MARKET PROVISIONING OF TECHNOLOGY-ENABLED AGRICULTURAL SERVICES IN INDIA

Context

Farmers in India, especially smallholders, face a number of challenges that make their income streams low and unreliable. These include: (i) low productivity due to degradation of soil quality, insufficient water, poor quality of inputs, poor production practices, pest and disease attacks and insufficient access to tools and implements; (ii) shortage of formal credit to purchase inputs in part because of transaction costs and perceptions of repayment risks of formal lenders; (iii) climate variability leading to low productivity and wastage of inputs and produce (such as unexpected rains washing away fertilizers or ruining crops); (iv) market risks including price volatility and not availing the best market price available; (v) lack of storage facilities or processing to realize higher incomes; and (vi) inefficient business processes of farmer producer organizations (FPOs) leading to difficulties in offering collectivized services to their members. All of the above combine to make smallholder farming a risky business that generates losses all too often.

Small farm sizes, low incomes and declining last-mile extension services by the government prevent farmers from investing in productivity enhancing technologies thereby increasing the chance that they stay in a poverty trap. Low willingness and ability to pay has deterred private provisioning of services. However of late, entrepreneurs and investors seem to be convinced that there are enough efficiency gains to be had for them to profitably provide income enhancing services that address the above challenges.

In this context in recent years, a slew of start-up companies have entered the agriculture sector with a fee-based revenue model alongside leading technology firms like Microsoft, IBM and Google. Armed with technology, data analytics capabilities and risk capital, these agritech firms[1] provide a range of services to farmers from input sales and conventional cropping advisories, to hiring out farm implements and sales. For farmer collectives and for institutional buyers, farm Enterprise Resource Planning (ERP) software are being used for automation across the value chain and for traceability. Finally, some forecast weather, pest and disease attacks and yield and loss estimates, automate optimal irrigation and provide intelligence on borrowers' creditworthiness and claims payouts to banks and insurers. There are around 450 agritech firms in India today; of these 35 were started in 2018 alone. Venture capital is rapidly increasing and total investments jumped up from US$73 million in 2018 to US$248 million in 2019 (as of July). A NASSCOM report states that about half of the agritech CEOs interviewed expect that one of the firms in this space will reach a valuation of US$1 billion within the next three years[2].

This note explains the services offered by these firms and provides a perspective on these services based on experiences in World Bank projects and stakeholder interviews.

> *"Armed with technology, data analytics capabilities and risk capital, agritech firms provide a range of services to farmers from input sales and conventional cropping advisories, to hiring out farm implements and sales"*

1. There appears to be no clear definition or categorization of agritech services. The National Association of Software and Service Companies (NASSCOM) report includes Samunnati's lending to farmer collectives and DeHaat's selling of input and outputs under agritech though neither uses any specialized technology that is core to their business. Agritech can be broadly denoted as private provisioning of goods and services to stakeholders in the farming ecosystem, using better organization and software to formalize or modernize the sector or using analytics and prediction technologies.
2. NASSCOM Report, "Agritech In India: Emerging Trends in 2019", July 2019

Interventions

Market-provisioned technology-enabled agricultural support services. The table below summarizes the technology-enabled agricultural support services offered based on the type of service and illustrative providers. Most of the expansion appears to be in the marketing space based on the number of players and marquee investments made. Services are classified into three categories based on the level of technological complexity of the solution offered: (i) conventional services, (ii) newer services using mature technologies, and (iii) advanced analytics based services.

Type	*Specific services*	*Selected providers*[3]
Inputs and cropping advisory and forecasting services	*Sale of quality inputs* *Advisory on inputs, crop selection, package of practices, pest and disease remedial action* *Weather forecast to schedule farmer operations better* *Pest and disease attack forecast and protection advisory* *Predicting sowing and harvesting windows* *Forecasting crop health and yield*	*Agrostar* *Weather Risk Management Services* *Satsure* *IBM* *Vassar Labs* *Farmguide*
Marketing and sales	*Identify and negotiate with buyers*	*DeHaat* *Ninjacart*
Enterprise resource planning (ERP) software for FPOs	*End-to-end cropping planning to sales automation software for FPOs, and farm contractors*	*Cropin* *FarmERP* *SourceTrace*
Credit and insurance	*Inform lenders of creditworthiness of a farmer; estimate crop health and yield and hence repayment risks to lender* *Remote sensing of cropping area and losses for insurers to make payouts*	*Impact Micro Ventures* *Aye Finance* *Credit Vidya* *Think Analytics*
Precision irrigation	*Detect soil moisture and recommend/ automate ideal amount of water to be released*	*Avanijal* *Conserwater*
Farm implements	*Rent farm tools from Custom Hiring Centers*	*Oxen* *Goldfarm* *Trringo* *Kethinext* *Agribolo*

3. Most of these providers offer services in multiple categories. Disclaimer: the Bank does not endorse any of these companies.

Image Credit : Rohit Jain

Conventional services using software and Information and Communication Technology (ICT) channels.

- ***Inputs and cropping advisory:*** These include SMS and voice-based advisory on crop selection and production practices along with sale of the recommended inputs and package of practices reminders that are sent through SMS on the phone.
- ***Pest and disease protection advisory:*** Farmers or community extension workers are provided with a mobile app to take a photo of the affected plant and send it to a back-end agri-specialist who diagnoses and recommends remedial action by phone call or through the app.
- ***Marketing and sales:*** The provider negotiates with buyers based on the harvest date and amount, and offers a price to the farmer in exchange for a commission. They further organize collection centers for sales after harvest. They also recommend good inputs and procure and distribute the same to farmers. The provider uses software for demand aggregation and logistics.
- ***Farm tools rentals:*** These often use Uber-like apps for hiring farm implements.

Newer services using mature technologies.

- ***Weather forecast-based advisories:*** Providers forecast rainfall and temperature 24 hours to 15 days in advance, downscaled to block or sub-block levels and advise farmers to schedule farm operations better (such as harvest a few days earlier before a thunderstorm destroys the crops). This has been enabled by use of satellite data, installation of automated weather stations and improved forecasting algorithms.
- ***Precision irrigation automation:*** Plants need a certain amount of soil moisture at different cropping stages. Providers use satellite data or field-installed sensors to determine current soil moisture and use weather forecasts to determine the ideal amount of irrigation. Internet of Things[4] (IoT) controllers help release the right amount of water from the irrigation source to maintain ideal soil moisture for a given crop.
- ***Farm ERP software:*** This is end-to-end software which can help an FPO or the principal in contract farming arrangements to manage the entire value chain from crop planning, inputs supplies, credit needs, sowing and harvest dates, logistics, sales, invoicing and payment through to accounting. It has the potential to help an FPO or buyer to monitor and manage a large number of member farmers where manual processes would be too difficult. It can also provide traceability of food through the value chain.

Advanced analytics based services.

- ***Predicting sowing window:*** Recommending the ideal sowing window that would maximize yield based on historical sowing and yield data as well as weather forecasts.
- ***Estimating farmers' sown area, current crop health and yield at the end of the season:*** Using historical data and satellite imagery, providers make available intelligence to: (i) inform lenders about the creditworthiness of a farmer; (ii) recommend the ideal repayment schedule for the lender's loan collection officers; (iii) alert an institutional buyer in case the contracted quantity of yield may not materialize; and (iv) estimate yield to inform crop insurers the extent of losses and hence the claim payout amount.
- ***Automated diagnosis and prediction of pest and diseases:*** The provider receives the photo which is fed into a classification model that diagnoses and prepares an advisory. Additionally, based on the location, weather conditions, soil and water conditions, the forecasting engine can predict an imminent attack and warn the farmers through SMS.

4. IoT is a network of "smart devices" that can sense and interact with their environment by means of the Internet for their communication and interaction with users and other systems. In this context an irrigation IoT system will enable automated operation of pumpsets.

Potential clients. The table below lists the types of clients and how they benefit from Agritech services.

Public, private, small banks, NBFCs	*Borrower risk assessment and repayment collection intelligence to banks*
Public and private insurers	*Yield loss estimates to insurers largely of PMFBY to settle claims*
Government	*Departments of agriculture, horticulture, rural development and farmers who received individual advisory*
Direct to farmers and FPOs	*Farmer pays for inputs supplies and crop advisory is delivered through phones as SMS or through an app*

Key Learnings (Assessment of the sector)

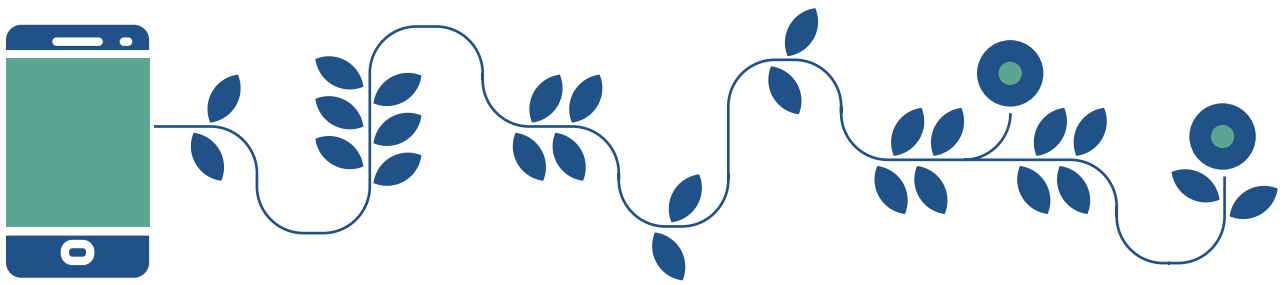
The sector is in a rapid growth phase. Agritech providers are profit-seeking firms operating on commercial principles and are funded by venture capitalists. While some earn user fees from farmers, others get paid by the government, buyers, insurers and lenders. Investors are interested because: (i) the agriculture market size is large, (ii) portfolio companies make regular earnings and the burn rate is moderate, (iii) there are large institutional customers like lenders and insurers, and (iv) low mortality rates of 10%–20% of these start-ups.

Multiple enabling factors. A combination of high penetration of mobile phones and data, free or cheap satellite data, and skills in machine learning[5] and artificial intelligence[6] as well as capital and interest of sophisticated human resources that apply modern business practices, has enabled providers to develop forecasting models and deliver advisories to farmers electronically at a lower cost compared to field extension services and with less reliance on scarce agriculture experts.

Sizeable early outreach. Aggregated sectoral outreach figures are not readily available. However, as the table below shows, the outreach of these services are considerable, well above pilot figures, and include high-profile projects and stakeholders.

Both mature and cutting-edge technologies are being used. For example, a large part of venture capital investments is given to marketing and sales service providers. They simply organize (without using modern technology) this part of the value chain (which was formerly largely in the informal sector) into the formal sector professionally using sophisticated staff.

Potential farmer impact. A randomized controlled trial of mobile based advisories delivered by Avaaj Otalo[7] found that the demand for advice was high and the intervention was impactful. It increased the farmers' yield of cumin (28%) and cotton (8.6%, for a sub-group that received the



5. A class of techniques that enable a computer to do well, things which are difficult for humans, such as playing the game Go.
6. A class of techniques that enable a computer to do well, things that come easy to humans, but have previously been a struggle for computers such as identifying a cat in a picture.
7. This is a mobile phone-based technology that allows farmers in India to call a hotline, ask questions and receive responses from agricultural scientists and local extension workers.

reminders). An assessment of Manna's precision irrigation interventions in demo plots found large (>50%) increases in yields of fruits and vegetables[8].

Benefits to lenders and insurers. Better assessment of credit risk and loan monitoring helps banks target borrowers better and optimize repayment collections. This has the potential to enable private and public lenders to profitably cover more poor farmers. Correct and lower loss estimates can enable insurers to make correct and timely claims payouts to insured farmers.

Provider	Outreach
Satsure	• Lending intelligence to ICICI Bank's 100,000 customers • Loan monitoring of ICICI Bank's INR 18,000 crore portfolio • Loss estimates for settling 73,000 Pradhan Mantri Fasal Bima Yojana (PMFBY) crop insurance claims by various insurers • Leading public and private crop insurers are using satellite data from analytics firms to estimate yield loss as per PMFBY guidelines
Vassar Labs	• Providing yield-increasing advisory through Multipurpose Extension Officers of the Department of Agriculture, Andhra Pradesh in a command area of 18,000 villages with 5 million farmers having varied land sizes
IBM	• Piloting farmer advisories through Krishi Vigyan Kendras (KVKs), including soil moisture, crop health and yield estimation, market price forecasts in 5 districts through Karnataka state's agriculture department
Agrostar	• Several lakh farmers directly pay for agro advisory services, package of practices, and inputs through a call center delivery mechanism
Cropin	• Weather, pest and cropping advisories to 8,000 self-help group member farmers in Bihar and Madhya Pradesh, and to 30,000 farmers in Jharkhand
Weather Risk	• Sells income guarantee product to farmers directly conditional on farmers adoption of recommended package of practices

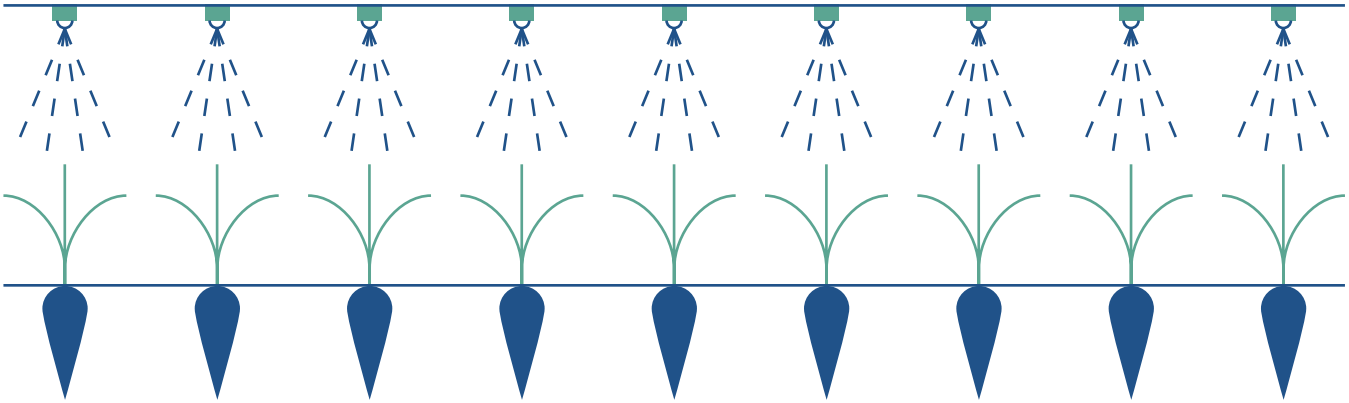
Way Forward

Technology-enabled agricultural services are very welcome development, with the private sector offering a valuable service to large numbers of neglected poor customers. However support is required for this sector to survive, grow and deliver income-enhancing services to farmers.

Support from government and funders: Not all providers have comprehensive domain knowledge or viable models to work with poorer farmers who are of particular interest to the development sector. Hence more engagements with government subsidized projects to service low income farmers, already aggregated

Image Credit : Rohit Jain

8. World Bank internal presentation.



into collectives will enable providers to gain experience of servicing smallholders profitably at a lower unit cost due to economies of scale and lower cost of client acquisition. As the initial willingness of farmers to pay is likely to be lower than the benefits, these government subsidized projects will help farmers test out and experience the value of these services to decide if they want to pay out-of-pocket after the project period.

Data availability to speed up forecast services: Availability and access to data is a major constraint. For a provider to predict, for example, when a pest will attack, it needs "training" data on past cropping practices, prevailing conditions and incidences of attacks from that pest to prepare a forecasting model. However, lack of access to such data is preventing providers from preparing more accurate models for more crops. Such data are available with agricultural universities and government departments and should be made available publicly.

Hype cycle: There is an over-promising of the accuracy levels of forecast-based services and a shortage of accuracy disclosure. Studies are needed to measure the accuracy of services, and develop common terminology and performance benchmarks for customers to gauge the quality. There is hardly any documentation on the effectiveness of these services.

More clarifying reports that demystify these services and illustrate the specific use cases through which agritech services will benefit the ecosystem will speed up understanding of this sector by potential clients. Carefully done evaluation studies will help make the benefits and use of cases clearer.

Data privacy: Government laws place restrictions on some providers from storing farmer level data on their servers, which makes data integration and hence delivery of services more difficult. In these cases it would be helpful to relax the restrictions and place other privacy protection policies so that farmers can be benefitted.

ABOUT THE DISCUSSION NOTE SERIES

This note is part of the South Asia Agriculture and Rural Growth Discussion Note Series, that seeks to disseminate operational learnings and implementation experiences from World Bank financed rural, agriculture and food systems programs in South Asia.

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Publication Design & Illustrations: Parth Varshney

We are grateful for the generous support from DFID.

WORLD BANK GROUP Agriculture

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