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Mission India for Transforming Agriculture (MITrA)

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This report is part of a series of Strategy Papers drafted on the request of the Prime Minister's Office**,** India. The other reports in this series include:

- Transforming Agricultural Marketing in India: Linking Farmers to a National Gateway and E-Markets, Current Scenario and a Way Forward;
- Soil Health Mapping and Direct Benefit Transfer of Fertilizer Subsidy;
- Pradhan Mantri Krishi Sinchai Yojana: Enhancing the Impact through Demand Driven Innovations;
- Transforming Weather Index-Based Crop Insurance in India: Protecting Small Farmers from Distress, Status and a Way Forward;
- Digital Agriculture; and
- Self-sufficiency in Pulse Production.

Cover page photos: *PS Rao, ICRISAT*

Mission India for Transforming Agriculture (MITrA)

Suhas P Wani, David Bergvinson, KV Raju, Pooran Gaur and Rajeev K Vashney

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Background

Humankind's biggest challenge in the 21st century is to ensure food and nutritional security for the growing population and improved livelihoods for smallholder farmers. World population is estimated to swell to 9.3 billion by 2050. India has to feed 1.4 billion people by 2025 and water demand for food production will increase dramatically. This challenge becomes increasingly acute in light of the depleting water resources (5177 m^3 in 1951 to 1545 m^3 in 2011), degrading land and increasingly variable weather associated with climate change. The Ministry of Agriculture & Farmers Welfare, Government of India has taken a novel initiative to transform agriculture in India as part of the Digital India program by transforming the rural economy and creating skilled jobs in rural areas. The Government of India has initiated various innovative schemes to enhance food production and to mitigate impacts of climate change.

At the request of the Prime Minister's Office, Government of India, to prepare a long-term strategy to increase economic opportunities for rural families in India, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)[1] has prepared a set of six strategy papers: 1) Pulses[2] 2) PMKSY[3]) Soil Mapping[4]) Agri Markets[5]) Crop Insurance[6] and 6) Digital Agriculture. The draft versions, based on the PMO request, were discussed with the Ministry of Agriculture & Farmers Welfare, Government of India[7] and its senior officers made detailed suggestions to refine and strengthen these papers. This summary, elaborated in the following sections and the set of strategy papers, attached separately, incorporate the suggestions made by the Ministry officials and other leading sector-specialists from India.

Across all six strategy papers, tremendous impact can be realized if a Mission Approach is taken to foster stronger integration across ministries and partners to leverage short-term interventions to support smallholder farmers while developing roadmaps for longer term strategies to ensure social, economic and environmental sustainability of Indian agriculture. Accompanied by a results framework to track progress, increase transparency and accountability and good governance to ensure farmer welfare, the Mission Approach impact will be realized. The best possible way to achieve sustainable growth in the agricultural sector is through Mission India for Transforming Agriculture (MITrA) in which innovative institutions, policies and enabling mechanisms for convergence, capacity development (skill development), collective action and cooperation of all stakeholders will be created. Through innovations and partnership we aim for economic gain/profitability by enhancing resource use efficiency to address the issue of equity and environmental protection. Convergence is essential to lift farm families out of poverty and to ensure safe, nutritious and diverse foods to support a young population that represents India's future. Increasing productivity of staple cereals alone is not sufficient. Under the Prime Minister's call for Digital India, we must ask what this means for India's 125 million farmers and their families. We believe that Digital Agriculture can provide the tools and technology to accelerate the delivery of MITrA and support integration across sectors critical to supporting rural development and creating opportunity for all.

Goal & Objectives

The overall goal of MITrA is to enable double-digit growth in the agricultural sector through scaling-up of science-inspired development and adopting innovations in ICT, public-private partnerships, advanced big data analytics, biotechnology, and increasing water and nutrient use efficiency – more crop per drop. With increased emphasis rightly being given to farmers' welfare, democratization of information to support equitable access to market opportunities by smallholder farmers will be key to incentivize productivity increases, attract youth to agriculture and ensure an adequate supply of nutritious, safe and affordable food for all. This will enable the objectives of the National Food Security Act to be realized. The Prime Minister's call for a Digital India will be key to realizing the goal of MITRrA as it will draw heavily on spatial

1. A member of CGIAR
2. Self Sufficiency in Pulse Production in India
3. Strategy Paper on Pradhan Mantri Krishi Sinchai Yojana (PMKSY): Enhancing the Impact through Demand Driven Innovations
4. Strategy Paper on Soil Health Mapping and Direct Benefit Transfer of Fertilizer Subsidy
5. Transforming Agricultural Marketing in India: Linking Farmers to National Gateway and E-Markets Current Scenario and a Way Forward
6. Transforming Weather Index Based Crop Insurance in India: Protecting Small Farmers from Distress Status and a Way Forward
7. Meetings were held on 23-24 September 2015, in Krishi Bhavan, New Delhi.

data infrastructure, mobile technology and business intelligence analytics to support the integration and coordination required for broad-based economic development in the agriculture sector. The specific objectives of mission MITrA are as follows:

Objectives

To enhance the agricultural production in India in a sustainable manner and to enable risk mitigation and better prices to farmers, the following objectives are formulated:

1. To achieve self-sufficiency in pulses production by 2020;
2. To enhance water use efficiency through integrated water and land resources development, PMKSY and Digital Agriculture;
3. To restore soil health based on soil health mapping and micronutrient-based soil enrichment;
4. To build resilience against the impacts of climate change through weather index-based crop insurance, strengthening the agricultural value chain and building the capacity of the farmers and other stakeholders;
5. To provide competitive marketing choices to farmers and simplify and reduce the cost of transactions by creating a national e-market.
6. To make agriculture a commercially attractive enterprise for youth and ensure resources (human, financial and natural) are used to support a modern food system that delivers safe, nutritious food while reducing the environmental footprint of food production in India by leveraging digital technology.

Strategy

- Transforming agriculture in India will require a mission approach to integrate resources of different sectors that intersect agriculture and horticulture. It should be coordinated by the mission Director General with the aid of integrated databases and business intelligence tools to coordinate programs at the district level.
- Cloud computing will enhance efficiencies when applying real-time monitoring to track implementation and support policy and investment decisions at all levels of government through ‘dynamic aggregation and disaggregation’ of geospatial/temporal data.
- The proposed strategy for this initiative harnesses the power of demand-driven innovation and science-led development for scaling-up improved technologies. These technologies include harnessing rainwater, enhancing water use and nutrient use efficiency, crop diversification, local value addition and linking farmers to equitable markets. Additional efforts include reducing storage losses and waste as well as making consumers more conscious of the role of nutritious food and health.
- The project will adopt the principle of 4 Cs, i.e., Consortium, Convergence, Capacity building and Collective action. The consortium consists of development agencies such as line departments of state government, NGOs, national and international research institutions and select private companies/ partners that are coordinated by leveraging integrated databases to take a holistic approach to agriculture development to keep farmers at the center of design interventions through participatory research. This would enable MITrA to realize the 4 Es i.e., Efficiency, Economic gain, Equity and Environment protection, which are important pillars for sustainable and inclusive development in India.
- MITrA will converge agriculture and horticulture through PMKSY and undertake soil health mapping, develop national markets for achieving pulses self-sufficiency and also increase food production while empowering smallholder farmers to manage weather and market risks to increase resilience and their economic opportunities
- Develop innovative and effective mechanisms to share knowledge with different stakeholders and build community-based institutions for sustainable development. India is a pioneer in the use of participatory video (e.g., Digital Green) to support peer-to-peer learning on best agricultural practices. What is needed is the integration of a certification process to ensure recommendations are based on sound science.

- Harness public-private partnerships for backward and forward linkages along the value chain (create equitable weather-agile value chains connecting input providers to farmers to markets) to ensure more value is captured by farmers and not middle men. Democratization of market information and mobile money to reduce transaction costs are two important tools to empower farmers to capture greater value.
- Translating Digital India into *Digital Agriculture* by leveraging digital technologies (cloud, mobile, remote sensing, sensors, advanced analytics, etc.) to support demand-driven innovation of sustainable and equitable food system that ensures safe, nutritious and affordable food for all.
- The urgency for change is real and the challenge is to achieve effective convergence amongst various departments, stake holders including private corporates through changing the mindset of the actors and creating linked and shared incentives.
- The principle of "Seeing is believing" needs to be adopted. For scaling-up science-led development, a well-coordinated initiative led by a neutral agency like ICRISAT and ICAR in the country needs to be established nationwide through a network of consortium partners that include the private sector.
- More investments in demand-driven innovation are required to ensure farmers have a voice in the design, development and delivery of appropriate technologies. This has been proven to be more cost-effective in scaling up adoption of relevant interventions.
- MITrA provides a framework for convergence with agriculture-facing ministries and rural development partners to support broad-based economic opportunities in rural India. This is now made possible with cloud computing, mobile phones, remote sensing and social media to democratize information, share knowledge and target interventions along value chains to ensure farmer welfare, nutritional security and environmental sustainability of India's modern food system.

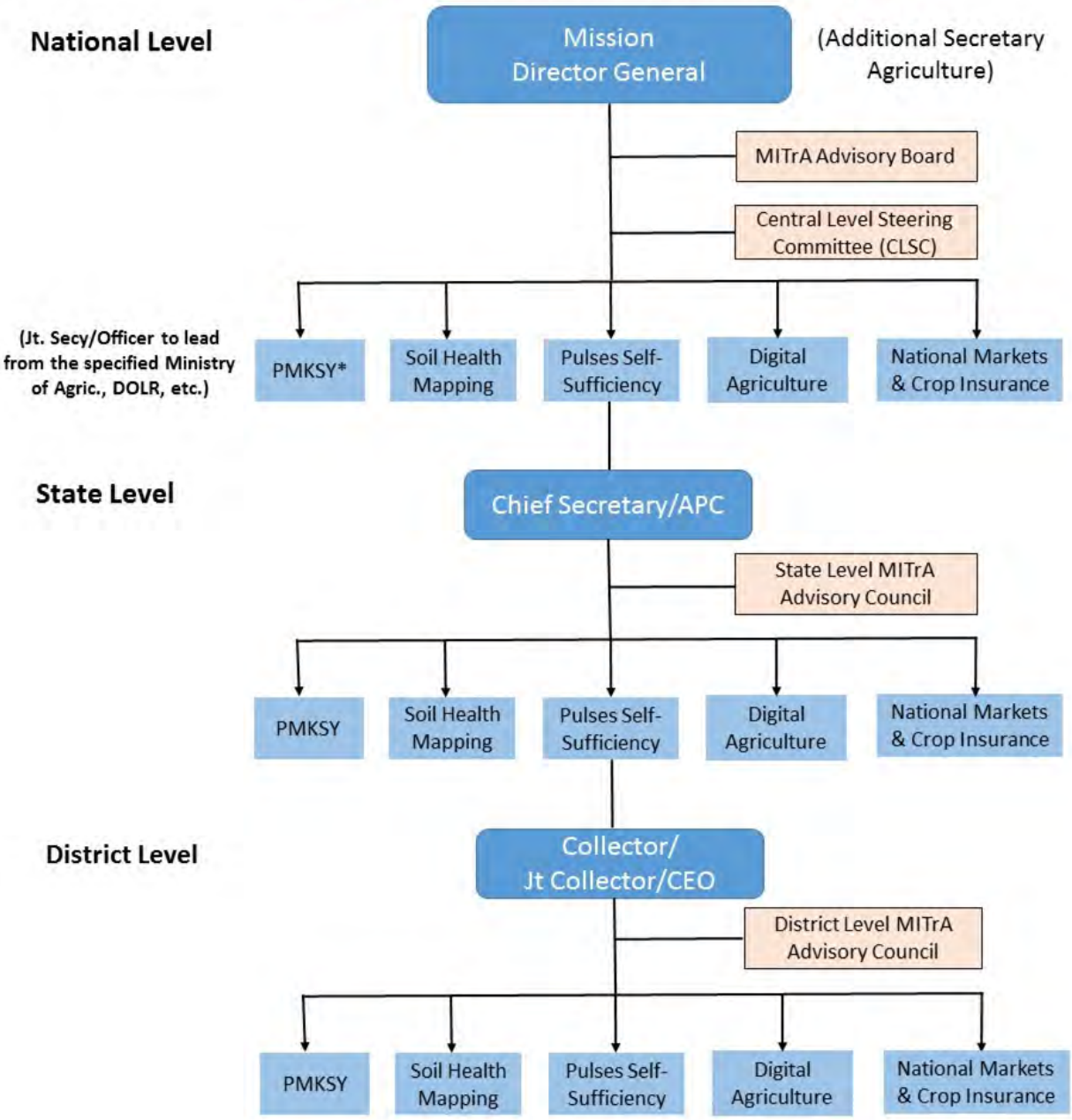
Expected Benefits

- Implementing mission MITrA in totality would benefit the country in terms of achieving self-sufficiency in pulse production as well as improving the livelihoods of farmers and attracting youth back to agriculture by making it commercially attractive. The details of the benefits from the different strategies under MITrA are as follows:

Sl. No	Name of the Strategy Paper	Investment needed in 5 years	Expected benefits in 5 years	B:C ratio
1	Towards Self-sufficiency in Pulse Production in India	₹ 0.12 lakh crores	₹ 1.18 lakh crores	10:1
2	Pradhan Mantri Krishi Sinchai Yojana (PMKSY)	₹ 2.52 lakh crores	₹ 23 lakh crores	9.2:1
3	Strategy Paper on Soil Health Mapping and Direct Benefit Transfer of Fertilizer Subsidy	₹ 0.254 lakh crores	₹ 4.33 lakh crores	17:1
4	Transforming Agricultural Marketing in India: Linking Farmers to National Gateway and e-markets: Status and a Way Forward	These three interventions will contribute significantly towards enhancing the productivity and profitability of farming. However, these are new interventions and a detailed implementing strategy and more piloting will be needed during the first two years before scaling-up at the country level.		
5	Transforming Weather Index Based Crop Insurance in India: Protecting Small Farmers from Distress: Status and a Way Forward			
6	Digital Agriculture to accelerate rural development			

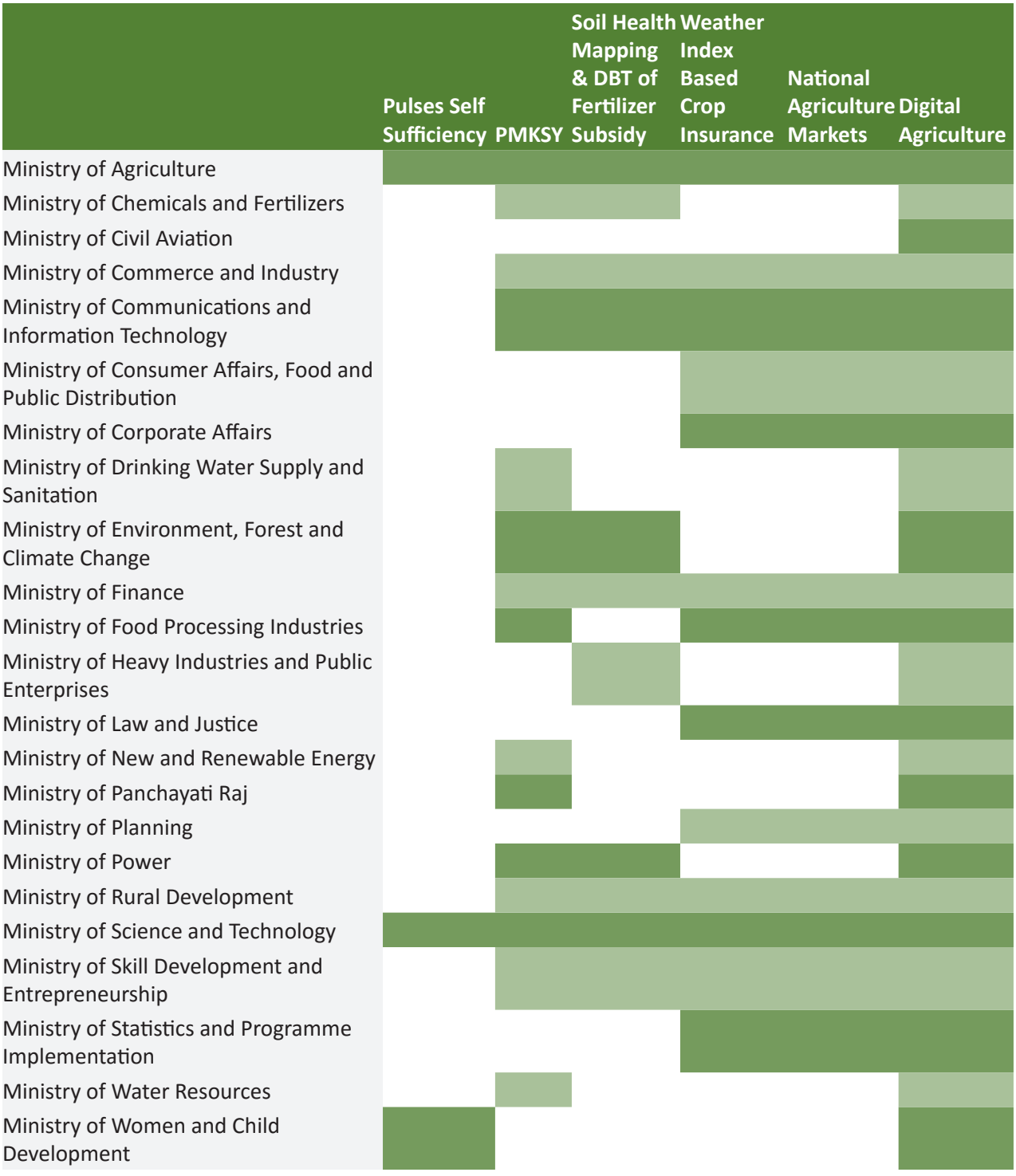
Institutional Arrangement for Implementation

Mission India Transforming Agriculture (MITrA)



* PMKSY includes Planning & Budgeting, Capacity Building, Implementation, Monitoring & Evaluation and Micro Entrepreneurship Development cells for effective implementation and monitoring.

Convergence of Multiple Ministries



Executive Summary

Self-sufficiency in Pulse Production

Pulses (chickpea, pigeonpea, lentils, *urd* bean and mung bean) are source of protein and nutrition for the Indian diet. However, pulses are largely cultivated on rain-fed, degraded lands by resource poor famers. Current levels of production (17-19 million tons) are not keeping pace with demand (22 million tons) and the shortfall is projected to increase over the next five years if concerted action is not taken. The proposed strategy suggests a three-pronged approach to make the country self-sufficient in pulses by 2020:

- In the short term (3-5 years), make the country self-sufficient by expanding the area under pulses (rice fallows and increasing cropping intensity through intercropping) through scaling-up seed production and seed storage (i.e., using hermetic bags) to increase seed of market-preferred varieties. Coupled with improved agronomic practices, promoting mechanization to reduce labor costs, and dampening price volatility (e.g., by setting up warehouses to increase buffer stocks) will drive towards self-sufficiency.
- In the medium term (5-7 years), self-sufficiency through intensification in increasing productivity by using high-yielding cultivars (i.e., developed using molecular breeding), mechanization to increase local processing and storage, and further increases in water and nutrient use efficiency. Insect resistant and herbicide resistant pulses through the use of transgenic traits will offer significant benefits to farmers in reduced spraying of insecticides and safer food through reduced pesticide use.
- In the long term (>7 years), research in high-end areas such as gene editing (e.g., CRISPR Cas9), expanded use of systems biology to improve nutritional quality and climate/weather resilience of pulses. Sustainable self-sufficiency will be achieved through innovation in processing to reduce storage losses and further reduction in the ecological footprint of agriculture by increasing the nitrogen fixing capacity of pulses to reduce dependency on urea.

Specific initiatives will focus on:

- Expansion of pulses area in eastern India Indo Gangetic Plains (IGP) through scaling-up of holistic cropping systems to cultivate an additional 5 million ha of pulses in rice fallows within five years.
- Establishment and scaling-up of improved seed supply chains through collective initiatives such as Farmers' Producers Organizations (FPOs) and seed villages. Hermetic storage of seed in 50-100 kg plastic bags can provide pulse seed security for smallholder farmers between cropping seasons.
- Strengthening value chain approach for the pulses and promote market support. This includes variable floor prices for seed of new varieties to incentivize sale of seed back to seed distribution systems.
- Monitoring production region/country-wide to ensure symmetrical information across the agricultural value chain – from inputs (and their price) to markets (farm gate price) and inventory / storage.
- Strengthening modern breeding programs focused on improving productivity, improving phosphorus use efficiency, increased herbicide tolerance and insect and disease resistance and enhancement of protein content. Marker assisted breeding is now being used to enhance existing varieties with key productivity and nutritional traits to deliver impact in the short term.
- Developing and popularizing pigeonpea hybrids suitable for different agro-ecologies and cropping systems that will incentivize private sector investment in pulse seeds.
- Developing, testing and commercializing Bt chickpea and pigeonpea to reduce pesticide sprays, improve farmer safety, increase profitability and increase productivity by over 20%.
- Mechanization and improved management practices such as transplanting of pigeonpea and use of supplemental efficient irrigation, seed priming and hardening, site-specific nutrient management and targeted fertilizer applications for increasing pulses productivity and profitability for farmers.
- Increasing availability of improved infrastructure (e.g., warehousing and information services) and marketing of pulses along with enabling policies and incentives. Pulses require cooler storage facilities

than cereals and effort to establish specialized silos closer to farmers will be critical in building stocks, reducing price shocks and empowering farmers to obtain higher prices through the use of warehouse receipt systems that can be mobile-enabled.

- Government-developed interventions and incentives (e.g., MSP and procurement) for enhancing production and trade to establish buffer stocks (at least 2 million tons) of pulse grains to reduce price volatility.
- Liberalization of import and export of pulses to further dampen price volatility
- Dedicated funding (not for salaries and non-recurring contingencies) to ICAR and State Agricultural Universities for demand-driven research to accelerate genetic gains and cropping systems to deliver long-term solutions to meet the projected market demand of 39 million tons of pulses by 2030.

The implementation of the proposed initiatives will cost approximately ₹ 11700 crores over a ten-year period from 2015-16 to 2026-2027. The anticipated direct benefit to farmers is estimated at ₹ 118674 crores over the next ten years. The projected benefit-cost ratio for these investments in pulses is 10:1. In addition, the nitrogen fixed over the 5 million additional ha of pulses sown nationally would be valued at nearly ₹ 350 crores (price substitution for urea).

Pradhan Mantri Krishi Sinchai Yojana (PMKSY)

The Ministry of Agriculture and Farmers Welfare, Government of India, has launched the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) to address India's key agricultural challenges in the 21st century i.e., to reduce poverty and ensure food security for the growing population in the face of climate change, scarce and limited water and land resources. This initiative proposes to provide irrigation to every farm in the country (*Har Khet Ko Pani*) and improve water use efficiency (Per Drop More Crop and Income). It aims to bring together various schemes and programs for water harvesting, conservation and efficient management in order to ensure there is enough water for agriculture. This program also aims to harness the potential of agriculture by effectively utilizing green (soil moisture) and blue water (irrigation) for improving efficiency, sustainability, equity and resilience at the farm level, especially in rainfed, marginal and fragile areas using an integrated approach.

- All the four components of the PMKSY namely, Accelerated Irrigation Benefits Programme, Per Drop More Crop and Income, *Har Khet Ko Pani* and Integrated Watershed Management Programme (IWMP) need to be implemented in a coordinated and transparent manner by adopting a micro-watershed as a unit and integrate meso- and macro- watersheds at a basin level.
- The PMKSY when implemented fully in 10 years, can add a total value of ₹ 23 lakh crores[1] to the Gross Domestic Product (GDP), assuming an investment of ₹ 251,665 crore is made by central and state governments in the form of incentives. The total cost including farmers' contribution would be ₹ 466,850 crore, with farmers' share of 10% in watersheds and 50% in other interventions. In addition for implementation of the scheme, 10% additional resources would be needed for capacity building, monitoring and plan preparations as well as for establishing the "sites of Learning".
- Accelerated irrigation benefits under the PMKSY can be achieved by reducing the transmission losses and by adopting the goal of 'zero flood irrigation by 2020'and popularizing micro irrigation (MI) systems with need-based irrigation scheduling for the crops rather than calendar-based irrigation.
- However, Maximum benefit of ₹ 17.54 lakh crore is expected from Integrated Watershed Management Programme and *Har Khet Ko Pani* interventions in rainfed areas and ₹ 5.58 lakh crore from the Cultivable Command Area (CCA) as well as groundwater irrigated areas.
- The B:C ratio for the PMKSY at macro level would be about 9.2:1. For individual farmers', the benefit would vary from ₹ 3,000 to 150,000 per ha per year with different technologies. Higher returns are expected in rainfed areas with benefit-cost ratio (BCR) at 9.6:1 compared to the returns from irrigated areas with BCR at 8.2:1.

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1 lakh = 10^5 and crore = 10^7 (10 million)

- More resources/investments are needed to make agriculture in vulnerable rainfed areas drought proof and climate resilient. Private investments could be channelized to develop rainfed areas in the country for cultivation of high-value crops through protected cultivation under *Har Khet Ko Pani* and watershed programs.
- Integrated watershed development, *Har Khet Ko Pani* and Per Drop More Crop and Income programs are critical in transforming rainfed agriculture and also in facilitating adoption of diversified livelihood options among smallholder farmers, women and youth.
- However, a 'business as usual' approach will not deliver results. For realizing the full benefits of the PMKSY, it needs to be implemented in a mission mode, led by the Director General at the national level for effective convergence of programs and practices in an integrated way for benefit of smallholder farmers, who are marginalized, and socially and economically backward. All resources of the PMKSY need to be vested with the Director General of the PMKSY and annual allocations for the component implementation can be disbursed to the implementing department/ministry which is assigned the responsibility. This would ensure accountability and the maximum impact of the PMKSY.
- A three-tier structure at national, state and district level is proposed for effective planning, implementation, monitoring and achieving the impact in a coordinated manner. Nodal agency at each level to be supported by the Advisory Board consisting of renowned subject experts, secretaries of all the concerned departments, financial institutions like NABARD and NGO representatives.
- Agroecological zone-wise crop planning is another important intervention for improving water use efficiency in the country. This can be implemented through innovative incentives, market support and penalties such as no market support, no fertilizer and seeds subsidy, for the non-adopters.
- Groundwater recharging through aquifer mapping, aquifer recharging and rainwater harvesting needs to be pursued vigorously in the most parts of the country. Enabling policies (for example, use of drones for digital imageries, incentives for using organic manures, warehousing and marketing support, etc.) and institutions for sustainable management of groundwater need to be developed urgently. Good practices like participatory groundwater management and sharing of bore wells by the community need to be scaled up. It is proven that Community participation is important to promote demand-driven interventions for ensuring success rather than target-based supply-driven interventions.
- New science tools like remote sensing, Geographic Information System (GIS), water budgeting, simulation models, and ICT among others need to be fully integrated and their use made compulsory for effective planning, monitoring and ensuring transparency. Public Private Partnerships (PPP) models can be used to harness these latest technologies for the benefit of smallholder farmers.
- Capacity building is a critical part for the successful implementation and existing institutions like WALMTARI, National Institute of Rural Development (NIRD), State Universities, National Research Institutions and good NGOs can be strengthened. Services of international institutes like ICRISAT can be harnessed effectively.
- Specific regions/areas which are more vulnerable to droughts (for example, Vidarbha and Marathwada in Maharashtra, Bundelkhand in Madhya Pradesh and Uttar Pradesh, rain shadow regions in Karnataka, Rayalaseema region in Andhra Pradesh and drought prone districts in Gujarat, Rajasthan, Telangana and other states), climate change impacts, flooding, poor groundwater quality (arsenic, fluorides or nitrate affected areas) should get higher resources (technical, financial as well as human) for helping the communities in need.
- Productivity of rainfed agriculture (76 million ha) can be doubled by adopting science-led interventions, improving knowledge delivery systems using ICT, skill development for building the capacity of all the stakeholders by adopting value-chain approach through consortium, convergence, collective action and capacity building. This would contribute significantly for improving livelihoods as well as food and nutritional security.

- Groundwater recharging through aquifer mapping, aquifer recharging and rainwater harvesting needs to be pursued vigorously in the most parts of the country.
- Enhancing water use efficiency (WUE) through conjunctive use of green and blue water efficiently, while growing high-value crops in protected cultivation as well as by bringing in rainy season fallows (2 million ha) and rice fallows (11.6 million ha) under cultivation using improved land, water, crop management practices.

Soil Health Mapping

- Site-specific fertilizer recommendations would add ₹ 4.33 lakh crores value to GSDP in 10 years with a B:C ratio of 17:1 with an investment of ₹ 0.254 lakh crores. Key to realizing this impact will be the generation of digital soil maps stored in the cloud to track soil sampling and analysis by a network of accredited (and calibrated) soil labs.
- Using this approach, infrastructure and institutional arrangements can be prioritized to ensure soil health analysis of 137 million land holdings. This can be realized over a rotating 3-year analysis cycle based on stratified soil sampling.
- Studies show widespread deficiencies (18-100%) of multiple nutrients in many parts of the country, which are becoming a major constraint in realizing optimal farm profitability. Crop yields can be increased up to 120% using soil test-based fertilizer recommendations.
- The Ministry of Agriculture & Farmers Welfare, Government of India has embarked on a bold initiative to urgently put in place the needed infrastructure to assess soil health reliably. However, such an ambitious initiative can only be successful if a comprehensive plan is prepared and implemented with the appropriate quality controls put in place to ensure accuracy.
- Regional and state consortia of research and academic institutions like SAUs need to be formed to assist the Department of Agriculture, Krishi Vignan Kendras, Department of Horticulture and NGOs guided by the National Consortium to collect stratified soil samples. Adopting a uniform method, metadata and standardized training on collecting soil samples from the identified farmers' fields is critical to ensure sample integrity that includes accurate GPS coordinates and depth of samples.
- For analyzing the soil samples, state of the art laboratories in each district need to be identified, accredited by the national accreditation group and undertake the analysis of soil samples for all plant nutrients by adopting standard methods across the country.
- New institutional mechanisms for operationalizing the innovative scheme are recommended through national, state and district levels to (1) undertake soil sampling through farmers' participation, (2) analyze soil samples in accredited soil laboratories to maintain quality standards, (3) develop soil test-based fertilizer recommendations at the taluk level, and (4) establish "sites of learning" for the farmers.
- There is an urgent need to develop and adopt a new fertilizer recommendation strategy based on soil health mapping down to at least the taluk level for different crops and cropping seasons to maximize productivity and maximize return on fertilizer inputs for farmers using expert recommendation systems that leverage ICT, remote sensing, soil/moisture sensors and spatial data infrastructure.
- Direct Benefits Transfer to offset fertilizer costs for those farmers who follow the recommended fertilizer application based on soil testing. Farmers wanting to apply more fertilizer are free to do so but at full cost. This will reduce the over application of urea, reduce the quantum of fertilizer subsidy and incentivize farmers to have their soil tested and optimize fertilizer application to improve soil health.
- There is also a need to develop low-cost formulations of nutrient carriers to supply essential plant nutrients including biological and organic formulations along with inorganic sources.
- Soil Organic Matter (SOM) is generally low in India which in turn reduces water and nutrient use efficiency. Incentives to increase SOM should be considered under carbon credits and reduced greenhouse gas emissions under the soil health initiative.

- In addition to a B:C ratio of 17:1, several environmental benefits, employment generation and enhanced sustainability of Indian agriculture are important outcomes of an integrated soil health program.

Transforming Agricultural Marketing

Constraints

- Physical trading of agricultural commodities in India falls under the jurisdiction of the state governments. Each state has its own Agricultural Produce Market Committee (APMC) Act to regulate trading. The APMC Act requires buyers and sellers to assemble at designated places known as regulated market yards or *mandis*.
- Each regulated market yard is governed by a market committee, which is expected to facilitate competitive price discovery for farmers. Once a state government declares a particular area to be part of a market committee, all wholesale trading in that area has to be undertaken at the designated regulated market yard forcing farmers to travel long distances to these *mandis*. Further,

  farmers are prohibited from selling their produce directly to buyers (processors, exporters and retailers) forcing them to sell to the traders and local aggregators licensed by the *mandi*. Increased intermediation on account of such archaic rules have created inefficiencies in the current marketing structure leading to poor price outcomes for both farmers and consumers.
- The regulated markets have steadily grown from 286 in 1950 to 7157 in 2010. However, lack of reforms have led to several problems including a) large number of intermediaries involved; b) artificial barriers to participation e.g., need to own premises to participate; c) high transaction costs including excessive travel by farmers; d) long processing time (time taken to process and pay); e) poor grading and quality description to assist in arriving at a fair price; f) poor storage leading to wastage (conditions of storage and inter-temporal price); g) inadequate price information and h) poor infrastructure in markets.

How is the Government already intervening?

- To provide farmers with choices to market their produce and to encourage private investment for the development of market infrastructure and alternative marketing channels, a Model Act on agricultural marketing had been formulated by Ministry of Agriculture & Farmers Welfare, Government of India in 2003. Seventeen states have already amended their respective APMC acts, another seven states have also notified APMC rules under their acts. Also, some attempts at ICT based automation of *mandis* have been attempted in the hope that it would result in better functioning of *mandis* and better prices to farmers but the fundamental and systemic issues in *mandis* remain.
- To deal with these problems in agriculture marketing, Government of India has recently approved a new Central Sector Scheme for promotion of a National Agricultural Market (NAM). A NAM can be realized through a pan-India electronic platform which can facilitate the participation of buyers and sellers from all over the country. Key enablers to operationalize this platform are provision for material accounting, trade fulfillment, fund processing and post-sale document creation (like generation of e-bills) which would increase efficiency of intermediation. Generating e-permits for all transactions conducted on the platform would create an audit trail verifiable across the country and simplify movement of goods.

Towards National Agriculture Market

- Barriers to entry limit licensing which in turn limits competition. Mandatory physical presence in a market for obtaining a license for participation in that market and licensing requirement that mandates a separate license for each market are two main impediments leading to fragmentation of demand. Participation of buyers has to be on an all-India basis for the national market to take roots. Policy reform to facilitate Pan-India licenses and freedom to participate across all markets with single license should be the first step in realizing the NAM.

- Grading is another area that needs a substantial overhaul. A scientific system of grading is needed immediately. Due to a lack of grading standardization, farmers find that they are not compensated for better quality produce. Reliable assaying and quality testing infrastructure has to be established in every market and quality based bidding encouraged. Standardization of quality and quantity parameters, dissemination of these parameters to buyers, clearing and settlement mechanisms and dispute resolution are key prerequisites for participation from remote locations in a Pan-India Market. It is worth noting that the Ethiopian Commodity Exchange has implemented a spot-market system for

Where are we now	Why change	Options	Preferred option and players
Produce sold in local markets (mandis) with poor infrastructure, handling, storage, price stability and intermediaries. Agricultural input distribution to remote areas by private marketers is better placed than the farm outputs. Market regulation policies of states are outdated due to the differential licensing system. Agricultural commodity movements are restricted within and across the states. Financial institutions not geared up to meet the requirements of the agricultural markets Standardization of quality and assaying limited, leading to farmers not getting higher price for better quality produce.	Farmers get too little, consumers pay too much, and aggregators and wholesalers make a big cut Need to align with international practices and quality and face the fiercely competitive globalized world There is potential to improve the contribution of agricultural sector to the GDP of the nation. No national consistency: Some states reformed the markets act, however there is no improvement in Infrastructure. Mechanisms of determining prices are arbitrary and do not favor the producer Storage facilities, logistics need to upgrade to improve the quality of produce and turnaround times of the transactions. Quality and standardization along with grading have been neglected. Hence, the products are not competitive in global markets. Lack of traceability while handling agricultural, horticultural or dairy produce (including animals)	Integrated National Market System has been proposed in this document to initiate the piloting in some places and later for scaling up Use technology to digitalize and network all the markets using ICT. Improved e-trading, computerized billing, end- to- end process Key processes required: Issue of lot number linked to the farmers account, auto-recorded electronic weighment, standards and assaying, trading, interstate participation in tendering, interstate free movement of goods, warehouse receipt system, linking electronic banking for facilitating direct payment to the producers Establishment of improved testing and grading systems Creating a conducive environment for licensing of farmers, traders and intermediaries with good governance. Linkage with spot exchange and networking with commodity markets at the national level. Infrastructure development through PPP for storage and warehouse receipt system Establishment of Dairy Animal Information System (DAISy) Developing forward and backward linkage of markets through FPO Upgrading and capacity building of all stakeholders	Integrated National Agriculture Market Policy and establish a national level market institution. National market with pan-India electronic platform for trading. Setting up of a national level cell for a SPV to implement the National Agriculture Market Policy A national level regulator for agricultural commodity standards, assaying and testing Capacity building of FPOs and producer organizations through the existing National Skill Development Corporation Develop PPP and or BOT models

local produce that is based on transparent grades and standards and quick settlement and payment mechanisms that should be considered as a national marketing system is designed for India.

- Some key features that a NAM must have to realize the intended potential are: a) Auction of the produce takes place simultaneously in the same electronic platform in all regulated markets (APMC markets) in the country; b) Every regulated market is supported by infrastructure for quality assaying of the produce; c) A buyer, irrespective of his location, can participate in any market of his choice; d) Collection of sale proceeds from the buyer and remitting it to the bank account of the seller is facilitated by the market; and e) Restrictions in transportation of the commodity should be removed. This will require a national Goods and Services Tax (GST) to support the movement of produce across state lines.
- In the longer term, marketing system needs to transform into a warehouse based trading system. A Negotiable Warehouse Receipt (NWR) system wherein as soon as farmer brings his produce, the produce gets graded with a standard testing protocol and given a NWR which guarantees the grade quality of the produce for a certain period of time should be the way forward.
- The need to improve processes leading to expansion of infrastructure (logistics, supply chain, storage), movement of commodities within and between states, quality standardization, certification, participation of private players along with producer organizations (FPOs) and value addition through processing of produce in a sustainable way have all been highlighted in this document. The Maharashtra model of linking FPOs with Apni Mandi concept is providing marketing platforms to retail produce of FPOs to consumers need to be considered.
- An action plan has been discussed in this document with a Special Purpose Vehicle (SPV) designed as a way forward to implement the strategy. The PPP model adopted by Karnataka with NCDEX help, wherein an SPV was floated to create a UMP model across 65 markets offers some key lessons on some aspects of operationalizing the NAM. Additionally, besides the PPP model, a BOT model also needs to be explored.

Weather-Index Based Crop Insurance

- Index-based weather insurance uptake has not achieved the envisaged numbers despite its theoretical benefits. While pricing is one of the key determinants, financial literacy is also a major factor in the rural environment where the individual farmer's familiarity with the framework and confidence in the insurance seller is paramount to the product success.
- The current crop loan insurance is largely tied to an institutional loan, and benefit farmers with irrigation to a large extent. This is because more than half of the cropped area in India is dependent on rains, and any aberrations in rainfall or in its distribution can adversely impact crop yields.
- The review of related case studies highlight that the Weather Index Based Crop Insurance Scheme (WIBCIS) must provide added value to the client, which should be beyond the simple financial protection provided by insurance. As a stand-alone product, this may be seen as an unnecessary cost and have little demand from poor smallholders, who face a variety of risks and productivity constraints in addition to weather risks.
- In most cases, insurance is more appealing when linked to an existing development program that targets these constraints or when linked to other market opportunities. One obvious linkage relates to seasonal credit, but can be further enhanced when a package of credit and inputs is provided.
- For WIBCIS to find widespread favour with farmers, emphasis on education and awareness is required as well as confidence in timely payments once a claim is filed and validated.
- Crop insurance is subject to structural design and financial issues. Several agencies and organizations are involved in crop insurance programs, which can be effectively implemented through coordinated efforts. Support is needed for long-term development of improved products that aim to minimize the basis risk. Good examples to learn from include ACRE in Kenya, Rwanda and Tanzania. The greatest barrier to expansion is access to reliable long-term data to base agricultural insurance indices on.

Where we stand	Why change	Options	Preferred option and players
WIBCIS is intended to provide insurance protection to the cultivator against adverse weather incidence. It currently covers only about 15% of farmers and 17% of cropped area. Since the product is based on the adverse macro weather patterns rather than actual loss, processing time for claims is reduced as damage assessment processes are bypassed. The Scheme has succeeded only where it has been compulsorily bundled with loans as an alternative to the traditional area-based yield insurance. Against the backdrop of a change in the policy landscape in cognition of climate change, weather-based indices offer better protection against covariate risks like drought and floods. The market has a minimum credible number of weather-index based products; farmer literacy is the key hindrance. Investment in human capital development for delivering agriculture extension services is lacking; efforts to strengthen the system are required.	A shift from a social crop insurance program with ad-hoc funding from the Government of India to a market-based crop insurance program with actuarially sound premium rates and product design is needed. The 'indirect' approach might sometimes overlook actual individual losses, one of the reasons why farmers are still reluctant to trust the product. Dedicated efforts to make farmers understand the medium to long-term benefits of this 'costlier' instrument would induce them to adopt these products. An improved product and the active involvement of private sector insurance markets are expected to lead to significant benefits such as faster settlement of claims, a more equitable allocation of subsidies, and lower basis risk for farmers. Pro-poor products need to be introduced as a large chunk of insurance buyers are small and marginal farmers. Insurers and government must experiment with cost-effective ways of increasing outreach. Government should provide equal opportunity for all insurers participating in WIBCIS.	Special Purpose Vehicle (SPV) to provide agriculture extension services. The product and active involvement of private sector insurance markets may significantly benefit farmers in terms of faster claims settlement, a more equitable allocation of subsidies and lower basis risk. Establishing pilots with quality automatic weather stations representing several farmers' fields in one village or a cluster of villages is the key to weather index- based insurance. The Farm Livelihood Obligation Fund (FLO-F) would envisage creating an initial pool for public sector insurance companies to enable premium payments. It is recommended that WIBCIS and the electronic platform facilitating transactions in the National Agricultural Market be integrated.	Special Purpose Vehicle to strengthen extension services with the help of FPO/ PC, and public and private agencies. The Farm Livelihood Obligation Fund to overcome financial obligations along with financial institutions. The National Agricultural Market electronic platform will be used to pay farmers for the produce sold. The farmer database may be made more comprehensive and integrated with banks and financial institutions to maintain loan data. Regular capacity building of farmers and FPOs through existing national level skills development corporation.

For index insurance to be affordable and accurate, 10-20 years of historical rainfall or yield data is required. Companies that specialize in down-scaled daily observed historical data will be critical partners, such as aWhere Inc. based in Colorado, USA.

- There is a need for a comparative statistical analysis of different insurance products. Enhanced consumer protection legislation for indexed insurance products is required. In addition, research on better methods so as to combine the information from different indices should be promoted so that farmers can rely on timely claim payments in bad years.

Digital Agriculture

The Prime Minister of India, Mr Narendra Modi, launched Digital India on 1 July 2015 to create digital infrastructure for empowering rural communities, enabling digital delivery of services and promoting digital literacy. Given that 58% of India's population is rural and agriculture is the main source of livelihood for them, one must consider the role of Digital Agriculture within Digital India. Digital Agriculture can

be defined as ICT and data ecosystems to support the development and delivery of timely, targeted information and services to make farming profitable and sustainable (socially, economically and environmentally) while delivering safe, nutritious and affordable food for ALL. During the launch of Digital India several CEOs announced their contributions to the initiative but probably the most significant was Microsoft's commitment to provide broadband connectivity to five lakh villages in India and make India its cloud hub through Indian data centres. Rural connectivity will be key to providing low cost data and access to information to empower rural youth to realize their full potential, farmers to increase their profitability by accessing equitable markets and rural businesses to offer value added services.

The key components to support the implementation of Digital Agriculture is Spatial (and Temporal) Data Infrastructure (SDI) and low-cost smart phones and tablets to support the bi-directional flow of data and information to rural consumers. SDI has been the key driver to support modern farming in the USA, Australia and Europe as well as emerging economies of China and Brazil. Agriculture is data-intense enterprise when one considers soil variability and nutrient levels, moisture, rainfall variability, timing of key operations like planting and harvesting, market price volatility. Advanced agriculture industries help farmers manage these production and market risks through the application of spatial/temporal data bases that are cloud enabled and integrated through Application Programming Interfaces (APIs). This creates a rich and dynamic data ecosystem that enables advanced analytics to inform farmers of the best economic options to maximize profitability and minimize risk – the two critical variables farmers in India would also like to manage.

Smart phones are the other key intervention as they are equipped with GPS to track where photos of field infestations or hail damage have taken place for technical support or insurance claims and can be used by farmers to integrate into structured markets based on approved grades and standards that can be verified using calibrated photos and settlements made through mobile money. While India has over 960 million mobile phones, only 17% of the population has a smart phone but this is changing quickly with over 204 million smart phone users projected for 2016; however, this percentage will be very low for rural consumers but it too is changing as the price point for smart phones manufactured in India is dropping as are phablets (phones and tablets that support rural education and extension).

Digital technology will be key to increasing agriculture productivity by delivering tailored recommendations to farmers based on crop, planting date, variety sown and projected market prices to optimize recommendations. These recommendations will be based on advanced big data analytics related to down-scaled daily observed weather that is now 3 km x 3 km but will soon be under 1 km x 1 km that feed into crop growth models to estimate yields, harvest data and potential pest and disease outbreaks to optimize pest control measures. Remote sensing is another big data resource to support the development of derived weather products (radar), improved hydrology and watershed management, soil health, crop coverage and health estimates among other application. This is now complimented by Unmanned Aerial Vehicles that can capture multispectral images to assess crop health, damage and yield far more accurately than satellites.

The greatest impact Digital Agriculture will have is on democratization of market pricing and transactions to enable farmers capture a higher portion of the produce value. Agricultural value chains are complex with several actors along the chain but information asymmetry between the farmer and aggregator or intermediaries results in farmers having to sell into saturated, weak markets that are not based on standards. Powerful business models have emerged from Africa, Brazil and China that use big data and mobile phones to increase value chain efficiency for upstream access to appropriate inputs and credit down to targeted recommendations to improve productivity through to market integration based on agreed grades, standards and prices. It is not uncommon for farm incomes to double in the case of cereals to quadruple in the case of perishable produce. India is well positioned to realize the same opportunities for its farmers by providing the basic spatial data infrastructure in place to enable coordination along the value chain from input providers to farmers to aggregators down to consumers who will increasingly want to be assured that their food is safe and hence traceable.

With the Direct Benefit Transfers system and the unique identification number called Aadhaar to support transfer of government subsidies to citizens, India is uniquely positioned to leverage these platforms to support the earlier interventions around soil health, PMKSY, national markets and weather indexed insurance. When combined with spatial/temporal data infrastructure, subsidies can be validated (e.g., application of fertilizer on a specific field under a targeted fertilizer subsidy program) and targeted (e.g., digital soil map and crop to be cultivated and rainfall anticipated) to increase farm profitability and manage production and market risks that in turn give famers confidence to invest in their farms to further increase productivity.

Digital Agriculture will also leverage social media platforms to build human capacity. One of the best examples originating from India is Digital Green that uses participatory video to have lead farmers explain best management practices to other farmers. This approach is ten times more cost effective than traditional extension services as farmers trust other farmers more given they can better relate to someone like themselves who are building a livelihood under similar circumstances.

Mobile money is the last key intervention that has unlocked tremendous opportunities for rural consumers in Africa and will do the same for India. Paper money is expensive and risky to rural consumers but mobile money is safer, especially for women, and costs lees to transfer. Mobile money also allows rural consumers to bypass poor infrastructure to support savings and access credit.

While Digital Agriculture is most advanced in the USA, the concepts are scale neutral and are being successfully applied to smallholder farmers around the globe. We need to move with a sense of urgency to apply these new tools to accelerate the pace of agriculture development to not only realize the vision of the Prime Minister of a Digital India but to facilitate the achievement of Sustainable Development Goals before 2030. Digital agriculture will also help achieve the objectives of the National Food Security Act in the most efficient, effective and equitable manner to ensure ALL have access to safe, nutritious and affordable food.

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