide.

Status of agriculture with respect to federal structure between the Central and State governments in India:

The Constitution of India assigns some subjects to the Central (federal) government, some subjects to the state (provincial) governments and there are some subjects over which both the centre and state government exercise control. These subjects are defined by the Union List, the State list and the Concurrent List of the Schedule VII of the Indian Constitution. As far as Agriculture is concerned, it is in the State list. Entry 14 of the state list is Agriculture, including agricultural education and research, protection against pests and prevention of plant diseases and entry 18 is Land, that is to say, rights in or over land, land tenures including the relation of landlord and tenant, and the collection of rents; transfer and alienation of agricultural land; land improvement and agricultural loans; colonization. Entry 45 and 46 deal with maintenance of land records, survey for revenue purposes and records of rights and taxes on agricultural income, among other things. Thus, one issue which arises as far as substantive reforms are concerned in Indian Agriculture is that given that agriculture is a state subject, respective state governments have to legislate any changes to their respective laws. Each state has its priorities and different needs in the agriculture sector. Thus, even if most experts agree on certain policy changes, it is an extremely uphill task to get all the states on board and get them to legislate/ amend the laws in their states suitably for the purpose of such reform.

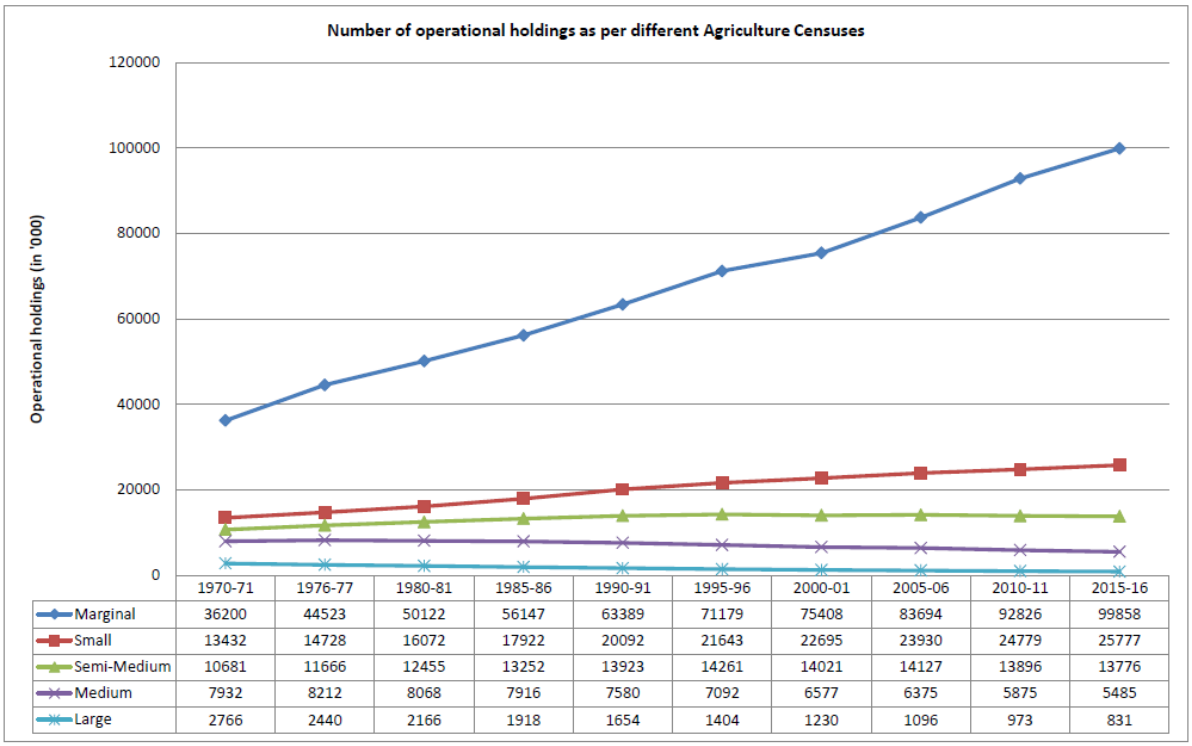
Issues related to agricultural land in India:

Status of agricultural land in India:

Agriculture census is quinquennial (happening every 5 years) in India and the latest happened in 2015-16. As per Agriculture Census 2015-16, the total number of operational holdings in the

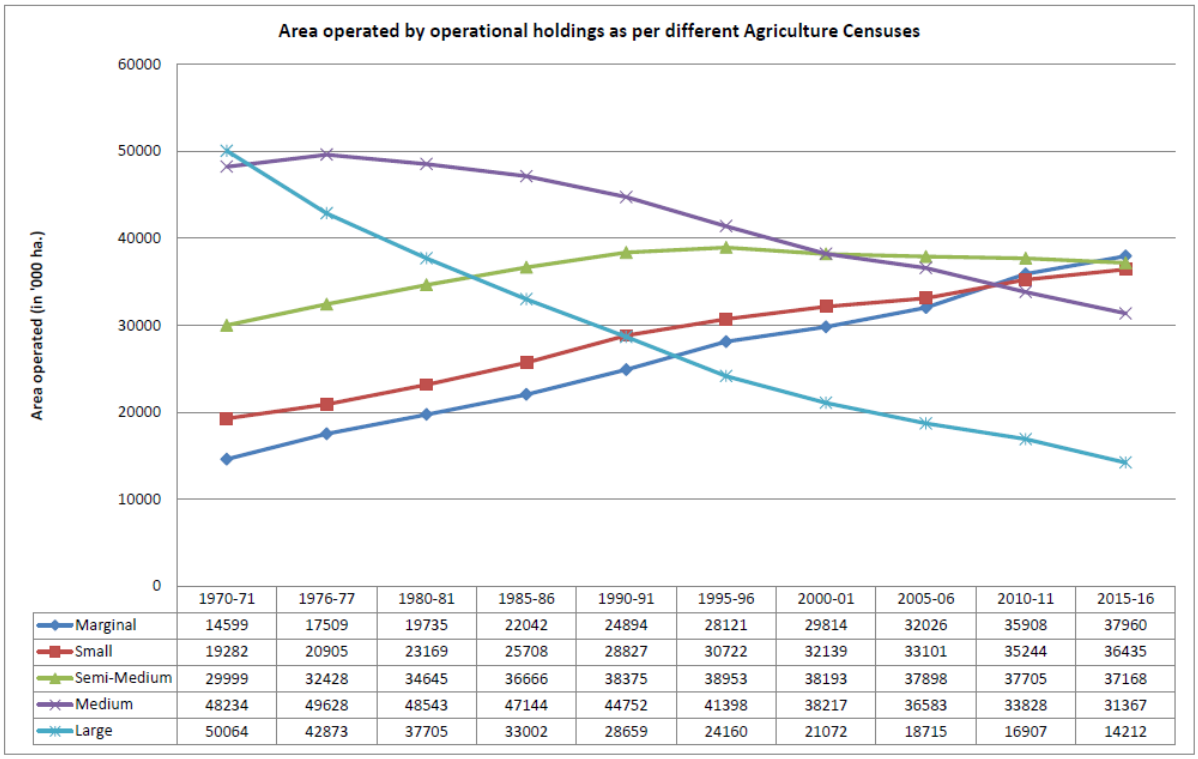
country has increased from 138 million in 2010-11 to 146 million 2015-16 i.e. an increase of 5.33%. The Agricultural census defines operational holding as 'All land which is used wholly or partly for agricultural production and is operated as one technical unit by one person alone or with others without regard to the title, legal form, size or location.' As far as operated area is concerned, there is a decrease in the operated area from 159.59 million ha. in 2010-11 to 157.14 million ha. in 2015-16 showing a decrease of 1.53%. Operated area has shown declining trends in most of the states. Out of 36 States/UTs in the country, it was found that 14 States viz. Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh and West Bengal account for about 91.03% in terms of number of operational holdings and about 88.08% in terms of area operated in the country. The average size of operational holding has declined to 1.08 ha. in 2015-16 as compared to 1.15 in 2010-11. The small and marginal holdings taken together (0.00-2.00 ha) constituted 86.21% in 2015-16 against 84.97% in 2010-11 while their share in the operated area stood 47.34% in the current census as against 44.31% in 2010-11. Semi-medium and Medium operational holdings (2.00-10.00 ha) in 2015-16 were only 13.22% with 43.61% operated area. The corresponding figures for 2010-11 census were 14.29% and 44.82%. The large holdings (10.00 ha & above) were merely 0.57% of total number of holdings in 2015-16 and had a share of 9.04% in the operated area as against 0.71% and 10.59% respectively for 2010-11 census. (Data Source: Agriculture Census 2015-16)

Thus with respect to the previous censuses, while the average size of landholding and total operated area have been declining, the total number of operational holdings, number of small and marginal holdings and the share of area operated by small and marginal farmers have been showing increasing trends in India. Trends of the above are provided in the charts below. The proliferation of small and marginal holdings as well the increase in area operated under them is a cause of concern with respect to per unit agricultural productivity. It is difficult to achieve economies of scale with respect to irrigation, mechanisation and other agricultural operations when the land parcels are small and scattered and managed by different entities. Even then, one reason that a lot of cultivators choose to operate them unsustainably/ at extremely low margins or even keep their land fallow is the fear of losing their land or mired in litigation if they lease out due to the existing laws regarding leasing. We discuss this in the following section.



	1970-71	1976-77	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2010-11	2015-16
Marginal	36200	44523	50122	56147	63389	71179	75408	83694	92826	99858
Small	13432	14728	16072	17922	20092	21643	22695	23930	24779	25777
Semi-Medium	10681	11666	12455	13252	13923	14261	14021	14127	13896	13776
Medium	7932	8212	8068	7916	7580	7092	6577	6375	5875	5485
Large	2766	2440	2166	1918	1654	1404	1230	1096	973	831

Trends in number of operational holdings as per different agriculture censuses (Source: Agriculture Census 2015-16)



	1970-71	1976-77	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2010-11	2015-16
Marginal	14599	17509	19735	22042	24894	28121	29814	32026	35908	37960
Small	19282	20905	23169	25708	28827	30722	32139	33101	35244	36435
Semi-Medium	29999	32428	34645	36666	38375	38953	38193	37898	37705	37168
Medium	48234	49628	48543	47144	44752	41398	38217	36583	33828	31367
Large	50064	42873	37705	33002	28659	24160	21072	18715	16907	14212

Trends in area operated by different size categories as per different agriculture censuses (Source: Agriculture Census 2015-16)

Ownership and leasing of Agricultural land in India:

Due to historical reasons, leasing of agricultural lands have been completely banned or severely restricted/regulated by most states in India. This has led to hidden and informal tenancy which is not a great situation for tenants and is a major hindrance to meaningful reform like direct benefit transfer, ensuring saturation access of formal agriculture credit to all cultivators etc. This is because due to the legal restrictions on leasing of agricultural lands, neither do tenants invest to upgrade the infrastructure of the lands they till nor are landowners interested in investing in up gradation of land. Landowners sometimes are compelled not to move out or keep land fallow for fear of losing their land or getting stuck in litigation if they lease out their land.

As per the latest available figures (Agriculture census 2010-11) wholly or partly leased in holdings were just around 2% of the total number of operational holdings and 2.2% of the total operated area. The corresponding figure for the number of operational holding and area operated is 13.7% and 10.2% as per the NSSO data 70th Round. Gulati and Juneja write that, experts believe that official estimates hugely under-report actual tenancy. It is generally believed, based on several micro-level surveys, that about a third of the agricultural land in India is under tenancy (Indian Express https://indianexpress.com/article/opinion/columns/narendra-modi-govt-farmer-crisis-agriculture-reforms-landowners-protect-rights-5915552/). Agricultural census captures tenancy status but even they admit the vulnerability of data and clearly mention that de facto and de jure status could be different. Thus there is no way and no conclusive database to accurately estimate the status of tenancy in India.

NITI Aayog constituted a committee under the chairmanship of Tajamul Haque in September, 2015 to prepare a Model Agricultural Land Leasing Act based on critical review of the existing agricultural tenancy laws of states and keeping in view the need to legalize land leasing. The terms of reference of this committee clearly state that there is a need to amend existing agricultural tenancy laws of states and legalise and liberalise land leasing for much needed agricultural efficiency, equity, occupational diversification and rapid rural transformation. It has come out with a model agricultural land leasing act in March 2016. While the model act encourages states to legislate/suitably amend their own land leasing laws in accordance with the model land leasing act, registration of the leases with the government has been kept optional. As of 2018, more than 2 years after the model act was circulated, only Madhya Pradesh and Maharashtra have enacted an act allowing land leasing broadly in accordance with the model act. Uttarakhand and Uttar Pradesh have amended their land laws; while Uttarakhand has done it comprehensively and allows a maximum lease period of 30 years, Uttar Pradesh has gone for some amendments but introduced a ceiling of 3 years for leasing. Shorter ceilings like 3 or 5 years for leasing don't carry enough incentive for the tenant to invest capital in the land for upgradation and also discourages longer duration crops like horticulture crops.

Digital Land Records and Maps:

The genesis of the problems associated with land ownership and leasing as explained above lie in the system of property ownership in India. Land ownership in India is presumptive and not conclusive. In 2008, India also decided to adopt the system of clear property titles or the Torrens system, as prevalent in other countries, such as Australia, New Zealand, UK, USA, Canada, Switzerland, Singapore, Malaysia, etc.

To implement conclusive titling, the Govt. of India launched "National Land Records Modernization Programme" (NLRMP) in 2008 henceforth renamed Digital India Land Records Modernization Programme (DILRMP) in 2016. The DILRMP has 3 major components - (a) Computerization of land record (b) Survey/re-survey (c) Computerization of Registration. The District has been taken as the unit of implementation, where all programme activities are to converge. In this programme, till August 2019, computerisation of land records has been completed in 89.81% villages, mutation has been computerized in 59% villages, and issuance of digitally signed RoR (record of rights) is in only 37% villages while RoR linkage with unique id Aadhaar has been completed in less than 5% villages across the country as a whole. As far as cadastral maps are concerned, 53.11% maps have been digitized and real time updation of RoR and Maps has been completed in just 21% villages.

How ICT can help in the above issues:

In the year 2019, the Government of India introduced an income support scheme for small and marginal farmers called PM-Kisan which provides that all small and marginal farmers would be provided an annual cash support of Rs. 6000 (Rupees Six Thousand) in 3 installments of Rs.2000 every 4 months. A few months later, the Government of India expanded the scheme to include all farmers irrespective of the size of their landholding. The entire financial burden of the scheme has been borne by the Central government but the responsibility of identifying and preparing the beneficiary list under PM-Kisan has been entrusted to the state government and it's implementing mechanism. If we study the implementation of the scheme, we find that there appear huge data divergence in the number of farmers which the scheme had assumed and the actual number of beneficiaries being submitted by the state governments. The PM-Kisan scheme takes the number of operational holdings available from the Agriculture census 2015-16 to be the number of farmers in the country. But if we see the number of beneficiaries from some states, there is wide divergence in the numbers. A Business Standard news report, citing government sources, mentioned that in Karnataka, where the number of farmers had been estimated to be 8.7 million, the list sent by the state government has 6.3 million beneficiaries. Similarly, for Kerala, against an estimated 7.5 million beneficiaries, only 3.5 million names have been submitted by the state government. Thus, out of the expected around 140 million beneficiaries, the report indicated, names of only around 80 million have been submitted by the states and in any case the number is expected to not cross 100 million at the most. This divergence of 30-50% (depending on which base figure we use to calculate) in the number of farmers is real and difficult to explain even if we consider aspects of the policy which excludes some farmers from availing benefits under PM-Kisan and change in land ownership in the period after the data collection of Agriculture census 2015-16. The census of India, 2011, on the other hand, puts the total number of cultivators in the country at 118.7 million.

Next lets suppose that leasing laws are rationalised according to the model land leasing act proposed by the NITI Aayog committee, lease contracts can be completed/ registered online. This should be possible because the model land leasing act does not seek to create any entries on the land record/ record of rights and there is no provision to allow any occupancy/ownership rights under any duration or any other condition of lease. It also provides for automatic resumption of land to the lessor landowner at the end of lease period. Respective governments can facilitate this process through mobile apps/web portals and also payment of requisite fees through online channels. One of the benefits of digitisation could be the possibility of ensuring a transaction without the need for any human interface. It is well understood in the Indian context that the need of approvals, registration, deposit of government fees, charges etc., is a time consuming affair in India which also opens avenues for corruption, favouritism etc. Availability of data in real time could be another huge benefit of introducing ICT into leasing processes. Most importantly, the benefits that the government provides to agriculture through different subsidies like the fertilizer subsidy, direct income support, agriculture insurance, cheap agricultural credit, disaster relief etc., would then accrue to the actual cultivators and thus better the state of Indian agriculture.

The above clearly illustrates the relevance of digitising land records as well as geo-tagging agricultural plots. The data collection methodologies should be digitized to gather accurate as well as real time data in Indian agriculture. Government support, market mechanisms and the entire agricultural value chain can be much better coordinated and farmers benefitted from availability of good quality real time data and robust policy action can also be taken on the basis of such data.

Agricultural Marketing in India:

Agricultural Marketing in India is still a throwback from the pre-1947 days in many ways. The idea of regulated markets goes back to 1923, though at that point it was more about ensuring good prices for the manufacturing sector in Britain. But after 1947, the existing system continued, where farmers sold to traders they knew, which was exploitative and opaque, especially since the country still had limited media coverage with only 9 radio stations and less than 300,000 radio sets, no television station (Prasar Bharti Website) and the literate population made up less than 20% of the whole.
It was in this background, that in the 1960s, formal overseeing of agricultural marketing was mooted and the concept of Agricultural Produce Market Committees (APMC) was introduced.

APMCs are intended to be responsible for:

- ensuring transparency in pricing system and transactions taking place in market area;
- providing market-led extension services to farmers;
- ensuring payment for agricultural produce sold by farmers on the same day;
- promoting agricultural processing including activities for value addition in agricultural produce;
- Publicizing data on arrivals and rates of agricultural produce brought into the market area for sale; and

- Setup and promote public private partnership in the management of agricultural markets

However, the catchment areas for each of these Committees were geographically defined and the Committees began to limit licenses, that allowed for cartelization and continued exploitation of the farmers. Availability of market related information continued to be skewed in favour of the traders, who had wider networks to understand events in consuming markets, than farmers who had less access to such sources. Over a period of time, these markets have acquired the status of restrictive and monopolistic markets, harming the farmers rather than helping them to realise remunerative prices. A National Commission for Farmers set up in 1970, mentions this point as does every other study in the area including the Patil Committee of 2013, set up by Government of India.

APMC operations are hidden from scrutiny as the fee collected, which are at times exorbitant, is not under State legislature's approval. Agents in an APMC may get together to form a cartel. This creates a monopsony (a market situation where there is only one buyer who then exercises control over the price at which he buys) situation. Produce is procured at manipulatively discovered price and sold at higher price, defeating the very purpose of APMCs.

APMCs are authorized to collect market fee ranging from 0.50 % to 2.0 % of the sale value of the produce. In addition, the traders charge commissions that vary from 1 % to 2.5 % in foodgrains and 4 % to 8 % in fruits and vegetables. Further, other charges, such as, purchase tax, weighment charges and hamal charges are added. In some States, this works out to total charges of about 15 %.

Further, APMCs play dual role of regulator and market. Consequently, their role as regulator is undermined by vested interest in lucrative trade. Generally, member and chairman are nominated/elected out of the agents operating in that market.

To address these issues, a Model APMC Act, 2003 was developed by the Central Government for States to adopt (Agriculture is a state subject as already mentioned), which provided for the freedom of farmers to sell their produce. More than one market in a catchment area, special markets, contract farming, direct sale, multi market licenses, no commission farmer markets, one point collection of market fee, market committee to create facilities etc. was mooted. However, the adoption of the Model Act by the States has been patchy, with very few states adopting the entire Act; most preferring to pick some of the ideas. The envisioned private markets and increased competition in the markets, has not materialized and in 2017, a new Model Agricultural Produce and Livestocks Marketing Act, 2017 has been released that looks to reform the markets again.

In 2015, the Central Government started a National Agriculture Market which is envisaged as a pan-India electronic trading portal which seeks to network the existing APMCs and other market yards to create a unified national market for agricultural commodities. NAM was proposed to be achieved through the setting up of a common e-platform to which initially 585 APMCs selected by the states would be linked. The Central Government planned to provide the software free of cost to the states with a grant of up to Rs. 30 lakhs per mandi as a onetime measure for related equipment and infrastructure requirements.

While it is an essential part of opening up of the markets, the lack of credible grading and logistics infrastructure to back the online trades, makes it impossible to buy without physically checking the produce, which defeats the purpose of the platform. Over time, the markets need to evolve to harmonize grades over markets, set up standard assaying practices, and build a credible certification system, on the lines of Chicago Board of Trade, which facilitates pan continental trades.

Minimum Support Price:

While introducing new technologies to farmers under the Green Revolution, the government also began offering a Minimum Support Price for some key commodities to encourage farmers to adopt the new practices with minimum market risk. This ensured that farmers got a fair price and the government could procure stocks to manage its various Public Distribution Schemes. However, over the years, the program has grown to become unmanageable as it mandates the government to purchase all quantities offered by a farmer, as long as it meets the quality specifications. This has led to large stocks especially of wheat and rice, that far exceed the buffer stock and emergency stock norms set for the Food Corporation of India. However, as per a report submitted by the Patil Committee on restructuring food crops in India, only 6 percent of total farmers in the country can sell their crops at MSP due to lack of procurement centers being available in their proximity. The farmers would like more ways to bring in more areas and crops to be brought under MSP to attain the real advantage of the increased price and de-risk their ventures substantially. Though there are 20 crops for which MSP has been declared, procurement is effective only on paddy and wheat. There needs to be serious political will to dismantle this program or to reform it to ensure that the most vulnerable farmers are given the benefit of the price de-risking.

Essential Commodities Act:

The Essential Commodities Act was enacted in 1955 to allow the Central Government to regulate the production, supply and distribution of a whole host of commodities it declares 'essential' in order to protect consumers from irrational spikes in prices of essential commodities. Enforcing the Act, forces liquidation of stocks to a government declared level, bringing prices down but also making farmers and traders wary of investing in the said commodity.

Provisions in the Act allowing overnight setting of new stock limits, that discourage private investments in agricultural markets must be re-examined while ensuring essential supplies to the people and preventing exploitation by unscrupulous' traders through providing exemptions to exporters, food processors, large retailers and large departmental retailers from applicability of stock limits.

In an era when India faced food shortages, hoarding could have been a problem, leading to commodities becoming unaffordable to the public. However, by the time the new millennium was ushered in, price rises were more market led than trader led, i.e. higher incomes could drive higher demand, leading to higher prices, or a higher demand in export markets could lead to higher prices in the domestic markets. Fall in supply due to a smaller crop could also lead to

increase in prices, but as the markets grew in size, the number of players has increased so "cornering" the market has become much tougher. However, the lack of competition or cartelization, could lead to high prices in adequate supply. In the case of poor supply, the government can intervene through subsidizing the prices but should ensure return on risk that the trader deserves.

On the flip side, as almost all crops are seasonal, ensuring year long supply requires adequate build-up of stocks during the season. Mechanisms to differentiate between genuine stock build-up and speculative hoarding are possible through maintaining data on stock position over the years, for each month and identify outlier data and the reasons thereof. Monitoring of stocks, production and consumption and making them transparently available in the public domain is a key solution to reducing rumours of supply shortage and managing prices through timely import/export policies nudges that don't disturb the markets. ICT can be extensively use for all these data operations.

As disturbing as using this Act is to the market, despite calls for its removal, every government has at best promised not to misuse it, but refuses to give up the powers under the Act to meet some eventuality at some point in time.

Futures Markets:

In India, spot markets are not well linked with the forward and future markets to receive price signals. The futures trading in agricultural commodities is also regulated by the Government and has led to overnight policy decisions to suspend trading in specific commodities, following spikes in the spot prices.

In 2008, the Abhijit Sen Committee studied the impact of futures trading on Spot markets and reached the conclusion that changes in fundamentals especially on the supply side were more important in causing price rise than their listing on the bourses. In certain commodities, price volatility was found to increase post listing, but it helped traders more than farmers.

Such evidence relating to unexpected changes in futures markets growth over a rather short period of time should not be a hindrance to orderly growth of futures markets. But excessive speculative activity in futures markets can destabilize spot prices especially if driven not by those who manage price risks in physical trade by hedging in futures markets but by speculators.

Efficiency of futures markets requires: (i) that spot and futures prices should be co-integrated and that futures prices should be unbiased predictors of future spot prices except for reasonable risk premium. In India, however, this co-integration and futures-spot links has been found tenuous as it differs for each commodity and at different points in time.

Post Harvest Facilities:

The Indian farmer loses a lot of his share of the value chain, owing to lack of awareness and infrastructure to manage post harvest activities. Post harvest losses are the biggest cause of the loss in value. Estimation of post-harvest losses has been made by different studies in the past.

A High level Expert Committee on Cold Storage constituted by Department of Agriculture and Co-operation has estimated that 25 to 30 % of fruit and vegetables and 8 to 10 % of foodgrains are wasted annually due to lack of post-harvest technology and non-existence of integrated transport, storage and marketing facilities, etc. The Ministry of Agriculture conducted a Millennium Study, State of the Indian farmers in the year 2004. It was estimated that about 7% of foodgrains and 30 % of fruit and vegetables are lost due to inadequate handling facilities. Approximately, 10 % of valuable spices are also lost due to lack of proper post-harvest infrastructural facilities. A Study conducted recently by ICAR on status of post- harvest losses in 2010 indicates that the total losses of various commodities at various stages of marketing ranges from 3.9-6.0 % for cereals, 4.3-6.1 % for pulses, 5.8-18.0 % for fruits and 6.8-12.4 % for vegetables. The above post-harvest losses of agriculture commodities in monitory terms have been estimated at about Rs 44,000 crores at 2009 wholesale prices.

Use of better grading, storage, transportation and packing is the key to reducing this and it is imperative to educate the farmers on the importance and options available for utilizing to enhance incomes and margins, from the same crop. But there are several hurdles to this. The size of the crop of a marginal farmer makes it difficult for him to bear the cost of storing and handling his produce.

Under the State APMC Acts, warehousing is a regulated activity requiring a license from the respective APMC, in whose market notified area the warehouse is located; several licenses if the warehouse covers several APMC markets, if the warehouse will store notified agricultural produce.

The Warehousing (Development and Regulation) Act 2007 has already been enacted and its provisions have been made effective from 25th October, 2010. The Negotiable Warehouse Receipts (NWRs) issued by the warehouses registered under this Act would help farmers to seek loans from banks against NWRs to avoid distress sale of their agriculture produce. It will also be beneficial for a number of other stakeholders such as banks, financial institutions, insurance companies, trade, commodities exchanges as well as consumers, the accredited warehouses by providing for trading of Negotiable Warehouse Receipts. This Act will pave the way for removing the constraints of warehousing system in India and facilitate farmers to get pledge loan facilities.

However, the cash flow situation of most farmers renders it impossible for them to not liquidate their produce soon after harvest. Farm level grading and sorting are also not very popular; the grading sorting facilities in the APMC markets are used more by traders, than farmers.

However, India has built a reasonable network of warehouses and in 2016, it was estimated that the storage capacity in the country was 126.96 Million Tons, though not all for agricultural produce. Of this only 18.97 million tons was in the private sector, the rest being owned by government agencies or co-operatives.

Cold Chain infrastructure in terms of cold storage units are in line with the demand for such units but other infrastructure like integrated pack houses and ripening units and refrigerated transport fall short by over 75% according to a 2015 study by the Government of India.

Subsequent governments have used subsidies and education as their strategy to increase supply and demand for the facilities, but the lack of harmonization of grades, specifications etc. is an impediment. Rigorous practices on grading, packing and traceability are followed only for export markets, where not meeting the norms could get the entire shipment rejected.

ICT solutions that are in place for export markets should be introduced for domestic markets too to improve quality of produce and better incomes for the farmers. This could include online databases on storage capacities available through the country, RFID tagging of batches for traceability and dissemination of market prices for online auctions of grade certified produce.

Agriculture Extension, Research and Development:

In independent India, the agricultural review team chaired by MW Parker of USDA (1963) suggested reforms to the agricultural research in the country leading to research centres across the country coming together as the Indian Council of Agricultural Research (ICAR) and the setting up of State Agricultural Universities (SAUs). These infrastructural reforms helped in ushering the Green Revolution and research and education to suit Indian needs. Today the National Agricultural Research System includes some 27,500 scientists and more than 100,000 supporting staff actively engaged in agricultural research.

According to the Economic Survey 2017-18, the total R&D expenditure in India as percentage of GDP has been stagnant at 0.6 to 0.7 per cent in the last two decades. The actual expenditure of Department of Agricultural Research and Education/Indian Council of Agricultural Research has increased from Rs.53930 million in 2010-11 to Rs.68000 million (Budget estimate) during 2017-18 and investment in Agriculture Research and Education protected new Agricultural innovation by filing 45 patent applications at Indian Patent Office (IPO) and the cumulative patent applications have now risen to 1,025 (Economic Survey, 2017). It is estimated, that the private sector contributed an estimated 20 per cent of the country's agricultural research spending in 2009.

Agricultural R&D is the main source of innovation, which is needed to sustain agricultural productivity growth in the long-term. After the Protection of Plant Varieties and Farmers' Right Authority notified new genera, applications for 135 varieties were filed at the Registry and 155 high-yielding varieties/hybrids of cereals were released for cultivation in different agro-ecologies of the country during 2016, the Economic Survey stated.

ICAR's research focuses on issues of national importance, whereas university research mandates target state-level priorities. Compared with the universities, research undertaken at ICAR generally has better funding, as well as better research infrastructure and equipment. ICAR researchers spend relatively more of their time on basic science, germplasm conservation,

socioeconomic research, and emerging areas (such as biotechnology and nanotechnology). University research, on the other hand, tends to be more applied. The emergence of state veterinary universities is reflected in the substantial focus on livestock health by universities.

Agricultural universities have been starved of funds making them less able to make meaningful contributions. Over time, greater fragmentation of the higher education sector, coupled with recruitment restrictions, has eroded research capacity at agricultural universities.

One of the key problems with technology adoption for agriculture in India is that farmers cannot afford expensive tech-solutions. Their low risk taking ability, low literacy level and a general distrust with modern technology, makes them wary of adopting them. Incentives to adopt new technologies, providing new technologies that are intuitive and simple to use and successful demonstrations can help improve the adoption and shorten the adoption cycle.

ICT has been put to good use in areas of data collection and information dissemination especially of best practices, with government, private and startups working in the space. Cheap hardware and telecom subscription rates coupled with excellent telecom coverage should start to see more and more traction in this area.

Access to institutional financial services:

Researchers from the Reserve Bank of India have empirically established that the direct agriculture credit amount has a positive and statistically significant impact on agriculture output and its effect is immediate. The number of accounts of the indirect agriculture credit also has a positive significant impact on agriculture output, but with a year lag (Das A., Senapati M., John J., RBI Occasional Papers, 2009).

Status of Institutional Finance Region wise:

The share of Agriculture credit across regions is not equitable in the sense that it is not proportional to the gross cropped area. The table below gives account of the percent wise share of 6 regions in agriculture credit, accounts, gross cropped area (GCA) and number of relevant bank branches for agriculture credit. It is clear that North-east and East region fare poorly as compared to the other regions. Central region, even though accounting for the highest percentage of GCA in the country, only accounts for 14% of credit amount and 17% of number of accounts. This could be caused by various factors and it is difficult to identify 1 single causal indicator for this state of affairs. Thus, it may also be caused due prevalence of informal tenancy due to which the cultivators are not able to access institutional credit due to lack of any documents to establish their tenancy, among many reasons.

Sl No	Region	Agriculture Credit in % (2017-18)	Agriculture Accounts in % (2017-18)	Gross Cropped Area(GCA) in %	Rural/Semi urban branches
1	Northern	22.02	12.71	20.11	16.62
2	North-East	0.88	1.37	2.83	3.16
3	Eastern	8.1	14.29	14.65	17.99
4	Central	14.43	17.63	27.26	21.51
5	Western	12.04	10.96	16.47	12.98
6	Southern	42.53	43.04	18.68	27.74

7	All-India	100	100	100	100

Region wise share of Agriculture credit, Agriculture accounts, Gross Cropped Area and Rural/Semi urban Bank branches in India Source: Bhanwala and Mehrotra, Financial Express

Institutional Finance for small and marginal landowners, landless cultivators like tenants, oral lessees, sharecroppers etc.:

As per RBI directions, all commercial banks and regional rural banks (RRBs) are required to lend 18% of their total credit towards agriculture. A sub-target of 8% is also prescribed for lending to small and marginal farmers (SF/MF) including landless agricultural labourers, tenant farmers, oral lessees and share croppers. The Government implements the Kisan Credit Card (KCC) Scheme aimed at providing adequate and timely credit support from the banking system under a single window to the farmers for their cultivation and other needs. With a view to ensure availability of agriculture credit at a reduced interest rate of 7% p.a. to the farmers, the Government of India in the Department of Agriculture, Cooperation and Farmers' Welfare implements an interest subvention scheme. Under this Interest Subvention Scheme (ISS) short term crop loans up to Rs.3 lakh are extended to farmers at a subvented interest rate of 7% per annum for a period up to one year. In case of prompt repayment, the farmers can avail a prompt repayment incentive of 3% per annum and thus the effective rate of interest on such loans is only 4%. Although technically tenant farmers, landless and oral lessees are eligible for loan under KCC, they face practical difficulty due to unavailability of land records for collateral purposes. Thus, to ensure their inclusion and bring small, marginal, tenant farmers, oral lessees, etc. taking up farm activities, off-farm activities and non-farm activities, into the fold of institutional credit, Joint Liability Groups (JLGs) have been promoted. As on 31st March, 2017, cumulatively 2.453 million Joint Liability Groups (JLGs) have been provided Rs. 268,481 million in loans by banks across the country (figure also includes small and marginal farmers availing loan through JLG mode of financing).

Year	Target (Rs trillion)	Achievement (Rs trillion)	Percentage Achievement	Percentage share of SMFs in amount disbursed
2015-16	8.5	9.15	107.71	41.51
2016-17	9	10.65	118.42	50.14
2017-18	10	11.62	116.26	49.93
2018-19	11	12.54	114.06	49.9

Source: NABARD and Press Information Bureau

How ICT can solve the problem of institutional finance:

The process of application and obtaining an agricultural loan involves extensive documentation and it also involves coordination of different bank branches in the vicinity as well as departments like land and revenue, settlement branch, agriculture department depending on the state. To begin with, some of these processes can be digitized. Again, this has the potential to reduce time taken, streamline response of stakeholders like bank branches and reduce transaction costs for all

concerned, especially farmers. In fact, digital land records linked to unique id of farmer can speed up loan approvals as well as build a solid credit history of the farmer and weed out duplications and habitual defaulters. It has the potential to check frauds and ensure that the eligible benefit from the credit schemes meant for agriculture.

Farmers' ability to leverage all the above:

Average age and Literacy levels of farmers in India:

It is generally accepted that the younger generation in India is not keen on taking up agriculture and the average age of the Indian farmer is above 50(Age and literacy table below). Adoption of digital tools requires some digital literacy and although the curve is on an upwards trajectory here, a full realisation of self operated digital tools to a satisfactory extent cannot yet be fully achieved in the existing scenario although this is 1 area where there is a lot of push from the present government through the Digital India initiative. Even then, given the situation of literacy and the average higher age of the target group, it becomes difficult to reorient the farmers' thinking from what they have been practicing towards new methods, production technologies or new crops altogether and push digital solutions.

Sl. No.	Size Groups	Total No. of Operational Holders	up to 30 years	31 - 40 years	41 - 50 years	51 - 60 years	61 - 65 years	66 years & above	Average age (years)
1	2	3	4	5	6	7	8	9	10
1	Marginal (below 1.0 ha.)	100.0	3.2	12.1	34.7	34.1	9.9	6.0	50.08
2	Small (1.0 - 1.99 ha.)	100.0	4.3	14.7	32.5	30.7	11.4	6.4	49.61
3	Semi-medium (2.0 - 3.99 ha.)	100.0	4.0	12.7	31.4	31.6	12.1	8.1	50.47
4	Medium (4.0 - 9.99 ha.)	100.0	3.6	12.0	29.1	32.5	13.1	9.7	51.23
5	Large (10.0 ha. and above)	100.0	2.8	9.0	27.5	33.6	14.3	12.7	52.72
	All Size Groups	**100.0**	**3.5**	**12.6**	**33.7**	**33.2**	**10.5**	**6.5**	**50.10**

Note: (1) Total may not tally due to rounding off. (2) Figures in Col.3 to 9 are percentages.

Percentage distribution of number of operational holders into different age groups Source: All India Report on Input Survey 2011-12

Sl. No.	Size Groups	Total No. of Operational Holders	Educational Qualifications of Operational Holders						
			Illiterate	Up to Class V	Middle	Secondary	Senior Secondary	Technical Diploma below Degree Level	Graduate & above
1	2	3	4	5	6	7	8	9	10
1	Marginal (below 1.0 ha.)	100.0	31.3	22.2	23.4	15.3	4.8	1.2	1.8
2	Small (1.0 - 1.99 ha.)	100.0	30.2	23.0	21.5	15.5	5.8	1.4	2.6
3	Semi-medium (2.0 - 3.99 ha.)	100.0	28.9	23.2	21.7	15.8	6.2	1.2	2.9
4	Medium (4.0 - 9.99 ha.)	100.0	28.6	23.6	20.5	15.8	6.4	1.4	3.6
5	Large (10.0 ha. and above	100.0	31.1	22.5	18.8	15.4	6.1	1.6	4.6
	All Size Groups	**100.0**	**30.7**	**22.5**	**22.7**	**15.4**	**5.2**	**1.3**	**2.1**

Note: Total may not tally due to rounding off.

Percentage distribution of operational holders in each size groups by educational status Source: All India Report on Input Survey 2011-12

Data Issues in Indian Agriculture:

While on paper, the data collection protocol for agriculture including area and yield estimation are robust, they depend heavily on individuals in administrative positions estimating the same without much of a quality check of the data itself. Each village has a Patwari (grassroots revenue official), who is to send the details of what the farmers in his village have sown in how much acreage. All data from villages of a block are added for a block level estimate, and then a district level and finally a state level. But over the years, it has been found that the data is not collected sincerely and a lot of guesstimation is used to avoid travelling and meeting farmers. At each level of data aggregation, an informal "moderation" is also carried out to meet expectations or original targets set. Private trading organizations have often pointed out that the difference between their estimation based on sampling and the government estimation based on a census vary by large margins. In 2015-16, the government projected a robust production of wheat but tightening market supplies and rising prices showed the prices were in line with 5 million tons lower private sector estimates.

India does not collect data on farm incomes in regular intervals, except for one off surveys by the National Sample Survey Organisation (NSSO). The last such survey was published in December 2014 using data from a year before. So, policymakers use proxy indicators like production estimates and prices to arrive at average incomes for the base year.

With more and more agriculture insurance being sold, yield estimations have also taken more importance. While protocols existed earlier too, private insurers believed the data to not be credible and now private parties are hired to monitor or even conduct the crop cutting and yield estimation exercises.

Despite this credibility crisis, the budgetary allocation for the department of economics and statistics (under the agriculture ministry) was slashed by nearly 30% year on year—from Rs 3270 million in 2014-15 and Rs 3090 million in 2015-16 (revised estimates) to a budgeted Rs

2360 million in 2016-17. While the private sector is stepping in to some extent, given that the government needs to build its policies and programs around this data, it is important to institute more strict protocols and use ICT to automatically collect data or collect from a sample that can be used to check the reliability of the rest of the data.

Both states and the central governments of India have large databases of historical data of which only a part have been made public. Making all the available data public or at least easier to access, would help find new insights into the sector and may provide the much needed innovation in policy development. New technologies like precision farming, AI and machine learning will yield more results if more historical data is accessible.

Precision agriculture covers everything from when it is best to apply fertilizers, chemical and seeds; to from where in the field it is best to apply a rate. It can ensure profitability, efficiency, and sustainability and it can be used along with the big data gathered to guide both immediate and future decision-making. This would improve farmers' income and margins substantially, once it's optimised.

According to agriculture funders, the big data practice comprises capturing relevant data from a huge number of sources, collecting it today and translating it into actionable information to improve business processes and solve problems at scale and speed. Real-time insights to help performance optimisation and advance analytics can show how farmers are utilising their inputs and what adaptations are required to take account of emerging weather events or disease outbreaks.

To achieve this, advanced algorithms are needed to swiftly unlock the highly valuable insights for products to perform well on an ongoing basis despite changing conditions. The development of highly-specific customer segmentation set has become possible to tailor product offerings to meet customer needs.

Conclusion:

The biggest structural issue in Indian agriculture is extremely large number of small holdings and lack of complete and credible data on them. This hampers all policy and planning initiatives required to reform the sector. ICT can play a stellar role in building a database covering digital land records/revenue records and geospatial maps allowing for real time changes in land ownership status. Linking them to unique id opens up the possibility of direct benefit transfer of various subsidies and other benefits which the government is desirous of providing to the farmers.

Such robust data can form the basis of policies towards rationalization of the various expenditure which the government undertakes in the agriculture sector such as those for input subsidies on fertilisers, seeds, power and agricultural credit etc. Such expenditure exceeds a staggering Rs. 3.3 trillion annually for the Government of India when we include the food and fertiliser subsidies along with the direct income support and allocations for the federal agriculture ministry but excluding the power subsidies as they are provided by the state governments. Relief in times of disaster and insurance pay-outs and claim processes can be extremely fast tracked too if such real time databases are available. The problem of duplication and ghost beneficiaries would be almost solved in such expenditure leading to savings in revenue, which can be pumped in other areas in

the agriculture sector itself to rejuvenate the sector. The public expenditure on research and extension including agricultural education needs to go up and the resulting savings in existing expenditure can be pumped into these priority areas in agriculture. Predictive analysis based on big data, forecasting output and production etc. can also be undertaken using such databases and combined with weather data and satellite imagery. ICT can be used to disseminate such information to farmers to help their decision making. In the private sphere, ICT interventions including those involving hardware such as sensors will depend on both willingness and ability to pay and return on investment for the farmers.

The aspect which has the most direct bearing on these decisions apart from the return on investment is the consistency and predictability of government policies relating to export and import decisions in agriculture. Farmers need to be sure of the market options for their produce; diversification and acreage decisions can be taken and appropriate technology deployed if there is conviction that there won't be a situation where the farmer has to rue his/her choices due to abrupt change in policy which follows almost as a knee jerk reaction in the form of government controls on holding, import and exports of produce.

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