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Digital platforms for connecting actors in the agtech space: insights on platform development from participatory action research on KisanMitr

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Received 24 April 2021
Revised 16 September 2021
14 October 2021
Accepted 16 October 2021

Abstract

Purpose – This paper aims to explore the development of digital platforms in agtech space as a mechanism to mitigate the disconnects among the various actors in the innovation, business and entrepreneurship and extension ecosystems that impede the journey of technology from labs to farms. It does so by tracing the birth and evolution of KisanMitr, an agriculture digital platform created in India.

Design/methodology/approach – The research follows a participatory action research approach.

Findings – Digital platforms can be useful for integrating varied actor groups, in particular by facilitating the open flow of information among actors, and thus bringing to light the ways in which they can collaborate.

Practical implications – The paper demonstrates that digital platforms can become the backbone of integrated agricultural innovation systems, just as in the high-tech industries. Greater information flow enabled by such platforms allows the actors to collaborate more effectively. However, it is necessary to maintain farmer-focus, undertake off-platform activities to facilitate mutual engagement among actors and watch for potential governance issues if these platforms were to make a true impact for farmers.

Social implications – KisanMitr was initiated with the motive of helping the Indian farmers, especially the reverse migrants during the COViD-19 pandemic, specifically for increasing the range of technology options available to them to make agriculture a viable livelihood option.

Originality/value – KisanMitr platform is one the first of its kind in India and in the agricultural sector. Unlike the digital platforms developed by private corporations, it was created by a government agency.

Keywords Entrepreneurship, Innovation, Farmers, Extension, Digital platforms, Agriculture technology

Paper type Research paper

Introduction

Agriculture is the primary source of income for 58% of the Indian population (Indian Agriculture and Allied Industries Report, 2021). The average monthly income of agricultural households is as low as Rs 6,426 (Economic Times, 9 February 2021), often triggering

The authors thank Nagaraja (Naga) Prakasam and Dr Kalpana Sastry for their insights and support. The authors thank Biswa Prakash Jena for the excellent research assistance.

Journal of Indian Business Research
© Emerald Publishing Limited
1755-4195
DOI 10.1108/JIBR-04-2021-0145

rural-to-urban migration. The reverse migration during the COViD-19 pandemic reaffirms the need to transform agriculture into a viable livelihood option for the rural Indians. It is argued that this will require farmers to become "agripreneurs", i.e. agriculturists with an entrepreneurial mindset (Singh, 2019; Uplaonkar and Biradar, 2015). A key aspect that differentiates agripreneurs is how they incorporate science and technology solutions into farming practices, generating value-added products that would move them up in the value chain. With such a transformation, the Government of India hopes to achieve an ambitious goal of doubling farmer incomes by 2022 (Chand, 2017).

Many changes in the Indian agricultural sector in the past decade were driven by this vision of converting agriculture to agripreneurship, in particular, by means of technology. Both public and private sectors promote agtech (Indian Agriculture and Allied Industries Report, 2021). In the public domain, many government-funded institutions that conduct fundamental research and develop technologies for agriculture and allied sectors (such as 100+ research institutes under the Indian Council for Agricultural Research (ICAR), 71 state agricultural universities, the Council of Scientific and Industrial Research (CSIR) funded labs, Indian Institute of Science, Indian Institutes of Technology and the other engineering colleges) have Technology Management Cells to facilitate commercialisation of technology via patenting and licensing (Sheth *et al.*, 2019) and more recently, incubation facilities to support technology start-ups. In the private sector, many start-ups that offer solutions based on biotechnology, artificial intelligence, internet of things and data analytics have been set up in the past 5 years (Menon *et al.*, 2020), with the support of incubators and accelerators in both private (e.g. Villgro and Indigram Labs Foundation) and public sectors (e.g. Association for Innovation Development of Entrepreneurship in Agriculture and PUSA Krishi). Large chunks of the public, philanthropic, developmental and private investments are directed towards funding such initiatives (Farm Tech Investing Report, 2020; Indian Agriculture and Allied Industries Report, 2021).

Such efforts are supposed to make technology more accessible to the farmers on the field, and help them turn into agripreneurs. This transition has been slow, however. Large sections of farmers, even today, have access only to basic fertilizers or pesticides and are still far from being able to access scientific, deep technology-based solutions. A key reason for this is thought to be the disconnectedness among the actors in the related ecosystems, that impedes the journey of technology from labs to farms.

In this paper, based on participatory action research on KisanMitr – a digital platform introduced for the purpose of connecting the wide range of actors in the agtech space – we share our insights on how digital platforms can be developed to address the above disconnects and promote mutually beneficial engagement among the relevant actors. Here, we build on the literature on innovation, entrepreneurial and agriculture ecosystems that are, thus, far discussed within the respective disciplinary siloes (Granstrand and Holgersson, 2020; Oh *et al.*, 2016; Pigford *et al.*, 2018) and contribute to the emergent literature on digital platforms (Jovanovic *et al.*, 2021) by illustrating how they can become mechanisms for integrating disparate ecosystems into an agtech ecosystem that ultimately benefits the farmers.

Background literature

Taking agtech to farms – ecosystems and actors

Successful incorporation of agtech into farming requires three categories of activities: firstly, creating appropriate technology, secondly, making the technology available in the market as products and services and thirdly, getting the farmers to adopt the agtech products and services. Historically, the academic literature on these three categories of activities has evolved separately as part of three different disciplines, namely, innovation, business/entrepreneurship and agricultural studies (Granstrand and Holgersson, 2020; Pigford *et al.*, 2018; Stam and van de Ven, 2019). However, interestingly, the conceptualisations in all three disciplines use the notion of "systems". In a generic sense, the term "systems" is used to denote the range of actors and institutions required to bring each of the above sets of activities to fruition (Oh *et al.*, 2016; Pigford *et al.*, 2018; Stam and van de Ven, 2019).

In innovation studies, the idea of "systems" began to appear from the late 1980s and early 1990s with the research on national, regional and sectoral systems of innovation (Oh *et al.*, 2016). Systems here means innovation networks and communities, comprising actors who create or enable innovations, including universities, research institutions, government agencies, funders, non-governmental organisation (NGO)s and policymakers (Granstrand and Holgersson, 2020). In the past 15 years, the term has evolved further and is now called "ecosystems", slightly widening its scope to also include actors supporting entrepreneurial/business activities (Granstrand and Holgersson, 2020), such as start-ups, business firms, venture capitalists, incubators/accelerators, financial institutions and business schools (Jackson, 2011).

In business and entrepreneurship literature, the notion of "ecosystems" had made its appearance from the 1990s. It refers to the actors and factors that enable or constrain entrepreneurship/business in a particular geography (Stam and van de Ven, 2019). The actors and institutions that are part of entrepreneurial ecosystems are understood to be co-evolving, interdependent and embedded in a complex nested hierarchy (Hawley, 1950; Stam and van de Ven, 2019), while being vested in the processes of exploring, evaluating and exploiting the opportunities for creating new products and services (Schumpeter, 1934; Shane and Venkataraman, 2000). The research, however, has tended to focus narrowly on high-growth start-up ecosystems as in Silicon Valley and Route 128 (Kenney and von Burg, 1999).

In agricultural studies, notions of "ecosystems" featured since the early 2000s (Cook *et al.*, 2021). While its theoretical roots can be traced partially to the national systems of innovation literature, much of it emerged from agriculture technology transfer and extension literature. In contrast to the unidirectional technology transfer approach since the 1960s that viewed farmers as passive recipients of technology, the current ecosystem approach regard the farmers are co-creators of technology and calls for holistic Agriculture Innovation Systems, integrating all relevant actors, namely, research institutions, government departments, NGOs, local trainers, farmer groups, etc (Cook *et al.*, 2021).

Implications of disconnects between actors

It may not be hard to appreciate that an agtech ecosystem aimed at bringing scientific research to farms in the form of commercially available products and services will have to effectively integrate the innovation, business/entrepreneurial and extension ecosystems. A key challenge here is that each ecosystem comprises different actor groups and institutions, who vary in their goals, motivations and approaches (Jackson, 2011). As a result, disconnects occur where these actors are supposed to collaborate, hampering the progression of technology from labs to farms. In this paper, we focus on two specific disconnects: Firstly, the disconnect between the actors in the innovation ecosystems and those in the entrepreneurial/business ecosystems that prevents the successful conversion of scientific research to commercial products and secondly, the disconnect between the actors in the innovation and entrepreneurial ecosystems and those in the extension ecosystems that impedes technology adoption by farmers.

The first disconnect occurs because of the lack of sufficiently developed mechanisms for research-industry collaboration. Compared to the university-industry collaboration systems in the USA, Europe and other developed countries, the systems in India lag considerably behind (Joseph and Abraham, 2009; Kumar and Gupta, 2017; Rupika *et al.*, 2016). The absence of exclusive licensing options often dissuades the corporate actors from engaging with the research labs, and instead makes them rely on their own research and development (R&D) capabilities (Joseph and Abraham, 2009). To mitigate this, there has been a thrust on setting up commercialisation and incubation facilities in research institutions themselves (Kumar and Gupta, 2017). However, due to the lack of inclination, incentives and/or skills on the part of academic researchers, this is yet to show results (Joseph and Abraham, 2009; Rupika *et al.*, 2016). Many feel that entrepreneurial actors are much suited for this job. Nonetheless, because of the historical disconnect between the research scientists and the commercial sector, the industry rarely gets to know of the technologies under development in the research institutions (Rupika *et al.*, 2016). As a result, promoters of start-ups end up developing solutions based on their own technical expertise or past experience in the corporate sector R&D and hardly turn to the research institutions for solutions. Consequently, a large proportion of the technologies developed in the Indian research institutions are not developed into products (Rupika *et al.*, 2016).

A similar disconnect exists between the producers of technology products and the farmers. Farmers are known to be slow adopters of technology for multiple reasons, including appropriateness of technology, financials involved, etc (Swanson, 2008). Traditionally, agricultural universities and departments conducted extension programmes to educate farmers on the new farming methods and technology (Cook *et al.*, 2021). Krishi Vigyan Kendras, NGOs and more recently private sector foundations work closely with the farmers to help them choose and adopt technology (Gulati *et al.*, 2018; Nedumaran and Ravi, 2019). While many of these extension actors find it easier to connect with the progressive farmers and farmer collectives such as cooperatives and Farmer Producer Organisations (FPOs), the fact remains that the vast majority of the Indian farmers are small and marginal (Swanson, 2008). In India, technology is often not developed in consultation with such farmers, responding to their specific needs (pull approach), but thrust upon them at the end (push approach). Despite the intentions, mechanisms to integrate farmers into technology and product development are still largely lacking (Cook *et al.*, 2021).

Integrating ecosystems – how can digital platforms help? A recent solution that industrial manufacturers have embraced to better integrate ecosystem actors is that of digital platforms (Jovanovic *et al.*, 2021). Creation of digital platforms is typically undertaken by a central actor (a "platform sponsor" or "platform leader") who opens up the platform to "complementor actors", including technology providers and intermediaries (Hilbolling *et al.*, 2020). Although the central actors create the digital platforms to advance their strategic objectives, such platforms are also meant for the other member actors to connect with each other, leverage their capabilities and work collaboratively towards improving their own innovation and financial performance (Jovanovic *et al.*, 2021; Zahra and Nambisan, 2011). A widely cited example is that of Apple's digital platform, which hosts a broad range of start-ups and small firms, where the member actors contribute not only to Apple's product development but also pursues their own innovations with the help of the other actors (Granstrand and Holgersson, 2020; Zahra and Nambisan, 2011).

Digital platforms for the purpose of ecosystem integration as above are yet to make a foray into the agricultural sector. However, time for that might be ripe, with the recent discussions on agricultural innovation systems (AIS) that enable multi-actor, cross-sectoral collaborations (Pigford *et al.*, 2018). AIS is inspired by the innovation ecosystem literature

(Kilelu *et al.*, 2013; Schut *et al.*, 2016), but broader in its scope. The traditional business innovation ecosystems and integration platforms tend to restrict their membership to mainly innovation and market actors; AIS, in contrast, invites extension actors and farmers as well to be its members (Pigford *et al.*, 2018). Further, AIS literature is more mindful of the power hierarchies among the actors (Pel, 2016; Duncan and Pascucci, 2017; Späth *et al.*, 2016) and insists on more egalitarian ways of mutual engagement (Cook *et al.*, 2021). Agricultural innovation platforms of this nature have recently been experimented with in different parts of the world (Devaux *et al.*, 2018), however, they have rarely been predominantly digital.

Although technology platforms are sometimes used to support some activities of actor sub-groups (e.g. mobile technology in agricultural extension, Swanson, 2008), digital platforms that encompass actors in all three ecosystems, namely, innovation, business and entrepreneurial and extension, are yet to emerge in the agricultural sector. As a result, little is known about the process of developing such platforms. The purpose of this paper is to address the above research gap. This paper traces the birth and early stages of the growth of KisanMitr – a digital platform from India. KisanMitr aims to connect the entire range of actors involved in taking technology from labs to farms and overcome the disconnects outlined earlier. We hope that the insights from this paper will contribute to building a knowledge base on developing digital platforms as an integrative backbone in the agtech space.

Methodology

This research focusses on the case of KisanMitr, an initiative launched by the Office of the Principal Scientific Advisor, Government of India. To the best of our knowledge, KisanMitr is among the first of its kind worldwide for agriculture-related ecosystems integration, and therefore makes an ideal setting to draw early lessons from (Eisenhardt, 1989).

We followed participatory action research methodology (Whyte, 1991) in conducting our research. Participatory Action Research is a form of applied research following Action Research principles, originating from the works of Kurt Lewin (1946) and the socio-technical systems research of Trist and colleagues (Trist, 1976) at Tavistock Institute, UK (Susman and Evered, 1978). Action Research aims to attain the twin goals of solving practical problems and generating theory simultaneously (Rapoport, 1970). It takes a cyclical approach that encompasses progressive phases including diagnosing, action planning, action taking, evaluating and specifying learning (Susman and Evered, 1978). Participatory Action Research is a variant of Action Research that places emphasis on the collaborative engagement of practitioners and researchers in realising its twin goals (Whyte *et al.*, 1989). Staying true to this idea, one of the authors of this paper is a practitioner closely associated with conceptualising and implementing the KisanMitr initiative and the other is an academic who came on board from the start as an action research partner.

Participatory action research entails data collection integrated into the intervention itself and relies on a range of data, collected in a variety of manners (Susman and Evered, 1978). In our case, the embeddedness of both authors in the initiative allowed collecting data on an ongoing basis as the project unfolded. Both authors participated in all meetings with all relevant actors right from the very beginning and the other actors were informed of the roles of the authors in the initiative. The authors were copied on all email correspondence between the actors. The academic researcher conducted interviews with individual actors to capture their experiences, concerns and suggestions. Extensive notes of the interviews and meetings were kept by the academic researcher. Status update reports and presentations were prepared on a regular basis to track the turns that the initiative took and the milestones attained. All the above formed the raw data for this paper.

The data analysis was done using a general inductive approach, as outlined by Thomas (2006). The analytic strategy was guided by the evaluation objective of distilling the learnings from the initiative and focussed on inductive teasing out of insights from multiple readings and interpretation of the raw data. The aim was to arrive at thematic categories that can form a coherent model or framework that sheds light on the evaluation objectives. Firstly, we coded the activities that were undertaken as part of the initiative, which we found pertained to three major categories, namely: actors, technologies and the digital platform for connecting them. Next, we explored the activities under each of these categories deeper and found that they had evolved over time as expected in an action research initiative. We paid closer attention to how they evolved, with the objective of uncovering patterns. Drawing on the guidance of Langley (1999) and Langley *et al.* (2013), we sought to do "temporal bracketing" of longitudinal data, which involved identifying "progressions of events and activities separated by identifiable discontinuities in the temporal flow" (Langley *et al.*, 2013, p. 7). This part of the analysis revealed 2 temporal brackets of time, indicating 2 cycles in action research parlance (Lewin, 1946; Susman and Evered, 1978), each starting with identifying an issue(s), followed by introducing and implementing actions to address them, observing the outcomes and reflecting on its efficacy to decide how to go forward. Finally, we created a visual representation to summarise the 3 thematic categories of activities along with the 2 temporal cycles (Gioia *et al.*, 2013; Langley, 1999). To ensure the consistency of the interpretations and the trustworthiness of the findings, as suggested by Lincoln and Guba (1985), the authors had undertaken the coding separately but held regular meetings to discuss the themes and interpretations and arrive at a consensus where there were variations. Further, these insights were discussed with the Steering Committee members as a form of member check (Lincoln and Guba, 1985).

Findings

In this section, we present the birth and evolution of KisanMitr through 2 action research cycles (summarised in Table 1).

Cycle 1: Birth of KisanMitr

KisanMitr originated during the early days of the COViD-19 pandemic, amidst the exodus of the migrant workers, which rekindled the discussion in the policy and practice circles on the need for viable livelihood options for rural Indians. The conversation initiated from the Office of the Principal Scientific Adviser to the Government of India (PSA) centred around how providing better access to scientific research and technology to the migrant youth and farmers might enable them to succeed as agripreneurs.

Actors. The Programme Director at the PSA's Office, championing the initiative, reached out to a whole range of actors in the relevant ecosystems, including Ministries, government departments and programmes, corporates, private foundations, incubators, start-ups, financial institutions, academic institutions, extension outfits, farmer collectives, etc. Rather than seeking institutional-level support, connections were established with individuals within institutions who were moved by the cause, and therefore willing to champion the initiative within their respective institutional settings. The initiative was originally named the Friends of the Farmers (and later KisanMitr) as it brought together these kindred spirits.

Given the focus on taking technology from labs to farms, these actors were initially grouped into two categories: supply-side and demand-side. Supply-side consisted of creators of novel science and technology solutions and included research institutions, start-ups, small and medium enterprises and farmers themselves. Demand-side consisted of users of technology in the broad sense and included intermediaries interested in commercialiation of

Table 1. Unfolding of KisanMitr – a summary of the action research cycles

Thematic categories	Action cycles Cycle 1	Cycle 2
Actors	• Gathering the actors and getting their buy-in • Grouping actors into supply-side and demand-side	• Further differentiation in actor groupings • Introducing varied pathways for engagement • Greater involvement of the actors in the platform development activities
Technologies	• Aggregating technologies • Classification of technologies based on sectors and subsectors	• Classification of technologies based on the stage of development/market readiness • Aggregating databases with information inputs • Expansion into off-farm technologies
Digital platform	• Creation of the technology repository • Creating the digital platform as a tech information exchange	• Separate listing of scientific research and market-ready products • New sections for support services such as agriculture fin-tech solutions and off-farm technologies • Integration of data resources and creation of Atmanirbhar Krishi app • Special sections for highly excluded farmer groups
Lessons	What works? • Useful for farmers to scan the types of solutions available for the specific issues they have • Useful for comparing a set of solutions/products • Can connect unknown and unconventional innovators/entrepreneurs with farmers What needs addressing? • More nuanced capturing of the requirements of the actor groups and stages of technology development is necessary to further enhance the usefulness of the platform	What works? • Open-source model of collaboration encourages the participation of actors in the platform development • Openly prioritising farmer needs helps to reinforce farmer-centric technology and product/service development • Farmers are not mere consumers of technology; they can be co-creators too What needs addressing? • Whether to leave it as an open platform for collaboration or to introduce any formal governance mechanisms to ensure fair engagement

Source: Prepared by the authors

technology (such as agri-tech companies, incubators, accelerators and investors) and enabling farmers' access to technology (such as Krishi Vigyan Kendras and other extension actors, private foundations and financial institutions), as well as the farmers (FPOs, cooperatives and progressive farmers).

A core group emerged to steer the initiative. This comprised individuals who were personally vested in the cause and included the Programme Director from the PSA's Office, an angel investor and a leading farming expert (This group later expanded to include a technology expert and a social sector expert). An academic was brought in as an action research partner. The idea was not to monitor the progress through pre-set targets and milestones but to take a more reflective action learning approach that would tap into the collective learning of all actors involved.

Technology. A key goal of the initiative at this stage was to create a National Repository of Scientific Research and Technologies. All the public and private research institutions (e.g. including ICARs, CSIRs, Indian Institute of Technology, Indian Institute of Scientific Education and Research, etc.), start-ups and micro small and medium enterprises (MSMEs) in the supply-side were contacted with a request to submit the details of technologies that they had developed or been in the process of developing. These technologies were evaluated by the farming expert in the core committee to assess their suitability for farmers before adding them to the repository.

The purpose of creating such a repository was to have all information on technologies under development in India in one place so that the interested actors from the demand-side could be made aware of their existence and given the opportunity to directly engage with the supply-side actors for their further development, commercialisation or field deployment. The repository now contains 1,720 technologies, that support the various stages in an agricultural value chain, namely, input supply, production, post-harvest processing and distribution and retail.

Digital platform. It was decided early on to host the technology repository on a digital platform for ease of access and maintenance. A few design principles also were agreed on at the beginning itself. Firstly, the digital platform was to be open to the public and without any costs to the farmers. Indian Council for Social Transformation (ICST), Bangalore volunteered to develop this platform free of cost.

Secondly, the platform had to be unique in nature and could not duplicate existing digital platforms (including apps). A comparative study of the digital platforms of Agriculture Ministries, Ministry of Rural Development and National Bank for Agriculture and Rural Development was undertaken to ensure this. It was decided that the platform would serve as a Technology Information Exchange between the supply and demand sides. The platform featured all technologies gathered from the supply-side, grouped into two main categories, agriculture and livestock and their respective subcategories for ease of browsing and searching. The platform also incorporated chat facilities, dashboards, management information system, a rating system and payment gateways. The digital platform was named KisanMitr after the initiative itself.

Thirdly, to keep the efforts and cost to a minimum, repurposing the existing or open-source platforms was preferred to developing from scratch. For instance, the livestock technologies section was developed using the architecture of the e-Paashu Haat web portal, which was developed by the same digital platform developers.

Fourthly, it was decided that the mutual engagement of supply and demand sides would not be centrally controlled. The actors on the supply and demand sides could register themselves on the platform and be free to engage with each other directly as per their own vision and internal processes.

Finally, to kickstart the engagement among the supply and demand sides, it felt necessary to build awareness about the platform. To this end, a monthly webinar series was started (live sessions hosted by National Association of Software and Service Companies and N.S. Raghavan Centre for Entrepreneurial Learning-Indian Institute of Management Bangalore and recordings by the KisanMitr platform).

Lessons. Feedback interviews and discussions during this period yielded insights on what worked and what needed addressing.

In terms of what worked, we found that the digital platform was indeed helpful for farmers and the other demand-side actors as a single-stop to quickly scan and compare the entire range of technologies available to the specific issues that they had. However, comparing farming solutions was not like comparing consumer products and often required clarifications on its appropriateness for particular crops, land and weather conditions. The interactional facilities on the platform helped in obtaining clarifications, arranging demos and negotiating prices and pricing options. Interestingly, we found that the platform served to connect unconventional and relatively unknown supply and demand-side actors, such as an MSME entrepreneur from a farming family in Haryana, who supplied a pulping and juice extraction machine, with a community-based farming and food processing start-up from Manipur that was looking for such a machine.

As for what needed addressing, we found that within the supply and demand sides themselves there were variations in the requirements of different actor groups, as well as the technology development stages that they could effectively engage in. For instance, the information that an FPO needed was different from the information that an incubator or investor needed although both were grouped under the demand side. Similarly, while the FPOs and Krishi Vigyan Kendras were looking for market-ready solutions, the corporates and technology incubators were interested in technologies in pre-commercialisation stages. This spurred its next stage of evolution and growth.

Cycle 2: Evolution and growth

The next cycle of action was geared towards consolidating the strengths and addressing specific actor needs.

Actors. As the variations in the actor's needs and expectations began to surface, a key concern became how to effectively capture such differences and cater to them. The first response was to go forward from the earlier grouping of actors into the supply and demand groups (creators vs users of technology) to more differentiated categorisations. More attention was paid to the fact that technology development and adoption was a process that involved several stages and many of the actors now began to be seen as "enabling intermediaries" who made possible the progress of technology through its various stages of development. While research scientists and start-up innovators were involved in the early stages (namely, ideation, proof of concept and proof of validation), they needed the help of farmer interfacing organisations such as Krishi Vigyan Kendras and Foundations for the validation stage. Most research scientists did not have the inclination or expertise to see them through commercialisation stages and incubators and corporates had to step in here. This differentiation was incorporated into actor groupings.

While doing the above, it became apparent how important it was to facilitate interactions and engagement among actors for technologies not to get stuck in any stage of development and to indeed pass from actors involved in one stage to those who can take it through the next. Attention was now turned to creating varied pathways for engagement among actor sub-groups for this very end. While the informational webinars from the first cycle continued, other avenues were introduced. The immediate focus was on making market-ready technologies reach the farmers. Specific interventions to this end included an in-depth webinar series hosted by the National Institute of Agricultural Markets, which were open to around 20,000 people all around the country, in particular, the members of FPOs and farmer cooperatives, Krishi Vigyan Kendras and Foundations and outreach arms of companies; or televised series on Doordarshan Kisan on select agricultural technologies and modern farming techniques that can be immediately adopted.

Actors were encouraged to engage not only with each other on the digital platform and the outreach activities but also in the design and development of the platform and the activities themselves. The Indian Farmers Fertilizers Cooperative was invited to fund the Doordarshan Kisan series, Confederation of Indian Industries to coordinate the international engagement activities under the KisanMitr platform and the Flipkart technical team to evaluate the digital platform as a third party.

Technology. The differentiation that was brought in actor classification is reflected also in technology classification. Earlier, technologies were classified based mainly in terms of the agricultural or value chain aspects. Further differentiation was included to capture the technology development and commercialisation stages. In the KisanMitr digital platform, the technologies were bifurcated into two buckets – Scientific Research and Market-ready Technologies, to get the attention of the right actor groups. While those in the Scientific Research bucket were targeted at the potential commercialisation partners such as incubators, corporates, agtech entrepreneurial aspirants and investors, those in the Market-ready Technologies bucket were targeted at Krishi Vigyan Kendras, foundations, FPOs, cooperatives, NGOs, progressive farmers, etc.

It began to emerge that in addition to agricultural technologies, farmers also needed other supporting technologies and informational inputs. In response to this, a repository agri-fin tech solutions (mainly from start-ups) was included, to help both farmers in managing their own accounting and financial statements and Non-Banking Finance Corporations in monitoring FPO financial progress. In addition, it was decided to create a mechanism to assemble and disseminate the informational inputs required for new-age farming (such as quality of soil, weather, moisture, water tables and air pollution), which were already being collected by the various national and international agencies and were resting in their respective databases.

Another observation was that, just as farmers, rural artisans also would benefit from greater access to technology, leading to the introduction of a repository for off-farm technologies. Technologies related to Textile and Creative Manufacturing – including leather, carpets, gems and jewelry – were included in this repository and the respective supply and demand-side actors were brought on board.

Digital platform. The digital platform continued to be a technology information exchange. However, it expanded to host the supporting technologies and off-farm technologies that were newly introduced to the repository. The digital platform now contained a separate section named "Agri Fin-Tech" for financial technology products for farmers and financial institutions catering to the farmers. Similarly, another section called "KalaMitr" was introduced to host off-farm technologies. The development of a solution for providing informational inputs started and the plan was to launch it through not only the KisanMitr platform but also unified mobile application for new-age governance and a separate app named "Atmanirbhar Krishi".

At this stage, more actors began to pitch in for the expansion of the digital platform. While ICST continued as the host and main developer of the platform, many public and private sector organisations stepped in to collaborate. Examples included Information Technology-Indian Space Research Organization (for the development of the informational inputs solution), Tech Mahindra (for developing the section “Kala-Mitr” and “Atmanirbhar Krishi” app) and a start-up founder (for integrating multi-source databases).

The teleological focus on farmers prevailed and greater attention began to be paid to groups who experienced greater degrees of exclusion. A special section named “Himalayan Bazar” was created on the digital platform for farmers in the mountain states in India who were into nutrition agriculture (i.e. region-specific crops, forest produce and traditional food products) but found it particularly difficult to access profitable markets. Himalayan Bazar was not meant for the urban elite to sell their products but for the village farmers to reach buyers looking for nutritious agricultural produce. The demand side here consisted of local Mid-day Meal implementation partners (e.g. Akshaya Patra and State Government Schemes) and women and child self help groups so that they could use this high nutrition product for the benefit of malnourished children.

Lessons. Ongoing feedback interviews and discussions revealed that the tailored modes of engagement among specific sub-groups of actors were more effective than blanket approaches offered to the wider audience. Separating Scientific Research and Market-ready Products indeed helped to steer the right actors to the right solutions. The farmer focus leading to the inclusion of a wider range of technologies and informational inputs were largely appreciated.

The biggest learnings were in relation to how actor engagement began to evolve. There were now more public and private sector organisations offering to not only cooperate but also take the responsibility for carrying out the different projects under the initiative and integrating them into their own programmes and initiatives. This helped to align actors more closely for the execution of projects and keep budgetary requirements to a minimum.

More importantly, we also saw farmers emerging as active co-creators of technology, rather than its passive consumers. For example, Temperate Technologies, a start-up offering less energy-consuming cold storage solutions for fruits and vegetables, had listed their product on the KisanMitr platform and presented them in a webinar. Bhagavatula Charitable Trust (BCT) that worked with farmers in Visakhapatanam, approached Temparate Technologies with the farmer feedback – that they would require cold storages that are mobile and solar-powered to meet their needs – which translated to a modified problem statement and kickstarted collaboration between Temparate Technologies and BCT for product development.

The key question that was emerging towards the end of the second cycle was what the ideal governance mechanism might be to keep the platform going – whether to leave it as an open platform for collaboration or to introduce any formal governance mechanisms to ensure fair engagement. As of now, it is left as an open platform staying true to the original design principle of minimal regulation.

Discussion

The disconnects between the actors in the innovation, business and entrepreneurial and agricultural extension ecosystems have historically hampered the progression of technology from labs to farms, affecting the chances of farmers to turn agriculture into a viable livelihood option. In this paper, we trace the formative phases of KisanMitr, a digital platform that was created to integrate the actors from all three ecosystems. As one of the first digital platforms for ecosystem integration in the agtech space in India (and, perhaps, the world), we discuss how KisanMitr compares against the platform models in both technology and agricultural sectors and reflect on its development trajectory from an evolutionary perspective.

Comparison of KisanMitr with other technology and agriculture sector platforms

Digital platforms are understood to be meta-organisational forms that seek to integrate diverse sets of organisations and actors (Kretschmer *et al.*, 2021). Digital platforms are becoming prevalent in technology sectors (Jovanovic *et al.*, 2021; Hilbolling *et al.*, 2020); innovation platforms in the agriculture sector are less digital still (Devaux *et al.*, 2018; Kilelu *et al.*, 2013; Swaans *et al.*, 2013; Thiele *et al.*, 2011). We compare KisanMitr against these other platform models (Table 2).

While all three models bring multiple stakeholders under their folds, they differ in who exactly these actors are. The technology sector digital platforms include industry ecosystem actors as their participants, with the platform owners, complementors and consumers almost exclusively from the private sector (Hilbolling *et al.*, 2020; Rietveld and Schilling, 2021). With their interests in commercially-oriented innovation, these participants tend to be large corporates, start-ups, funders and industry bodies and often exclude academic research institutions. Agriculture sector innovation platforms involve a broader set of actors from the agriculture ecosystem, spanning the public, private and developmental sectors, as well as the farmers themselves (Devaux *et al.*, 2018). The range includes farmer groups, government, developmental agencies, NGOs, technology and input providers, finance providers, training providers, etc (Kilelu *et al.*, 2013). KisanMitr encompasses actors covered in both technology and agriculture platforms and more, as it integrates innovation, entrepreneurial and agriculture ecosystem actors, spread across the public, private and NGO sectors and includes research and academic institutions, start-ups, incubators/accelerators, funders, ministries and government departments, foundations, NGOs, corporates, farmer groups, extension actors, etc.

Technology is a central part of all three platform models, yet they differ in the types of technologies that they are interested in and the place of technology in the larger canvas of innovation. Technology sector digital platforms involve multiple technologies, as long as they are related to a specific product or service category (e.g. iPhone and automobile fleet management) (Jovanovic *et al.*, 2021; Oh *et al.*, 2016). These platforms actively pursue technology innovation for the purpose of value creation; they are equally keen on business model innovation that would enable greater value capture (Cennamo and Santaló, 2019; Hou and Shi, 2021). Agricultural innovation platforms take a produce-centric view on technology, such as those related to the production and marketing of potatoes, dairy and meat (Thiele *et al.*, 2011; Kilelu *et al.*, 2013; Ayele *et al.*, 2012; Stür *et al.*, 2013). Technology, however, forms only a smaller component of the innovations that they generate in these platforms, compared to the organisational, institutional, business process innovations. In relation to the technology itself, the emphasis is often on the adoption of appropriate technology rather than new technology development. In comparison, KisanMitr deals with a much wider range of technologies that span all stages in the agriculture value chain (i.e. inputs, production, post-harvest processing and market access and retail) irrespective of the produce. However, it is focussed exclusively on innovation, development and dissemination of technology, rather than other types of innovations.

Digital platforms as the meeting ground of actors have gained prevalence in the technology sector, but are less common in the agricultural sector. Two aspects of digital platforms become salient in how they enable mutual engagement among actors: platform architecture and platform governance (Hou and Shi, 2021; Jovanovic *et al.*, 2021). Platform architecture deals with the structure of the platform, whereas governance covers control and monitoring, as well as communication and coordination (Rietveld and Schilling, 2021). Technology sector digital platforms tend to use a modular architecture that reflects the product modularity, with different sets of complementor actors engaging with each other around individual modules (Jacobides *et al.*, 2018). However, the platform as a whole is

Table 2. Comparison of KisanMitr with platform models in technology and agriculture sectors

Elements	Technology sector digital platforms	Agricultural sector innovation platforms	KisanMitr
Actors	• Industry ecosystem actors • Platform sponsors, complementors and consumers – mostly private sector players • For example, Large corporates, start-ups, funders and industry bodies	• Agriculture ecosystem actors • Mix of public, private and developmental sector actors along with beneficiaries • For example, Farmer groups, government, developmental agencies, NGOs, technology and input providers, finance providers and training providers	• Innovation, entrepreneurial and agriculture ecosystem actors • Mix of public, private and NGO sector actors along with beneficiaries • For example, Research and academic institutions, start-ups, incubators/accelerators, funders, ministries and government departments, foundations, NGOs, corporates, farmer groups and extension actors
Technologies	• Product-centric • Focussed on technology and business model innovation	• Produce-centric • Focussed broadly on organisational, institutional, business, process innovations and not on technology innovations alone • Technology adoption than innovation	• Wider range of technologies for all stages in agriculture value chain irrespective of produce • Focussed on technology innovation, development and dissemination
Digital platform			
Architecture	• Modular and product-centric • Owned by the platform sponsor	• Value-chain centric • Collaboratively managed	• Emerging modularity • Coordinated by the platform sponsor, however, modules developed independently by the complementors
Governance	• Bi-lateral agreements between the owner and others • Oriented towards market goals	• Commonly agreed-upon terms of engagement • Oriented towards social goals (livelihood and sustainability)	• Informally agreed on principles following open-source innovation models • Hybrid goals – Social goals with respect to farmers, market goals with respect to commercial complementors
Relevant Literature	Cennamo and Santaló, 2019; Constantinides *et al.*, 2018; Hilbolling *et al.*, 2020; Hou and Shi, 2021; Jacobides *et al.*, 2018; Jovanovic *et al.*, 2021; Kretschmer *et al.*, 2021	Kilelu *et al.*, 2013; Swaans *et al.*, 2013; Thiele *et al.*, 2011; Devaux *et al.*, 2018	

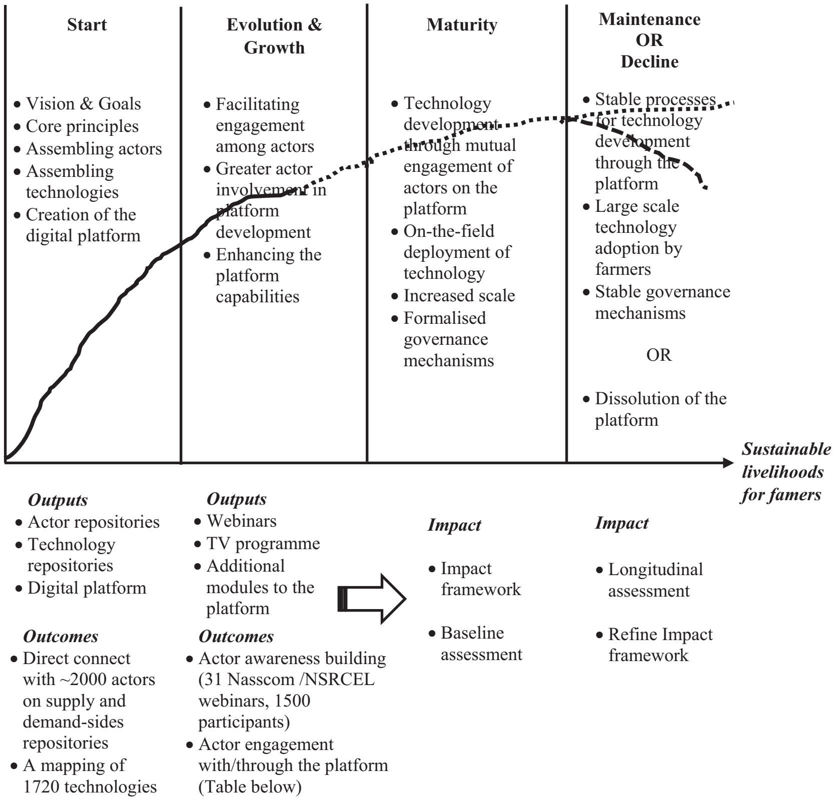
usually owned by the platform sponsor (Kretschmer *et al.*, 2021). Though the digital aspect may not be as pronounced, the platforms in the agricultural sector also have a distinct architecture, which has increasingly become value-chain-centric (Devaux *et al.*, 2018). All actors relevant to the value chain of particular produce are brought together under the platform architecture to holistically address the issues pertaining to the successive stages in the value chain from input supply, production, post-harvest processing, to market access and retail. Such platforms are often collaboratively managed by the participating actor groups (Kilelu *et al.*, 2013). KisanMitr can be seen to blend both models in some ways. KisanMitr recognises the need to take value chains into account, but its way of contributing to the value chain is by ensuring the availability of appropriate technologies to all stages in the value chain. To this end, KisanMitr uses a combined approach. Technologies with respect to broad produce/product categories are segregated into different modules on an online platform (e.g. farm, livestock etc.), which are further divided into sub-categories reflecting the value chain stages. There are also actor-group-specific modules – while the "Market ready" solutions seek the engagement of farmers and extension actors, "Scientific research" is for commercial actors who want to explore the business potential of the ideas. Although the Principal Scientific Adviser's Office coordinates the platform development and maintenance, the responsibility for the upkeep of individual modules is increasingly being spun off to complementors willing to assume the responsibility.

The governance mechanisms are equally varied. In the technology sector, platform owners usually control only their own engagement with the complementor actors (by means of bi-lateral agreements), but do not seek to govern the exchanges among the complementor actors (Jovanovic *et al.*, 2021). It is for them to shape their own governance mechanisms. What they have in common in all the mutual governance arrangements is a shared orientation to achieve market goals; as commercial players they all want their collaborative efforts to yield them profits and market advantages (Cennamo and Santaló, 2019; Hou and Shi, 2021; Kretschmer *et al.*, 2021). In contrast, the agricultural innovation platforms sometimes abide by the overall governance frameworks put in place by the government or developmental agencies or the farmer collectives who initiate the platform formation (Kilelu *et al.*, 2013; Swaans *et al.*, 2013). In general, these governance frameworks are oriented towards social goals, such as farmer livelihood, poverty reduction and agriculture sustainability (Devaux *et al.*, 2018). KisanMitr uses neither bi-lateral agreements nor formal governance frameworks. At present, the governance mechanism is largely composed of informally agreed on principles that are similar to those in open-source innovation models (Hilbolling *et al.*, 2020). The goals are, however, hybrid – in the sense that KisanMitr aims to achieve social goals with respect to the farmers, however, understands that it has to also support the market goals of the commercial complementors to ensure attainment of social goals in a sustainable manner. It does have a goal hierarchy nonetheless – the social goals get the priority here as is reflected in the efforts to put the farmers at the centre of every activity.

KisanMitr – the evolutionary path

Scholars stress that the development of such ecosystem platforms, including the digital platforms, is a co-evolutionary process that unfolds over a long period of time (Hou and Shi, 2021; Moore, 2006; Jovanovic *et al.*, 2021). Our findings that unveil the cycles in the development of KisanMitr reiterate this. The stages of development typically encompass a start, evolution and growth, maturity, maintenance/decline phases (Rabelo and Bernus, 2015).

Founded in May 2020, KisanMitr has been in existence only for 15 months at this point, which is a very short time in the life cycle of digital platform ecosystems. However, KisanMitr has been rapid in its transition from the starting phase to the evolution and growth phase, as captured by the two action research cycles detailed in the findings section (Figure 1). In line with the prevalent literature, the starting phase sets the overall vision for the platform and the core principles and impact goals that drive the initiative (Rabelo and Bernus, 2015). KisanMitr was motivated by the plight of rural farmers who migrated to urban centres as they could not have sustainable livelihood from agriculture. The core idea was to put to use the technology developed in the country (by public research institutions



#	Outcome indicators for the Digital Platform	Count
1	Count of Technology Products	1642
2	Count of Technology Product for Showcase and not Market Ready Overall	1261
3	Count of Technology Product for Showcase and not Market Ready Category wise [Agritech 352, Lifestock Tech 201, Scientific Research 194, Kalamitr 113]	860
4	Count of Market Ready Technology Products [Agritech 25, Lifestock Tech 356, Scientific Research 0, Kalamitr 0]	381
5	Count of Organisations registered as Sellers	1327
6	Count of Organisations registered as Buyers	63
7	Count of Individuals registered as Sellers	0
8	Count of Individuals registered as Buyers	101
9	Count of FPO Organisations and contacts available	111
10	Total number of users in the system	17392
11	Total email count sent since inception for Webinars	11,80,993

Figure 1.
KisanMitra – The evolutionary path

and private actors) to help them transform to agriprenerus, by ensuring that the technologies developed in labs indeed reached the farmers. The first phase focussed on bringing together the relevant actors and technologies in one place and led to the creation of the digital platform of KisanMitr to this end. Right now, it is progressing through an evolution and growth phase. As the literature suggests (Moore, 2006), the focus now is on devising ways to facilitate engagement among these disparate actor groups. Innovation literature suggests that it involves various push and pull factors (Choi, 2018; Clausen *et al.*, 2020) and efforts are being made to embed these factors in the facilitation mechanisms.

Scholars also point out that the outcomes and impact of such digital platforms must be explored in relation to the stages of development (Rabelo and Bernus, 2015). Digital platforms take time to bring the actors together, facilitate productive engagement among them, create outputs and refine these outputs before they are able to show tangible outcomes, which in the long-term cumulatively contribute to the desired social and/or market impact. Rather than impact measures, short-term output and outcome measure appropriate for the specific stage of development help to measure progress towards impact (Rajeev and Joy, 2021). Outputs in the start phase included large repositories of actors and technologies from across the country and the KisanMitr portal that homes these repositories. The outcome was a comprehensive mapping of the whole ecosystem that was publicly shared, enabling actors to know who all are there and what they do. In addition, it served to get the buy-in of all actor groups to the broader impact goals. In the second stage, as KisanMitr increased the range of activities, outputs included tailored approaches for actor engagement, the differentiated module structures and the modules created by the complementor actors. Outcomes here consist of greater mutual engagement between actors and the onset of mutual collaboration independent of the platform sponsor. As the literature predicts (Hou and Shi, 2021; Moore, 2006), we imagine that KisanMitr would continue in the evolutionary phase a little while longer till the actor engagements began to show tangible outputs in terms of technology development and/or on-the-ground deployment.

Despite the promising outcomes, thus, far, the question remains if the initiative would be sufficient to deliver the desired social impact. A crucial influencing factor may be governance. Currently, governance follows an informal open-source approach (Hilbolling *et al.*, 2020), which also opens up the possibility of derailing social impact goals if the more powerful actors do not endorse them. Further, the past research suggests that wider ecosystem development activities that involve institutional, organisational, business process innovations are necessary to make lasting systemic changes (Thiele *et al.*, 2011; Kilelu *et al.*, 2013; Ayele *et al.*, 2012; Stür *et al.*, 2013). Much of these other innovations and developmental activities remain outside the scope of KisanMitr.

Conclusions

Agriculture sector world over is moving towards embracing an Agriculture Innovation System (AIS) approach (Pigford *et al.*, 2018) in order to enhance the viability of agriculture for farmers. KisanMitr initiative shows that digital platforms can become the backbone of such systems, just as in the high-tech industries (Jovanovic *et al.*, 2021). It demonstrates how such digital platforms can remove the bottlenecks in information flows between the ecosystems and actors (Oh *et al.*, 2016) and facilitate inter-ecosystem integration. With greater transparency, actors can pursue collaboration or even competition – while the former helps to perfect the solutions, the latter offers alternatives (Stam and van de Ven, 2019). KisanMitr suggests that open digital platforms may allow all actors to benefit and flourish (Hilbolling *et al.*, 2020; Oh *et al.*, 2016). It also underscores the importance of retaining farmer centricity as a teleological ideal (Cook *et al.*, 2021) to alter the power structures and truly privilege the farmers (Duncan and Pascucci, 2017).

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