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Organized Data and Information for Efficacious Agriculture Using PRIDE™ Model

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Abstract

Farmers in India are faced with a myriad of issues from access to agricultural inputs, scientific agriculture practices, and market intelligence over climate and weather calamities which often make farming an unprofitable business.

A combined approach of group farming and effective farm management with the help of efficient data collection, processing and analysis is a widely accepted solution to these issues. Progressive Rural Integrated Digital Enterprise (PRIDE™) is an innovative business model which enables rural India to tackle these challenges and prosper collectively. The technology enables efficient collection of data from farmers' fields, agricultural universities, and other private and public stakeholders which is processed and disseminated to farmers on their mobile phones.

Keywords: Information and Communication Technology (ICT) for agriculture, PRIDE, mKRISHI - mobile agriculture, agricultural data management, FPO, group farming

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Introduction

According to World Bank (2016), "Agricultural development is one of the most powerful tools to end extreme poverty, boost shared prosperity and feed 9 billion people by 2050. Growth in the agriculture sector is about two to four times more effective in raising incomes among the poorest compared to other sectors" and can be greatly enhanced through recent cost effective technology developments.

Agriculture in India and Problem Statement

Agriculture, with allied sectors, is unquestionably the oldest and largest livelihood provider in India. It contributed approximately 13.9% of India's GDP (Gross Domestic Product) during 2013–2014; providing livelihood to nearly 600 million Indians (MoA GoI 2015 and DAC 2014). Various studies show that population growth is creating pressure on agriculture to meet the growing demand for food, consequently, leading to rising food prices and poverty levels (ICT in Agriculture 2012; World Bank 2011). While the population of India continues to rise, agricultural productivity is not keeping pace. Farmers face a plethora of problems which are restricting the growth of rural agrarian economies and decreasing the share of agriculture in India's GDP continuously from 1950 to 2014 (Planning Commission GoI 2015).

There is a need to focus on increasing agriculture production in sustainable ways to fulfill the growing needs of the population. Table 1 shows a sampling of vegetable productivity compared with the highest productivity worldwide. Except for a few vegetables, productivity in India is lower than the global average; and in all cases, it is lower than the maximum productivity that can be achieved. This low productivity is due to the lack of access to scientific agricultural advisories, timely availability of inputs, credit, weather information and farm labor (as agricultural labors are migrating to cities for better employment opportunities); and lack of agro-climatic focus in crop selection and management issues (Figure 1). Many small and marginal farmers are attempting to leave farming as the costs of production are higher than the net returns making it unprofitable.

Table 1. Comparative analysis of vegetable productivity in India and worldwide (2012–2013).

Vegetable	Highest Productivity	Productivity in India	Average World Productivity
Tomato	Spain (74 t/ha)	20.7 t/ha	32.8 t/ha
Cabbage	Japan (66 t/ha)	22.9 t/ha	27.7 t/ha
Cauliflower / broccoli	Pakistan (24.8 t/ha)	19.6 t/ha	6.9 t/ha
Okra	Saudi Arabia (13.3 t/ha)	12.1 t/ha	6.9 t/ha
Onion	Turkey (30.3 t/ha)	16.0 t/ha	19.1 t/ha
Potato	USA (44.3 t/ha)	22.8 t/ha	17.7 t/ha
Brinjal	Egypt (49.2 t/ha)	18.6 t/ha	25.0 t/ha

Source. National Horticultural Board, 2013.

Figure 1. Spectrum of challenges faced by farmers in India

Motivation

Globally, researchers are seeking solutions to problems faced by farmers and how to make farming a more profitable venture. Studies conducted by Ghoge (2013); and Gupta and Parida (2013) found that utilizing group approaches to addressing the organization and management of farm activities is an effective problem solving measure. Centralizing agricultural data and information is a key to efficient data management and processing. It helps decision makers make appropriate choices, plan agricultural activities and take preventive and curative measures as needed. ICT tools can provide an important mechanism in achieving the aim of effective data management, handling, processing and dissemination resulting in increased productivity, minimized risks, increased returns from agriculture and ultimately better living in rural areas.

ICT in Agriculture

Information and communication have always mattered in agriculture. Throughout history people have sought information from each another in order to improve efficiency. New advancements in ICT, organizing and processing large amount of data; as well as addressing and managing large farmer groups is becoming more proficient and effective.

ICT tools allow the exchange or collection of data through interaction or transmission. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. Advances in affordability, accessibility and adaptability have resulted in large scale use among rural homesteads relying on agriculture. Many of the questions asked by farmers can now be answered faster, with greater ease, and increased accuracy. These types of ICT-enabled services are useful to improving the capacity and livelihoods of poor smallholders and are growing quickly with the booming mobile, wireless and internet industries (World Bank 2011). There are a number of initiatives on the market using ICT-based innovations in agriculture. An analysis of some important advancements are presented in Table 2.

Table 2. Analysis of important ICT product and services interventions in agriculture

ICT Product / Service	Description	Communication Mode	Limitation
Reuters Market Light (RML)	▪ Provides daily information on commodities prices, weather, and advisory services ▪ Services are available in English and regional languages ▪ Network agnostic	SMS and Mobile app messages	▪ Voice messages are not available ▪ Generalized information ▪ Only market intelligence is available, lack of focus on establishing market linkages
IKSL: Indian Farmer's Fertilizer Cooperative (IFFCO), Kisan Sanchar Limited	▪ Joint venture between the telecom network operator Airtel and IFFCO ▪ Information on crops, diseases, weather, and market prices ▪ Dedicated agricultural help line ▪ Information on the availability of products such as fertilizer	Voice based service on mobile	▪ SMS and mobile apps are not available ▪ Generalized information ▪ Lack of focus on establishing market linkages
Farmer's Friend Google product in Uganda	▪ By Grameen Foundation's AppLab ▪ Weather forecasts and agricultural advice ▪ Google trading service for agricultural commodities, and other products ▪ On-demand service (pay at that time, not prepaid) ▪ Generates employment among farmers by hiring some of them for data collection	Mobile App	▪ Works with only Mobile Network Operator MTN Uganda ▪ Voice messages are not available ▪ Generalized information
Digital Green, India	▪ Disseminates targeted agricultural information to small-scale and marginal farmers through digital video ▪ Works with existing, people-based extension systems to amplify their effectiveness	Video	▪ Focus is on dissemination of best practices only ▪ Only static information
e-Choupal	▪ Price information, options for selling the produce, buy inputs at kiosk, advice on farming practices related to input use ▪ Wide spread network	Kiosk and Mobile phone	▪ Generalized information ▪ Crop specific advisory is not available
M-PESA, Kenya	▪ Pilot was focused on microloans and repayments ▪ Person-to-person business model in which customers can buy e-money from agents ▪ Perform financial transactions	Mobile Phones	▪ Only focus on financial transactions ▪ No emphasis on agriculture information and advisory
Esoko	▪ Market information service providing price information and a virtual marketplace for buyers and sellers	Mobile phones (SMS) and Internet	▪ Focus is on market only

Source. IKSL (2016); RML (2016); The Guardian (2013); e-Agriculture (2012); and World Bank (2011).

However, there are limitations with current products on the market. These include:

1. Fragmented approaches to solving challenges in agriculture

The challenges in agriculture are more or less linked. For example if someone is providing scientific agro-advisory to farmers for increasing production, it is equally important for farmers to avail the required agricultural inputs at the prescribed time—at a reasonable rate. Many models provide market intelligence information but there also needs to be a mechanism linking farmers with respective buyers or markets. These services cannot be fully utilized if farmers are not able to act upon it. To maximize the returns from agriculture, problems need to be solved in an integrated manner. A study conducted by Kumar (2011) shows (Table 3) that farmers in India are willing to pay for agricultural services from agro-advisories for market intelligence and prioritize the rankings for services.

Table 3. Priority of farm information

Type of Farm Information	**WTP**	**P &R**	**WTP**	**P &R**	**WTP**	**P &R**
	Uganda		**Indonesia**		**India**	
Package of Practices	No	5	Yes	2	Yes	1
Package of Practices (leading to certification)	Yes	3	Yes	3	NA	NA
Pest Information, Alerts & Remedy	Yes	3	Yes	1	Yes	3
Weather Forecasts & Alerts	No	6	Yes	6	Yes	4
Market/Price Information for Commodities	Yes	1	No	7	Yes	5
Access to experts in real time (farm advisory)	Yes	4	Yes	4	Yes	2
Information on Farm credit & subsidies	No	2	Yes	5	No	6

Note. WTP: Willing to Pay**;** P & R: Priority and Rank
Source. Kumar (2011).

2. Lack of Integration among Technologies (Mobile: voice, messages, GPRS; web, etc.)

A mixed approach utilizing technologies for dissemination of vital data and information is necessary to reach a maximum number of users. Kumar (2011) shows (Table 4) that the mobile use among farmers in various countries differs substantially. In India, 90% of mobile users were able to make calls, however only 12–15% can send and receive SMS; and only 2% can access the internet. The percentages vary in Uganda and Indonesia. Although the percentages may have increased in different categories of mobile uses, some users find one feature more usable than another. Further, the cost of GRPS (mobile apps) is lower than the cost of voice messages and SMS. However, GPRS (mobile apps) adaptability in farmers is not so high. A mix of technologies is necessary in order to reach a wider audience and be cost-effective. Moreover, the messaging needs to be in local/regional languages for user understandability and friendliness (Table 5). For other stakeholders (field assistants—experts—FPO management), mobile and web solutions are needed to efficiently collect, process, analyze and effectively convey this useful data and information to farmers.

Table 4. Uses of mobile phones

Activity	Percentage of users who use mobile phones for the purpose in a week		
	Uganda	**Indonesia**	**India**
Make phone calls to other mobile phones or fixed lines	72%	82%	90%
Send/Receive SMS from another user	68%	85%	15%
Conduct financial transactions	23%	12%	0%
Listen to music/radio	37%	48%	12%
Click pictures and send to another user	12%	34%	10%
Receive SMS information from operator/third party sources	18%	28%	12%
Access mobile internet (GPRS/CDMA) and 3G	4%	18%	2%

Source. Kumar (2011).

Table 5. English language capacity

Self-reported ability to read English text	Percentage of users using mobile phones for sending and receiving SMS		
	Uganda	**Indonesia**	**India**
Not at all	6%	14%	8%
Not easily	14%	20%	12%
Easily	76%	24%	12%
Prefer local language	4%	42%	68%

Source. Kumar (2011).

3. Lack of personalized and real time information

Real time information sharing between farmers and researchers enables service providers to supply real time and personalized services based on a wide range of factors such as: location, crop, management practices, mechanization level, irrigation type, farm size and soil type (Vodafone Group 2015). This allows farmers to make informed choices and take swift agriculture actions when necessary. For example in cases of cyclonic or unexpected precipitation, the real time information helps farmers to make decisions such as whether to prepone harvest by a few days, and thereby avoiding huge losses. This could protect farmers from their season-long efforts and hard work. Accenture Digital (2015) has proven that for developing countries and smallholder farmers, personalized and real time information solutions can enable them to boost field productivity by providing fertilizer, pesticide, and seed recommendations personalized for each farmer's field.

Thus, farmers need an integrated solution involving a variety of technologies. After extensive research, Tata Consultancy Services (TCS) developed an innovative ICT-based platform (PRIDE™) to support the farming community. The model is available in the local language of the user (in this study *Marathi*); and uses various modes of dissemination viz. mobile (voice messaging, SMS and GPRS enabled apps) and web modules. It also accounts for farmer plot and crop specific information, crop history, weather (past, current and forecast), market intelligence, etc. by providing personalized and real time advisory.

Objectives

The objective of this study is to examine the role that the ICT-based PRIDE model has in improving agricultural productivity, reducing production costs, minimizing risks, and ultimately increasing agricultural returns for farmers in one of the project implementation areas.

Specific objectives include:

- To digitize and process farmer, plot, crop and allied data
- To provide personalized agricultural advisories; broadcasts and alerts (weather and market intelligence) to member farmers
- To provide access to agricultural inputs, credit, and access to markets to member farmers
- To increase productivity, optimize cost on inputs, minimize the risks and thereby increase returns from agriculture

Approach and Methodology

Study Area

The selected study area (Figure 2) of thirty-seven villages falls within Dindori tehsil of the Nashik district of Maharashtra state. The economy of Dindori tehsil is primarily agrarian with 64.68% of the total population depending upon agriculture for its primary livelihood (Government of Maharashtra 2014). The total net sown geographical area of Dindori tehsil’s is 1342.19 sq. km. or 54.6%. Major crops cultivated in Dindori include: tomatoes, capsicum, grapes, wheat, and onions. The cropping pattern of these crops is depicted in Table 6.

The study area is characterized by semi-arid tropical conditions with an average annual rainfall of 697.6 mm. occurring during the southwest monsoon season (June to September) (Pagar 2012). The mean temperatures range from 23°C to 40°C. It is drained by Godavari River and its tributary Kadwa (Shodhganga 2013). The net irrigated area is around 6% and availability of water is a major problem during the hot season. Soil in this area is derived from Deccan basalt, with a pH of 7.4 to 8.2, containing less clay and silt but rich in organic matter (Shodhganga 2013).

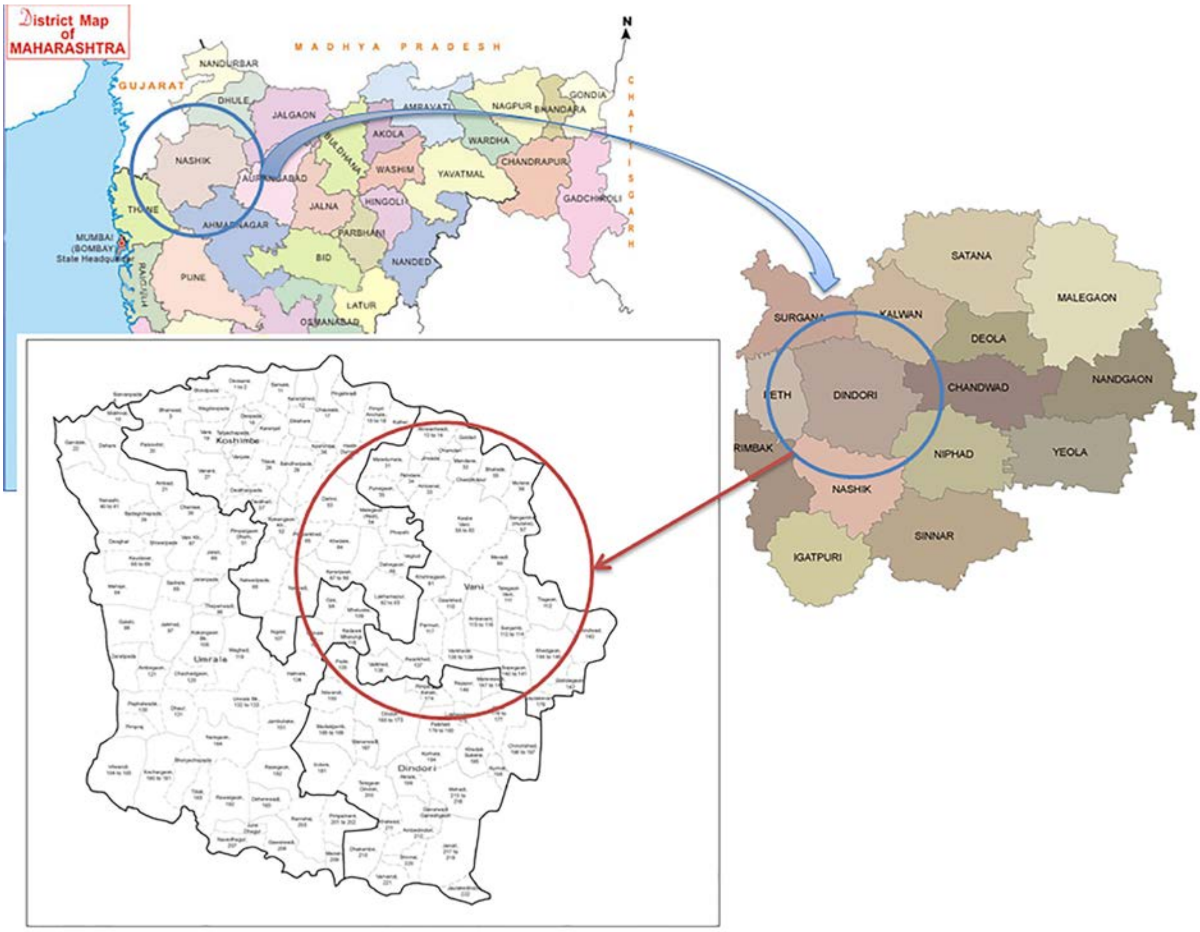


Figure 2. Study area

Table 6. Cropping pattern of major crops in the study area

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tomato	🟨	🟨			🟧	🟧	🟩	🟩	🟩	🟩🟨	🟨	🟨
Onion (Kharif)					🟧	🟧	🟩	🟩	🟨	🟨		
Onion (Rabbi)	🟨	🟨							🟧	🟧	🟩	🟩
Onion (Summer)	🟧	🟧	🟩	🟨	🟨							
Capsicum, Picador Chili	🟧	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨		
Wheat	🟩	🟨								🟧	🟧	🟩
Grape	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟧	🟩	🟩

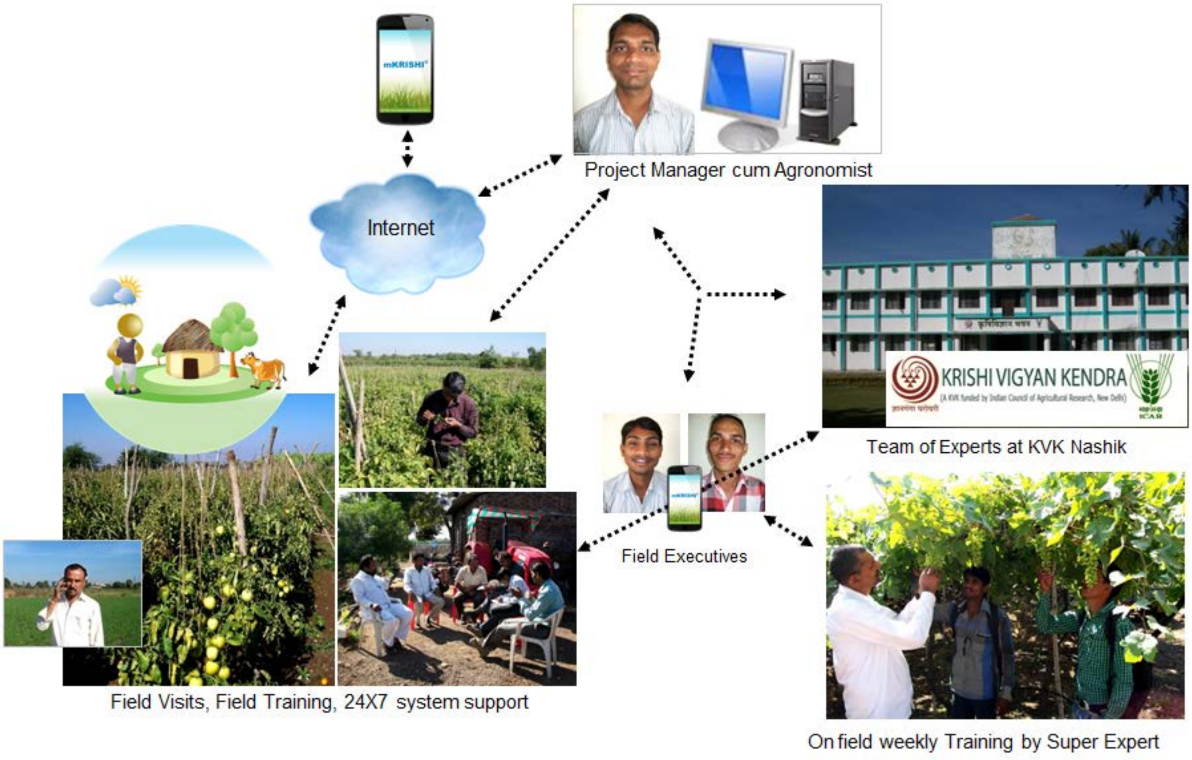
Sowing/Transplant/Pruning 🟧 Growth Period 🟩 Harvesting 🟨

Tata Consultancy Services' PRIDE™ Platform

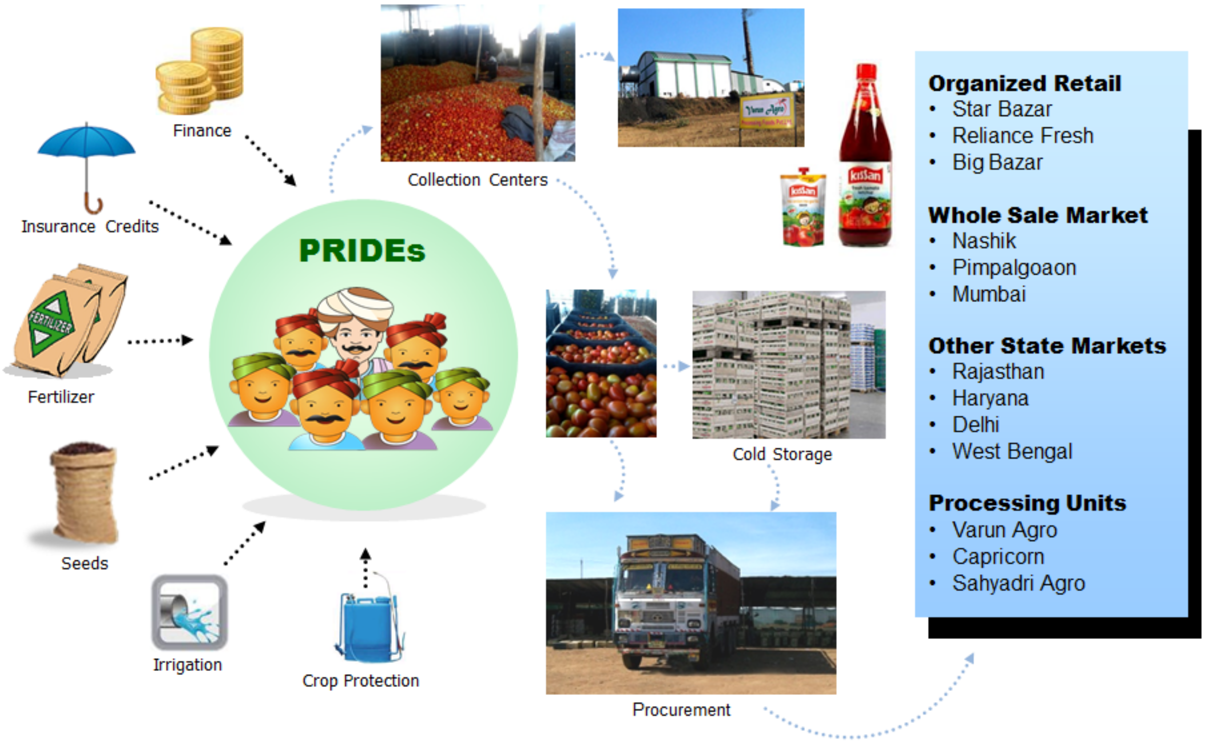
The Progressive Rural Integrated Digital Enterprise, PRIDE™, (more in Appendix 1) is an innovative business model enabling rural Indian farmers to improve farm efficiency through technological interventions (mKRISHI) and collective group management.

Farmer organizations or cooperatives convert to PRIDE through two phases. The first phase is through *Training and Capacity Building* in which farmers, farmer groups, and cooperatives are trained in the mKRISHI modules followed by the digitalization of vital information into the system through the collective efforts of the group. The second phase is the *End-to-End*

Integration in which farmers in the group are connected with external stakeholders such as experts, input firms and buyers, and so on. All transactions are performed through mKRISHI technology.



Phase I. Training, capacity building and data digitization



Phase II. End-to-end integration.

Figure 3. Phases of PRIDE Model Implementation

mKRISHI® Technology

The mKRISHI® – a patented Mobile Based Personalized Service Delivery Platform is the core technology used in the PRIDE model. This enables two-way data and information exchange between end-users such as farmers, field staff, and repositories of knowledge such as virtual knowledge banks, domain experts, input providers and procurement officers (PO). It requires professional and optimized management of resources, groupings of growers, provision of access to advisory or consultancy information, backward linkages (agricultural inputs and credit), forward (market) linkages, improving data visibility and enabling data analytics in a currently unorganized, unstructured sector. With this technology it is possible to effectively harness the power of farmer numbers under a common umbrella, coupled with a smooth flow of data and information to bring more structure into this sector (more on mKRISHI® is found in Appendix 2).

Implementation of Technology

The Farmers Producers Organization (FPO) and PRIDE envisaged using the viz. tomato for the purposes of the study since it is one of the major vegetables grown in the study region during the Kharif (monsoon) season (June–January).[1]

The Saptshrungi Farmer Producer Company Limited (SFPCL) associated with Agri Services Foundation (ASF) primarily works in Dindori tehsil of the Nashik district for the progress of farmers in the area. Prior to project implementation, farmers were facing problems related to crop productivity, availability of quality agricultural inputs and lack of access to better markets. To overcome these problems, SFPCL introduced the ICT-based PRIDE platform. Implementation started with Phase I involving awareness education regarding the technology and benefits, followed by digitization of data from the farmers and other stakeholders. Field staff associated with SFPCL trained the member farmers in technology and usage. Further field staff registered farmers on the mKRISHI system and digitized their unique profiles, including plot and crop specific details. In Phase 2, member farmers were provided personalized services at the field level and were connected with other stakeholders in the agricultural chain. These services are supplemented by occasional visits from field executives. Results of these actions are detailed in the following section.

Results and Implications

Prior to the technology implementation (years 2012–2013), farmers in the study region, were obtaining an average tomato yield of sixteen tons per acre. From 2013–2014 onwards, around 1140 farmers spread over thirty-seven villages have participated in the project. Initially they started with digitization of the farmer base, plots, crops followed by the creation of *crop protocols* (scientific crop management practices). These crop protocols are disseminated through *Interactive Voice Response* and supported by the *Agro-Advisory Module* which provides two-way communication between farmers and the agricultural experts. Farmers are further supported by occasional visits from field executives to farmers' fields. Timely *Alerts*

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[1] Tomatoes were selected as the major crop in this study region. Projects in other regions focus on major commodities including cabbage, cotton, grapes, onions, pigeon pea, potatoes, soybeans, sugarcane. We found the challenges farmers face are similar in all geographies.

and Broadcasts on forecasted weather and associated risks are also dispersed to member farmers.

In 2014–2015, SFPCL had 2162 farmers encompassing 1661 acres. Growth in productivity of tomato crops from years, 2012–2013 to 2014–2015 is illustrated in Figure 5 and Table 7. It is observed that productivity of tomato crop increased from sixteen tons/acre in the year 2012–2013 to twenty-seven tons/acre in 2013–2014; and thirty-five tons/acre in 2014–2015. Similarly, the number of farmers participating in the project has increased from 586 in 2012–2013 to 1140 in 2013–2014; and 2162 in 2014–2015. Thus, due to the personalized crop protocol, agro-advisory and timely alerts, the average increase in productivity was found to be 64% in 2013–2014; and 112% in 2014–2015. It also contributed to around a 90% increase in farmer participation in the second year.

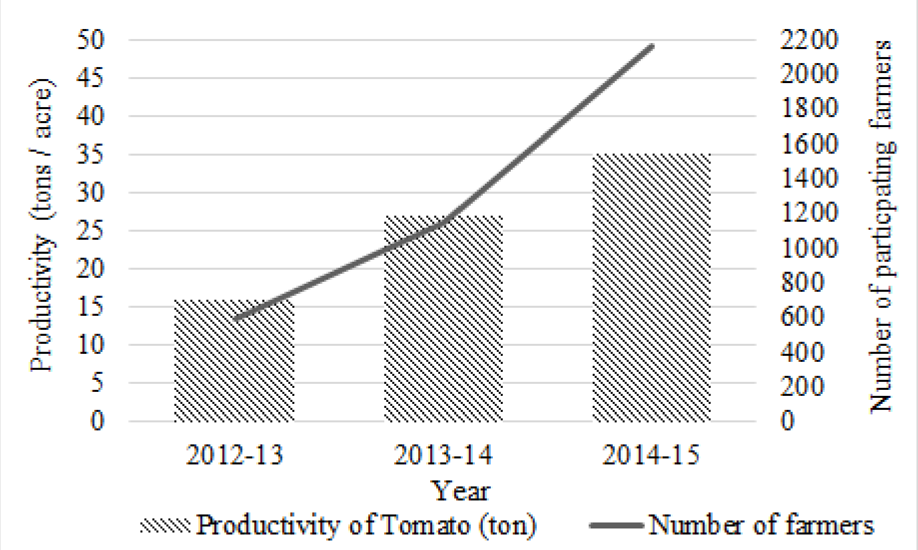

Figure 5. Growth in tomato productivity and participating farmers

Table 7. Growth in tomato area, productivity and number of participating farmers

Particulars\Year	2012–2013	2013–2014	2014–2015
Number of farmers	586	1140	2162
Area under Tomato (acre)	612	1010	1661
Productivity of Tomato (ton/acre)	16	27	35

The *Agricultural Input Management* module facilitates agricultural input requests from member farmers, aggregates the requests and communicates with the agricultural input providers. This results in larger group demand for agricultural inputs and associated optimizations on the costs incurred by farmers for inputs. It also helps input suppliers to plan their production and distribution activities accordingly. The member farmers are collectively ordering the agricultural inputs using this module and benefiting by purchase of quality inputs at reasonable prices at their door step. The outcome of this module combined with crop protocol, agro-advisory services, and weather alerts, resulted in optimizing the cost of production. Reduction in cost ~USD 227.38 per acre for tomato crop was observed in 2013–2014.

An essential implementation activity by SFPCL is the collective marketing of agricultural produce to agro processing companies and markets. This step is easy because all relevant data and information is stored within it. Farmers acquire the *market intelligence* from the system and accordingly plan when to harvest produce. Member farmers raise sell requests through the *Harvest Management Module* and communicate their plans for the harvest and sale of produce. Accordingly, SFPCL collects the harvested tomato from its member farmers, undertaking proper grading and sorting and finally marketing the aggregated produce to nearby processing industries and markets. Buyers registered on the system equally benefit as they receive requisite quantity and quality of produce directly from farmers. The SFPCL has established marketing agreements with two tomato processing companies in the area. Member farmers collectively market their produce at prevailing market rates, without any dependency on intermediaries. The system is also helpful for SFPCL in maintaining finance, audit and compliance at an organizational level, including bulk financial transactions.

Conclusion

Efficient data collection, management and its further use at the right time and with the right user base will help the agricultural community as a whole. The innovative PRIDE model has proven success in its pilot in Nashik district of Maharashtra with SFPCL. It helped farmers follow scientific crop management practices, receive correct and timely agricultural advice from experts, timely weather alerts to minimize associated risks, and collective demand for inputs and sale of the produce thereby increasing the returns from agriculture. The benefits of the model are not limited to the farmers only but to the other stakeholders involved in the agricultural chain which are agricultural input providers, agricultural processing companies, buyers, and so on. All this is possible because of mandatory data collection, effective organization, processing and efficient dissemination through the use of mKRISHI technology. Further it creates employment opportunities in rural areas (field staff, experts, and project managers).

This model is holistic, scalable and very promising for sustainable agriculture which leads to empowerment and growth of rural India. It caters mostly of the needs of various stakeholders involved in the agricultural namely farmers, service providers, researchers, extension workers, processers and market stakeholders.

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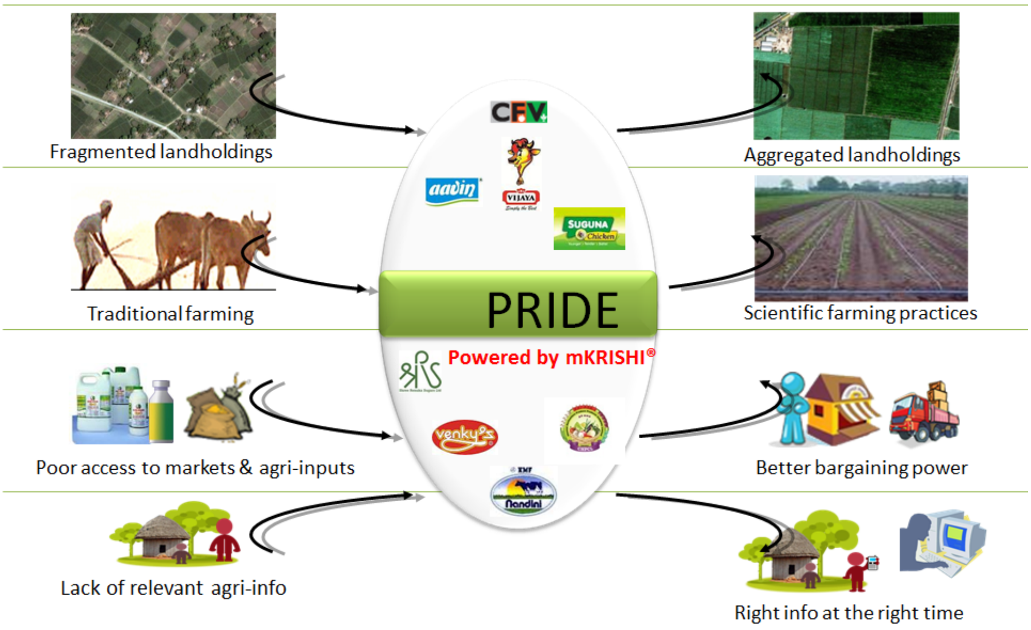
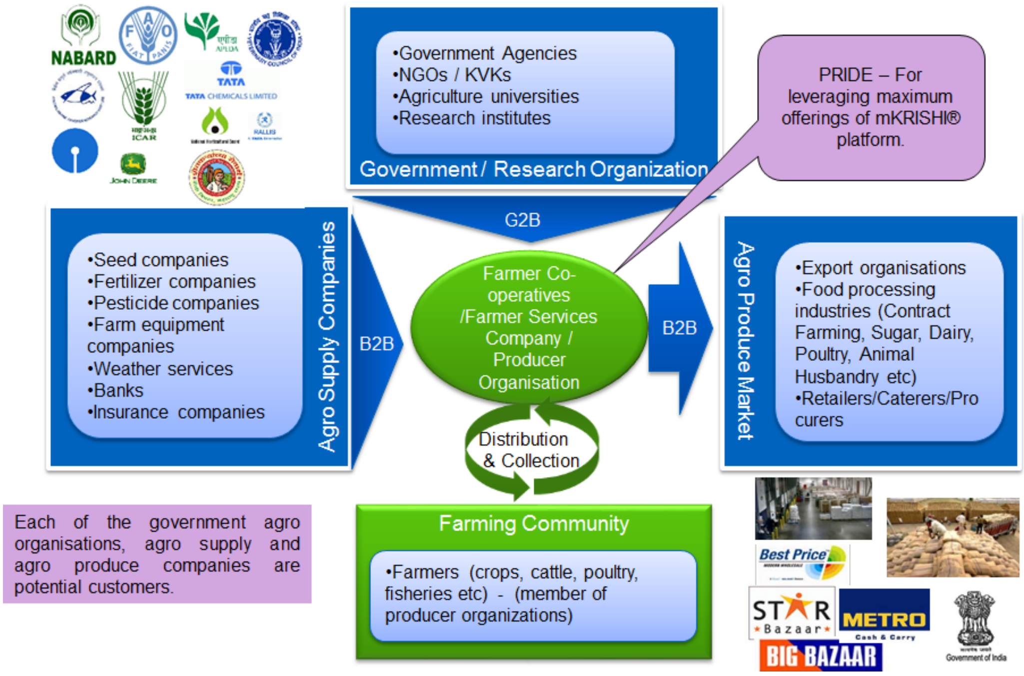
Appendix 1

PRIDE™ is powered by Tata Consultancy Services' mKRISHI technology. The model is primarily based on the agricultural data and information collected from farmers' fields, agricultural universities and research organizations, weather data, nearby markets, inputs suppliers, etc. Data collected from farmers includes basic, financial, family and other socioeconomic details; plot details, property location, history; soil and water test results; crop details; etc. All collected data and information is processed and converted into meaningful agricultural advice, alerts, and broadcasts transmitted to the respective users.



(a) Bridging the Gap



(b) Partners and collaborators

Appendix 2

Features of mKRISHI Technology

mKRISHI is a business solution combining the technologies of big data, Geographic Information Systems, analytics and mobile apps for enterprise management.

- Stakeholders registration and data management
- Agro-advisory
- Best practices
- Alert and broadcast services
- Weather forecast, reporting feature
- Agricultural input management
- Market intelligence
- Agricultural supply chain management services