From Technology Access to Smallholder Digital Engagement through Service Specialization and Knowledge Integration in Rural China

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Abstract. This is not the case where the smallholder will be able to use digital equipment in their everyday farming practice after installing it. The article considers the ways of getting farmers in Jiajiagou village in Qixia city, Shandong province, into the access of digital applications by using specific services. It relies on semi-structured interviews that were done in February and July 2025 as well as photographs and other cases. To determine the roles, dates and applications of organizations, the reports of government and media were consulted. It is an analysis of the work related to the process of choosing the technologies, the working of the machines and systems, and the modification of the practices based on the observations made in the field and the responses received from the buyers. The experiments conducted in known orchards would enable growers to determine whether they could use new methods of cultivation in the local environment. The equipment, data, and online systems were then managed by technicians and operators with specialized skills and knowledge, whereas the farmer had information about his plots and he could help in evaluating the suggestions. Business practices also changed: the business was forced to repackage its fruit because customers complained of the fruits being ruined during transport.It is possible to conclude that the involvement of smallholders in the digital world will be based on how the farms and service providers are structured. They have also done researches on the aspect of service scale operation and they have demonstrated why farmers still need their knowledge as a result of specialized services outside the home. This set up has also raised issues concerning governance of services. The farmers should get good help, explanations that they can grasp, the price should not be too high, and there should be chances to ask questions about the recommendations and the use of data regarding the farms.

Keywords: Smallholders; digital agriculture; specialized agricultural services; division of tasks; knowledge collaboration; rural governance.

1. Introduction

There are various digital technologies in the orchard. It is measured by the sensors of temperature and humidity. Watering and fertilizing systems have been built into irrigation and fertilizer machines to water and feed plants at a certain level, online stores where products are shown, orders made and customers receive feedback. They usually appear as the indicators of modernization of agriculture. To a small holder it will not be the case of having equipment close at hand. The cost, disparity in the digital abilities, inappropriate technology, and lack of support by the organization can all make it hard to use [1, 2]. Digitalization needs to be considered when these tools become part of normal farm operations.

This difficulty is especially evident in the hilly fruit-growing areas. Orchards are not uniform in slope, soil, tree condition and history of management. Since fruit trees grow on a long production cycle, a standard setting might not be appropriate to a specific plot. The work that farmers have to do does not end with an application: equipment needs to be set up and maintained, data processed and online sales channels kept up. Most families do not have time or resources to learn all these skills. Making each farmer purchase and use a full system may exacerbate disadvantages related to small farm size, aging workforce and unequal access to education. A more practical question is who can perform this recurring work and how farmers can get their assistance.

Studies of service-based scale operation provide an opportunity to answer this question. It differentiates the magnitude of a household farm and the magnitude at which machinery, capital and expertise are applied. Specialized providers can provide modern inputs to smallholders by aggregating demand across scattered farms [3-5]. Digital services might be operated on the same principle whereby technicians would maintain sensors and operators would manage platforms. But these services necessitate multiple exchanges of information. A technician should compare data with the history of a plot and evaluate recommendations with the conditions prevailing in the season. The feedback given by buyers can ask to make changes in production, packaging or delivery. In order to clarify how digital services operate we have to consider the way companies, cooperatives and farmers deal with such exchanges.

There is a village of Qixia city where these relations can be considered, i.e. Jiajiagou village. The technical personnel have been engaged in the improvement of varieties, irrigation and fertilization as well as online sales with the use of digital applications to manage production and market. Boying Fruit and Vegetable Cooperative and village organizations have created working connections with regard to such activities (Xiaopingguo Agricultural Technology Co., Ltd.) [6,7]. It was also not until professional employees were introduced that growers still relied on their experience in making the decisions regarding the production process. In terms of selling, there were livestreams and traceability screens, which enabled people to purchase products and get information about them, but the consumers could not change the work done offline. With the help of these things, we can follow the distribution of certain works.

The article poses the question of how smallholders can engage in digital agriculture where farm size and personal skills in using technology are constrained. It looks at how farmers evaluate technologies brought by others, how specialist jobs are distributed, and how local knowledge and market feedback guide further changes. Task division shows who does the work; knowledge collaboration explains how those actors bring their various knowledge to a decision. Taken together, these views focus on the connection between household farms and the services offered to them.

2. Literature Review

2.1. Smallholders and service-based scale operation

The early discussions on smallholders and modern agriculture were mainly concerned with the size of landholding and productive efficiency [3]. The subsequent research focused on how small farms could acquire modern input without increasing their holdings. According to Luo, service-based scale operation is an explanation of how specialization in agricultural activities can achieve this. A provider has the ability to aggregate demand among various farms and apply equipment or skills at a level that one household would be unable to sustain [4]. The associated concept of service-oriented agriculture is used to explain the way farmers are involved in a specialized economy but depends on capital and skills beyond the household [5]. Such approach applies to digital agriculture as it usually requires maintenance of the equipment, and its outputs need to be interpreted.

It is not as simple as that to arrange such services. In the process of renovation of the greenhouses, the villagers were able to be a collective in the village and coordinate the land, mediate the interests and organize the households, which allowed the scattered growers to receive the specialized services [8]. The study by Meng, Dong and Kong focused on the issue of agricultural production trust through supply and marketing cooperatives. Their results also indicate that social relationships and institutional ones are the factors that enable organizations to align resources [9]. There should be demand brought together by the providers, expectations set, and disagreements resolved. It is particularly challenging when it comes to providing a service where the circumstances in the field need to be adjusted over and over again.

The research on the rural digital economy will also focus on the skills of an individual in a larger context. Qiu and Qiao demonstrate that this environment has created the chances to farmers in the post-technological change [10]. Zhang and Shan have established that the county-level digital

economies are connected with the specific agricultural services, and the presence or absence of the digital literacy is determined by the people who can benefit [11]. These results imply that the use of technology among the farmers relies to some extent on assistance. One of these is the ability to work a machine alone, the other one is the knowledge where to find support.

2.2. Organizational Fit in Rural Digitalization

Digital governance research can be useful in understanding why the same technology may perform differently in different contexts. The research by Huang on street-level e-government investigated how organizational structures and frontline routines influenced the use of information systems [12]. Rural governance studies have also challenged methods that put excessive trust in technology. A platform might not have much practical application when it does not match local relationships, institutions or capabilities of its users [13-16]. This paper turns focus to the circumstances under which individuals decode and apply a tool.

Research on the subject of rural governance has been done in the form of collaborative research, and this can be explained as follows. Hu and Lu have also highlighted the social networks, the involvement, and the alignment of interests to develop a digital rural-governance community [17]. Zhang and Wang write about adaptation at personal, interpersonal, organizational and institutional levels [18]. The example of Chen and Che demonstrates that the interest convergence is beneficial in the process of village governance [19]. It will take more focus on production work when it comes to agriculture. Who is going to interpret the data and who will give advice? What are the consequences of adhering to it, and what is the chance of requesting an amendment? These issues are linked with the relationship between organization and technology use.

2.3. Digital Agriculture Knowledge Collaboration

The digitization process is altering the knowledge production and dissemination. Wu et al. in their research on digital government, have found that it is hard to combine technical information with the one about day-to-day activities. These problems were overcome by learning and organizational change [20]. In addition to this, the field study of Wang and Wu on the pig farming in a digital environment indicates the need of adaptation between the tools of the digital world and the processes of production as well as the organization of labor [21]. The literature review of social-science studies of smart agriculture and Agriculture 4.0 by Klerkx, Jakku, and Labarthe shows the changes in the relations of knowledge, work, and organization [22]. These two papers are also useful in understanding the reason behind the need to look into the use of digital data together with the individuals and the way they interpret the data.

A lot of that understanding is based on the knowledge about a certain location in agriculture. A grower might recollect the manner in which a slope was drained, or how trees reacted last season or what changes were visible and have been reported to be problematic. These observations are useful in interpreting standard data. The farmer-oriented description of services by Huang presents an argument that service providers should consider efficiency in coordination as well as the requirements of each family [23]. Sun and Tao also argue that the results of the work depend on the way of organization of the work and the participation of the farmers, and the type of supervision over the work varies among different types of services [24]. The digital services will therefore require examining the areas where the experience of growers comes into play in making decisions despite the fact that there are professionals doing the specialized tasks.

2.4. Research Gap

The paper discusses the factors that make digital services possible. The study of scale operation in terms of service-based business has demonstrated the access of households to the capital and expertise that is available elsewhere. It is the rural studies on digital-governance that have described the significance of organizational fit and institutional fit. Digital agriculture work with knowledge looks at how the technical information and experience are related. Not much was focused on the nature of

these relationships when they are working in a service: what jobs are given to who, when it is necessary to combine the two roles, when the farmers are involved in the decision-making process.

The research paper aims at filling this gap with the help of division of tasks and knowledge sharing. The work of technicians, workers in companies and cooperatives, platform users, and growers are traced by task division. To understand how the actors can put together their information when they are making or changing a decision, it is necessary to use the collaboration of knowledge. The question is posed as to whether the service arrangements that result will enable the farmers to access the digital services and make their farm knowledge an input on the application of these services.

3. Theoretical background and analytical framework

3.1. Access to Digital Capability through Services

The scale of operation in the service-based is not related to the size of a household farm, but the size at which one can operate with equipment and expertise. The inputs of high fixed cost or specific needs can be held by a provider and offered on multiple farms [4, 5]. This may involve maintenance of sensors, data analysis, or sales platform management in case of digital agriculture. By considering such services as professional ones it will be possible to understand how a family can benefit from digital support without having all the needed tools and skills to do so.

Farmers are not the judges of how that assistance is being used. It will also be responsive to biological and environmental factors, which may differ in adjacent fields. A technician can be able to comprehend the machines as well as the rationale behind a recommendation whereas a grower can know the history of management of an orchard and its current status of trees. This is because it is explained by service-based scale operation on how specialists can share work between farms. We need to consider the appropriateness of the resulting advice too, and the process of combining technical knowledge and local experience.

3.2. Professional operation and production judgment

It is the difference between production judgment and professional operation. The professional operations consist of installation and maintenance of equipment, data gathering and analysis, system maintenance, and web sites. They are usually highly trained or have to be paid attention to on a regular basis. Production judgment is an idea that refers to the use of information in any specific orchard or trade. It entails tree vitality, soil and slope, time of farm work, product quality, business risk as well as delivery results.

These categories are more of a description of types of work rather than specific groups of people. Technicians and farmers can be involved in both, and there can be multiple actors involved in a decision. The distinction helps identify where relevant knowledge comes from and who takes part in deciding what to do. Providers can reduce the burden on households by undertaking demanding technical operations. Farmers contribute by describing their plots, comparing advice with field observations, and reporting what happened after an operation.

It is therefore a question of how individuals interact with the information and in which manner they are involved in the process. The technical workers give an account of the system results. Farmers offer feedback on what cannot be provided by any device, and business operators will provide buyer feedback to their production and delivery decisions. They do not know all that there is to know. This way, these two types of contributions can be utilized to make a decision and analyze the outcome.

3.3. Analytical Framework

The process is based on the manner in which technology is evaluated and employed in the village. In local orchards, it will be possible to test the performance of an outside tool or advice in order to determine whether it can work with the existing conditions in the locality. The company, cooperative, technicians, or platform operators are responsible for the specialist activities that are repeated once

an application is already running. These events and knowledge applied by each one are summarized in Figure 1.

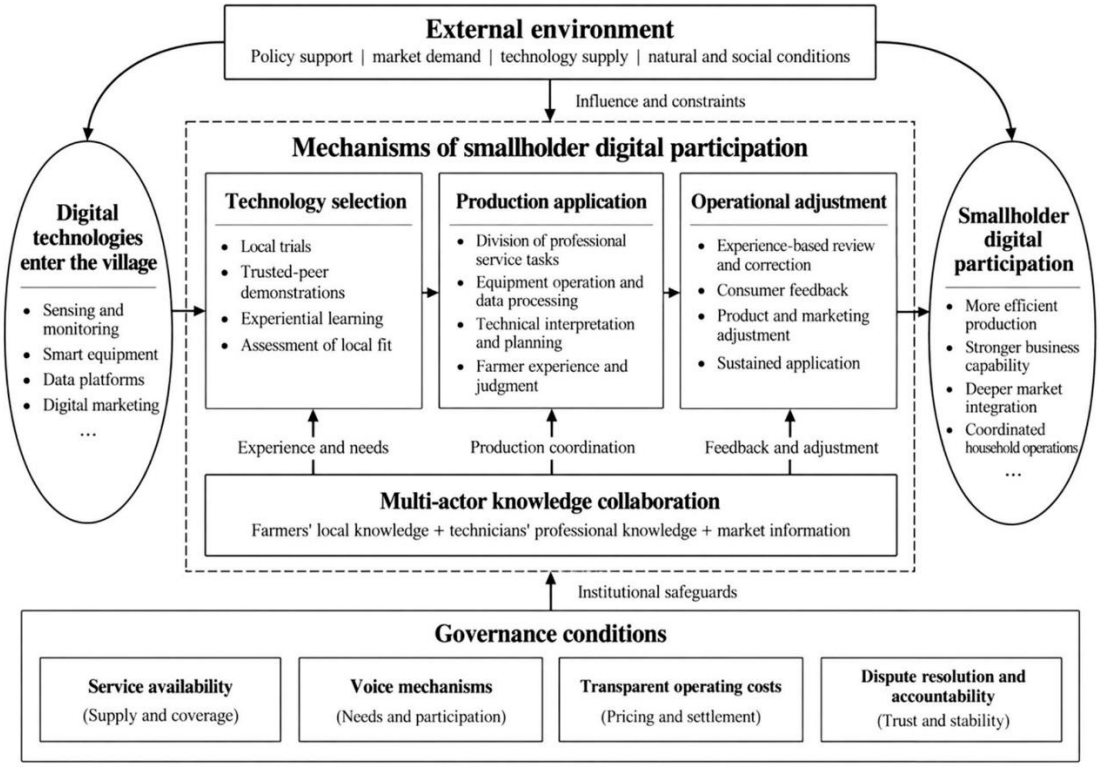


Fig 1. Analytical framework of smallholder digital engagement.

These are the activities that can be repeated and reverted to the previous choices. A complaint of a buyer can result in production or packaging changes, failure to trial will change the service that is offered. It may also have organizations before technology comes into existence. In Figure 1 the arrows show the inter-relationships between the activities, but not the order which each household should follow.

All of these relations are influenced by service governance. The initial step is that a family should be in a position to receive help. As soon as they are included, farmers will have to explain their demands and request explanations on what they want and how to solve issues. The cooperation can also be more predictable because there will be well defined charges, access to information and complaints or losses management process. Such arrangements are considered as the terms of the use of technology under the framework.

4. Research Design

4.1. Case Selection and Unit of Analysis

Jiajiagou is an apple-producing village located in Taocun Town, Qixia City of Yantai, Shandong Province. Yantai has a well-developed system of apple production and marketing and has been modernizing old orchards and substituting inferior varieties [25]. The case materials portray the orchards of Jiajiagou as hilly and discontinuous. There are older operators, some of whom have been experiencing declining returns on established varieties that have strained household production. Farmers need to maintain their orchards going at the same time as making decisions whether they want to change varieties, management practices or sales channels. Such situations generate demand of technical advice and business services.

The choice of Jiajiagou was based on the fact that it is a digital application which penetrated an established fruit business where there were issues in production and marketing. This can be used without taking into account the entire industrial development of the village, as their use is considered.

The company will also have technology firm, co-operative, village associations, and returning migrants. Their work offers them to follow how the capacity has been distributed to the scattered farms at home. Also included are the materials available to perform tasks on both sides of the business; irrigation and fertilization with the help of the computer, the analysis of technical suggestions, livestreaming, traceability, and replies to the customers.

The unit of analysis is the technical-service and relations in which people are involved in it. The experiment will be conducted locally, irrigation and fertilization, reviewing recommendations, digital marketing, and reacting to the consumer feedback. It does not provide the village with an average rate of digitalization. Blueberry farming and replacement of varieties are also incorporated since they can explain the choice of technology or investment conditions. None of them has been considered as digital technology per se.

4.2. Data Sources

The key evidence is the semi-structured interview, which was carried out in February and July 2025, photographs and other materials of the case, and the documents on policy. The people who were interviewed are village cadres, technical workers, returnees, farmers, township officials and employees of financial institutions. In order to verify the history of organizations as well as the roles of actors and reports of specific uses that have been published by government and media, the publicly reported organizational histories were checked. Table 1 gives a summary of the sources and their use of analysis. The English translation of the excerpts of interviews provided here has been done.

Table 1. Data sources and analytic uses

Source type	Content and timing	Analytical use
Interview records	accounts of technology selection, return migration, production management, and sales collected in February and July 2025	Identify participants' judgments, practices, and avowed reasons
Photos and process materials	materials on orchard machinery, irrigation and fertilization, digital marketing, traceability, and related activities	Consider technology usage and service activities together with interview narratives
government and media sources	Organization and personnel reports from 2023, profiles from 2024, and reports on digital applications from 2025	Refer to the recorded history of organizations, roles of actors and dates of application
regional industry and policy sources	materials on Yantai's orchard renovation, production management, regional brand, and relevant policies	Set the industrial and institutional context of village operations

Case material and public sources. Interviews and public reports may be based on the same underlying accounts, and agreement between them is not considered to be independent corroboration.

4.3. Analytical Method and Scope

The problem was tracked, the actors that acted in response to it, the information they used and how they responded to it as well as any modification of practice. The records were also dated and put into order by time so as to get organizational growth and technology use. This was followed by the analysis of the interview passages concerning the choice of technologies, the involvement, field judgment and business adjustment in the initial setting. Such a comparison of production and sales processes enabled one to find recurring relations without taking into account the fact that there was a common process of stages. These events were explained by means of undated retrospectives, which did not replace the dates of interviews with the dates of the event. Equally, the date of publication of a report was not considered as the establishment of a company or cooperation.

The study was concerned with the effectiveness of participation and there is no material that can be used to estimate its net effects. There were no ongoing farm-level input-output statements as well as total internal records of the organization. The analysis thus does not suggest any other income, cost

saving or productivity increase in a digital application. It is an application which is recorded on a livestream, traceability system or smart device, but it is not a performance improvement. The leaders and active participants are also more highlighted by the interviews. Those who do not take part, leave a service or join in conflict are the farmers. This has skewed the data on how many households received services and how stable the situation was.

5. Case Description

5.1. The Orchard Economy and Pressures for Change

It was the decline in the production of older apple types that preceded the experimentation of technologies at Jiajiagou. Zhao Zhongxiang and other residents made trips to areas where apples are grown, such as Luochuan in Shaanxi and Aksu in Xinjiang, and returned with some varieties like Ruixue. These were tested in orchards of Zhao and in plots with varying soils and slopes, the irrigation, fertilization and pruning of which were adjusted to the growth of the trees. The interviewee said that she had no choice but to change: When I worked hard all year round, my apples could not even buy fertilizer (Interview record 120250220CZS). This business problem is related to technology decisions. Farmers needed to take into consideration the returns, the capital that would be invested and the period of time that they will wait until their investment is recovered.

It was not easy to wait since orchard replacement requires years, but households keep on needing income. The case materials explain blueberry cultivation as a means of supporting the longer-term apple improvement with short-term revenue. Zhao said that Apple farming is an investment in the long run, but blueberries can bring back returns within the same year. That income will assist us to survive through the hard transition period until the apple orchards are upgraded" (Interview record 120250220CZS). Blueberry farming is applicable in this case since it aids in sustaining trials and subsequent technical investment. It does not fall under digital application.

5.2. Business entities and specialized personnel

Before the arrival of some of the digital applications that were analyzed in this paper, there was already a relationship between company, cooperative and village. According to a report on the Qixia municipal government, Xiaopingguo Agricultural Technology Co., Ltd. has been established as a fruit and vegetable growing firm in China, and it is also known as the Boying Fruit and Vegetable Cooperative [6]. In 2024, Zhao Zhongxiang was found to be an agricultural entrepreneur and one of the leaders of the organization of the village (Zhao). These dual roles allowed them to relate their local demands with the external professionals and human resources.

There were also those who went back to the country and worked in technical-service as well as digital-marketing. According to their descriptions, the local industry was not able to provide a livelihood, which is why they had to come back. In fact, I did not know what to do until I saw the actual results of these investments (only then did I realize that I should leave my job in Hangzhou) (Interview record 320250220JSY). The village attachment was not enough. The business would grow with more people being employed to carry out the work on the internet but could only be trained in short-term visits.

5.3. Principal Digital Applications

To manage production, the agricultural technology firm implemented environmental sensors and combined irrigation and fertilization machines. Mobile interfaces showed readings such as temperature and humidity and operational suggestions. The equipment was operated by technicians, data was interpreted, and advice was explained. Farmers were connected with production and business services through a cooperative and village-organization leaders assisted in coordination of resources. According to interview material, the way of reviewing recommendations was AI-based preliminary assessment plus local-expert review. One of the reasons why this review was required

was provided by a technician: The textbook knowledge that is acquired by AI should be put into practice in the fields (Interview record 320250220JSY).

The marketing was also done through livestreaming and the traceability of products. On February 14, 2025, Yantai Daily wrote about AI-avatar streaming and tracking business processes in Jiajiagou [26]. The materials of the case state that the companies operated as part of the livestreams and information on cultivation, inputs, and harvest were shown to the consumers using a traceability system. Online presentation was handled by trained workers and the producers provided data on fruit and production. The physical aspect of the handling of products would then be modified due to the feedback of the buyers. When customers complained about bruising fruits during transport, the company switched its packaging (Interview record 120250220CZS).

Such activities link the field trials and production management to online sales and responses to buyers. There is no evidence that all households participated in all of these activities. Table 2 names the main actors and their roles. The analysis below discusses how work and knowledge shifted between such actors in the activities discussed.

Table 2. Main actors and their involvement in the case.

Actor	Main activities	Role in digital applications
smallholders and local growers	Manage orchards, monitor plots, provide fruit, and report issues	contribute local knowledge and assess implications for household farming
agricultural technology company and technicians	Run machines, analyze information, clarify suggestions and upkeep systems	Specialist tasks and digital information explanation.
Cooperative	Contact farmers, combine production and business needs, coordinate services.	Match distributed demand with specialized providers
Digital marketing and returnee operators	Manage live-streaming, traceability displays and platform feedback	Perform online marketing tasks and transmit consumer information
Village organizations and major players	Coordinate resources, keep external contacts and mobilize participation.	Help actors coordinate their work and maintain local relations

Source: Assembled based on interviews, case records and available sources.

6. Mechanism Analysis

6.1. Local Fit Trial and Demo Assessment.

The first step that the farmers had to take was to have a reason to decide on whether a new way of doing things would work in their orchards. The reports of another region which produces crops may indicate a good variety or method, but it will not be certain as to how it will perform in the hillside plot at Jiajiagou. Growers were able to witness the approach in the local trial, and they could see it in the orchard they were familiar with. It also gave an opportunity to compare the results between soils, slopes, and tree conditions by testing them. The farmer might then be able to correlate the claim of an outsider to his own farm.

The trial was done by the person that would be the judge of how the farmers perceived it. According to one of the growers, Old Zhao can do it, and we cannot make any mistake in doing what he does (Interview record 1620250704NH). The villagers had a chance to see the investment and crops that were being grown by Zhao over that period of time, and they could also inquire about his way of doing things. It was easier to evaluate this experience than an advertising or a suggestion of an outside expert who came on a short visit. This is because of the familiarity with the grower whereby the farmers would have the chances to interrogate the outcome and its validity.

The conclusion that can be drawn on these demonstrations is a small one. It helped the farmers to understand better, and this is not reflected in the materials as they have not become common practice. The first experimenters were exposed to most of the risks. They had other growers who would watch what was going on and then see how it compared with their own experiences and then decide whether or not to follow them. This implies that the absence of operational knowledge may come before the

lack of relevance: the farmer should be given some motive to learn about an approach prior to learning the application of such approach.

6.2. Sharing Repeated Digital Work via Specialized Services

Digital applications in Jiajiagou meant that work was to be done during the season. Equipment used in irrigation and fertilization needed to be installed and maintained. There was a person who had to decode the evolving production figures and clarify what they meant to the existing farm activities. Online sales also needed constant care. The requirement of teaching a farmer how to open an application would meet only a fraction of these requirements. This work was largely outside the normal capability of most households because it took time and expert care to maintain the services operational.

The division of labor was explained in the interviews and the process materials. The equipment and information were to be done by the technicians whereas the platforms were to be handled by the operators. The service and resources were linked with the needs of the farmers through the cooperative and village networks. The growers also continued the activities that were related to their orchards. This is an arrangement whereby one had to wait until the farmer needed the help he or she required at the right time. There was a constant relationship of service where skills could be used outside the home.

This allocation of labor implies that the scale is informational in nature and it is used to work on services. The process of plowing, sowing, protection of crops, and harvesting are all done by using a piece of machinery that is performed with a specific task over numerous fields. The interpretation and maintenance of digital services is also repetitive. There may be a technician who can provide support of systems to various farms scattered across the country and a platform operator can handle sales activities of a number of producers. This will allow pooling of specialist judgment and equipment as well as attention to service provision.

6.3. Integrating technical information with orchard experience

An expert who knows the device may not have much knowledge of the background of the plot in which he/she uses it. This was solved by Jiajiagou with the structure of AI-based preliminary assessment and local-expert review. The sensor data as well as the initial suggestions were compared to what had been observed on the orchard, and only then did they become a guide to the field operations. This analysis has provided an opportunity to use the experience of the locals in the application of the digital system.

The information provided by the participants was also required in that review. The system provided measurements and it was explained by the technicians of the output and equipment working. Growers were aware of how trees are performing, soil conditions and previous management. A farmer might have been able to tell whether an operation suggested on a plot was not suitable to the plot without knowing the process of the algorithm. Sensors however had offered constant reading which could not be achieved with experience. The comparison between these sources assisted the participants in making their decisions about using a recommendation.

Such cooperation needs channels of explanation and feedback. The providers should explain their recommendations and be ready to change them. Farmers must have a chance to describe field conditions and report what took place after an operation. When these exchanges are not made, the allocation of digital work to specialists can also result in farmers having little control over the subsequent decisions. Evaluation of participation thus entails paying attention to those who may contribute to a decision and request its reconsideration.

6.4. Acting on Market Feedback

The bruised fruit reports indicate the way information of a digital channel resulted in additional work. The platform rendered complaints of buyers visible, and the business reacted by altering the packaging that was used to deliver. The practical response occurred offline. This relationship was

also seen in production management whereby suggestions were to be translated and verified on the ground before reporting an altered operation. Information proved useful in both environments because of what individuals did as a reaction to it.

The comparison serves to clarify the role of feedback. The digital tools provided more information, but organizations had to assign responsibility in responding. Later decisions could be informed by the result of an adjustment. Feedback may alter packaging or a production process and may also necessitate a change in the service or the people who performed specific tasks.

These exchanges were not in any order. There were some organizations that existed before the applications came. The market issues may necessitate a comeback to production or delivery decisions, and local trials may influence the services provided in the future. Table 3 is an overview of the division of work, knowledge sources, and coordination needed in the main activities.

Table 3. Task division, knowledge sources and coordination requirements in digital applications.

Activity	work of special services	Contribution of farmers and local knowledge	Coordination needed
Irrigation and fertilization management	Operate equipment, interpret data and explain recommendations	Provide plot information and evaluate advice with respect to field conditions	Match farming schedules with digital information.
Review of the technical recommendations	Propose system recommendations and help tune them	Use farming experience to find differences between plots	It should allow to raise issues, give advice and report the results.
Digital marketing and delivery	Manage live-streaming, traceability displays, and platform feedback	Provide products that satisfy requirements and production information	coordinate records, product quality, packaging, and fulfillment

Source: Interviews, case materials and reference [26]. These arrangements are not proven to be contractual terms.

In all these operations, the local testing of the various methods was the basis of the farmers in the evaluation of unfamiliar ones, and the provision of the services was provided by the specialized service providers that could be used to perform the tasks on a regular basis. It was then based on the reports made by the growers and buyers that they were able to make another decision. The exchanges between farms and suppliers had to be kept participating. This is because it would be important as far as the working of the services was concerned since the information that farmers can receive, object, and get an answer.

7. Discussion

7.1. Digital Capability in Service Relationships

The access to the devices, the education level, age and the skills of a particular person are factors that influence the farmer in terms of using digital technology. In the case of Jiajiagou, it is evident that these steps should be also taken into consideration in addition to the services offered. Farmers who had no ability or desire to sustain the system of sensors could make use of its features as the work was being done by the technicians. The cooperation workers, farmers, and platform operators have provided their various abilities in the digitally assisted transactions. It was one of the capabilities which were made available with the help of the service relationship since they could collaborate.

This was a relationship where the need to know what each person had been doing. The farmers were required to explain the issues, evaluate the solutions and make decisions on whether they would accept the proposed actions. In their turn providers had to be available in cases when farm work needed to be done and the price that could be afforded by the households. These circumstances are partially covered by training sessions and installed terminals, which do not inform us about the actual

service we receive. It is also necessary to consider the evaluation of the people who were assisted, the duration of the responses, and the awareness of the farmer of the advice provided.

7.2. Knowledge Sharing in Service-based Scale Operation

The example of the case is a service-based scale operation that demonstrates the level of knowledge needed to operate a digital service. The movement of machines between farms will be able to scale in a relatively uniform area of work. The orchard suggestions are more vulnerable to plot differences. It may also require changing advice at one slope or stage of tree growth, but it can be applied in another place. With the development of digital services, there will be an opportunity to consolidate the specialist activities, however, there will be some information on the part of the growers that should be used to determine the use of the specialists.

This is how the information will be connected with the knowledge of specialists in this area. A service provider can benefit by having a focus on technical aspects and still has to find out what happens at every farm. It is part of the quality of service as well, which involves taking the feedbacks of the growers and applying it. The growth alone cannot guarantee that the suggestions will be relevant to the various plots. These exchanges are organized so that it would be possible to establish whether a particular service can work in large scale or not, depending on the local differences.

7.3. Professionalization and the role of farmers in decisions

In Jiajiagou, the process of professionalization has made it to take responsibility of some operations to professionals and left farmers to be involved in the effects of such actions. The experience is still used as a basis of making recommendations by the case materials that would justify the assumption that data and algorithms can only replace the growers judgment. It may also be possible to have a technician, and this could fit with a farmer who wants to describe the state of the orchard and then ask how he or she arrived at a particular advice and then disagree when it seems like an ill-advised suggestion. These are opportunities to participate.

There is also the threat of dependency in case one firm owns the equipment, information and the way it interprets the data. Even though they are not as busy with their work, the farmer might be less able to understand the advice that he or she gets. It needs responsibility to be made clear and the information provided should be easy to access. A farmer must know who gave a recommendation and what is involved in the recommendation and where to complain about it. Such chances will give them a better opportunity to evaluate their power than whether they can imitate the skills of a technician.

7.4. Making Cooperation More Predictable

There were a number of workers in the Jiajiagou who had to cross their boundaries. In fact, there was an agricultural business man and also a head of the village organization by name Zhao Zhongxiang. Such interlinking of positions assisted in making connections between the resources outside and local demands as well as mobilizing them into action. They are also left with the unanswered question of how long this arrangement will hold on. It is not possible to determine the degree of cooperation that was based on the organizational processes and the extent to which it was based on the trustworthiness of certain individuals and relationships.

The trust of people can be used to make a service, but the farmers should also have their own terms that are guaranteed by them. They must be aware of what they may access, when they may require assistance and how they may pay fees and how much. It would be necessary to explain who will revise the inappropriate advice, whether it is possible to see the data and what happens in case of losses or disputes. When village organizations or the resources of the public are involved in the commercial supply, then there is a need to bring accountability to society. In this way, the availability of household services has to be shown through the services that the farmers use; the possession of a digital facility by business does not mean the existence of such services.

7.5. Scope Conditions

Jiajiagou possessed a well-developed fruit industry, business organizations and powerful local actors. The production and marketing base of Yantai provided digital applications with specific issues to solve. The company and cooperative had roles that were supported by specialized personnel whereas the key players had relations within and outside the village. These circumstances restrict the extension of the findings to such an extent. The case is most informative in areas where there are some existing industrial and organizational capacity. In cases where markets are weak and providers are unable to maintain specialist staff; the development of viable service base may be more important than the installation of additional equipment.

The local trials, division of tasks, review of experience, and market feedback must also be viewed as interrelated processes that may overlap and repeat. They do not constitute a four-step path to digitalization. The paper describes the mechanisms in one environment and does not make comparisons between the performance of other organizational models. By reviewing failed services, withdrawal by farmers or stalled projects it would be possible to determine what relationships are required to participate and where the explanation becomes ineffective.

8. Conclusions and Further Studies

8.1. Main Conclusions

In the Jiajiagou case, it is possible to say that in order to offer digital agriculture to small holders, a specific service should be provided as they are not able to have an entire technical system of their own. The trials conducted locally were useful in determining the new methods and approaches by the growers who could not understand them on the basis of the known conditions. There was repetition of the digital work which was performed by technicians and operators whereas the review of recommendations was based on the knowledge of farmers. It also caused some modifications in the packaging to deliver. This work has been shared with the households farms and the service providers and the process of participation was created.

The implication of this is two fold. The house owners should have access to the professional skills and facilities which they are not able to manage on their own in a good way. They also require some form of participation in the decision making of production and the report of the effects. It is possible to be dependent on providers without being involved, but it is not possible to be independent of technical obstacles without the help of providers. This is important to a working digital service in terms of provision of assistance and management of knowledge among farmers.

8.2. Practical Implications

The digital-agriculture investment plans are supposed to have the services of the installation. The staff, maintenance and interpretation of data, parameters adjustment and the timely response require ongoing resources. It is possible that service organizations, cooperatives and village coordinators may be used as a point of contact with the scattered families. This should be evaluated by how much the farmers get help in these arrangements whether they reach smallholders or not.

The training must be based on the choices that farmers make. The growers should have sufficient knowledge to understand simple instructions, explain the situation in the fields, identify a problem and consult someone else in case of need. Technical personnel can still do more challenging technical jobs. This split will lighten the learning load on families but give the farmer an opportunity to participate in making decisions concerning his or her production.

The users should be informed of the rules of service. A farmer has to understand what a service comprises and how much is charged on it. It also needs to inform them of the information that are kept, who can access them, the procedure of requesting an explanation or challenging advice, as well as the procedure of handling losses. The coverage of services, time of responses, affordability, and

solving the issues reported can be monitored by project assessments in addition to the presence of facilities. This would make the farmers have more understanding of the practice.

8.3. Limitations and directions for future research

There are some weaknesses in the evidence. The leaders and the people who are involved are also present in the interviews, but the nonparticipants as well as the farmers who had stopped their services and the dispute participants are not so much seen. This is likely to be an underestimation of the problem and disagreement. It was impossible to evaluate the impacts on productivity, net income or even how benefits were distributed due to lack of long-term comparisons between groups of farmers, continuous production records and service-fee accounts. In addition, the materials do not necessarily make it possible to distinguish clearly between the operations conducted by the company bases and those that have been performed on behalf of normal houses. It has not been decided whether the changes would be able to endure with the change of key personnel.

It is possible to conduct further studies on the difference between the villages and the agricultural industries with various organizational backgrounds such as those in which services were not so effective or projects failed. The farm production data, contracts, and fees would be useful to measure the economic results of the farm and who benefits. It is also important to research the issue of ownership and usage of the farm data, the explanation of the algorithmic advice and the responsibility towards the losses that are caused by the recommendations. Such questions have a direct impact on the possibility of providing special services to lower technical barriers and at the same time allow farmers to make their own choices regarding their farms.

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