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Digitalization for Agricultural Value Chains in China and India:

practical examples of software platform-based solutions for smallholder producers

Editors:
Prasun Kumar Das
Michael Hamp

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Foreword

Application of information and communication technologies (ICT) solutions are being used extensively to improve the efficiency of agricultural value chains. The networked information and communication technologies (ICT) solutions, as a subset of the larger ICT, have three primary applications to value chains. First, it can facilitate or strengthen market linkages and provide accessibility to otherwise informal systems prevailing in developing countries. Secondly, the value chain actors can enhance productivity and incomes through improved efficiency and quality by integrating workable solutions into market operations. Lastly, the ICT may allow for better understanding, transparency, and service delivery to all actors in the value chains through well designed data retrieving system from internet.

Studies across the globe already proved that the smallholder producers in agriculture and allied sector commonly face a lack of technical expertise (production related), low farmer market power (asymmetries between producers and buyers), and high vulnerability to risks from pests, diseases, climate change, and/or other weather-related events (lack of access to the alert systems). A well-coordinated ICT solution could be able to improve the situation which however varies from region to region even within the country and the development agencies are sincerely looking for the suitable solutions to bring in equitable growth in agriculture. There are several factors that contribute to a lack of long-term sustainability, including inherent design challenges for ICT-business models, difficulties in receiving support from government and private investors, and more fundamental problems in navigating impact-oriented but profit-driven business strategies.

APRACA since last 43 year of its existence is in the forefront to rural revitalization and agricultural development by engaging with its member institutions spread over 24 countries in the Asia-Pacific region through provisions of technical and knowledge support in building their capacity to deliver requisite services to the last mile supported by rigorous research and development. We congratulate the International Fund for Agricultural Development (IFAD), the global leader in development finance and inclusive financial system development, for their generous funding in documenting the case studies from China and India on application of inclusive ICT solutions.

Keeping in view and the potential of right kind of software application which can generate real impact to the smallholder producers and the urgent need to document few ready, workable, and sustainable business models, This document on application of information technologies through detailed case studies from China and India which are based on some established and workable business models for ICT solutions with farmers as the primary beneficiary to reach the market and financial institutions. I believe that these good practices are relevant to both the APRACA member institutions and to IFAD partners and investments.

SENARATH BANDARA

Chief Executive Officer, Bank of Ceylon, Sri Lanka and Chairman, APRACA

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We also acknowledge the generous co-financing received from International Fund for Agricultural Development (IFAD) for documenting the case studies and reality check on the usage of ICT solutions in improving efficiency of the agricultural value chains in China and India.

The editors would like to put in record special gratitude to those individuals who prepared the case studies and the colleagues who provided valuable information and shared their insights and experiences and provided the requisite and appropriate information and data to synthesize four cases from China and India on usage of software based platforms in building efficient value chains to support smallholders in accessing markets and financial services.

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1. *Case Analysis on the Financial Operation Mode of China's Agricultural Industry Chain: An Example of Nixn Pig Industry Chain*: By Yueshu Zhou, Yujie Da (College of Finance, Nanjing Agricultural University, China), Ying Yu, Jinhuan Wang (Nxin Internet Technology Co., Ltd., Beijing, China).
2. *E-Commerce Platform-Driven Agricultural Value Chain Finance: The initiatives of Ant Financial in China*: By Longyao Zhang and Yuyun Xu (College of Finance, Nanjing Agricultural University, China).
3. *Digital Agriculture Value Chain Information system in India: A Case Study of Source Trace Systems*: By Sankar Datta and Sonakshi Anand on behalf of BASIX Consulting and Technology Services Ltd., India.
4. *Bridging the Gap with Technology in India: A Case Study of National Collateral Management Services, Ltd.*: By Sankar Datta and Sonakshi Anand on behalf of BASIX Consulting and Technology Services Ltd., India.

Last but not the least, the editors are also thankful to Mr. Chris Jarzombek for helping the editors in putting together all the case studies.

Prasun Kumar Das (APRACA)
Michael Hamp (IFAD)

Abbreviations

ACPC	Agricultural Credit Policy Council
ACE	Audit Control and Expertise
APMAS	Andhra Pradesh Mahila Abhivruddhi Society
APMC	Agricultural Produce Market Committee
AVC	Agriculture Value Chain
BCTS	Basix Consulting and Technology Services Ltd.
CEO	Chief Executive Officer
CM	Collateral Management/Collateral Manager
CNY	Chinese Yuan
CWIG	Crop, Weather and Price Intelligence Group
EFT	Electronic Funds Transfer
ESE™	eService Everywhere
FAO	Food and Agriculture Organization of the United Nations
FI	Financial Institution
FCI	Food Corporation of India
FPCs	Farmer Producer Companies
FPO	Farmer Producer Organization
GOI	Government of India
GSMN	Global System Management Network
HAFED	Haryana State Cooperative Supply and Marketing Federation Limited
HDFC	Housing Development Finance Corporation
HR	Human Resources
HYV	High Yielding Variety
ICICI	Industrial Credit and Investment Corporation of India Limited
ICS	Internal Control System
ICT	Information and Communication Technologies
IDBI	Industrial Development Bank of India
IFC	International Finance Corporation
IFFCO	Indian Farmers Fertilizer Cooperative Limited
INR	Indian Rupee
Kg	Kilogram
KVB	Karur Vysya Bank
KYC	Know Your Customer
MFIs	Micro Finance Institutions
MIS	Management Information System
MSP	Minimum Support Price
MT	Metric tonnes
NABARD	National Bank for Agriculture and Rural Development

NBFC	Non-Banking Finance Company
NFIN	NCML Finance
NCDEX	National Commodity and Derivatives Exchange Limited
NCML	National Collateral Management Services Limited
NEFT	National Electronic Funds Transfer
NFIN	NCML Finance Private Ltd.
NMPL	NCML MktYard Private Limited
NOP	National Organic Program
NPA	Non-performing asset
NPOP	National Program for Organic Production
Nxin	Nxin Internet Technology Co., Ltd.
QR Codes	Quick Response Codes
RBI	Reserve Bank of India
SaaS	Software-as-a-Service
SBI	State Bank of India
SEDF	Soros Economic Development Fund
SPEM	State Pig Exchange Market
STC	State Trading Corporation of India Ltd.
US$	United States Dollar
UP	Uttar Pradesh
US	United States
VC	Value Chain
WR	Warehouse Receipt
WRF	Warehouse Receipt Finance

Converion rate:

1 US$ = INR 65.5 (as on 31.08.2018)

= CNY 7.05 (as on 31.08.2018)

Executive Summary

1. As world population grows and as poorer people achieve greater financial inclusion[1], the demand for more and quality food also grows. Consumers are becoming increasingly concerned with how their food is produced; and they are demanding fairer treatment for producers along with production enhancements that ensure that food is safe, free of unwanted by-products and environmentally-sustainable. These developments are putting pressure on the producers and other players in the Agriculture Value Chain (AVC) to find ways to meet these expectations. Both the emerging and developing economies across the continents are responding to this demand, and rapidly moving from traditional methods of agricultural systems to more modern ones. They are adopting the technological innovations both in agriculture (Agritech) and information and communication technologies (ICT) to modernize the agri-food systems. According to an assessment from 55 existing ICT solutions in developing countries[2], nearly 80 percent of all solutions offered multiple services on these platforms, with over half offering three or more services. About 54 percent of the services receive tailored information on market prices and information on financial services.

2. Despite the profound changes mentioned above, the AVC in the emerging economies such as China and India remain fractured and inefficient which might be due to socio-economic-climatic diversity and large population of small producers who are incapable to adjust with the innovations (Agritech and ICT) to support the modernization drive. The AVC actors in China and India are geographically dispersed, loosely linked, and they share information only as needed. Further, they typically have working capital sufficient only to address immediate needs, which limits their ability to plan, scale up or even store products until sale prices are better. Financial institutions (FIs) are shying away in financing these "risky" players who have little to no credit history. These and other factors limit the effectiveness and potential scale of the AVC, but they also create opportunity.

3. Networked information and communication technologies (ICT) has profoundly improved the efficiency of value chains in other industries; and it can likewise could be able to elevate the agricultural industry also. As the AVC suffers from a lack of information, the networked ICT has the ability to capture, store and share valuable data, which has the potential to overcome some of the more severe agri-food market inefficiencies such as: (a) Supply and demand sides are poorly coordinated (*ICT can be used to enhance production and purchasing decisions*); (b) Producers lack knowledge about farm management (*ICT can be used to give them access to experts and information on best practices);* (c) Pricing asymmetry creates unfair advantages (*ICT can be used to make pricing transparent and provide access to competitors*); (d) Credit information is unavailable (*ICT can be used to accumulate and share information on producers and products which can be used to develop risk scores*); and (e) Consumers demand traceability *(ICT can be used to track products as they move through the value chain*).

4. The market for bringing ICT revolution to improve the efficiencies in the AVC is wide open, and some business houses (both private and public sector) are moving to fill the need. As the networked services becoming cheaper and more pervasive, eventually leading to build inclusive software platforms that address specific issues in agricultural value chains and share the resulting data with other players in the chain, creating a more holistic benefits and inclusive development.

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[1] According to the 2017 Global Findex database (World Bank) shows that 1.2 billion adults have obtained an account since 2011, including 515 million since 2014. Between 2014 and 2017, the share of adults who have an account with a financial institution or through a mobile money service rose globally from 62 percent to 69 percent;

[2] Feed the Future – US Government's Global hunger and food security initiatives (2017): Policy brief: Information and Communications Technology (ICT) solutions for inclusive Agricultural value chains; Available at https://www.agrilinks.org/sites/default/files/brief_5_-_ict_solutions_for_agricultural_value_chains.pdf

5. As per the latest available global production rankings for agricultural commodities finds China and India leading the league tables for many soft commodities of significance (FAOSTAT). In cereals, China and India rank number 1 and 2 respectively for wheat and rice; for maize, China is the second largest producer, however, Maize production in India is not that significant. India lead the production and consumption of milk and milk-products whereas China is the world's largest country for pig breeding and consumption[3]. The pig meat industry in China is directly related to the economy and large number of people's livelihoods in the country. The Chinese smallholders are moving from traditional methods of production and marketing to more modern ones; however, the product movements are facing significant regional differences in addition to insufficient access to financial services. India's geographic diversity produces a wealth of crop variety, but its wide expanse also makes it difficult to link the various small farmers and other AVC players. Lack of technological support to trace the commodities and minimal presence of professionally managed storage are posing major challenges, with as much as 10 percent of food product wasted as a result of poor product management.

6. This publication is a revelation of usage of the innovative ICT based network technologies in China and India to support access to markets, finance and information by the last mile actors in the agricultural value chains. This document spotlights how Nxin Internet Technology Co. Ltd. (*Nxin*) and *Ant Financial* have developed ICT interventions to the Chinese agricultural value chains. This also highlighted the role of technological platform SourceTrace and National Collateral Management Services Ltd. (NCML), a collateral management company in India in supporting smallholder farmer to improve their participation in value chain development.

6.1 Dabeinong is a leading high-tech agricultural enterprise in China. Through their subsidiary company, *Nxin* Internet Technology Co., Ltd., they offer a suite of software solutions that links multiple players in the agricultural value chains. The *Nxin* Mall platform is an online store that gives farmers increased access to agricultural input suppliers and offers transparency of pricing as well as built in safeguards to help prevent price gouging. The *SPEM* platform provides a market for the sale and purchase of live pigs, ensuring that the buyer understands the quality of the product being sold and ensuring that no product is past its sell-by date. Transactions are secure and guaranteed through the system. The pig farming platform provides standardized management tools and personalized support for day-to-day farming decisions and tracking of livestock down to the individual pig. Because detailed production data is recorded, producers receive warnings and reminders at every stage of the pig life-cycle, making it easier to manage processes and to track production. In addition, other tools provide for treatment of pig disease, including remote and automatic diagnosis and access to actual veterinarians when needed. The *Swine Disease* platform has benefitted over 354,000 users.[4] It has accumulated 361,800 cases, 133,900 through the automatic diagnosis platform and 229,900 through the manual Q&A platform. There were 258 articles on pig diseases published on the platform, with over 15,000 readings per article. The page view of the most favourite article and video on pig farming has exceeded 2.6 million. Each of these platforms is serviced by the *Nxin* financial platform. As transactions are processed across *Nxin* platforms, users can establish credit profiles. Built-in mechanisms ensure loan repayment (*Nxin* is repaid first on transactions) and wise use of financing (funds can only be used to purchase goods through *Nxin* online stores). In addition, *Nxin* financial provides wealth management and payment services and insurance products. The suite of platforms creates a closed network of actors and processes, greatly increasing the efficiency of the Chinese AVC.

[3] China's 2015 pork production was 52.99 million tonnes, accounting for 48.5 percent of the world's total pork production and 62 percent of China's total meat output of 85.4 million tonnes; *Source: China Agricultural year book 2015, Ministry of Agriculture and RURAL Affairs, People's Republic of China.*

[4] Figures as of July 2017.

6.2 Ant Financial is a technology company offering inclusive financial services globally. They offer payment, credit, insurance and integrated financial services in 1,000 counties in China through an integrated software platform. Ant Financial provides integrated software platforms using cloud-based services and a Software-as-a-Service (SaaS) model. The Ant Financial platform collects transactional data on farmers and traders which allows credit profiles to be created and direct financing to take place. Farmers receive financing and make purchases using the AliPay payment platform. Farmers can only use the funds to purchase agricultural inputs through the Rural Taobao platform which is an online store that provides price transparency and helps to eliminate middlemen and minimize logistical costs. Farmers sell their pigs to traders using the TMall platform, which has controls in place to ensure purchase commitments and to ensure that farmers first make loan repayments when transactions take place. The MyBank application provides an online banking account for users. The suite of products creates an integrated network of buyers, sellers and financers, making it easier for funds to be available when and where they are needed to close the gaps in the Chinese AVC.

6.3 SourceTrace is a new generation Social Enterprise that leverages the strength of ICT to fuel the growth in agriculture of the Green Revolution. As the name suggests, their technology provides complete visibility from field to market, and it tracks the value chain at the source, even in remote, low-bandwidth environments. They offer a software platform called *eService Everywhere (ESE™)* that uses the SaaS model and cloud-based networking. ESE provides extensive pre-production data and support that is accumulated and shared from numerous farms, including how and when to plant, what methods will be most successful and yield estimates. ESE allows farmers to capture extensive information on crops and crop production, providing tracking down to the individual piece with Quick Response (QR) code labels. Data can be collected in online or offline mode – for when internet access is unavailable – and uploaded to servers that track the movement of the product. Post-production, ESE tracks sales, distribution and processing. This data provides traceability on goods, and it can be used to certify a product's safety and quality throughout the value chain and to the end consumer. In addition, this product data is used to develop credit and risk profiles on producers so that they become more attractive clients to financial institutions. The ESE platform ensures visibility at each stage in the agriculture production process, helping streamline the Indian AVC.

6.4 National Collateral Management Services Limited (NCML) is India's leading post-harvest management organization, providing technology-enabled warehousing and supply chain solutions. NCML specializes in post-harvest intervention where the value of the product is a function of where, when and in what form (processed or unprocessed) it is sold. Their integrated software platforms help ensure product quality, value-added services and direct financing. NCML operates their own and third-party warehouses for storing agricultural products, and the Collateral Management platform provides logistics management of the warehouses and quality control for the housed products. Using the warehoused stock as collateral, the *N-Fin* platform provides warehouse receipt financing to farmers, giving them access to needed funding and allowing them to time the market for their goods. The *MktYard.com* platform provides an online store for transparent pricing for selling the warehoused stock. Together these NCML products address significant gaps in the Indian AVC by providing direct financing to the farmers who need it while also helping to ensure better overall product quality.

7. Each of the cases documented in China and India are the testimony of innovative application of ICT to agricultural practices which are considered to be successful due to the use of tailored network-based software platforms. These interventions have shown the capability of addressing the deficiencies in agricultural value chains, and they show significant promise for scale and wider implementation. Because these solutions integrate into existing value chains, they can strengthen linkages between players while minimizing significant disruptions to traditional roles and also can facilitate the financing needed at each node in the chain.

8. However, there remain challenges to address in implementation, uptake and scale these network-based ICT solutions in agricultural development space. Start-up costs can be significant for small players, and keeping pace with rapid changes in technology can be difficult even for larger players. Technological literacy is lacking in poor countries: despite widespread usage of mobile phones and similar devices, not every user is proficient enough to manage data entry let alone sophisticated management tools. Internet connectivity is usually limited in farming and storage areas, and while "offline" modes are becoming more common, the nearest upload point may be significantly far from where the tool is used. Finally, change is always difficult. It can be daunting to introduce new processes into work that has been unchanged for decades; and the disruptions that technology brings to players who thrive on inefficiencies create another type of resistance.

9. Despite these real obstacles, investors, donors and public institutions need to promote software interventions as the pathway to boost the efficiency of the agricultural systems. Over time, and with the aid of technology, the links in the value chain will become stronger; as information is made more available, it will create even more opportunity to improve production, facilitate price discovery; and as financing becomes easier, formally excluded value chain actors will have a greater chance to participate and profit from this development.

10. This study report also helped to explore innovative and effective models and approaches for extending services to sustainable market and access to finance in rural households and communities. The report has been presented in five chapters of which C*hapter 1* presents a brief overview on the new trends in food systems (production and consumption), concepts and models in understanding agricultural value chains (movement of commodities from production till consumption), and explains the importance of network-based information technology platforms to support improving its efficiency. *Chapter 2* synthesizes and highlights the key findings from four cases documented from China and India to understand the benefits of ICT in reaching out to the value chain actors (with special reference to the producers) to support in accessing markets and financial services. *Chapter 3* offered *two (2)* compact examples and details analysis on best practices of network-based ICT solution trends in China to support access to market and access to finance by the small-scale producers. *Chapter 4* provided two (2) detailed case analysis from India to showcase the efforts initiated by using the ICT based solutions to address the deficiencies in the agricultural value chains. The *Chapter 5* consists of the lessons learned from the documented cases of two major developing countries and the way forward in replicating the best practices of reaching out to the fragmented smallholder communities and provide them more opportunities in improving their efficiencies and participation in the value chains.

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CHAPTER 1

INTRODUCTION

1.1 Background

Agriculture is a sector that holds great promise for pro-poor economic growth. Economic growth is a key success factor for reducing undernourishment, but it has to be inclusive and provide opportunities for improving the livelihoods of the poor. Enhancing the productivity and incomes of smallholder family farmers is the key to progress[5]. In fact, agriculture is around four times more effective at raising incomes among the poor than other sectors.The agriculture and food sector remained as one of the few bright spots in otherwise troubled global economy during last two decades. With strong underlying growth driver such as demographic changes (increase in population, urbanization, and the rise of the middle classes etc.) as the growth driver, it is expected that this sector will gain more importance in next decade. This sector of the economy enjoys enormous political support as food security tops national government agendas. On the other hand, the sector is also facing plethora of challenges driven by climate change, technological innovations, emerging market trends and access to information. These forces are directly impacting the volatility, complexity and scrutiny throughout the value chain of agricultural commodities and its movements.

1.1.1 Food production and consumption: New trends

Over the past century, enormous progress has been achieved worldwide in improving food production, marketing, processing and distribution systems which are in line with the radical changes in the patterns of consumption due to the evolving global value chains. As world population grows, demand for food likewise increases. As poorer people gain greater financial inclusion, their demand for more and higher-quality foods also increases. The International Institute for Environment and Development[6] indicated that not only urban citizens but also increasingly peri-urban and rural people eat fewer staple grains, more animal and dairy products, more processed food and a much greater proportion of food is consumed outside of the home. Changing consumption patterns and shifts in consumer behaviour, such as the desire for more varieties and flavours, appear to be the driving forces in this dietary transition. Increased income is also playing an important role in enhanced consumption, for example in China, increased consumption of livestock products is closely associated with their disposable income.

The Asian subcontinent is growing at an unprecedented rate, with economies such as China and India as vanguards apart from the developed economies like, Japan, Republic of Korea and Malaysia. The rising dragons of Vietnam and Thailand are also rapidly progressing on the economic growth trajectory along with the countries like Philippines and Indonesia. Asia is transitioning and this is also reflected in its diet. It is replacing its staple, rice, and consuming more like the western countries. Global production rankings for agricultural commodities find China and India leading the league tables for many soft commodities of significance. Indonesia and Malaysia head the list of the world's palm oil producers (87 percent of world total). In cereals, China and India rank number 1 and 2 respectively for wheat and rice; for maize, China is the second largest producer. Asian countries are also leading

5 FAO http://www.fao.org/hunger/key-messages/en/

6 IIED, "Food consumption, urbanisation and rural transformation," Working Paper (London, May 2016).

producers of cash crops, with China and India taking the top two slots in that order for cotton and tea. India is second only to Brazil amongst the top sugar producers in the world. Vietnam holds the second spot among global coffee producers, with Indonesia and India also in the top five. Natural rubber is also dominated by Asian countries, led by Thailand, Indonesia, Vietnam and India in that order. India continues to be the world's largest spice producer. Asia's population is expected to increase from 4.3 billion in 2015 to 5.1 billion by 2050. Specifically, Asia's two giant economies – the People's Republic of China and India – are already enormous players within the global food system. For example, China and India together account for 28 percent of world cereal consumption and nearly 40 percent of palm oil consumption. China alone accounts for 25 percent and 27 percent respectively of world soy and meat consumption. Asia's importance for food markets is becoming amplified by higher economic growth in Asian economies, which will have an impact on both the composition and the level of food consumption (FAOSTAT).

1.1.2 Demand for food quality, fair trade and traceability

Recently, consumers have become more interested in how their food is produced. They have begun to insist on food products being "fair trade," meaning that they want to make sure that the people producing the food are getting a fair value for their work, not just the middlemen who move the food. Additionally, consumers demand confidence in the safety and security of their food; they want to know that it was produced under safe, humane and environmentally-sustainable conditions. This requirement has led to a demand for quality goods, ones that have been produced with minimal or no harsh ingredients. Although the terms "fair" and "quality" can be ambiguous (and thus subject to abuse), overall, they do drive higher standards for food production.

Where food comes from is important not only for ensuring customer satisfaction, it is necessary for ensuring food safety. When food-borne illnesses strike, governments need the ability to determine where food originated and where it has been in order to prevent additional harm. Unfortunately, the demand for traceability, along with greater variety and quantity has meant increased cost to food. As Europeans insisted on certified agricultural products, Asian suppliers could not accommodate these demands, and this situation was likely a factor in the spike in worldwide food prices of a decade ago. Traditional low-productivity farming methods simply could not meet the needs of a global market; in order to survive, suppliers are racing to become part of the high-productivity agricultural sector.

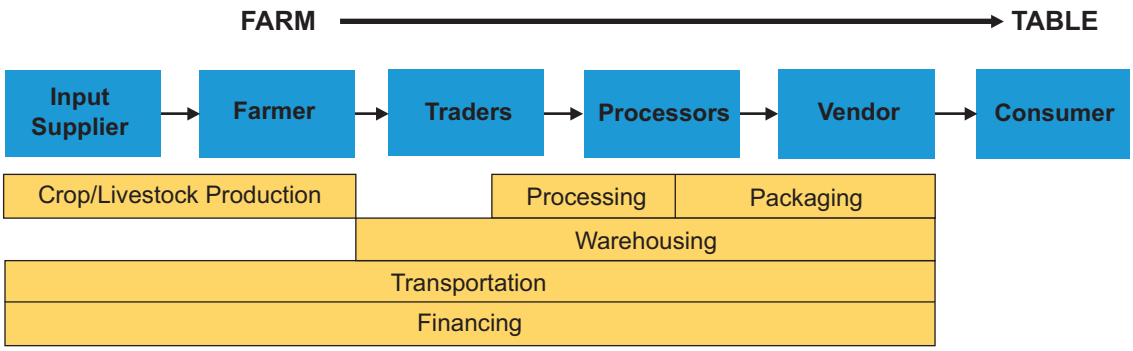
However, meeting the demands of a global market does not mean simply "producing more", it means becoming a critical link in the agricultural value chain.

1.1.3 Actors in Agriculture Value Chains (AVC)

The agriculture value chain (AVC) is a shorthand term for all of the players and processes that make it possible for food to be produced and consumed. In the simplest sense, food moves "from farm to table"; and while most people can envision a farmer growing produce and a consumer who ultimately eats it, in fact, the AVC is quite a bit more complex, involving scores of individual players and dozens of processes and transactions. *Figure 1* below provides a (still simplified) diagram of the AVC.

There are numerous players in the AVC. The following list provides a brief description of each type of player and the role they play in the AVC. This list should not be considered exhaustive.

Figure 1: Simplified AVC



Source: Illustration by editors

- ***Input suppliers*:** Food production cannot even begin without certain basic materials. Raising produce requires seed, fertilizer and pesticides; raising livestock requires feed and vaccinations. Food production often requires specialized tools or equipment (e.g. harvesting equipment, fencing for animals). Input suppliers includes all those companies who produce and sell these raw ingredients and devices. It can also include professional services (e.g. consultative farmers, veterinarians).
- ***Farmers/Producers*:** Farmers are the people who grow produce (fruits, vegetables, grains) or raise livestock (pigs, cows, chickens). They may be small-scale individuals with small plots of land or individuals operating as part of a larger cooperative like a Farmer Producer Organization (FPO), or a large conglomerate producing food on a large scale.
- ***Food processors*:** Food processing includes any player who modifies (and adds value) to the product after it leaves the farmer's hands. This list includes players like slaughterhouses and mills that transform the raw product to make it easier to easier to sell or consume, but it also includes ancillary production players like packagers and marketers.
- ***Traders, sellers, vendors*:** Anyone who buys and/or sells the agricultural product is a link in the chain from farm to table. These players are often generically referred to as "middlemen."
- ***Transporters*:** Agricultural products must be moved from farm to table, and that requires transportation and logistics services.
- ***Warehouse operators*:** Between farm and table, food must often be stored and maintained safely and securely, which requires warehouses and related services.
- ***Financiers*:** Banks and other financial institutions (FIs) are critical to the AVC as access to credit can be the difference between a successful and unsuccessful player in the chain.
- ***Consumers*:** Consumers are the ultimate purchasers of food products. Their demand drives the entire process.

1.1.4 Factors influencing efficiencies of AVCs

The *Figure 1* above provides an idealized model of the AVC, with agricultural products moving smoothly from production to consumption in an efficient, fair and transparent market. In fact, the AVCs are quite disorganized and inefficient in most of the underdeveloped countries and in case of developing countries it is an emerging and focused area. In underdeveloped countries, the agricultural market a loose conglomeration of supply side actors and demand side actors who are geographically dispersed, typically know little about the needs of the other and have limited means to address those needs.

There are numerous gaps in the market, including the following:

- *Production*: producers grow and raise what food they can in hopes of selling their product, but production is seldom informed by actual demand, which leads to wastage as a result of over production and unacceptable product quality.
- *Transportation*: poor resource management means that vehicles are often unavailable when needed or carry empty loads leading to wastage and higher fuel costs.
- *Relationships*: many players in the AVC understand only their immediate role in the food production process, and relationships are often fairly simplistic one-on-one agreements. What is needed is a greater alignment of business partners and better integration of need and need-fulfilment so that gaps in the market can be filled.

Apart from the above primary impediments, the low information, non-transparent pricing, limited financing and lack of storage facilities are also important factors that create market inefficiencies. These issues are described in greater detail below:

- *Low information/information asymmetry:* The information necessary to make knowledgeable decisions is limited if not lacking altogether in poorer markets. Limited information means little opportunity to see trends, foresee problems or to leverage best practices.
- *Non-transparent pricing:* At harvest, farmers lack information on best price, and so they must settle for whatever is offered; similarly, they know little about competitive pricing on agricultural inputs, and so may pay more. To a certain extent, all players suffer from this lack of transparency, as no one can be sure that they are paying the best price or getting the best product available.
- *Limited financial services:* Financial services are not much deepened for the value chain actors in the underdeveloped countries. Farmers are often desperate to sell their product immediately upon harvest in order to have enough cash on hand to begin the next production cycle. This situation means that farmers (and some other players) typically settle for lower prices and rarely have stock on hand to use as collateral for credit (Box 1). Less capital means lower production capability, reduced opportunity for planning or scaling up, and little if any resources for insurance against loss. Furthermore, farmers in the underdeveloped countries often lack the financial literacy needed to take advantage of such services in any case. As a result, farmers (and others) remain locked in a survival mode and mostly dependent on *internal*[7] financing system, whereas in developing and developed countries, both the *internal* and *external*[8] financing system work efficiently.
- *Poor storage capability:* Adequate storage facilities are lacking, both in number and in quality, especially in underdeveloped countries[9]. What facilities do exist often have poor management and security in place; and even when good facilities are available, farmers can rarely take advantage of them because they lack the necessary funds. Without access to storage, farmers cannot take advantage of time-delay pricing: harvest prices are typically lower because of surplus, but food that is stored can command higher prices when stocks are in greater demand. Likewise, storage facilities can often offer other processing services (e.g. cleaning, drying, packaging) that can add even greater value to the farmer's stock. This lack of storage denies farmers a mechanism for collateral that could be used to acquire financing.

[7] Internal financing is more common in the developing and underdeveloped economies where one of the value chain actors finance other actors. For example, input suppliers sell requisite inputs to the farmers who repay after harvest either by cash or kind (harvested products).

[8] External Financing are being supplied to the actors by the formal financial institutions outside of the AVC and willing to take the risks as a business model.

[9] The World Resources Institute (WRI) in 2015 estimated that Asia, with 17% of food produced subject to losses, compares well with developed economies of North America & Oceania (42%), industrialised Asia (24%) and Europe (22%). While the developed world incurs losses largely at the (downstream) consumption level, losses in South and South East Asia are mainly at the (upstream) production, handling and storage levels.

Box 1: Improving the AVC through financial linking/direct financing

Time and again, it has been proved that the efficiency of AVC could be significantly improved by greater access to credit and other direct financial services such as:

Immediate access to funds when needed: Buyers can only purchase product for which they have cash on hand. However, with access to credit, they could purchase significantly more, not only increasing volume but likely reducing cost per unit because they could buy in bulk. Farmers who bought agricultural inputs on credit could likely produce more and better-quality product; and they could avoid settling for lower sell prices out of desperation. Further, with access to credit, farmers or traders could take advantage of warehousing and processing services that could increase the ultimate sale price of products. Throughout the AVC, all players could benefit with more immediate access to capital. Credit facilitates planning and better management, and it can provide a buffer against loss.

Swift reconciliation: Better financial linkages could also benefit AVC players. Rather than rely on physical checks or carrying cash, sellers could receive quick electronic payments, making funds immediately available for use for purchasing or investment. With linkages to financial services, players would also have better access to other financial products such as savings, investment and insurance. Linkages benefit creditors as well, because loan repayment can be made as part of the transaction settlement process.

Lowered risk: Ultimately, financing can produce a "virtuous circle": as players take advantage of credit services, they can improve their outputs, establish their credit rating, and thus make themselves more credit-worthy. Networks of input and output providers can ensure that available funds are always re-circulated, reducing loss to fraud and risky behaviour, and ensuring a growing market.

Source: Compilation by editor

1.1.5 Application of Information Technology for improved AVCs

The application of new generation Information and Communication Technologies (ICT) already proved its potential to make the AVC significantly more efficient and sustainable in many parts of the world. The software platforms tailored to support the efficient movement of goods and services along the agricultural value chains are increasingly becoming popular in developing countries and huge amount of success stories are being documented. There are many examples of networked ICT usage in agricultural development, however, some of them are exclusively impacting the movement of products and finances along the value chain.

- *Disruptive technologies:* As technology improves, it often causes disruptions to existing markets, and the agricultural industry is no exception. Information and Communication Technologies (ICT) are making the AVC more transparent by making information (competitive pricing, alternate vendors) more widely available. ICT is also displacing some players, especially some middlemen, who often benefit from information asymmetry.
- *Information access:* The AVC suffers from a lack of available and transparent information. With internet access and published data, players could have access to pricing information, stock information and credit information. Such transparency increases competition among players, creates better quality assurance, provides important historical information to creditors, and makes credit and risk scoring possible. Likewise, shared information can improve production, as farmers gain access to best practices and expert advice.
- *Stock management and traceability:* Farmers and warehouse operators can benefit from improved data on their products. With handheld devices, livestock farmers can capture and keep track of stock at the individual animal level, and they can share images for better diagnosis of disease or infestation. Warehouse managers can achieve better stock management, tracking the amount and quality of stored goods while also ensuring their safety and security. Simple Quick Response (QR) codes can be placed on animals or goods, providing a wealth of information and product traceability.
- *Blockchain Technologies:* The Distributed Ledger Technology (DLT) popularly known as Blockchain technologies which is a decentralized system for recording transactions with mechanisms for processing, validating and authorizing transactions that are then recorded on an immutable ledger of the actors in the agricultural value chains. It is expected that in the

agriculture domain, self-executing smart contracts together with automated payments would be the game changer. The process of designing, verifying, implementing and enforcing smart contracts in traditional agricultural value chains is still a work in progress, with only a few pilot implementations to show proof-of-concept. In the financial service support sector, some innovations already started providing an alternative financial infrastructure for the aid industry built on blockchain technology. It provides end to end real time tracking, providing complete and immutable data for reporting, auditing and compliance trails.

- *ICT market in AVC:* The market for ICT solutions in AVC is expanding as multiple companies see the enormous potential. Technology companies are introducing software platforms that address numerous deficiencies in the market, while also allowing multiple players to work together, exchanging information, transacting goods and services, and providing payment and financing. Many of these products are developed using the Software-as-a-Service (SaaS) model, which means that users pay a fee to use the software (or some subset of its features) rather than own it outright. The advantage of the SaaS model is that it offers a lower threshold to entry. The provider can make updates (new features and services) that become available to all users. The model allows for client customization, but it also makes the product more "standard" such that all users fit the same data and transaction formats, which makes it easier to bring together diverse players and industries.

1.2 Objectives and methodology of preparing this report

This publication aims to showcase some relevant and excusive examples in two large economies in Asian continent (China and India) who are driving the global growth during the last decade. This publication will help the countries in Asian region to learn about the effective use of Information and Communication Technologies (ICT) solutions which are being used extensively in these two countries to improve the efficiency of movements in agricultural goods and services. The publication also pointed out that how a well-coordinated ICT solution able to improve the situation which however varies from region to region even within the country. This document may also support the development agencies who are looking for some suitable solutions to bring in equitable growth in agriculture and its value chains.

The publication synthesizes four cases, two each from China and India on usage of software-based platforms in building efficient value chains to support smallholders in accessing markets and financial services as a subset of the larger ICT applications to value chains. These in-country case studies serve to illustrate a number of issues associated with use of software-based platform to support to agricultural value chains in greater detail. Information were collected by the experts from primary and secondary sources through interviews and publicly available reports, documents and statistics, contacts to relevant organisations in the respective countries, and field visits.

CHAPTER 2

NETWORK BASED SOFTWARE PLATFORMS TO SUPPORT AGRICULTURAL VALUE CHAINS

The network-based software platforms as an extended facility available in ICT have been a significant contributor to growth and socio-economic development in business sectors, countries and regions where they are well adopted and integrated. The large adoption and integration of ICT network-based platforms have improved service delivery, created new jobs (while making some older ones less relevant), generated new revenue streams and saved money. Many interventions in this subsector of ICT application have been developed and tested around the world, with varied degrees of success, to help agriculturists improve their livelihoods through increased agricultural productivity and incomes, and reduction in risks.

2.1 Network based ICT support to AVC: Chinese context

China is the world's largest country for pig breeding and pork consumption. Pork is the main source of animal protein, and the industry is directly related to the economy and people's livelihood. Nevertheless, the industry is highly inefficient: it has underdeveloped production and management methods; poor linkages among players; and insufficient financing efforts. China is moving from traditional agricultural methods to modern ones. However, the development of a tightly-linked AVC is daunting partially due to China's strong regional differences which can be hard to bridge, but also as a result of insufficient financing opportunities, especially among the poorer players.

China is one of the world's oldest agricultural societies and at the same time it has one of the fastest growing e-commerce sectors in the world, with highly adapted mobile payment systems and the most rapid 4G network expansion of any country. It's no surprise that Chinese agriculture and e-commerce are coming together in a big way. It is estimated that the agricultural E-commerce accounts for only 3 percent of the total agriculture trades in the country being supported by nearly 4,000 e-commerce platforms with a total transaction of roughly RMB 100 billion (US$ 16.1 billion)[10]. The rural Chinese e-commerce has undergone rapid development in recent years, with volume increasing every year. The synthesis below presents two efforts to address the Chinese AVC deficiencies: the Dabeinong model and the Ant Financial model to support the smallholder producers to access the markets and finance respectively.

2.1.1 Revolution in Chinese Pig Industry: *Nxin* model

Dabeinong is a leading high-tech agricultural enterprise in China. Through their subsidiary company, Nxin Internet Technology Co., Ltd. (*Nxin*), they have developed a suite of software products that address deficiencies in the Chinese AVC. These products include: (a) Nxin Mall: a business-to-business (B2B) online store that facilitates the sale and purchase of agricultural-related products; (b) Internet + pig farming: a farm management tool that allows farmers to track information on individual pigs; it provides

[10] Technode (2015): China's E-Commerce Boom Set to Overhaul Agriculture; https://technode.com/2015/08/21/e-commerce-agriculture/

information and services to improve production; (c) SPEM: an online store that facilitates the sale and purchase of livestock; and (d) Nxin Finance: a money management service that includes credit, loans, wealth management, payment and insurance products.

How it works

The *Nxin* platforms work within the AVC, assisting the players and making transactions more efficient. *Input suppliers* sell their goods and services using the online Nxin Mall platform where they have access to numerous clients, can better track their supplies and sales, and receive assured payments. *Farmers* buy their agricultural inputs on the Nxin Mall where they have access to a greater variety of products and transparent pricing. During production (raising livestock), *farmers* have access to consultation services through the Pig Farming Platform where they can utilize management tools for tracking individual pigs, receive instruction on farming best practices, diagnose disease and render treatment when problems arise. Once livestock is ready for sale, *farmers* can sell their pigs through SPEM, where they can track livestock quality and quantity, have access to numerous buyers, and can compete for better sales price. *Traders* purchase the livestock through SPEM, where they have access to numerous sellers, can be assured of product quality and quantity, and can quickly settle transactions.The platforms share information so that credit profiles can be established on the players. Through the Nxin Financial platform *input suppliers* can receive distribution loans, *farmers* can receive farming loans, and *traders* can receive purchasing loans; and because the loans are provided on the basis of using the funds within the platform, Nxin ensures a complete cycle whereby funds are used to make purchases within the AVC, and loan repayments are made at the time of transaction settlement.

Product features and benefits

Nxin products are provided using the SaaS model: users pay to use the features of the software rather than own the software. The products are integrated such that data is shared among the platforms and is available through cloud-based servers. Nxin Mall and SPEM each bring together buyers and sellers in an integrated online marketplace. Nxin Mall gives farmers increased access to agricultural input suppliers and offers transparency of pricing as well as built in safeguards to help prevent price gouging. The data analysis tools help to link buyers to appropriate sellers based on their needs while also minimizing logistical costs. SPEM collects information about live pigs, ensuring that the buyer understands the quality of the product being sold and ensuring that no product is past its sell-by date. Transactions are secure and guaranteed through the system. The shared data allows for transparent pricing, more efficient planning and procurement, transparent pricing, and online auctions.

- *Pig farming platform* provides standardized management tools and personalized support for day-to-day farming decisions and tracking of livestock down to the individual pig. The system records detailed production data and offers warnings and reminders at every stage of the pig life-cycle, making it easier to manage processes and to track production. As this data is stored and shared in the cloud, production data and analysis are used to provide overall understanding of the pig production and give farmers metrics against which to measure their own progress. Other tools provide for treatment of pig disease, including remote and automatic diagnosis of disease, an online veterinary system that provides access to actual doctors, Q&A tools and even live doctors when needed. The system offers early warning monitors and forecasts, and it can even offer preventative information. A classroom module provides additional opportunities for self-learning.
- *Nxin financial* primarily benefits the AVC by making needed financing available. By collecting data on users based on personal information and historical transactions across Nxin platforms, users can establish credit profiles. Built-in mechanisms ensure loan repayment (*Nxin* is repaid first on transactions) and wise use of financing (funds can only be used to purchase goods through *Nxin* online stores). In addition, Nxin financial provides wealth management and payment services and insurance products.

The table below (*Table 1*) showing the product wise features and their benefits of the software platform developed by *Nxin* to support improved value chains of pig breeding, production, market and financing:

Table 1: Benefits of *Nxin* platforms

Product	Features	Benefits
Nxin Mall	Online sales platform for agricultural materials	• *Input suppliers*: access to more buyers and ensured sales as farmer financing must be used to buy inputs • *Farmers*: access to more sellers and transparent pricing
SPEM	Online sales and auction platform for live pigs	• *Farmers*: greater access to sellers • *Traders*: access to more sellers and better quality goods
Pig Farming Platform	• Farm management • Disease treatment • Shared data/knowledge base	• Better farm management • Healthier livestock (more product/less loss) • Disease prevention and treatment
Nxin Financial	• Ready access to financing • Payment services • Wealth management • Insurance	• Better credit information, as user transaction history is accumulated and stored • Lowered risk, as funds are used within the AVC • Ensured repayments, as transaction reconciliations pay lender first • Swift settlement of transactions

With these products, Nxin Internet aims to promote the transformation and upgrading of agricultural industry and to ensure its healthy and sustainable development.

2.1.2 Ant Financial model

Ant Financial is a technological service provider company established by AliPay (company promoted by Alibaba, the global online marketing giant) offering inclusive financial services in China and other parts of the globe. They offer payment, credit, insurance and integrated financial services in 1,000 counties in China through an integrated software platform. Their software offering includes the following applications: (a) *Ant Financial*: offering financing and insurance to AVC players; (b) *AliPay*: the world's largest online and mobile payment platform (mobile wallet); (c) *Rural Taobao*: an online agricultural products platform; (d) *TMall*: an online livestock sales platform; and (e) *MyBank*: a private online (cloud-based) bank.

How it works

Ant Financial works within the agricultural value chains with special focus on smallholder farmers. The *Traders* agree to purchase stock from *farmers*, and *farmers* take out production loans through the *Ant Financial* platform based on this agreement. The funds are disbursed through the *AliPay* platform and can only be used to purchase agricultural inputs on *Rural Taobao*. Upon sale of livestock, the *farmer* first re-pays *Ant Financial*. The *trader* sells the purchased stock on the *TMall* platform which has additional risk controls with *Ant Financial* should the *trader* fail to live up to the purchase agreement. Because the platforms work together, they share important information about the farmers, traders, transactions, and stock quality and quantity.

Product features and benefits

Ant Financial products are provided using the SaaS model: users pay to use the features of the software rather than own the software. The products are integrated such that data is shared among the platforms and is available through cloud-based servers.

- *Ant Financial* collects personal and transactional data on farmers and traders which allows credit profiles to be created. It provides also insurance products.
- *AliPay* is an online payment platform that allows users to send and receive monies. Farmers receive financing through the application and make purchases using the application which helps to ensure wise usage of funds, because only agricultural inputs can be purchased. Similarly, as traders purchase pigs from farmers, transactions are reconciled through AliPay, which ensures that loan repayment is made first.
- *Rural Taobao* is an online store for agricultural products. It creates a marketplace for goods that allows farmers to purchase products. It provides price transparency for buyers and helps to eliminate middlemen and minimize logistical costs.
- *TMall* provides an online platform for traders to sell purchased pigs. It has controls in place with Ant Financial that ensures traders follow through with their purchase commitments.
- *MyBank* is an online cloud-based bank available to AVC players.

Together, the platforms create a closed system wherein funds are guaranteed and re-invested and circulated through the AVC. Shared data creates better communication among players. Table 2 below shows the product wise features and their benefits:

Table 2: Benefits of Ant Financial platforms

Product	Features	Benefits
Ant Financial	• Ready access to financing • Insurance	• Better credit information, as user transaction history is accumulated and stored • Lowered risk, as funds are used within the AVC • Ensured repayments, as transaction reconciliations pay lender first
AliPay	Payment platform	• Swift settlement of transactions
Rural Taobao	Online sales platform for agricultural materials	• *Input suppliers*: access to more buyers and ensured sales as farmer financing must be used to buy inputs • *Farmers*: access to more sellers and transparent pricing • *Financiers*: risk controls on loans to farmers
TMall	Online sales and auction platform for live pigs	• *Farmers:* access to more buyers • *Traders*: access to more sellers and better quality goods • *Financiers*: risk controls on loans to traders
MyBank	Cloud-based banking	• Secured online accounts

2.2 Network based ICT support to AVC: Indian context

Agriculture, with its allied sectors, is the largest source of livelihoods in India. In 2017-2018, total food grain production was estimated at 275 million metric tonnes (MT). India is the second largest producer of largest producer of rice, wheat, sugarcane, cotton and groundnuts. India is also the second-largest fruit and vegetable producer, accounting for 10.9 percent and 8.6 percent of the world fruit and vegetable production, respectively (FAOSTAT). Agriculture plays an important role in the

rural development of the country and it is an essential link in the value chains of the manufacturing sector. In India, the marketable surplus of agricultural commodities has shown a healthy and growing trend during last 2011 till 2017. India also has the largest number of farmers practicing, but it ranks ninth in terms of total land area cultivated. This has progressively moved Indian agriculture from being a subsistence enterprise in the pre-green revolution period to a market-oriented, commercial production, with increased market surplus. The need for an efficient marketing system is needed to enable fast and effective movement of goods from producers to consumers.

There is also a sea change in the demand from the consumers who are demanding more knowledge about the commodities (traceability) and its fair-trade which are almost absent in most of the commodities available in the market. This situation is largely the result of the Indian market being made of small farmers with small and dispersed land holdings. Unfortunately, this expanse also means that farmers are separated geographically, transportation and linkages within the value chain actors are poor, and food storage is lacking, leading to preventable product loss of as much as 16 percent. The lack of collateral means that farmers are largely excluded from credit services. On the positive side, India is rapidly adopting mobile technologies and it is expected that it will overtake the US by 2020 in the number of mobile phone users. The other varieties of ICT application in agricultural systems are being piloted and proved to be successful. The synthesis below presents two efforts e.g. the *SourceTrace* model and the NCML model to address the inefficiencies in agricultural value chain in India.

2.2.1 *SourceTrace* model

SourceTrace is a new generation Social Enterprise that leverages the strength of ICT to fuel the growth in agriculture of the Green Revolution. As the name suggests, their technology provides complete visibility from field to market and tracks the value chain at the source, even in remote, low-bandwidth environments. *SourceTrace* specializes in software focused on sustainable agriculture and empowerment of small-holder farmers in developing economies. Their farmer-centric mobile applications help manage the AVC from the first to the last mile, enabling smallholder farmers to participate in global markets. *SourceTrace* mobile applications can be used by all players in the AVC, from small co-operatives, farmer producer companies to large agribusiness corporations and government agencies working in the sustainable development sector. SourceTrace offers a software platform called eService Everywhere (ESE™) that addresses key needs in the Indian AVC. Using the SaaS model, the platform provides the services like (a) *data collection*: users can capture product information in online and offline modes (for when internet connectivity is unavailable); (b) *credit information*: Risk is managed by providing information on farmers and their product to potential lenders; and (c) *traceability*: players in the AVC can verify the provenance for products, helping to certify its safety and quality.

How it works

ESE™ provides services and collects data throughout the AVC. *Farmers* are provided with tools that help them manage their farm. These tools include features such as geo-tagging of farms (assists with weather and geographic information), farm distribution and crop area mapping (how best to lay out crops), activity calendar (when to sow, fertilize, harvest), pest and disease monitoring, yield estimates and crop certification. *Processors* and *warehouse operators* have access to warehouse monitoring and process plant monitoring. *Traders* and other middlemen have access to tools such as procurement tools, product tracking, payment management and sales management. *Processors* and *warehouse operators* have access to tools to manage and track stock. Traceability features in all services. The data collection is stored and shared such that financiers have access to credit information and can make loans to the various players.

Product features and benefits

The **ESE™** application is standardized, so that different crops and their value chains can be incorporated with minimal customization, making the reach and potential of **ESE™** much greater. With the ability to capture all the information about the sowing, cropping patterns, soil type, land owned, social status, income status, etc., the application covers all the necessary information needed for ensuring better source traceability and transparency. FIs can use this information to calculate risks and be confident when providing financing for small holder producers. Consumers can trace their produce back to the farmers, and certification of farmers is made an easier and more inclusive process. Table 3 below provides an overview of how the AVC players benefit from the features of the ESE™ platform.

Table 3: Features of ESE™ platform

Players	Benefits of using ESE™
Farmers	• Farmer account management • Geo-tagging of farm • Crop area mapping • Yield estimate • Farm distribution Management • Crop activity counter • Crop and farm inspection • Pest/disease monitor
Traders	• Product certification • Payment management
Processors	• Product transfer tracking • Processing plant monitoring • Warehouse stock management
Vendors	• Retail sales management • Product sales management • Traceability

2.2.2 NCML model

National Collateral Management Services Limited (NCML) is India's leading post-harvest management organization, providing technology-enabled warehousing and supply chain solutions. NCML specializes in post-harvest intervention where the value of the product is a function of where, when and in what form (processed or unprocessed) it is sold. NCML has developed a software platform that addresses the problems of financing and storage in the AVC. It includes the products and features such as: (a) *Crop Weather and Price Intelligence Group (CWIG*) which provides weather and pricing information to producers and insurers; (b) *Collateral management (NCML)* and provides quality and logistics management of warehoused products; (c) *NFIN* supplies warehouse receipt financing; and (d) *MktYard.com* which facilitates transparent pricing and sales of warehoused stock.

How it works

NCML model of services to agricultural system integrates into the value chains. Beginning in the pre-harvest stage, *CWIG* provides *farmers* (and other stakeholders such as Insurers) with weather and pricing data which can aid in crop production. Once the *farmer* is ready to release the harvest, *NCML* has warehouse facilities available. As *warehouse operator*, NCML takes charge of the product, measures its quality and quantity, and provides additional processing services as desired. *NCML* issues a receipt for the product which certifies its value and secured status. With this quality assurance, *NFIN* can

provide financing to the *farmer*, which alleviates the need for distressed sales and can provide resources for value-add processing services from the warehouse (e.g. drying) in addition to capital for the next harvest. *MktYard.com* is an online sales platform which provides the *farmer* with access to multiple purchasers and further reduces the risk of financing as there are available buyers for the product. Likewise, *vendors* and *traders* have greater access to products and can be assured of their quality. The platform allows for a closed and more efficient cycle with advantages for all AVC players.

***Product features and benefits*:**

The services provided by the entities under the NCML model proved to be extremely effective for improving efficiency of agricultural value chains. Table 4 provides an overview of how the primary actors in the value chains are being benefitted from the NCML model.

Table 4: Benefits of value chain actors in NCML model

Players	Benefits
Farmers	• Avoid distressed sales • Use product as collateral • Gain access to financing • Take advantage of value-added processing services • Gain access to multiple buyers
Financial Institutions (FIs)	• Ensured product quality and quantity • Collateral management • Ensured buyers for product
Traders/Vendors	• Greater access to sellers • Higher quality and quantity of product • Reduced need for middlemen, brokers

2.3 Summary of benefits ICT-based network in AVC

The rapid growth of ICT provides new avenues to share and access important information. Digitization has provided the capability for convergence of these traditional network technologies and the emerging ones (Machine to Machine, Artificial Intelligence, Internet of Things etc.). Some of the important characteristics of agricultural value chains could be benefitted from the of ICT based network which are provided in Table 5.

Table 5. Benefits of ICT based network across agricultural value chains

Characteristics	Detailed benefits on use of ICT based network platforms
Transformation of processes	• ICT based network platforms have the potential to transforms the way actors in agricultural value chains collect, analyse, store and share agricultural information for their daily decision-making purposes.
Investments	• This stimulates investment in ICT infrastructure and human capital.
Efficient markets	• ICT based network leads to greater efficiencies in rural markets: lower transaction costs, less information asymmetries, improved market coordination and transparent rural markets. • ICT based network reduces wastage in various stages from the field-to-fork value chain. Around one-third of the food in the supply chain is either lost or wasted at the farm, during storage and distribution, or in households. By facilitating real-time information exchange, e-agriculture can improve supply chain efficiency which can significantly reduce such food waste.
Improved vertical and horizontal linkages	• This results in the development of trust-based relationships between value chain actors. • In conventional agri-value chains, intermediaries add to reduced transparency and thus increasing price manipulation resulting in mistrust. E-agriculture can help in reducing the layers of intermediaries and can make transactions unbiased and transparent, thus improving the trust factor.
Facilitation of information-sharing networks	• This facilitates the development of networks for agricultural information-sharing and knowledge societies.
Value-added services	• This leads to the development of value-added services for rural farmers and other actors of the agricultural value chains.
Reducing individual and institutional risk	• This can be leveraged to reduce uncertainty and enhance preparedness and response to climate change, disasters and other agricultural risks.
Increased food and nutrition security and safety	• ICT based network can improve food management through efficient information flow, data gathering and analysis, traceability, transactions and supply chain management.

CHAPTER 3

EVIDENCES FROM CHINA

Case study 1: **Case Analysis on the Financial Operation Mode of China's Agricultural Industry Chain: An Example of *Nxin* Pig Industry Chain;**

Case Study 2: **E-Commerce Platform-Driven Agriculture Value Chain Finance: The initiatives of *Ant Financial* in China.**

CASE STUDY 1

CASE ANALYSIS ON THE FINANCIAL OPERATION MODE OF CHINA'S AGRICULTURAL INDUSTRY CHAIN: AN EXAMPLE OF NXIN PIG INDUSTRY CHAIN

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1. Background

Dabeinong Group is a leading high-tech agricultural enterprise in China. Established in 1993, Dabeinong Group is committed to promoting the development of modern agriculture through technological innovation. Dabeinong Group went public in 2010 and became the highest-priced agricultural high-tech enterprise among China's listed companies in areas of agriculture and animal husbandry. Dabeinong Group embraces more than 140 production bases, over 240 branches and subsidiaries, and over 10,000 grass-roots science and technology promotion service points across the country. Its industry chain covers forage, animal protection, vaccines, breeding pigs, seeds, plant protection, and related services. With the rise of Internet technology, the "Internet + agricultural industry chain" has gradually become a new blue ocean market.[11] Dabeinong Group accelerated its implementation of the mobile Internet strategy in 2014 and launched a "three networks and one App" product system, which includes *Nxin* Cloud, *Nxin* Mall, *Nxin* Finance and an App called Intelligent Agriculture for farmers and middlemen. In 2015, Dabeinong Group set up a subsidiary, *Nxin* Internet Technology Co., Ltd. (*Nxin* Internet) which focuses on using the internet to change agriculture in China and aims to provide internet + solutions for the pig industry based on the "three networks and one App" product system.

China is the world's largest country for pig breeding and pork consumption. China's 2016 pork production was 52.99 million tonnes, accounting for 48.5 percent of the world's total pork production and 62 percent of China's total meat output of 85.4 million tonnes. The pig industry is closely linked with Chinese life, and pork is the main source of animal protein in the daily diet of China's consumers. In recent years, the per capita pork consumption of urban households has stabilized at about 20 kilograms a year (about 60 percent of total meat consumption), while rural households is about 14.3 kilograms a year (about 70 percent). As a result, the pig industry is directly related to China's economy and the people's livelihood. However, the general efficiency of pig farms in China is relatively low: management methods of production are underdeveloped, resulting in high production costs; the exchange process is too long and has too many links, leading to high transaction costs; and credit information is lacking, which leads to high financing costs. Therefore, it is critical for China to improve the performance of pig farms, raise the efficiency of the industry chain and ensure the smooth access to financing.

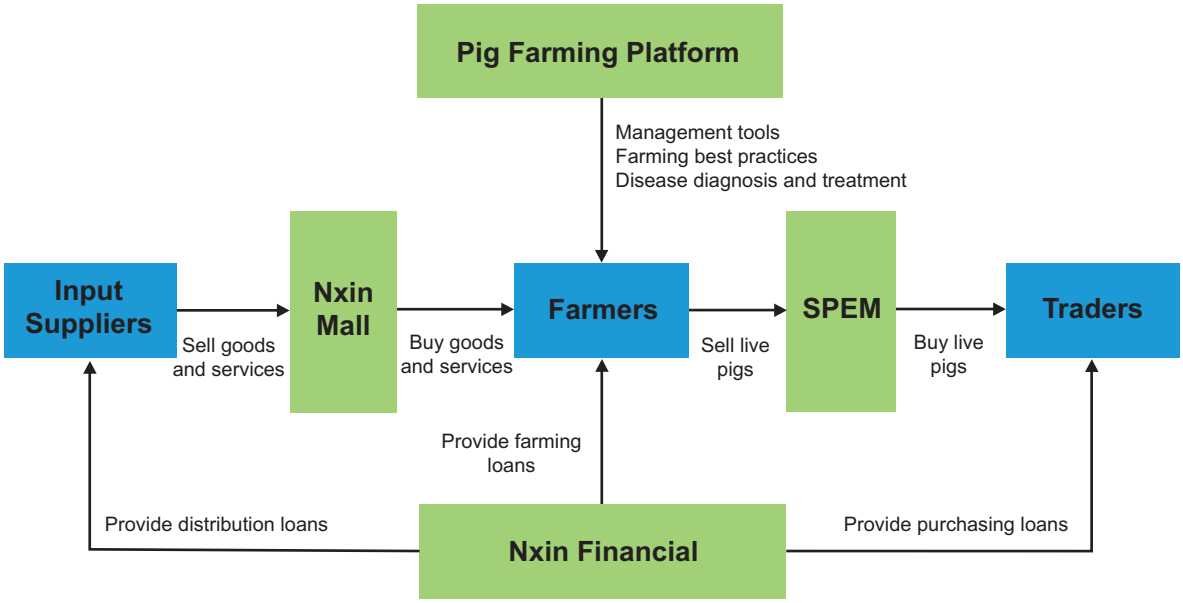
To address these issues, *Nxin* Internet introduced pig networking which integrates pig farming, trading and finance onto an internet platform. It solves the problem of low efficiency and high costs using a software-as-a-service (SaaS) model. All players in the pig agricultural chain can use the service, including input suppliers, farmers, slaughter houses and traders. Users pay for access to services that run on the pig networking platform. These services include: the ability to sell or purchase agricultural products (inputs and outputs) to other businesses (B2B); and access to financial services to facilitate participation, including loans, wealth management, payment and insurance. With these products, *Nxin* Internet aims to promote the transformation and upgrading of agricultural industry and to ensure its healthy and sustainable development.

2. "Internet + pig industry chain" platforms

Nxin Internet integrates the entire pig industry chain with appropriate services at each link in the chain. It provides an integrated internet ecosystem from pig farming to e-commerce transactions, in which financial support is always ready for all players (Figure 2).

[11] Blue ocean market is the simultaneous pursuit of differentiation and low cost to open up a new market space and create new demand. It creates and captures uncontested market space, thereby making the competition irrelevant. It is based on the view that market boundaries and industry structure are not a given and can be reconstructed by the actions and beliefs of industry players.

Figure 2: Nxin Internet Pig Industry Chain



Source: Illustration by editors

Input suppliers sell their goods and services on the online **Nxin Mall** platform where they have access to numerous clients, can better track their supplies and sales, and receive assured payments. *Farmers* buy their agricultural inputs on the **Nxin Mall** where they have access to a greater variety of inputs and transparent pricing. During production (raising livestock), farmers have access to consultation services through the **Pig Farming Platform** where they can utilize management tools for tracking individual pigs, receive instruction on farming best practices, and diagnose disease and render treatment when problems arise. Once livestock is ready, farmers can sell their pigs through **State Pig Exchange Market (SPEM)**, where they can track livestock quality and quantity, have access to numerous buyers, and can compete for better sales price. Traders buy livestock through **SPEM**, where they have access to numerous sellers, can be assured of product quality and quantity, and can quickly settle transactions.

The platforms share information so that credit profiles can be established on the players. Through the **Nxin Financial** platform input suppliers can receive distribution loans, farmers can receive farming loans, and traders can receive purchasing loans; and because the loans are provided on the basis of using the funds within the platform, Nxin ensures a complete cycle whereby funds are used to make purchases within the AVC and loan repayments are made at the time of transaction settlement.

2.1 Internet + pig farming platform

The **internet + pig farming platform** is a specially designed tool for daily production activities and management of pig farms. It provides services such as pig farm management, material management, financial management, remote diagnosis of pig diseases, technical training, pig price inquiry, etc. It provides an intelligent service system for pig farmers, enabling farmers to raise profitability at the level of the individual pig. At the same time, Nxin Internet establishes pig farming big data using the information of all pig farms on the platform.

2.1.1 Pig farm management

Based on the pig breeding cycle, the pig farm management system helps pig farms to achieve standardized management and scientific production. It provides personalized support for pig farmers on daily management decision-making. The system records detailed information about the birth, transfer, mating, delivery, immunization, sales and other production data of each pig. Based on the pig breeding cycle and the data of a certain pig, the system provides tips and warnings on production events, analyses the real-time production index, and generates standardized and visualized reports and graphs to help farm managers gain a clear view of their farms so that they can arrange production in a reasonable way. At the same time, the system automatically provides real-time operating performance analysis based on material and financial management, which constitutes data support for the decision-making of farm managers. In addition, Nxin Internet can provide customized services, including staff training, production data analysis, etc., according to the needs of the pig farm owners.

As the number of pig farms using the platform increases, the platform collects additional relevant data. Nxin Internet analyses these data with big data and cloud computing technology. This analysis can rate the production performance of pig farms, make statistics of the structure of sows and boars, forecast the number of live pigs, and correlate the quality of live pigs with forages, regions and environments. In doing so, instead of raising pigs blindly, farmers make production decisions under the guidelines of shared knowledge.

2.1.2 The treatment of pig diseases

To reduce the damage of pig diseases, Nxin Internet developed **Swine Disease**, a platform for diagnosis and treatment. It provides remote diagnostic services and exchange opportunities for farmers, dealers, veterinarians, technicians and other practitioners in the industry nationwide. At present, **Swine Disease** includes the following five systems.

- The *remote and automatic diagnosis system of pig diseases* uses big data analysis and modelling technology to build China's largest database for pig disease syndromes, and it provides 24x7 automatic disease diagnosis services for users.
- The *veterinary online Q&A system* brings together national professional and grassroots veterinarians. They provide question and answer (Q&A) services for the user through PC and mobile terminals. Each vet has a personal homepage in the system. They can publish courses and articles, answer questions, follow users, manage their fans circle and raise their reputation as professional service providers. Users can ask questions freely to an individual expert and request on-site service if necessary.
- The *early warning system of pig diseases* was established using the data of visitors to the pig diseases platform and the feeding, growth, immunity, medicine and environment data collected by the pig farming platform. Based on the data, it analyses the rule of incidence and forecasts the trend of a certain disease. It can even figure out the potential factors leading to the disease and offer corresponding precautionary measures in real time.
- The *wisdom agriculture classroom* provides various issues, articles, radio and video resources on farm construction, breeding management, epidemic prevention and other professional knowledge. It constitutes a self-learning platform for farm managers, helping them improve their level of operation, management and breeding.
- The *detection platform* integrates the resources of outstanding domestic poultry disease detection stations and immunity laboratories to provide pig disease detection service. The platform can not only help pig farmers understand what kind of disease their pigs get, but it can also can provide tips for the daily management about the disease and offer corresponding measures.

Swine Disease platform has benefitted over 354,000 users.[12] It has accumulated 361,800 cases, 133,900 through the automatic diagnosis platform and 229,900 through the manual Q&A platform. There were 258 articles on pig diseases published on the platform, with over 15,000 readings per article. The page view of the most favourite article and video on pig farming has exceeded 2.6 million.

2.2 "Internet + pig exchange" platform

The pig exchange platform addresses the issue of information asymmetry, the lack of guarantee in product quality due to the long transaction chain, the high transaction costs and the poor transaction experience. The **internet + pig exchange** platform consists of **Nxin Mall**, which connects agricultural material enterprises to pig farms, and **SPEM**, which connects pig farms to slaughtering enterprises and traders.

2.2.1 Nxin Mall

Nxin Mall provides a one-stop procurement service for farmers by bringing together onto a single platform well-known manufacturers and dealers of raw materials, forage, animal protection products, farming equipment and other agricultural inputs. In order to guarantee the authenticity of transactions and the quality of the products, **Nxin Mall** requires deposits from sellers as part of the transaction, effectively restraining sellers' behaviour and protecting the interests of users.

The **Nxin selected** application uses big data to help users purchase. Making use of the big data on the platform, it recommends high-quality products as "selected commodities" to users based on their purchasing and browsing records. It aims to match buyers and sellers according to geological distance, reducing intermediate links and logistical costs, effectively guaranteeing that users buy high quality goods at favourable prices.

2.2.2 SPEM

The **State Pig Exchange Market (SPEM)** is the only national live pig online trading platform established by the Ministry of Agriculture in accordance with China's "12th Five-Year Plan" outline. Currently, it is run by Chongqing Nxin Live Pig Trading Co., Ltd., a subsidiary of Nxin Internet. It aims to solve the problem that the transaction chain is too long, the product quality cannot be guaranteed and traced from the source, the transaction cost is too high and the transaction experience is poor. It can effectively solve the long-term volatility of China's pig price and enhance the core competitiveness of China's pig industry.

The transaction process on **SPEM** is as follows: The seller releases pig source information on the platform, including varieties, price, quantities and slaughter date (regarded as the date of delivery of live pigs). If shelf life exceeds 3 days of the slaughter date and no one has purchased the pigs, they are automatically removed from the shelf. The buyer can check the pig source map or list on the platform. The map or list displays in different regions which pig farms are selling pigs, what the variety is, the quantity, the price and so on. After placing an order, the payment is held by the platform. Once the buyer confirms he has received the right pigs, the platform sends payment to the seller. After completing the transaction, each side provides an evaluation of the other, which serve as references to their credit on the platform.

Under the guidelines of market economy rules, **SPEM** adopts a pig pricing and trading mode that is free, fair, convenient and fast. SPEM offers the following modes.

[12] Figures as of July 2017.

- *Guarantee mode* effectively ensures order fulfilment. It freezes 1 percent of the order amount from the seller's account as a deposit when he releases pig source information, and it freezes 2 percent from the buyer's account as a deposit when he makes the payment. After completing the transaction, the deposits are released immediately. The contract is violated if the seller fails to offer pigs or the buyer fails to receive pigs within three days of the slaughter date. Once complaints to default are verified, the platform gives the deposits to the non-breaching side.
- *Long-term supply mode* is available to seller with a long-term supply. In this mode, sellers don't need to fill in the quantity and sales date every time they issue information. Once a long-term supply of pig source is issued, it continues to be on sale for a long time. Buyers need to apply for deposit transactions. After the seller agrees, they enter the *guarantee mode* transactions.
- *Auction trading mode* is available to enterprise users. Enterprises first apply for bid seller qualifications then register and fill in the reserve price. Buyers enter the auction hall to bid. The system generates orders from high price to low price according to the bid. If the bid is lower than the reserve price, then orders will not be formed. They can make the bidding time and bid several rounds a day. In this mode, the platform freezes one-time admission deposits from both parties as agreed.

2.2.3 Market quotations

Considering the fluctuating, regional and phased characteristics of pig price, Nxin Internet developed market quotations to trace the price of live pigs and raw materials and analyse market quotations. The price is highly accurate because it comes primarily from pig farms on the platform when their pigs are ready for slaughter and from the transaction price on **SPEM**. At any time, users can acquire the live pig price, the pig-grain price ratio, the bulk raw material price, the market information, the daily pig review and other information of various regions nationwide. Using this transparent information, they can arrange procurement, production and sales in a more reasonable way.

In May 2017, Nxin Internet, together with Chongqing Nxin Live Pig Trading Co., Ltd., jointly published the pig market (trading) price index, which has the most extensive coverage on the real transaction price of live pigs. The index relies on the real transaction data (volume and price) of SPEM. With samples covering 20 provinces and municipalities, this index comprehensively measures the overall level and change of China's pig trading price and reflects the supply and demand relationship of live pigs. It provides important references for all AVC players as well as the government. It will also play a positive role in eliminating the environmental harm of the "pig cycle" and promoting pig futures.

2.2.4 Nxin logistics

Nxin logistics is specifically designed to serve agricultural logistics, such as finding goods, finding vehicles, settlement, insurance and other services. Based on Nxin big data, it can accurately match the needs of the person, the car and the goods, improving the overall transport efficiency and reducing costs. Nxin logistics integrates the information from **Nxin Mall**, **SPEM**, local live pig transportation departments and the resources of thousands of professional truck owners. It helps the owners of goods and trucks to realize seamless docking, greatly facilitating transportation activities of the AVC and helping to solve the problem of trucks-and-goods mismatch and the high empty-loaded rate.

2.3 The pig industry chain finance: "Internet + finance" platform

One of the major reasons why it is hard for the traditional pig industry to realize economy of scale is that pig farmers lack an overall credit system. As a result, they lack access to social financing and transparent lending, which results in high financial costs. In order to remove barriers in every link of financing and construct a self-circulation financial ecosystem, Nxin Internet designed products

addressing the entire financial chain: credit (**Nxin credit**), loans (**Nxin loan**), wealth management (**Nxin wealth management**), payment (**Nxin pay**) and insurance (**Nxin insurance**).

2.3.1 Nxin credit

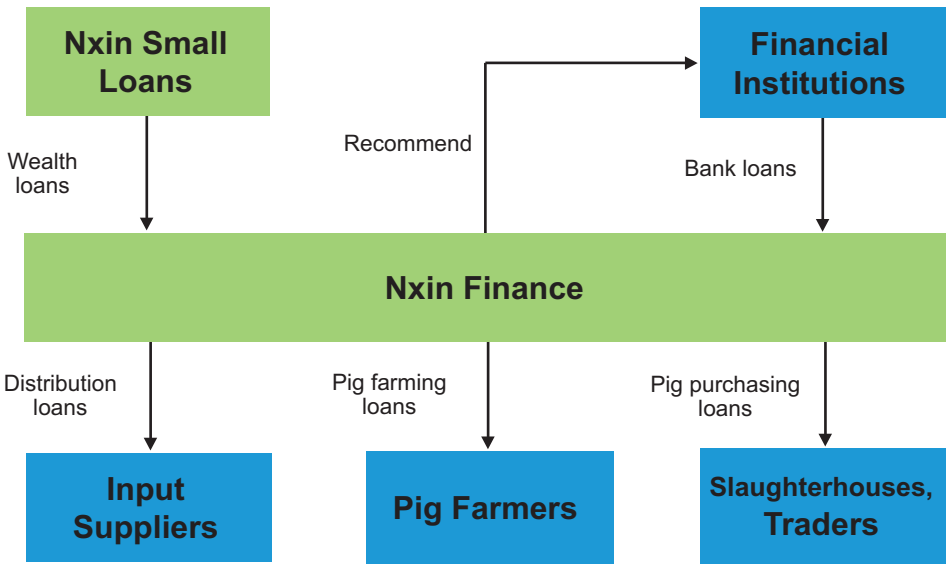
Nxin Internet, taking stakes in Tianchuang Cloud Credit Co., Ltd., specializes in the credit business of agricultural enterprises and farmers. **Nxin credit** shows users' credit conditions objectively and provides credit proof, credit rating and advance credit granting for all subjects in the pig industry chain. The system uses cloud computing and big data derived from the production, operation and transaction data on the platform along with information acquired by tens of thousands of employees in cooperative enterprises in their daily work providing in-depth services for farmers. By consolidating these data, Nxin Internet effectively controls its risk in offering financial services.

2.3.2 Nxin loans

Participants in China's pig industry chain are always faced with a shortage of funds and strict timeliness requirements. However, as they lack bank credit and suitable collaterals combined with the high risk in the pig industry, they have difficulties in financing. In 2015, Nxin Internet established Beijing Nxin Small Loans Co., Ltd (Nxin Small Loans) to specialize in the internet small loan service. It uses the internet financial platform to provide low cost, unsecured and quick loans, optimizing the supply of financial resources and reducing the cost of financing.

Nxin loans provides agricultural bank loans and agricultural wealth loans. For agricultural bank loans, Nxin Internet recommends reliable customers to banks based on its customer credit data, and it coordinates with banks to provide loans services. Nxin Internet has cooperated with more than 30 commercial banks such as China Everbright Bank and Postal Savings Bank of China and developed a variety of financial products. For agricultural wealth loans, **Nxin Small Loans** uses its own funds and bank loans to provide internet microfinance products. Types of Nxin loans available to support pig farmers are shown in Figure 3. **Nxin loans** provides

Figure 3: Types of Nxin Loans



Source: Illustration by editors

- Pig farming loans: 6 months at 12 percent annual interest rate; Borrowers pay the interest on a monthly basis and return the principal at maturity.
- Pig purchasing loans: 1 to 10 days at 0.05 percent daily rate.
- Distributions loans (to meet the dealers' demand for cash flow): typically, 6 months at 12 percent annual interest rate; borrowers adopt equal principal repayment.

2.3.3 Nxin wealth management

In the pig industry chain, short-term idle funds[13] often exit, resulting in the inefficient use of funds and high opportunity cost of capital. Nxin Internet cooperated with fund companies to develop "wealth management and payment" products to put such funds to better use. **Nxin wealth management** combines wealth management and payment services, while improving the efficiency of capital turnover and taking capital appreciation into consideration. The product allows users to receive financing income within a day, and to carry out large payments. The product has been approved by China Securities Regulatory Commission.

2.3.4 Nxin pay

Nxin pay is a convenient, safe and efficient payment product. It links **Nxin Mall** and **Nxin finance** to form a closed business loop. **Nxin pay** provides customers with professional and comprehensive settlement services, as well as fast and stable payment channels. Its payment types include collection and payment, online banking payment, electronic point-of-sale (E-POS), which helps farmers withdraw money offline.

2.3.5 Nxin insurance

Agricultural insurance is an essential link to effectively cope with the risks in agricultural production, ensure farmers' income and realize sustainable development of agriculture, but it is a weak link in China's agricultural production. Nxin Internet continuously improves its agricultural financial services, applying for insurance brokerage license and cooperating with a number of insurance companies in depth. Nxin Internet provides

- **Pig price index insurance:** reduces operating costs by helping stabilize the high fluctuations and strong periodicity in pig prices.
- **Pig transport insurance:** insures against the death of pigs in transit, reduces the loss for both sides and the economic disputes thereof.
- **Borrower accident insurance:** provides protection from accidental injury for borrowers on the platform, reducing the pressure of repayment after accidents.

2.4 Intelligent Pig Breeding

Intelligent pig breeding has become a hot topic in the pig industry. Nxin Internet laid out the Internet of things platform very early, striving to build the Internet of people, equipment and pigs for the industry, and began to explore the research of some key intelligent hardware.

2.4.1 The Internet of things platform

Nxin Cloud platform is committed to building an intelligent pig breeding ecological routing system, integrating intelligent equipment and artificial intelligence algorithms to provide a complete set of solutions for intelligent pig breeding. Specifically, Nxin hybrid cloud solutions can seamlessly connect with Ali, JD, Huawei and other mainstream cloud computing service providers to provide a highly

[13] Short-term idle funds are characterized as large amount, strong time regularity and fast circulation that are not readily invested.

reliable **IaaS** (infrastructure-as-a-service) platform for intelligent pig breeding. **Nxin Cloud** serves as the **PaaS** (platform-as-a-service) platform, providing logistics and algorithm support for intelligent pig breeding. The **IaaS** platform and **PaaS** platform provide unified entrance and human-computer interaction interface for pig farms. Unlike other providers, Nxin provides a combination of solutions, and helps users achieve overall efficiency improvement with strong ecological synergy.

2.4.2 Intelligent hardware

Centring on the key requirements of data collection, transmission, analysis and application in pig farms, **Nxin Cloud** platform is also trying to cooperate with multi-party equipment and artificial intelligence algorithm providers in the research of pig farm intelligent hardware. At present, **Nxin Cloud** mainly includes pig raising robot, intelligent speaker and boundary gateway.

3. Operation mode of "internet + pig industry chain"

Nxin Internet offers two versions of the platform: a pure online mode and an integration mode.

3.1 Pure Online Mode

The pure online mode provides access to the platforms and connects all the AVC players. Input suppliers sell products through **Nxin Mall**. **Nxin Finance** provides them with distribution loans based on their sales and cash flow requirements. Farmers buy piglets using **SPEM** and buy needed materials using **Nxin Mall**, and **Nxin Finance** provides loans to address any shortage of funds. Farmers can obtain relevant farming techniques and advanced management methods on the breeding platform. Farmers use **SPEM** to find buyers; buyers use **SPEM** to find sellers, and **Nxin Finance** can provide them with pig purchasing loans.

The pure online mode

- Links all players of the production chain;
- Streamlines and simplifies the trading channels while reducing costs;
- Provides all players the capital they need when they need it (through loans and efficient transactions);
- Promotes the healthiest product through the latest scientific raising methods; and
- Ensures all players financially.

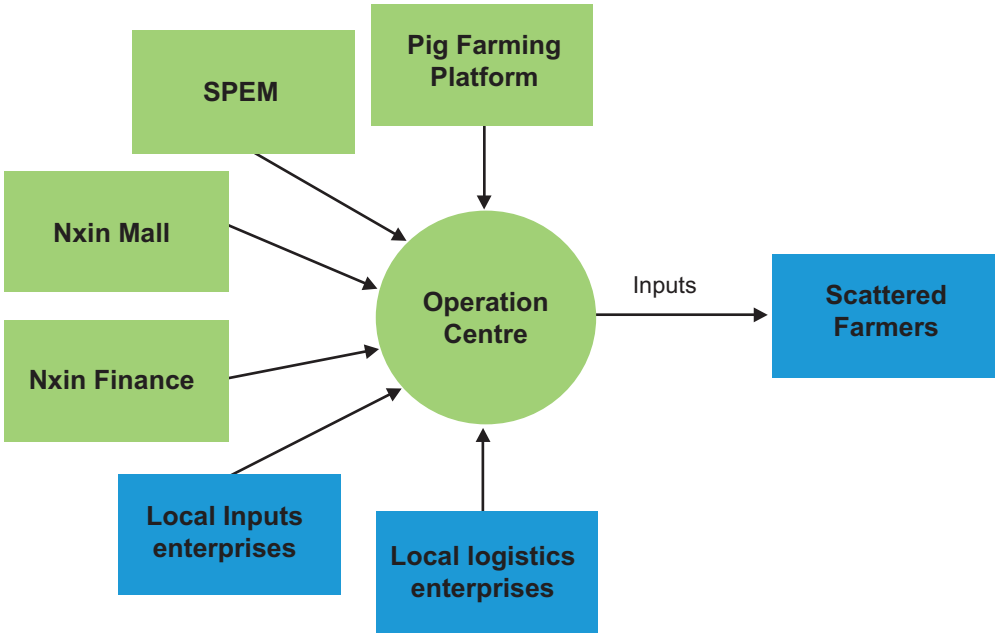
3.2 O2O Integration Mode

The online-to-offline (O2O) integration mode includes all the benefits of the pure online mode along with the **Operation Centre** and/or the **Regional Market**.

3.2.1 Platform + Operation Centre

Nxin Internet selects the largest local distributors in key counties across China and upgrades them into county-level operation centres to better serve local scattered farmers. The local distributors' information and influence is used to connect local leading businesses to farmers. The Nxin breeding, trading and financial platforms expand distributors' business scope and aid them in transforming from traditional dealers to integrated service providers. In other words, operation centres combine the advantages of internet platforms with the advantages of local distributors, providing all pig-related services in the local pig industry (Figure 4).

Figure 4: Diversified Services of the Operation Centre

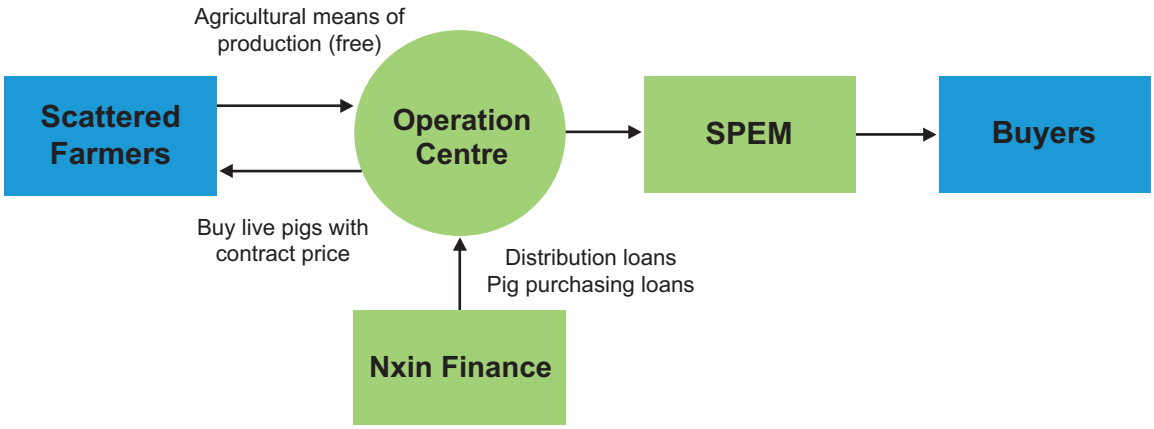


Source: Illustration by editors

Nxin Internet has 89 operation centres and another 30 are on trial. Based on a wide range of practices, Nxin operation centres have now explored two specific modes of operation: 'Foster Mode' and the 'Stocking Mode'.

In the *Foster Mode* (Figure 5), the operation centre relies on the Nxin exchange platforms and the local leading agricultural enterprises to provide free feedstuffs, vaccines and piglets for farmers. Farmers, in turn, provide pigsties and farming techniques and pay a deposit. When the pigs are ready for slaughter, the operation centre buys these pigs at the contract price and sells them through **SPEM**, thus gaining income. The operation centre receives most of the profits but also takes the risk of price fluctuation. **Nxin Finance** provides distribution loans as needed throughout the production cycle.

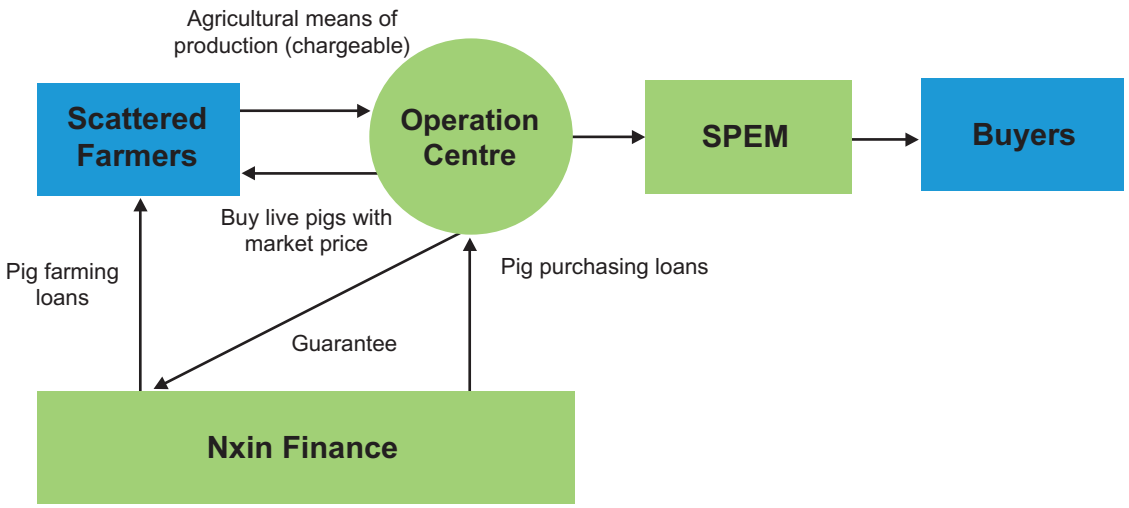
Figure 5: Foster Mode



Source: Illustration by editors

In the *Stocking Mode* (Figure 6), the operation centre integrates the advantages of various channels to provide farmers with price-friendly and high-quality feedstuffs, vaccines, piglets and other agricultural inputs; farmers provide pigsties and farming techniques, and pay a deposit. When the pigs are ready for slaughter, the operation centre shares the priority to buy these pigs at the market price and then sells them through **SPEM**. In this model, the farmers gain most of the profits and bear the risk of price fluctuation. **Nxin Financial** is available for financing throughout the production cycle.

Figure 6: Stocking Mode



Source: Illustration by editors

3.2.2 Platform + Regional Market

The regional markets constitute an important part of **SPEM**. Each county has only one regional market, which is built by influential local pig-related enterprises or traditional regional pig trading markets as partners. With their local influence, Nxin Internet integrates scattered farmers in the region to enhance their creditability and form regional distribution centres.

In the platform + regional market mode (Figure 7) local *farmers* report how many pigs are ready for slaughter to the *regional market*. The *regional market* purchases these pigs, categorizes them by breed, quality and weight and publishes this source information on **SPEM**. *Buyers* choose the pig source that matches their purchasing needs, and once a price is agreed upon, an online order is generated. Offline, the *regional market* organizes live pig delivery. Only when the *buyer* confirms the pigs are in perfect condition does the *regional market* receive the payment through the platform. **Nxin financial** provides financing for all stages of the process.

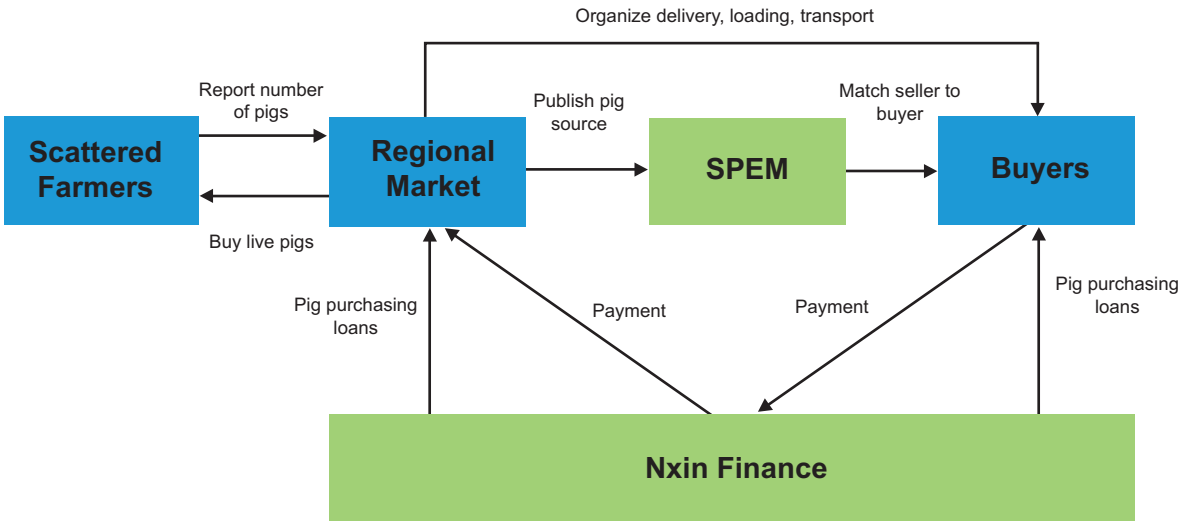
3.2.3 Platform + Operation Centre + Regional Market

The "platform + operation centre + regional market" (Figure 8) centres on the needs of farmers, with the operation centre responsible for product and the regional market responsible for sales. The **operation centre** connects scattered pig *farmers* to *input suppliers*, while the *regional market* connects scattered *farmers* to *traders* and food *processers*.

4. Platform performance

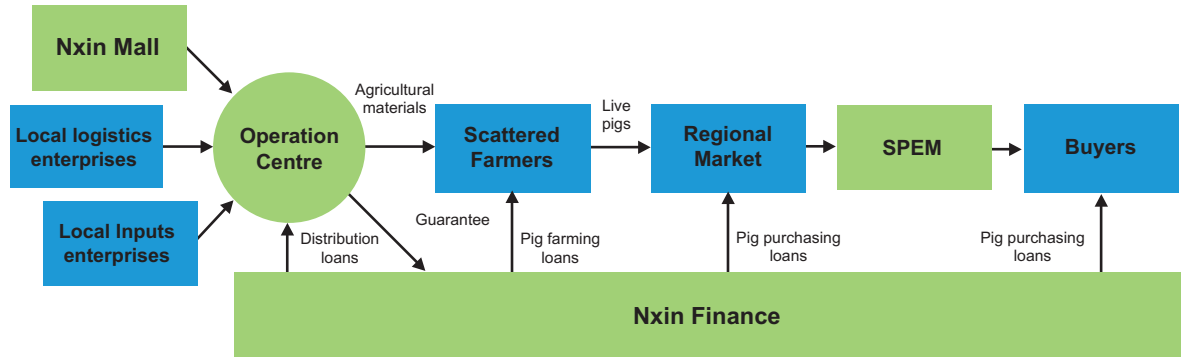
Users of the Nxin platforms have increased rapidly. According to *Research Report on China's Pig Industry "Internet +" Development (2017)*, by June 2017, users of pig networking covered 33 provinces,

Figure 7: Platform + Regional Market Mode



Source: Illustration by editors

Figure 8: Platform + Operation Centre + Regional Market Mode



Source: Illustration by editors

municipalities and autonomous regions nationwide, in which Henan, Shandong, Hebei, Guangdong, Jiangxi, Fujian, Guangxi, Sichuan, Hubei and Hunan provinces share a higher number of users, accounting for 59.66 percent of the total amount. Small and medium-sized pig farms are the major customers for pig networking; see Table 6 for a breakdown of users by farm size.

Table 6: Farm size as percentage of user base

Farm size (# of sows)	Percentage of platform users
< 50	2.62
50-199	21.62
200-499	37.89
500-999	25.44
> 1,000	12.42

Source: Nxin Internet Technology Company Ltd.

There are regional differences in the level of pig farming. The annual average number of weaned piglets per sow (PSY)[14] in the northeast region was relatively low, with an average number of 21.06, while the PSY value in the east region was higher, with an average number of 22.62. There's a big gap in the level of pig farming in different provinces in the north part and northwest part of China. Provinces such as Inner Mongolia and Ningxia lag far behind.

Most users participate in the transaction for a long time and the transaction volume is stable. See Table 7 for details.

Table 7: Performance of Internet + Transaction platform

Volume	– –
Total turnover of **SPEM** (as of July 2017)	48.88 billion
Transaction volume (Jan-Jun 2017)	20.391 billion yuan
Increase over 2016	204%
By Product	--
Live pigs	87.16%
Piglets	12.82%
Boars	0.02%
Daily average	--
Transaction volume	100 million
Pig trading volume	80,000
Average units # of per transaction*	--
Live pigs	140
Piglets	242
Time of release of pig source information	9:00-12:00 and 15:00-23:00

* Directly related to carrying capacity of transporter

Source: Nxin Internet Technology Company Ltd.

Since Nxin Internet launched microfinance products, Nxin petty loans business has shown a trend of rapid development with an abrupt increase in the number and total volume of loans (see Table 8).

Table 8: Performance of internet + finance platform

Loan increase (2016 to June 2017)	195%
Farming	343%
Pig purchasing	246%
Distribution	198%
Pig-related loans (as % of total #)	
Farming	57.17%
Distribution	35.06%
Pig purchasing	7.77%
Pig purchasing loans (% of total) (2016-2017)	
Number	80.70%
Volume	64.91%
Days to recover loan	
Pig farming loans	131.78
Distribution loans	130.98
Pig purchasing loans	5.35

Source: Nxin Internet Technology Company Ltd.

[14] PSY value is a key index in pig farming performance.

Pig purchasing loans take the lead in the number and volume. This is mainly due to the different turnover rate of funds in forage distribution, pig farming and pig purchasing. In the pig purchasing industry, short-term, high-volume and high-frequency funds are needed. Users with high credit usually apply for loans in batches according to their actual needs in production and operation activities, which reflects the productive features in the pig industry chain.

5. Lessons learnt

5.1 Advantages

Better data on the pig industry. All production and management activities are electronically recorded and relevant data is collected. With the gradual accumulation of diversified data in all areas of the AVC, combined with the external data such as GDP, population, consumption level and economic structure, information is analysed and better understood. With this information, AVC players can optimize their production and sales decisions to accurately match supply and demand, enhancing the production efficiency of the industry; and products can be traced to the source, which elevates the food safety in China. Overall, the consolidation and sharing of information provides effective data support for industry and government management.

Improved warning and forecasting. As big data of the pig industry improves, it is possible to formulate a reliable view about the live pig market and epidemics. The warning mechanism on pig epidemics and price is established based on an analysis of the model. This mechanism guides pig farming and transactions, thus improving production and trading performance. At the same time, it becomes possible to forecast the future price and possible epidemics of live pigs and provide a theoretical basis for public policies that can avoid losses caused by the pig cycle and swine diseases.

Increased financing. Practitioners in the pig industry have long been plagued by the lack of financial support. With the gradual accumulation of big data and the rapid development of internet finance, it is possible to conduct credit rating for all AVC players and provide diversified financial services for them. Nxin Internet offers a wide range of financial services, which improves the efficiency of capital turnover, takes better use of idle funds, makes loans much more accessible and solves the deficiency in agricultural insurance products, thereby increasing financial efficiency of the entire industry.

More intelligent pig farming. The entire pig production process, from the birth to the sale of each pig, is recorded. Tips or warnings on pig farming are offered using a production warning model. Specialized reports featuring production, inventory and performance are automatically generated, allowing users gain an overall view on the performance of pig farms. The effectiveness of this ”intelligent pig farming” has been verified as the users’ PSY value has risen from 20 to 22. The pig networking connects all AVC players and solves the “information island” problem commonly seen in traditional pig industry.

Enhanced competitiveness. Internet + transforms the external industry chain into an internal ecological chain by connecting all players. Enterprises gathered on the platform make coordinated arrangements to provide services such as production support, technical guidance, marketing strategies, financing and insurance. Because the production process is transparent, participants effectively supervise one another, enhancing competitiveness and ensuring a better product for everyone.

Decreased poverty. Internet + helps pig farmers, cooperatives and enterprises in impoverished areas to manage pig farms scientifically, thus raising their profits and achieving “hematopoietic poverty alleviation.” Poor households may join pig farming cooperatives through the pig networking to get salary or dividends, thus realizing industrial poverty alleviation. **Nxin Mall** provides them with agricultural materials and solves the problem of live pig transaction with low costs and high efficiency, thus realizing e-commerce poverty alleviation. **Nxin Finance** gives them access to loans, fund

management, insurance and other financial services, fundamentally addressing capital shortage and realizing financial poverty alleviation. In addition, the government can accurately allocate poverty alleviation funds and supervise the whole process through the pig network. It can also provide loans and insurance subsidies for poor households, maintain the healthy and sustainable development of pig farms and cooperatives, thus realizing "internet + precise poverty alleviation" in a real sense.

5.2 Challenges

Despite the clear benefits of **Internet +**, in practice, there are still daunting challenges.

Weak awareness of the internet makes promotion difficult. Pig farming belongs to the traditional industry. Most practitioners are in their 50's and have weak awareness of the internet due to their limited knowledge structure. The industry is characterized by on-site working, which means farmers rarely have time to work at a computer. As most players are small and scattered, it is difficult to promote internet products for marketing in a consolidated way. There are numerous AVC players, many of whom do not access the internet, and those that do, do so in unrelated or incompatible ways. At present, application of the internet in the pig industry can only create ripples, but it cannot prevail in the entire AVC in a short period of time.

Standardization is low. The degree of data standardization is better in areas such as forage, vaccines, veterinary drugs and pig farm devices. However, in pig production and circulation, the degree of standardization is relatively low. Currently, only the weight can be quantified. Indicators such as back fat thickness, meat rate and antibiotic residue cannot be detected or quantified quickly and easily. This situation makes it necessary to rely on the experience of pig traders to estimate the quality of live pigs during transaction. Pig traders view pigs on the spot and give a reasonable price, but this practice leads to great price difference even in the same area. Under such circumstances, big data cannot serve as an accurate guidance to price, nor can it precisely match sources to buyers. Therefore, transaction efficiency and risk control is limited.

Digital devices usage is low. Digital equipment is key to data collection. However, the popularizing rate of digital devices in China is relatively low. On the one hand, small and medium-sized players are not yet able to invest in such high-cost devices; and on the other hand, the quality of many devices is insufficient for actual production.

Financial services are still lacking. While the financial services required for the pig industry are quite special, the existing financial products and services are inadequate to meet the needs. Financial institutions have a poor understanding of the industry, so they are unable to develop suitable financial products. Internet companies understand the pig industry but are not qualified to provide relevant financial services. Third-party financial services are subject to the cost and efficiency issues. Therefore, they have limitations in product development, promotion, user experience and other aspects.

CASE STUDY 2

E-COMMERCE PLATFORM-DRIVEN AGRICULTURE VALUE CHAIN FINANCE: THE INITIATIVES OF ANT FINANCIAL IN CHINA

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1. Background

Agriculture value chain (AVC) finance is on the forefront for researchers and policy makers, and certain countries and regions have begun to amass practical experience in the field. Theory and practice show that market-oriented characteristics for agricultural value chain products have a substitution effect for physical collateral. Meanwhile, acquiring data about the transaction conditions and networking relations among value chain members could help address the information asymmetry issues of financial institutions. For certain peasant economy-oriented countries, value chain-based financing methods have broad prospects for the developmental expansion of financial institutions in agricultural and rural industries.

China has yet to form a mature and widely-replicable agricultural value chain finance model. Chinese agriculture is moving from traditional agriculture methods to modern ones. However, this process has been met with financial constraints arising from the financial imbalance between supply and demand sides. Outdated agricultural infrastructure, fluctuations in international food prices, the high level of concern among consumers with regard to food quality and safety, and the increasingly high safety standards for international and local food products have presented challenges for small farmers who wish to be part of the market-oriented agricultural product system. Through the joint efforts of the government and the private sector, the rapid development of leading agricultural enterprises, supermarkets and organized food retailers has driven the development of the AVC. As a result, certain institutions (e.g. contract farming, producer associations and cooperatives) have offered services to link farmers with organized retailers, which has created a relatively ideal AVC in certain regions. Examples include the broiler contract farming of Wens Foodstuff Group (leading enterprise and farmers) and the Orange & Tangerine Cooperative of Zhong County in Chongqing (leading enterprise, cooperative and farmers) (Chen et al., 2015). Financial institutions such as Longjiang Bank have already attempted to introduce the basic principles and mechanisms of value chain finance into the Chinese AVC in order to provide financial services for small farmers, cooperatives or agricultural enterprises within the value chain. The value chain finance model was initially developed for the industrial and trade sectors, and the AVC differs significantly from these in terms of its product characteristics, industry structure, production and operational features, geographically-dispersed features, and contractual stability factors. At the same time, the AVC has very strong regional characteristics such that features differ greatly from region to region in terms of extremely strong regional differences and product differences.

This study examines the Chinese AVC finance model that has undergone rapid growth in recent years and has attracted the attention of e-commerce platform-driven AVC finance. In recent years, rural e-commerce in China has grown significantly, with the volume of online transactions for agricultural products increasing annually at an explosive growth rate. Based on statistical data from the agricultural sector, the e-commerce transaction volume for agricultural products exceeded RMB 50 billion (US$ 7.4 billion) in 2013, RMB 87 billion (US$ 12.9 billion) in 2014, and RMB 100 billion (US$ 14.8 billion) in 2015, accounting for 3 percent of agricultural product sales. Meanwhile, there were over 4,000 agricultural-related e-commerce platforms. On Taobao alone, the average annual increase in the transaction volume for agricultural products was 112 percent between 2010 and 2015. In addition, Alibaba built a county-village service network through its e-commerce platform, maximizing the advantages of e-commerce while overcoming logistical and information flow bottlenecks, thereby enabling two-way directional flows whereby online goods could enter villages and agricultural products could enter urban areas. Meanwhile, e-commerce platforms have already begun to replace traditional value chain points, while the rapid expansion of the e-commerce market has brought about new opportunities and challenges to the purchasing and sales models of traditional enterprises. While more traditional enterprises are increasingly reducing costs and expanding their market size with "internet +" solutions, it is mostly internet-based enterprises that are providing convenient trade channels for traditional offline enterprises. Since 2014, Ant Financial, JD Finance and other

internet-based financial platforms have partnered with e-commerce platforms such as Taobao and JD.com to expedite the roll-out pace of rural finance and value chain finance in the forms of "e-commerce financing + leading enterprises + cooperatives (farmers) + e-commerce platforms" models, purchase order financing, warehouse receipt financing, and other forms of financing. E-commerce platform-driven AVC finance is an important supplement to existing finance models, and it could become one of the key models in the development of AVC finance models in China.

2. Rural e-commerce platforms in China

2.1 Development

Since 2014, e-commerce has been increasingly implemented as part of modern agricultural efforts. It has taken the form of integrated initiatives for model rural areas and "internet +" solutions, which were implemented from the central region to local regions. A string of corporate policies expedited the development of rural e-commerce platforms: Alibaba's "thousand counties and ten thousand villages" programme, JD.com's "Xing Huo Liao Yuan (a little spark makes a great fire)" programme, Suning's "xcygoo.com" programme and various others established rural e-commerce platforms. The rural internet retail volume in China has maintained a rapidly increasing trend since 2014. In 2017, rural internet retail sales in China amounted to RMB 1,244.88 billion (US$ 185.63 billion), exhibited a 39.16 percent increase from the previous year, with goods at RMB 782.66 billion (US$ 116.7 billion) and services at RMB 462.22 billion (US$ 68.92 billion). As of the end of 2016, there were 8.32 million rural internet stores (accounting for 25.8 percent of overall internet stores), which employed over 20 million people. The number of rural internet stores increased to 9.86 million by the end of 2017. There were 293 million rural internet retail stock-keeping units (SKUs), which accounted for 20.3 percent of the overall internet SKUs. As internet penetrated the rural areas, more and more Taobao sellers emerged in rural villages, with many sellers from the same village selling the same or very similar products. Soon thereafter, related businesses along the supply chain and other support business (e.g. web page design, shipping brand and management consulting) appeared in the same village. These villages are called Taobao villages by Alibaba (Qi et al., 2019). The first Taobao village appeared in 2009, and the number increased dramatically from 211 in 2014, to 2118 in 2017 (see Table 9).

Table 9: Chinese rural e-commerce development

	Rural Internet Sales (Billion RMB)	Number of rural internet stores (Million)	Number of Taobao Villages
2014	180.00	Data not available	211
2015	353.00	Data not available	780
2016	894.54	8.32	1,311
2017	1,244.88	9.86	2,118
Goods	782.66	Data not available	Data not available
Services	462.22	Data not available	Data not available

Source: Annual report on China's rural E-commerce Development and Chen et al., 2016.

2.2 E-commerce platform characteristics

Rural e-commerce platforms have some noteworthy characteristics.

- **Regional differences:** Region-specific characteristics drive the intensive processing of agricultural products; and e-commerce platforms typically reflect these regional differences.

- **Diversified market structures:** In 2016, various types of enterprises rapidly entered the field of rural e-commerce. National e-commerce platforms such as Alibaba, JD.com and Suning aggressively introduced e-commerce to rural areas, while exchange-listed agriculture-related enterprises delved into e-commerce platforms for agricultural means of production.
- **Fresh produce e-commerce:** The fresh produce e-commerce market in China is currently at a stage of rapid development; transaction volume amounted to RMB 91.39 billion (US$ 13.54 billion) in 2016 with a 68.6 percent year-on-year growth rate, although this rate showed a slowdown in growth compared to previous years.
- **Stable development:** E-commerce platforms for agriculture are gradually undergoing strengthening and basic construction processes, including the construction of service networks and logistic systems as well as the strengthening of specialized teams. As such, the platforms are entering a stable phase of development.

3. Ant Financial

Ant Financial is a tech company offering inclusive finance services globally. Ant Financial was officially established in October 2014 by AliPay.[15] At the end of 2016, Ant Financial announced the roll-out of its comprehensive rural financing strategy in Beijing, unveiling its "valley rain" scheme. Over the next three years, Ant Financial worked with 100 leading enterprises in core industries to provide large-scale breeders with financing services, offering payment, credit, insurance and integrated forms of financial services in 1,000 counties across China.

Ant Financial has established partnerships with leading enterprises such as Yiguo Fresh Produce, Mongolian Sheep Group, Zhengbang Group and Ecolovo Group to provide value chain financing services to farmers from loans to sales.

4. Product offering

In its exploratory efforts, Ant Financial discovered three main financial needs among the Sannong.[16] These needs can be visualized as a pyramid (see Figure 9) with the relevant business model that addresses those needs.

For rural consumers and small-scale operators (bottom tier), Ant Financial offers a data-based financial service model, which involves network-related measures. Users are provided with integrated financing services (including payment, insurance and credit services) through the **MyBank**, **AliPay** and **Ant Financial insurance** platforms.

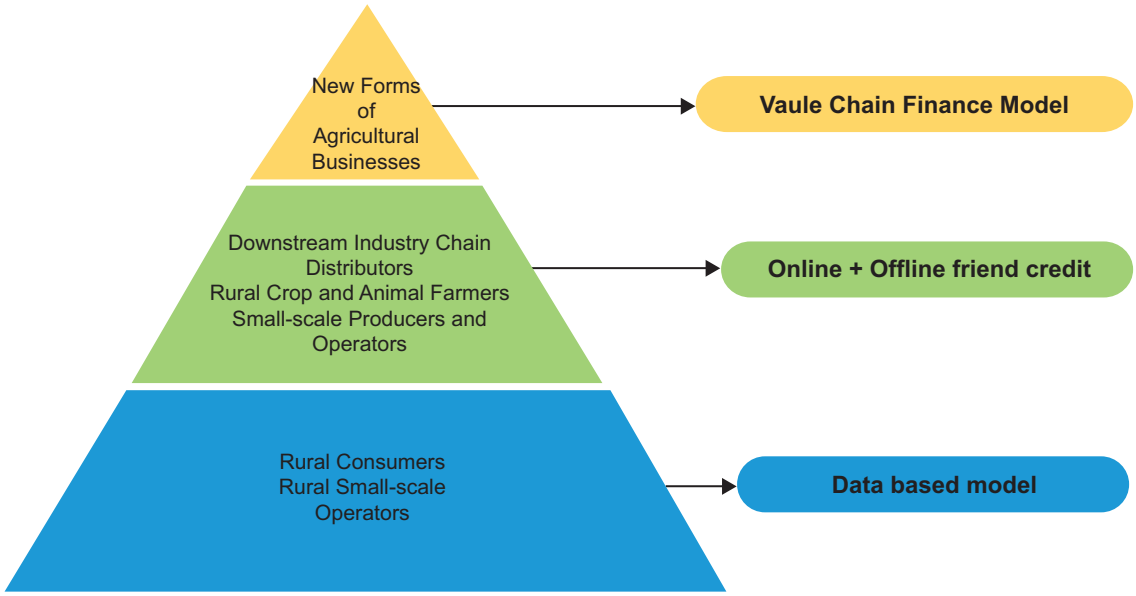
For small-scale farmers (middle tier), Ant Financial offers the "online + offline" friend credit model. For users in counties and villages lacking in information and financial services, Ant Financial connected with Alibaba Rural Taobao partners and offline CFPA microfinance "friends" to provide operating loans and other finance services. The service has attained nationwide coverage.

For large-scale breeders (top tier), agricultural industry upgrades are used to meet financing service needs. Since mid-2016, Ant Financial has explored partnerships with insurance companies in order to provide large-scale breeders with value chain finance services, and partnered with the agricultural sector to develop a direct reporting system for new businesses.

[15] AliPay was established in 2004.

[16] Sannong: the term refers collectively to agriculture, farmers, and the rural area.

Figure 9: Ant Financial's three main business models of rural financing



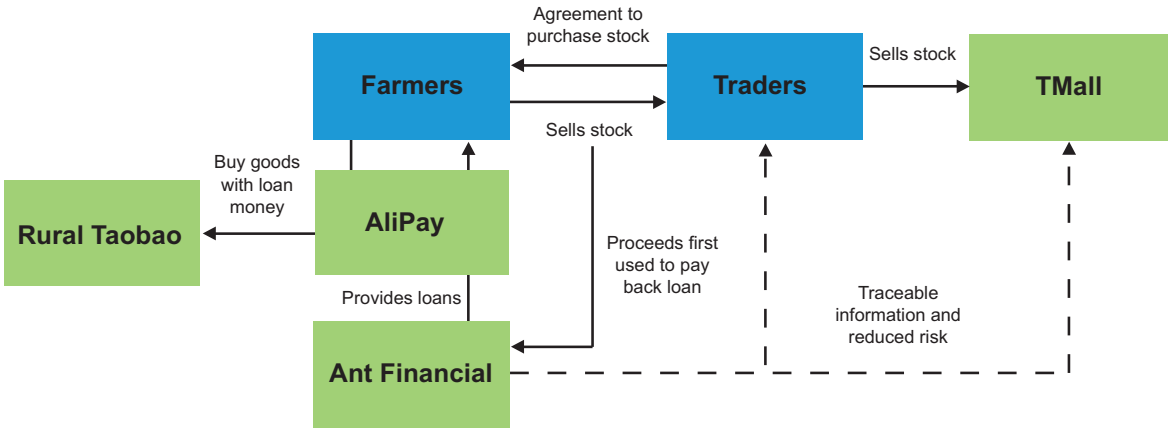
Source: Illustration by authors

The lack of collateral among farmers and credit systems in rural areas is a key reason behind the lagging development of rural finance, especially in terms of agricultural credit shortages. Ant Financial's strength lies in the vast data amassed through these platforms, including **Taobao** transaction data, **AliPay** payment data, **Ant Financial** credit points, and even lifestyle-related apps from other Alibaba subsidiaries.

4.1 How it works

Ant Financial works within the AVC as shown in Figure 10 below:

Figure 10: Ant Financial model and the AVC



Source: Illustration by editors

Traders agree to purchase stock from *farmers*, and *farmers* take out production loans through the **Ant Financial** platform based on this agreement. The funds are disbursed through the **AliPay** platform and can only be used to purchase agricultural inputs on **Rural Taobao**. Upon sale of livestock, the *farmer* first re-pays **Ant Financial**. The *trader* sells the purchased stock on the **TMall** platform which has additional risk controls with **Ant Financial** should the *trader* fail to live up to the purchase agreement. Because the platforms work together, they share important information about the farmers, traders, transactions, and stock quality and quantity.

4.2 Overview of product features

Ant Financial products are provided using the SaaS model: users pay to use the features of the software rather than own the software. The products are integrated such that data is shared among the platforms and is available through cloud-based servers. The features of the products and their benefits are shown in Table 10.

Ant Financial collects personal and transactional data on farmers and traders which allows credit profiles to be created. Ant Financial also provides insurance products.

AliPay is an online payment platform with the objective of "changing financing into finance assets." It allows users to send and receive monies. Farmers receive financing through the application and make purchases using the application which helps to ensure wise usage of funds, because only agricultural inputs can be purchased. Similarly, as traders purchase pigs from farmers, transactions are reconciled through AliPay, which ensures that loan repayment is made first.

Rural Taobao is an online store for agricultural products. It creates a marketplace for goods that allows farmers to purchase products. It provides price transparency for buyers and helps to eliminate middlemen and minimize logistical costs.

TMall provides an online platform for traders to sell purchased pigs. It has controls in place with Ant Financial that ensures traders follow through with their purchase commitments.

MyBank is an online cloud-based bank available to AVC players.

Table 10: Benefits of Ant Financial platforms

Product	Features	Benefits
Ant Financial	• Ready access to financing • Insurance	• Better credit information, as user transaction history is accumulated and stored • Lowered risk, as funds are used within the AVC • Ensured repayments, as transaction reconciliations pay lender first
AliPay	Payment platform	• Swift settlement of transactions • Cashless transactions
Rural Taobao	Online sales platform for agricultural materials	• *Input suppliers*: access to more buyers and ensured sales as farmer financing must be used to buy inputs • *Farmers*: access to more sellers and transparent pricing • *Financiers*: risk controls on loans to farmers
TMall	Online sales and auction platform for live pigs	• *Farmers:* access to more buyers • *Traders*: access to more sellers and better quality goods • *Financiers*: risk controls on loans to traders
MyBank	Cloud-based banking	• Secured online accounts

Together, the platforms create a closed system wherein funds are guaranteed, re-invested and circulated through the AVC. Shared data creates better communication among players.

From a **financial source standpoint**, the funds for loans in Ant Financial's model are largely derived from the credit funds of **MyBank** under the Ant Financial umbrella. As **MyBank** does not have offline terminals and the ability to absorb reserves, its funds are dependent on interbank lending, which in turn results in Ant Financial having less of an advantage in terms of capital costs compared to the Agricultural Bank of China and Postal Savings Bank of China.

From a **client standpoint**, the clients serviced under Ant Financial's model are the clients of the lead firm or cooperative members in partnership with Ant Financial. As such, the client group covered is limited, and the small-scale breeders, who have been largely side lined by the traditional AVC finance model, are still excluded.

From a **risk control standpoint**, Ant Financial's model requires relying on the lead firm to screen their clients. The loans are released through the "designated payment management system", and the capital flows come from Ant Financial to the AliPay accounts of breeders. However, the loans can only be used for the purpose of purchasing agricultural inputs on the Rural Taobao platform. The lead firm (or cooperative) would first repay the Ant Financial loan after the purchase of the agricultural products. Hence, a closed fund system is used to control the risks involved.

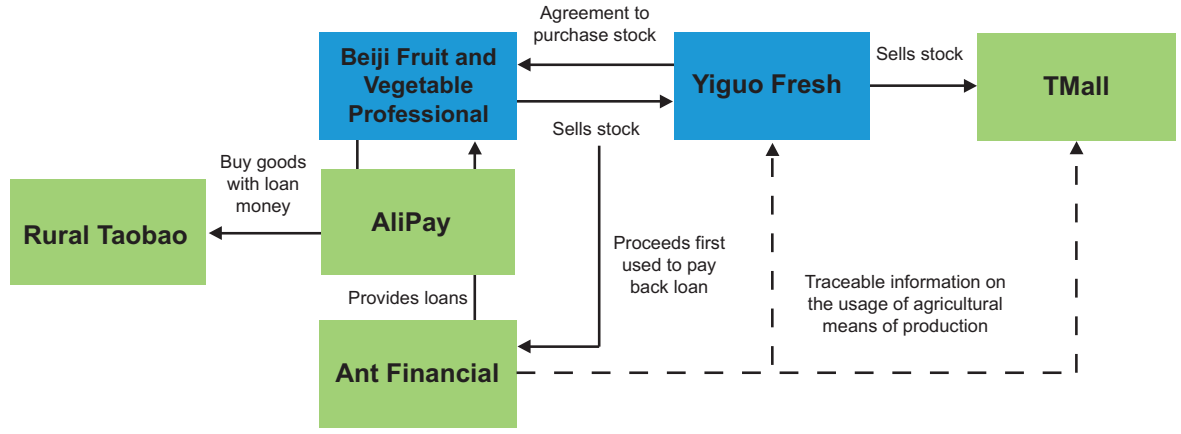
5. Caselets

The following section examines the Ant Financial model in practice across the country to support the smallholder producers.

5.1 Yiguo Fresh Produce

Zhouzhi County in Shanxi is one of the largest producers of kiwi fruits in the China, as well as the "original home" of kiwi fruits worldwide. The Beiji Fruit and Vegetable Professional Cooperative is the largest-scale kiwi fruit cooperative in Zhouzhi County, with hundreds of local fruit farmers within the cooperative. Ant Financial and Yiguo Fresh Produce partnered with this cooperative. The Ant Financial solution integrates into the fresh produce value chain as shown in Figure 11.

Figure 11: Value chain finance model of Ant Financial and Yiguo Fresh Produce



Source: Illustration by editors

Yiguo Fresh Produce signed a purchase order with *Beiji Fruit and Vegetable Professional Cooperative* stipulating that when the kiwi fruits are ripe at the end of October, *Yiguo* would purchase the premium "Cuixiang" kiwi fruits from *Beiji* and sell them on the fresh produce section of **TMall Supermarket**.

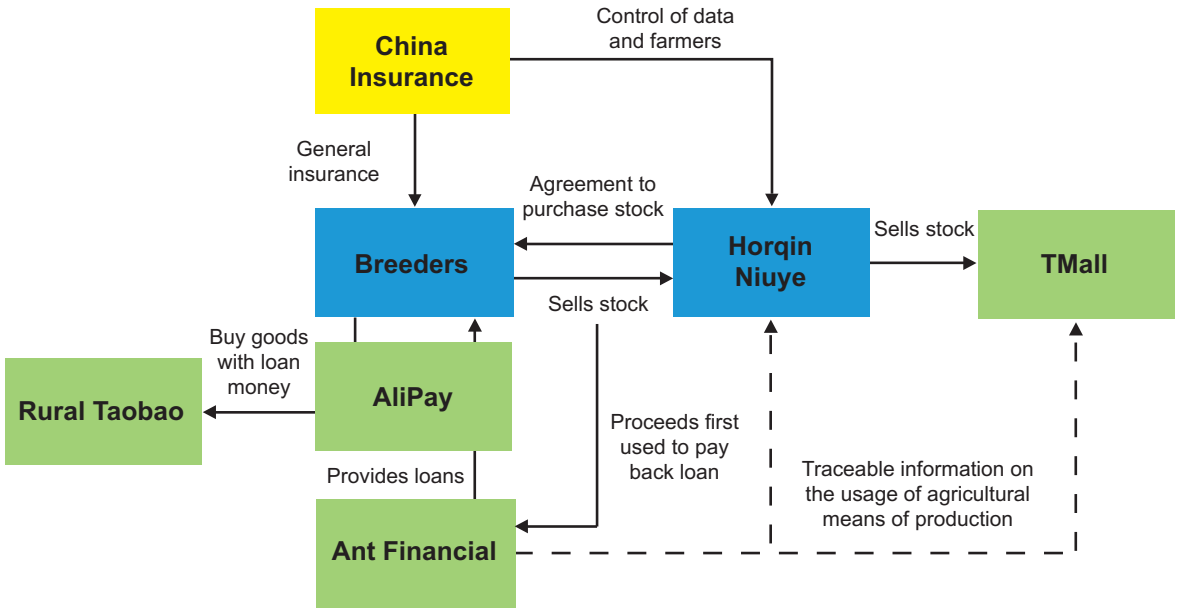
Ant Financial verifies and confirms the orders before providing loans to *Beiji* through **MyBank**. In order for *Yiguo* to ensure the quality of the fruit products, the loan is paid through the payment function, which is solely for purchasing agricultural inputs as indicated by *Yiguo* from **Rural Taobao**. *Beiji's* purchasing information is transferred to *Yiguo*, thereby ensuring control of the entire fruit production process. During this process, **Ant Financial**'s insurance department works with an insurance company to provide quality guarantee insurance for the agricultural inputs and pesticide sold online in order to ensure product quality.

Upon harvest, *Yiguo* purchases the kiwi fruits produced by *Beiji*, and the purchase proceeds are first be used to make payments on the principal and interest, thereby creating a closed funding system.

5.2 Horqin Niuye model

Inner Mongolia Horqin Niuye Co., Ltd., is the leading beef supplier in China, with 50,000 mu (approximately 8,237 acres) of land and four farms. Horqin needed financing for further expansion following its breeding scale expansion. Horqin adopted an "enterprise + farmers" commissioned farming model similar to that of Wens Group, whereby the stipulated feeding standards, breed cattle, feed, veterinary medicine and other items would be provided by Horqin, and the breeders would be responsible for the rearing. The raised cattle would then be purchased by Horqin. As the Chinese beef market is in short supply, many breeders wish to expand their scale. However, the construction of barns, breeding and feeding require funds. Horqin has limited funds, and the breeders often lack collateral and are unable to obtain loans, but the breeders have been working with Horqin for many years, which results in a certain degree of credibility. Therefore, Horqin signs purchasing contracts for every production cycle. In November 2016, Ant Financial established a partnership with Horqin, whereby Horqin would be the value chain lead firm in terms of capital flows and Ant Financial would provide loans for its upstream breeding. The Ant Financial solution integrates into the beef value chain as shown in Figure 12.

Figure 12: Value chain finance model of Ant Financial and Horqin Niuye



Source: Illustration by editors

Horqin signs a purchasing contract with the *breeders*, guaranteeing purchase of all cattle raised. The *breeders* purchase performance guarantee insurance from *China United Insurance Holding Company* based on their own repayment risks. This policy ensures that the insurance company pays the outstanding difference in the borrower's (*breeder's*) repayment amount should the borrower fail to repay the loans. Following due diligence procedures carried out by **MyBank** and China Insurance, **Ant Financial** provides loans to the *breeders*. Ant Financial assesses the breeders' production value and determines a percentage based on personal debt conditions and corporate control conditions; and the initial loan credit limit is the collected payment from the end sales of breeders multiplied by this percentage. The loan is released via **AliPay** and can only be used to purchase agricultural inputs on **Rural Taobao** where *Horqin* operates a store that sells calves, feed and veterinary medicine, thereby creating a closed ecology. This system prevents breeders from using their funds for non-production purposes, which would incur risks of loan repayment defaults.

Upon completion of the breeding cycle, *Horqin* purchases the cattle. *Breeders* use the sales proceeds to repay the **Ant Financial** loan. *Horqin* also runs a flagship shop on **TMall**, for which Ant Financial reserves the right to freeze *Horqin's* collected sales payments should risks occur.

The sales volume of the 2016 Singles Day sales event for Horqin's **TMall** flagship store amounted to RMB 22.08 million (US$ 3.27 million), and the **TMall** sales volume for the year amounted to over RMB 200 million (US$ 29.65 million). As the loans provided by **Ant Financial** to upstream breeders are between several hundred thousand and several million RMB, the sales volume of the **TMall** flagship store is completely able to cover regular risk factors. For Ant Financial, the prioritized order for the repayment of loans is as follows: the sales payments are first used to repay loans, and the insurance company will repay the loans for defaulters, which are less likely in this system.

In the partnership model with lead firms, Ant Financial regards the repayment ability of breeders as largely dependent on the lead firm (Horqin Niuye) in the value chain. As such, if problems occur in Horqin's production and operations, these problems would be passed down to the breeders in terms of their loan repayment abilities. From a financial standpoint, the funds for Ant Financial's agricultural-related loans are largely derived from the credit funds of **MyBank** (under the Ant Financial umbrella). As **MyBank** does not have offline terminals and the ability to absorb reserves, its funds are dependent on interbank lending, which in turn results in Ant Financial having less of an advantage in terms of capital costs compared to the Agricultural Bank of China and Postal Savings Bank of China.

6. Lessons learnt

6.1 Advantages

Usage of E-commerce platforms have the potential to reduce deficiencies in the agricultural value chains in the following ways.

- **Innovate financial services:** E-commerce financing replaces traditional financial institutions as a provider of funds in the AVC. The financing costs of e-commerce platforms are relatively low, and these lowered credit costs can help boost these platforms' competitive edge. Digital information technology, real-time and comprehensive risk control measures are implemented during the pre-loan, loan, and post-loan stages of financing, thereby reducing defaulting risks. The convenience of mobile payments is maximized, thereby lowering the time-related costs for deposit, withdrawal, and payment processes. Through the credit applications submitted by farmers through e-commerce purchase orders, the loan process is drastically shortened, and efficiency of the loan application process is boosted. Other insurance-related services are also provided.

- **Expand sales channels and boost supply chain value:** The Ant Financial model maximizes the cross-regional platform advantage of e-commerce and the ability of e-commerce platforms to form a rapid and comprehensive understanding of market demand information, helping leading enterprises, cooperatives, and even small farmers expand their product market. The platforms also enable direct access to manufacturers and end-product users, thereby eliminating traders and agents from the process. Activity planning allows end-user consumption, production, and processing to be synchronized in terms of time and quantities. Moreover, e-commerce platforms allow for improved accessibility, enrichment, and adherence, thereby enabling more effective coordination and combinations.
- **Allow a diverse range of players to participate in AVC finance:** Value chain finance links all players in the AVC. This connectivity offers an advantage in terms of allowing for wider combinations, that is, moving from an "N+1+1" model (multiple farmers + 1 leading enterprise + 1 financial institution) to an "N + N + N" model (multiple farmers + multiple leading enterprises + multiple financial institutions), which is realized through e-commerce platforms and facilitates better coordination and combinations.
- **Build a rural credit rating system:** The absence of a credit rating system in rural areas severely impedes the development of the rural financing market. E-commerce platforms link the agricultural production, distribution, and consumption processes, forming the overall link between upstream agricultural resources and end users. As e-commerce platforms host huge amounts of transaction data for agricultural product businesses, such platforms can perform real-time and comprehensive evaluations on the operational and credit rating statuses of relevant suppliers, thereby expediting agricultural financing efficiency. In addition, huge quantities of data on farmer production, sales, and financing becomes available. The rapid development and gradual enhancement of agricultural e-commerce would be helpful in establishing and improving a rural credit rating system.

6.2 Challenges

As rural e-commerce is still in its initial stage of development, there is room for improvement in terms of the management function of e-commerce platforms for the AVC. In the early stages of implementation, e-commerce-driven agricultural value chain finance could also face challenges in the forms of risk control and contract execution issues. There are four primary challenges.

A "closed fund system", which is a key risk control measure for traditional value chain finance, is difficult to implement or fully achieve, because online sales cannot completely replace traditional sales channels in a short term. In Ant Financial's model, although the lead firm runs a store on **TMall**, the majority of sales still occur offline.

The models require partnering with lead firms (or operation centres or cooperatives), and the e-commerce platforms do not truly replace the key points of traditional AVC finance. The problems posed by this model include that partnerships with lead firms reduce the scope of clients serviced, and there is also a certain degree of risk. The implication in this lead firm-dependent partnership is that the repayment ability of breeders largely depends on the lead firm in the value chain. As such, if problems occur in the production and operations of the lead firm, the problems would be passed down to the breeders in terms of their loan repayment abilities.

The problem of high capital costs is common. As the financing channels of e-commerce platforms are of a relatively singular form, financing limitations occur as business scale increases. As such, while the loan interest rates enjoyed by farmers are lower than those of traditional credit channels, the rates are still higher than those of formal financial institutions.

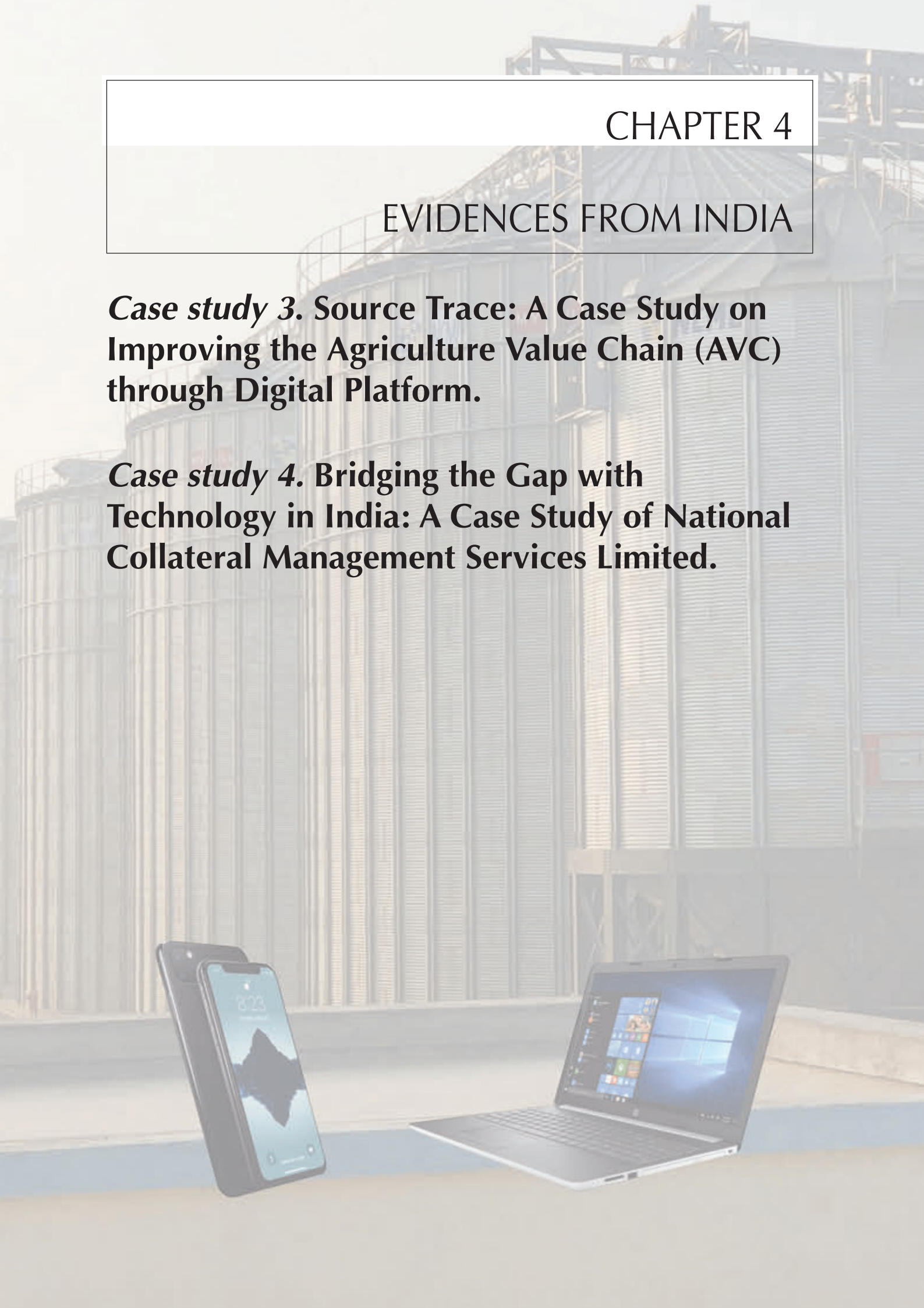
From an overall agricultural perspective, the model is only suitable for industries with higher levels of industrialization, and such a model is hard to implement in "dispersed" crop farming industries. There are abundant levels of retained data for the breeding industry, especially for the poultry farming industry, which has extremely high levels of industrialization due to large-scale purchase orders from KFC and McDonald's. However, risk control measures are difficult to implement for the crop farming industry, which has a very low degree of concentration and a less-than-ideal production, processing and sales chain. This scenario is further compounded by a core limitation in the form of land.

CHAPTER 4

EVIDENCES FROM INDIA

Case study 3. **Source Trace: A Case Study on Improving the Agriculture Value Chain (AVC) through Digital Platform.**

Case study 4. **Bridging the Gap with Technology in India: A Case Study of National Collateral Management Services Limited.**



CASE STUDY 3

SOURCE TRACE: A CASE STUDY ON IMPROVING THE AGRICULTURE VALUE CHAIN (AVC) THROUGH DIGITAL PLATFORM

Sankar Datta and Sonakshi Anand[1]

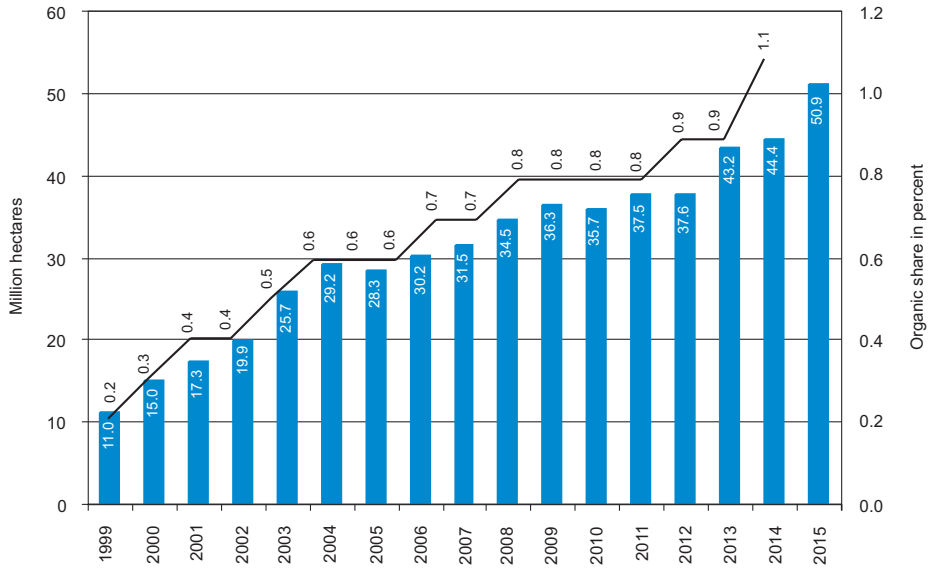
[1] Sankar Datta and Sonakshi Anand prepared this document on behalf of BASIX Consulting and Technology Services Ltd., India.

1. Introduction

1.1 Global organic food market

The last decades of the 20th Century have witnessed an awakening of consumer consciousness. People around the world have become more aware of the ecological damage that High Yielding Variety (HYV) technology are causing to themselves and the environment. They have become more aware of the "unfair" deal that was being meted out to the ultimate producers. This awareness has led to the emergence of new market channels of organic food[17] and fair-trade food[18] (see Figure 13).

Figure 13: Global growth of organic farmland and organic share (1999-2015)



Source: http://nrs.harvard.edu/urn-3:HUL.InstReport:8889458

1.2 Organic food production in India

India has the largest number of organic farmers (Figure 14), but in terms of the total land area cultivated, it ranks 9th behind smaller countries like Italy, France or Uruguay (Figure 15).

These new industries are information-intensive, requiring collation and processing of data about the producers and their production processes. Acquiring this type of information is difficult in the Indian economy with its very large number of small and dispersed producers.

In order to compete, India needs to adopt Information and Communication Technologies (ICT); it would be impossible to handle the large volumes of data without it.[19] Luckily, India has shown enormous growth in mobile and ICT. By 2015, it had more than 220 million smart phone users, growing at close to 23 percent annually. It is predicted that India will overtake the US by 2020, which currently holds the second position after China.[20]

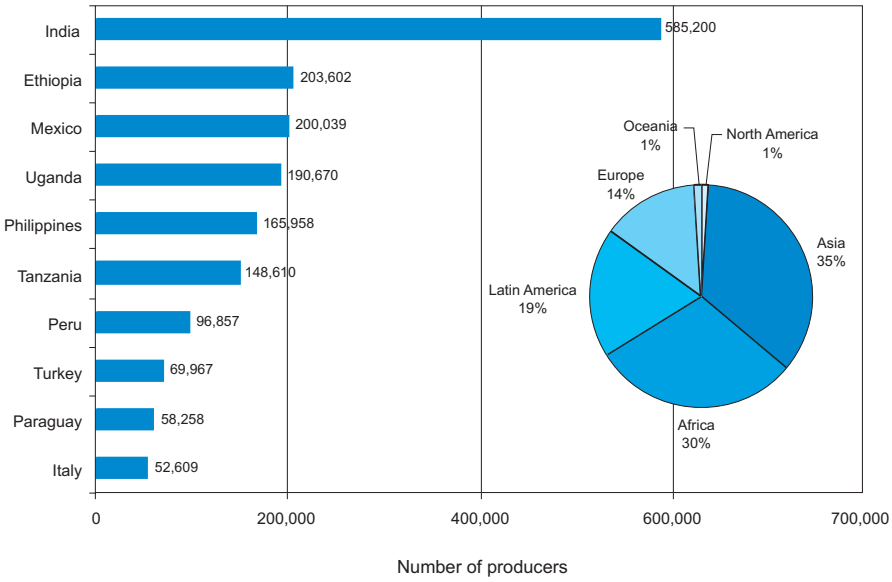
[17] Jessica Ellsworth, "The History of Organic Food Regulations," (2001); and Hamzaoui Essoussi, Leila and Mehdi Zahaf, "The Organic Food Market: Opportunities and Challenges," (2012) (available at http://nrs.harvard.edu/urn-3:HUL.InstReport:8889458)

[18] R. Dragusanu, Daniele Giovannuchi, Nathan Nunn, "The Economics of Fair Trade," *Journal of Economic Perspectives* 28 no. 3 (2014): 217-236; and John Wilkinson, "Fair Trade: Dynamics and Dilemmas of a Market Oriented Global Social Movement," *Journal of Consumer Policy* 30 (2007): 219-239.

[19] For a detailed discussion on the emergence of the sector see Thomas Haigh, "The History of Information Technology," *Annual Review of Information Science and Technology* 45 (2011).

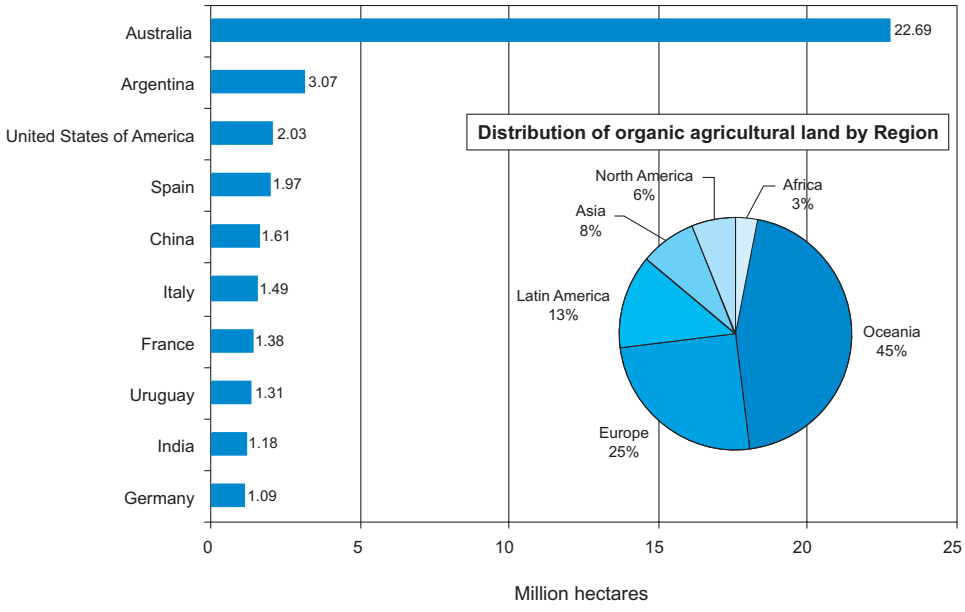
[20] Shankar Shamanth, "Mobile commerce in India likely to jump by 45-50% in 2017," *Riversand* (2017).

Figure 14: Number of organic producers by country (2015)



Source: http://nrs.harvard.edu/urn-3:HUL.InstReport:8889458

Figure 15: Land area used for organic agriculture by country (2015)



Source: http://nrs.harvard.edu/urn-3:HUL.InstReport:8889458

2. SourceTrace Systems

2.1 Company background

SourceTrace was incorporated in the United States in 2013 with its legal entity as STI Solutions, LLC. SourceTrace was initially supported by leading social venture firms such as Soros Economic Development Fund (SEDF), Gray Matters Capital and Serious Change. The Schmidt Family Foundation, Sorenson Impact Foundation and Impact Assets joined later as investors.

SourceTrace is a new generation social enterprise that leverages the strength of ICT to fuel the growth in agriculture of the Green Revolution. As the name suggests, their technology provides complete visibility from field to market and tracks the value chain at the source, even in remote, low-bandwidth environments.

SourceTrace specializes in software focused on sustainable agriculture and empowerment of smallholder farmers in developing economies. Their farmer-centric mobile applications help manage the agriculture value chain (AVC) from the first to the last mile, enabling smallholder farmers to participate in global markets. SourceTrace mobile applications can be used by all players in the AVC, from small co-operatives, farmer producer companies to large agribusiness corporations and government agencies working in the sustainable development sector.

SourceTrace also works in the fields of aquaculture, plantation and forestry, but agriculture and traceability are their core services.

2.2 Digital platform for AVCs

SourceTrace's software platform **eService Everywhere** (**ESE™**) captures data on all interactions at the touch points of the smallholder farmers at the field level for enhanced traceability and improved accountability of the value chain. **ESE™** has been deployed in 22 countries over three continents, setting the industry standard for mobile applications in remote and low-bandwidth environments. Real-time information allows management to increase operational efficiencies and reduce costs, and it contributes to "smart" agriculture by incentivizing smallholder farmer organizations to embrace technology and increase their production.

Information can be collected in an offline mode and then uploaded when connectivity is available. The software is available in multiple languages: the web platform is available in English, French and Spanish, while the mobile application is available in about 14 different local languages, including Hindi, Tamil, Telugu, BenhBahai and Swahili.

SourceTrace leverages remote data capture middleware and hardware in an on-demand, hosted on the Software-as-a-Service (SaaS) model to provide 360° visibility on data sources around the globe. The flexibility of the **ESE™** platform architecture allows SourceTrace to customize applications for the requirements of any market, agricultural crop, business practice or process. **ESE™** applications can be managed either from the cloud or locally within an organization.

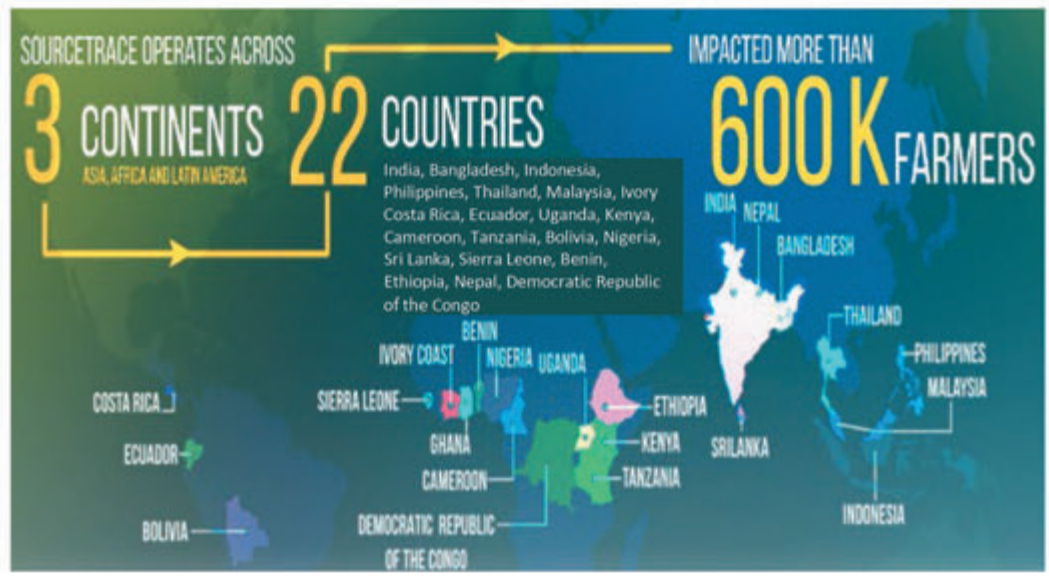
2.3 Presence of SourceTrace

SourceTrace has presence across Asia, Africa and South and Central America, operating in about 22 countries. It has over 100 customers and impacts more than 600 thousand smallholder farmers (see Figure 16). Of these, about 200 thousand farmers (mostly in Nigeria) have been linked with financial services (bank or microfinance agency). In India, AVC financing using **ESE™** is currently under trial, and many financial institutions have shown interest in using the tool to provide financing to the farmers.

SourceTrace has a strong presence in India and West Africa. Customers are located in more than 12 states throughout India; and the highest concentration of farmers in West Africa is located in Cote d'Ivoire and Nigeria. Customers are also located in South East and Far East Asia; Bangladesh, Nepal, Philippines, Thailand and Malaysia, and in several countries in East Africa and South and Central America.

In the next five years, SourceTrace plans to target an additional 10 million farmers in its operating countries. Moreover, they aim to adapt to the needs of financial institutions to manage risk and ensure financing of the farmers through **ESE™**.

Figure 16: Extent of operations



Source: SourceTrace website

2.4 Corporate strategy

The AVC includes all stages of agricultural production from raising to consuming product – from "Farm to Fork."[21] Over this chain, a product can change hands numerous times. SourceTrace recognized that in order to meet the information appetite of the consumer, product traceability across the entire value chain would be necessary. This information would also be valuable to players within the AVC. How much area was planted, with which variety of seed, and whether manure application was done in time, is essential information for estimating the total production. This information is necessary if appropriate eco-sensitive processing is to be arranged. This information, along with who produced it and how, will be demanded by the consumer of organic commodity. SourceTrace Systems adopted the following strategy.

- ➤ Collect and consolidate information across the entire AVC, whether or not the immediate user required it.
- ➤ Develop the system in a modular fashion, so that information could be activated and tailor-made to the individual customer's requirements.
- ➤ Consider as a client any of the players in the value chain, especially those dealing with a large number of transaction points and generating data. (These were mostly Agri-Business Companies or Co-operatives rather than individual farmers).

2.5 Core client targets and activities

SourceTrace delivers its services in India through one of its wholly-owned subsidiaries, SourceTrace India Private Limited (hereafter referred to as SourceTrace). The SourceTrace Clients include:

- C&A Foundation supported Farmer Producers Companies
- Chetana Organic Agriculture Producer Company

[21] These include, but are not limited to: winnowing, packing, transportation, storage, trading, processing, refining, consumer packing, and marketing, including wholesale distribution and retail sales before an agriculture commodity reaches the ultimate consumer. In some commodities, it also involves secondary and tertiary processing as well as storage, transport and sales.

- NABARD
- Vasundara Agri-Horticulture Producer Co., Ltd.
- Aditi Organic Certification Pvt. Ltd.
- Prathibha Syntex
- Krishi Pragati Foundation
- MHR Foundation
- Purvanchal Gramin Seva Samiti
- Adivasi Mitra Wefare Society
- Uttarakhand Gramin Bank

SourceTrace clients are those who perform some function in the AVC and who require the ability to handle large volumes of data from a large number of farmers. These include small co-operatives, farmer producer companies as well as large agribusiness corporations and government agencies working in the sustainable development sector.

SourceTrace facilitates financing of the value chain by making the information available to the financers. SourceTrace collaborates with the Central Bank of Nigeria and is in negotiations with several banks in India and Africa. Other clients include the following:

- WorldFish is using e-traceability for Bangladesh's shrimp value chain. This information is sought by the bankers for financing shrimp export, which is a major foreign exchange earner for the country.
- Chetna Organic, a pioneer of the organic cotton in India, is using SourceTrace traceability software to track bales shipped from ginning mills to spinners all the way to the farmers.
- Chetna Organic has successfully integrated the financing of smallholder farmers along with the inputs and procurement activities.

2.6 Future plans

SourceTrace is planning for the future. Among its plans are the following:

- Expand farmer base to 10 million farmers over the next five years. SourceTrace is hopeful that current organizations will use the application to link financial institutions to smallholder farmers.
- Partner with a GSM Association in order to integrate digital money in order to provide automated payments, increase accessibility and reach and make banking easier for the smallholder farmers.
- Integrate satellite information for ensuring crop insurance facilities. This information can be useful to financial institutions to keep track on the farmer's progress.
- Continue to add more local languages to applications as well create better offline functionality to support remote users.

3. Product offering

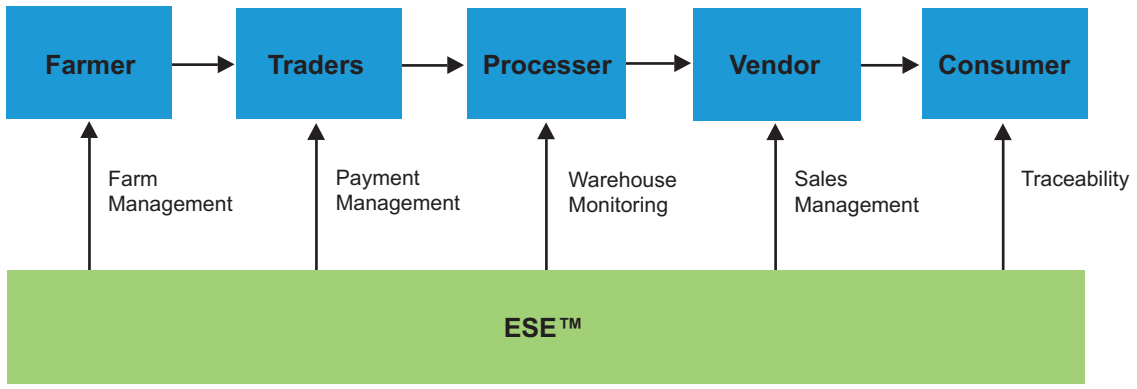
Farmers are geographically disbursed and often located in remote areas. **ESE™** connects them together, tracking any commodity through the AVC, from basic raw materials (like seeds) at the source to the central processing facilities of the final output. Data is collected on mobile devices and can be instantly fed to sophisticated, powerful server-based flow-of-goods analytics that enable farmer or producer organizations to respond to the market instantly.

ESE™ is offered as a "Software-as-a-Service" (SaaS) model. The application is served from the cloud and is made available to customers via mobile devices and the web. This model allows SourceTrace to offer services to customers around the world without having a local presence. When a local presence is required, SourceTrace leverages its extensive business partner network of over 20 business partners in various countries.

3.1 How it works

ESE™ integrates with the AVC (Figure 17).

Figure 17: SourceTrace model and the AVC



Source: Illustration by editors

ESE™ provides services and collects data throughout the AVC. Figure 5 provides a simplified diagram of the various ways that it intervenes in the AVC. *Farmers* are provided with tools that help them manage their farm. These tools include features such as geo-tagging of farms (assists with weather and geographic information), farm distribution and crop area mapping (how best to lay out crops), activity calendar (when to sow, fertilize, harvest), pest and disease monitoring, yield estimates and crop certification. *Processors* and *warehouse operators* have access to warehouse monitoring and process plant monitoring. *Traders* and other middlemen have access to tools such as procurement tools, product tracking, payment management and sales management. *Processors* and *warehouse operators* have access to tools to manage and track stock. Traceability features in all services. The data collection is stored and shared such that financiers have access to credit information and can make loans to the various players.

3.2 Overview of product features

Table 11 provides an overview of how the AVC players benefit from the features of the **ESE™** platform.

The **ESE™** application is standardized, so that different crops and their value chains can be incorporated with minimal customization, making the reach and potential of **ESE™** much greater. With the ability to capture all the information about the sowing, cropping patterns, soil type, land owned, social status, income status, etc., the application covers all the necessary information needed for ensuring better source traceability and transparency. FIs can use this information to calculate risks and be confident when providing financing for small holder producers. Consumers can trace their produce back to the farmers, and certification of farmers is made an easier and more inclusive process.

Table 11: Benefits of ESE™ platform

Player	Benefits of using ESE™
Farmer	• Farmer account management • Geo-tagging of farm • Crop area mapping • Yield estimate • Farm distribution Management • Crop activity counter • Crop and farm inspection • Pest/disease monitor • Access to market information • Access to agricultural best practice information • Access production information (weather, forecast, etc.) • Easier to manage production processes and stock • Increased productivity • Faster seller payment • Higher prices due to certified product • Easier access to financing
Traders	• Product certification • Payment management
Processors	• Product transfer tracking • Processing plant monitoring • Warehouse stock management
Vendors	• Retail sales management • Product sales management • Traceability
Financial Institutions	• Better historical and current information on farmers and yields • Reduced risk in financing • Easier financing/repayment
Development Organizations	• Better data capture • Better data management and monitoring • Better resource management/reduced operating costs
Consumers	• Better product • Certification and traceability of product

3.3 Financing

As financing AVC players is considered high-risk by most lenders, **ESE™** helps to manage the risk. It provides important information to the lender, including the crops, the cropping pattern, the estimated yield and the investment by the farmers. Additionally, the farmers' loan and repayment history is available to the financial institution, helping them to assess their risk. **ESE™** provides confidence to lenders, making them more willing to provide the necessary capital.

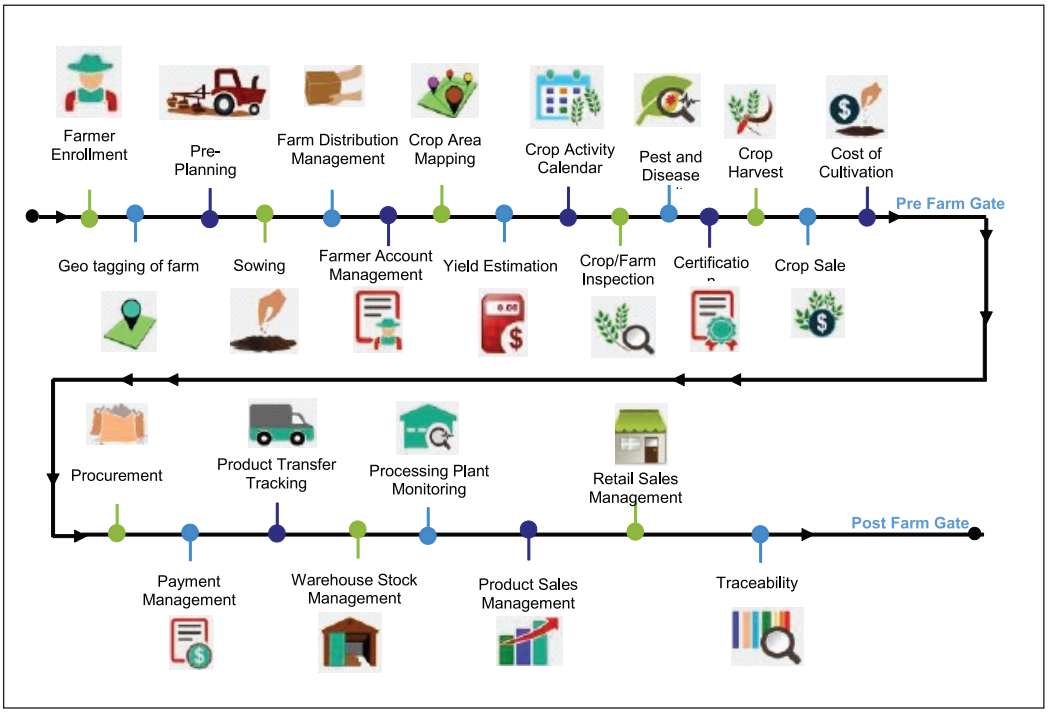
The Central Bank of Nigeria has used SourceTrace software to link more than 100,000 farmers to financial institutions. Chetna Organic and other development agencies in India are developing a similar plan to provide financial institutions information about farmers who are a part of registered cooperatives and Farmer Producer Organizations (FPOs).

3.4 Key points of intervention

The key points of intervention in agricultural value chains is described and shown in Figure 19:

The process of digitizing the AVC starts with farmer enrolment, which captures information directly from smallholder farmers and other providers on the field. Captured data includes information on the farmer, cropping pattern, land, household status etc., which are compliant with most standards like Fair Trade, Organic Certification and other such certifications as well as Know Your Customer (KYC) requirements of financial institutions (Figure 18).

Figure 18: Digital Agriculture Value Chain Developed



Source: SourceTrace website

Farmer land is geo-tagged and plotted for Crop Monitoring in the future. Field visits by bank or AVC Company staff are captured along with photos and notes on each visit. Geo-plots are also used for satellite-based advisory services using remote sensing data.

Field workers use mobile phones to capture data on field activities such as sowing, input distribution, crop area mapping, yield estimation, inspections, etc. Advisory services regarding weather and market prices are available on mobile devices.

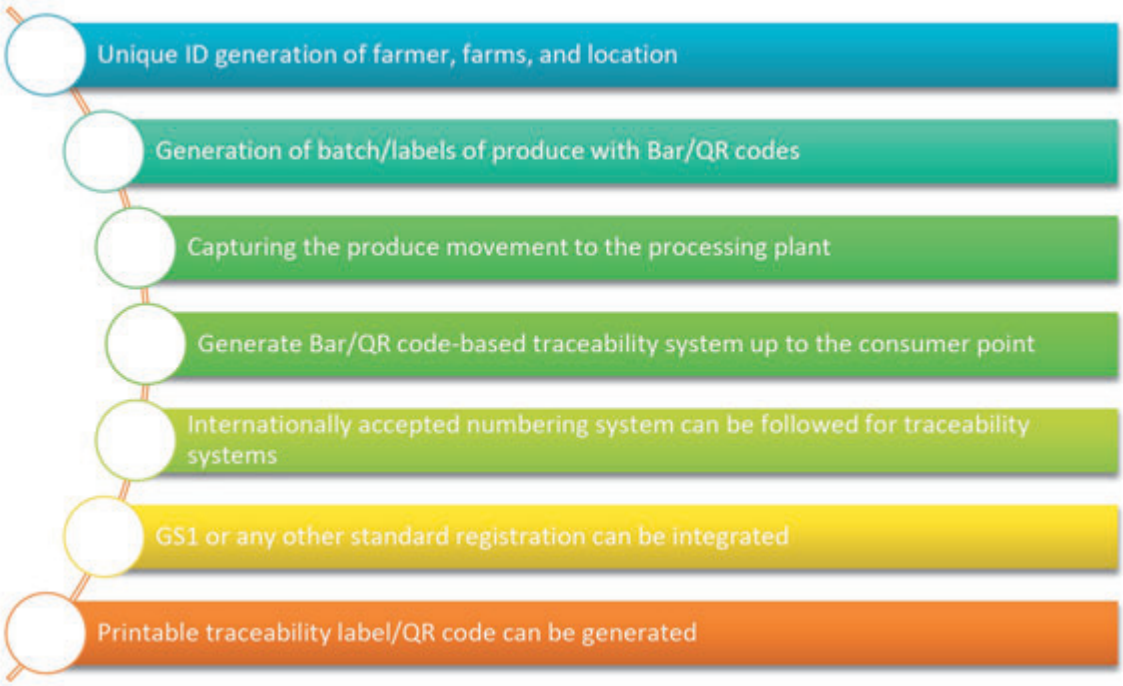
Digitized procurement methods ensure efficient purchase of agriculture produce in the field or other collection point. Data on the procured produce is automatically collected and added to receiving station stock, making the total stock visible for the buyers. Integrated digital weigh scales automatically enter weight data at the time of procurement thus avoiding error or malfeasance. Full traceability is established using lot numbers and batch numbers during procurement, and transactions are recorded in real-time with digital receipts to ensure reliability. Payment processing and immediate payment transfer is also available.

Each of these processes make certification easier. The **Certification Internal Control System** enables Farmer Organizations to create and maintain a digital Internal Control System (ICS) to support Internal Audit and certification process. Moreover, since the data is directly collected from the field, it ensures data integrity; images captured of the farm ensure source traceability.

3.5 Traceability

Traceability is an increasingly common demand of public and private systems for monitoring compliance with quality, environmental, and other product and/or process attributes. Food traceability is becoming a pre-requisite to establish safety of food products. **ESE™** has built-in traceability capability, which starts from the farmer to the warehouse, FPOs or the aggregators as the case may be (see Figure 19).

Figure 19: Processes involved in traceability

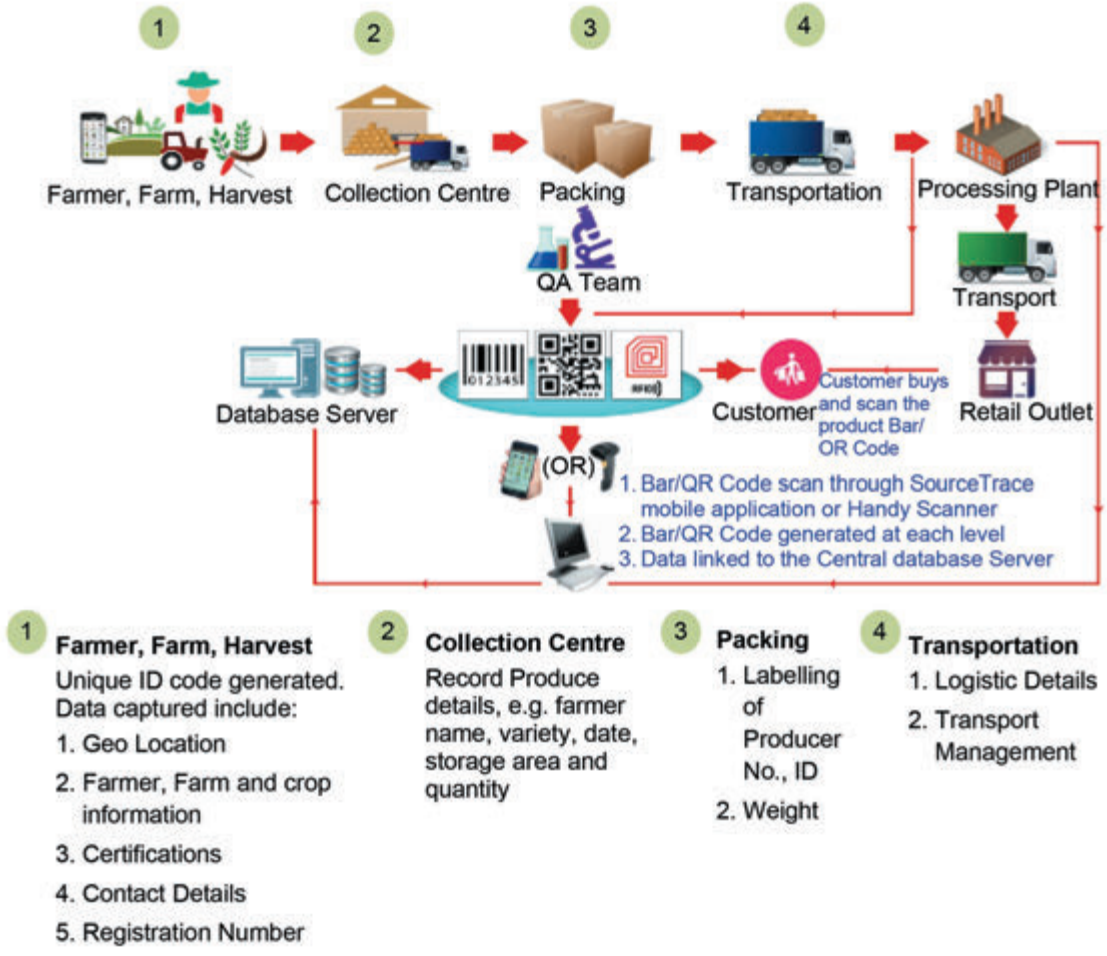


Source: Illustration by authors

All of this information can be captured on field staff mobile phones working at the various FPOs. Traceability data can be captured without internet connection, ensuring that even remote location information can be recorded. **ESE™** can generate QR codes immediately for use along with printing receipts. Data is uploaded to the internet once connectivity is available, at which point it becomes viewable on desktop computers for central management and monitoring.

The traceability process as shown in Figure 20, data is collected (1) at harvest time (farm geo location, farmer information, crop information and certification), (2) when the produce reaches the collection centre (quantity, variety and location in the packing centre), (3) when the produce is packaged (producer, QR code, quantity) and (4) when the produce is shipped (logistics, transportation detail). Ultimately, the consumer can scan the QR code to get the details of the purchased produce.

Figure 20: ESE™ traceability processes



Source: SourceTrace website

4. Caselets

4.1 Chetna Organic

Chetna Organic is a pioneer in promoting organic cotton in India. They work with farmers from the rain fed regions of Telangana, Andhra Pradesh, Maharashtra and Odisha, covering around 43,500 acres. Their strength has been collective action and the fair supply chain, aiming to promote economically and socially viable agrarian-based livelihoods in rain-fed and other ecologically depressed regions through sustainable agriculture.

Chetna Organic helped farmers form their own Farmer Producer Organization (FPO) for procurement of organic cotton to ensure better prices. However, they were having issues monitoring the field level operations, unable to keep real time systems in place along with the immense paper-based systems that they needed to maintain. SourceTrace was approached to help them better maintain systems and develop traceability for brands to identify the source of raw material, which was becoming an important parameter for the FPO to continue with organic cotton business.

SourceTrace customized their processes for Chetna Organic. They developed protocols for farm enrollment and internal inspections in compliance with organic certification and Fair Trade. Chetna Organic has used the SourceTrace system for two seasons to monitor the production of organic cotton. Field staff and extension workers have been trained to use the system; they enter their farmer enrolment,

inspection, inputs and procurement data on mobile devices. This process ensures transparency in production, procurement and flow of goods through the value chain.

4.2 Aditi Organic Certifications

Aditi Organic Certifications Pvt. Ltd. offers inspection and organic certification according to National Program for Organic Production (NPOP) and National Organic Program of the United States Department of Agricultural Standards (NOP) for a wide range of organic and agricultural products. The existing internal control system and certifying processes were being manually recorded on paper, making data consolidation difficult and cumbersome. It was likewise difficult to authenticate date and area of inspection, and it was not possible to get the current status of the projects, which affected the overall performance of the organization.

Aditi partnered with SourceTrace Systems to deploy the **ESE™** platform to manage their certification processes and their Client's Farmer Groups ICS (Internal Control System). The solution provides Aditi with an Android-based mobile application for field level data collection and monitoring and a web-based managerial reporting system and application administration module.

5. Lessons learnt

5.1 Advantages

SourceTrace is financially sustainable. Although designing and building the **ESE™** platform took a significant investment of time and money, the system is now ready for implementation across different crops, geographies, countries and continents. The customization needed by different agencies is minimal, and though clients are provided with all the software features, they can choose to use only the ones they need. The cost of service is marginal, and the product is available for use for a vast customer base. The product is further sustainable as SourceTrace continues to develop and adapt new technologies (e.g. satellite) to meet current needs.

ESE™ has been tested in many countries, with different crops and their respective value chains. It is a proven system. In the last two years, SourceTrace Systems has worked with over 140 customers across the globe with over 70 organizations in India. Given the flexibility of the model, its adaptability and replicability, the scaling up processes can be efficiently achieved.

The design of the **ESE™** platform makes the model replicable and sustainable.

- The intervention does not involve any change to the existing Agriculture Value Chain. All players continue to perform their current functions.
- Using the system does not involve any serious capital investment from the user. Simple mobile devices are the primary equipment.
- On-location internet connectivity is not required. Data can be collected locally and then uploaded wherever a connection is available.
- The system's modular design makes it easily customizable to the user's current and future requirements.

5.2 Challenges

SourceTrace faced issues in financing, training and understanding. Financing agri-related intervention is difficult as few investors are interested in such initiatives. Additionally, few small holder farmers want to invest in digitizing their processes, and those who do can rarely afford it. As such, SourceTrace focused specifically on capturing certified farmers who were promoted through organizations or agri-businesses and registered as FPOs or cooperatives.

Because the average smallholder farmer is unprepared to use software technology, SourceTrace works with development organizations rather than with farmers directly. Development organizations typically have the human and financial resources to understand and utilize software as a solution to AVC issues and bring these methods to the individual farm. Nevertheless, even skilled extension workers require training on the product, and SourceTrace often needs to provide continuous hands-on training to field staff

Initially, **ESE™** platform was provided in English, but it was observed during implementation that language was a barrier for many of the field staff as they were unable to understand the application requirements. In response, SourceTrace has updated the mobile application to support 14 different local languages and the web-based portal to support three languages.

In addition,

- AVC Finance can be made more efficient (without financing) by facilitating information flow. However, capturing this information requires work along the entire chain.
- Financial support becomes easier as information becomes more readily available; however, establishing the credibility of the information takes time.
- Authenticating information depends upon a large number of different players, so the ability to coordinate with them is an essential condition for the whole AVC to improve its efficacy. Coordination can be difficult as different players may have different information needs (and different data formats), making central databases difficult to design. Privacy of data can also be challenging, especially when financial institutions start using this data.

5.3 Role of the government and development agencies

Smallholder farmers often do not see the value of digitization. Even certified farmers who think it would be useful to ensure better returns on their crop are often unwilling to invest money or may not be literate enough to understand and operate technology. These factors make the role of governments and development agencies critical, who must reach out to farmers and farm workers to help them understand the benefits of digitized agriculture.

National Bank for Agriculture and Rural Development (NABARD) is setting up NabKisan Finance Limited to help FPOs adapt and to ensure financial linkages through this process. AXIS bank and YES bank are planning to enter the agricultural commodities space for finance through digitization. SourceTrace originally looked only at development agencies like Chetna Organic, Aditi Certifications, APMAS and Krishi Pragati, but as the role of governments and additional development agencies is increasing, SourceTrace plans to widen its scope.

CASE STUDY 4

BRIDGING THE GAP WITH TECHNOLOGY IN INDIA: A CASE STUDY OF NATIONAL COLLATERAL MANAGEMENT SERVICES LIMITED

Sankar Datta and Sonakshi Anand[1]

[1] Sankar Datta and Sonakshi Anand prepared this document on behalf of BASIX Consulting and Technology Services Ltd., India.

1. Introduction

1.1 India: A classic case of post-harvest loss of food grains

India is able to cultivate a wide variety of crops as a result of its varied agro-climatic conditions. However, these variations have also resulted in complex, unorganized, fragmented and inefficient value chains, with a large number of intermediaries between the farmer and consumer. Two significant drivers of this inefficiency are inadequate financing available to farmers and inadequate storage facilities for their product.

About 70 percent of the 118.7 million small farmers produce a variety of agricultural products, and these small farmers work close to 45 percent of the total cultivated area in India (Agri-census 2011). Despite these figures, small farmers have little to offer as collateral, and they engage with commodity markets and financial markets only marginally. Agriculture becomes wealth in the hands of the farmer only after it is harvested[22], but this lack of funds means farmers are always playing catch-up, needing to sell their product quickly, and often at a sub-par price, in order to fund the next harvest. Agricultural outputs could be impacted immediately with the availability of direct agriculture credit being made available to the farmers.[23]

Preventable post-harvest losses of food grains are as high as 10 percent of the total annual production of about 250 million metric tonnes (Ministry of Food and Civil Supplies, Government of India, 2012), which further reduces the value of product. Improving infrastructure for storage and transport would help minimize this high level of wastage.

1.2 Measures to support actors in agriculture value chains

In order to address the barriers and inadequacies in prevention of post-harvest losses, there have been some innovative efforts were undertaken to extend financial services in the Agriculture Value Chain (AVC) actors at post-harvest stage to support the smallholder farmers. Thus, it becomes important to understand and explore some of these innovative approaches to address the inadequacies in the financing of AVCs in India. Added to this, to reach a sizable scale given the proportion of smallholder farmers in India, especially in less endowed rural areas those innovations that have utilized Information and Communication Technologies (ICT) to ensure faster and accurate scaling up along with the needed efficiency deserve attention.

2. National Collateral Management Services Limited

2.1 Formation

National Collateral Management Services Limited (NCML) has produced an effective and innovative solution to the problems of value chain financing and storage. NCML is the country's leading post-harvest management organization, providing technology-enabled warehousing and supply chain solutions.

NCML was established in 2004 when National Commodity and Derivatives Exchange Limited (NCDEX) expressed the need for a service provider and a physical delivery agency for agri-commodities. Several banks (including Punjab National Bank, Bank of India, Canara Bank, Corporation Bank, Karur Vysya Bank and HDFC Bank) together with Indian Farmers Fertilizer Cooperative Limited (IFFCO) and

[22] Stephen R. Harris, "Production is only half the battle," Food and Agriculture Organization of the United Nations, Bridgetown, Barbados, December (1988).

[23] Narayan Chandra Pradhan, "Persistence of Informal Credit in Rural India: Evidence from 'All-India Debt and Investment Survey' and Beyond," *RBI Working Paper Series*, Department of Economic and Policy Research (2013).

Haryana State Cooperative Supply and Marketing Federation Limited (HAFED) formed a new company providing scientific warehousing practices for storage and preservation of agri-commodities. An agency which would ensure proper storage and maintain necessary storage protocols was therefore needed. The banks were also keen on developing a Warehouse Receipt Finance portfolio, with special focus on farmer finance, keeping in view the Priority Sector Lending targets. Thus, NCML was formed with the objective of providing storage and collateral management services. It was promoted by NCDEX, IFFCO, private and public-sector banks, along with an international company called Audit Control and Expertise (ACE) which had expertise in collateral management, providing this service in about 40 countries in Africa. NCML's goal is to be the most trusted and innovative risk manager and supply chain solution provider for commodities and inventories.

NCML has over 14 years of experience[24] in all areas of post-harvest risk management, including scientific Warehousing, Warehouse Receipt Finance (WRF), Supply Chain Management, and Testing and Certification services. NCML uses ICT-enabled systems, processes and controls to ensure automated checks and balances to minimize errors arising out of manual intervention.

NCML manages agri-commodities worth about US$ 230 billion across about 7,000 locations, spread over 22 Indian states, which have been funded by over 50 different banks and financial institutions (FIs). NCML manages non-pledged stocks aggregating about 0.75 million MT, across 742 warehouses, covering 126 locations spread over 17 states. NCML has been able to scale operations to this level because it invested in building technology solutions for all its operations from the beginning.

2.2 Strategy

NCML saw that there was high demand for providing post-harvest finance that had yet to be tapped. Because there is inadequate post-harvest financing, small producers are forced towards distressed sales. Moreover, while warehouse receipt finance was available in India[25], it was inadequate, as most financiers were unwilling to lend against such stock due to poor quality of storage. NCML focused on ensuring services such as pledged stocks, collateral management and warehousing receipt financing.

In spite of NCML's efforts, take-off of WRF by FIs fell short of expectation. As a result, NCML decided to promote its own non-banking finance company, which led to the formation of NCML Finance Private Ltd. (NFIN). NFIN is an RBI-registered Non-Banking Finance Company (NBFC) with a focus on rural and agri-business finance. The company is a wholly-owned subsidiary of NCML. NFIN provides customized solutions for simplified loan processes.

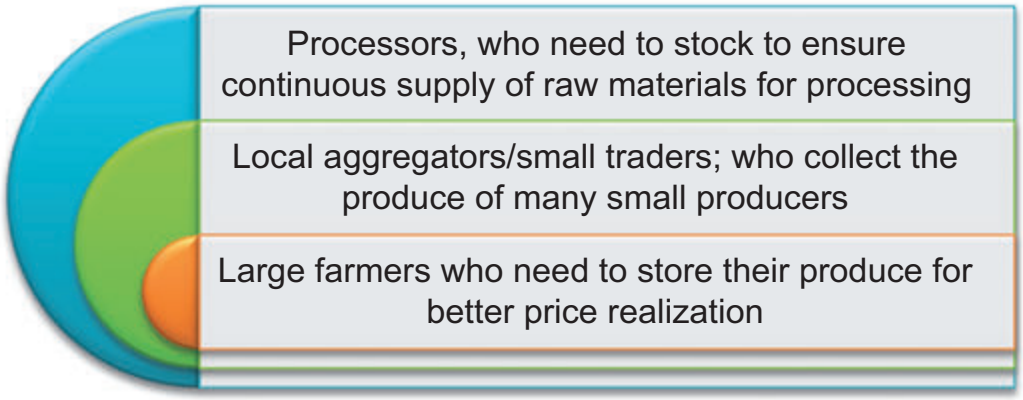
2.3 Clients

Warehousing is an essential part of an efficient marketing system of agricultural produce. Production of agricultural produce is always seasonal, so holding stock adds time-value to commodities. Warehousing not only prevents loss arising out of poor storage, it also equips farmers with collateral. The produce gains value over time as it moves from surplus (harvest time) to the lean period (off season). NCML focuses on three client groups: farmers (the core), aggregators or small traders, and processors (see Figure 21).

[24] As of 2018.

[25] Based on the study undertaken by Agricultural Finance Sub Committee set up in 1945 and recommendations of the Rural Credit Survey Committee appointed by the RBI in 1950, Agricultural Produce (Development and Warehousing) Corporations Act 1956 leading to formulation of The Warehousing Corporations Act, 1962 resulted in Warehouse Receipt Financing at the wake of Green Revolution. This was further strengthened by the Working Group of RBI on Warehouse Receipts and Commodity Futures in 2005 who recommended for introduction of negotiability in warehouse receipt system in line with similar instruments in operation in other countries.

Figure 21: Core Clients of NCML



Source: Illustration by authors

NCML's **agri-value chain product** provides support for producers (or aggregators) and ensures the supply of produce to the processors; it plays the role of collateral manager for various banks and facilitates financing.

NCML selects and screens clients based on a sample of the physical stock of the commodity delivered by the farmers to NCML-accredited warehouses. NCML does not insist on land details or land ownership.[26] The screening process includes various quality checks such as moisture levels, product grade, number of broken pieces, quality of the full grain, dirt in the sample, etc.

2.4 Capital structure

NCML established in September 2004 with an authorized capital of US$ 4.5 million. The paid-up capital reached the level of authorized capital within 18 months of inception. The initial shareholders included eight banks, a commodity exchange, two co-operatives and an international investor. Over time, the authorized and paid-up capital increased in line with the expansion in activities. The Company had a fresh capital infusion in 2011 and 2013, partly contributed by some of the then-existing shareholders, and partly by new international investors, such as Rabo Private Equity and IFC, Washington. Shareholding changed hands with Fairfax acquiring a majority stake in the Company in August 2015. They currently hold 89.53 percent in the paid-up capital of US$ 22.09 million of the Company; other shareholders include four banks and HAFED.

2.5 Organizational structure

NCML is a Fairfax company governed by a Board of Directors, including nominee, independent and executive directors. The company observes the highest standards of corporate governance. NCML day-to-day operations are managed by a team headed by the Managing Director and CEO ably assisted by the Deputy CEO and Business Segment Heads and Support Segment Heads. Each of the business segments has a team at the corporate and regional offices and also at field locations. The Support Segment teams are largely placed at corporate and regional offices. The top management consists of domain experts in the fields of agri-business, economics, finance, ICT, Legal, and HR. This structure has helped grow NCML into a leader in post-harvest intervention technologies.

[26] NCML does collect land details and ownership details for KYC reasons, but these are not required as part of the product screening.

2.6 Initial investment costs on ICT Systems

NCML's initial hardware investment was about US$ 150,000. The software was developed in-house at a cost of US$ 70,000-90,000. To date, the total expenditure on hardware stands at US$ 1.20 million and on software at US$ 75,000. The recurring expense on hardware and software is approximately US$ 30,000 per annum.

2.7 Outreach

NCML has relationships with over 50 banks and FIs. The major banks associated with NCML include SBI, Bank of India, IDBI Bank, PNB, HDFC Bank, ICICI Bank, Axis Bank, KVB, YES Bank and Indusind Bank. NCML manages agri-commodities worth about US$ 2.5 billion on behalf of different FIs at any point of time. As there is a regular turnover of stocks in the agri-commodities, the aggregate of the incoming and outgoing stocks on a year-to-year basis is approximately US$ 15,000 over the last 5 years (Box 2)

Box 2: NCML procurement services

NCML is the first private procurement agency engaged by the Government of India (GOI) to procure commodities under the Minimum Support Price (MSP) operations. They are the leading private service provider to the Food Corporation of India (FCI) in the states of Jharkhand, Orissa, Madhya Pradesh, Bihar, Rajasthan and Uttar Pradesh. NCML has procured and handled close to two million tonnes of paddy and wheat on behalf of FCI under MSP operations. NCML has reached more than half a million farmers through these services.

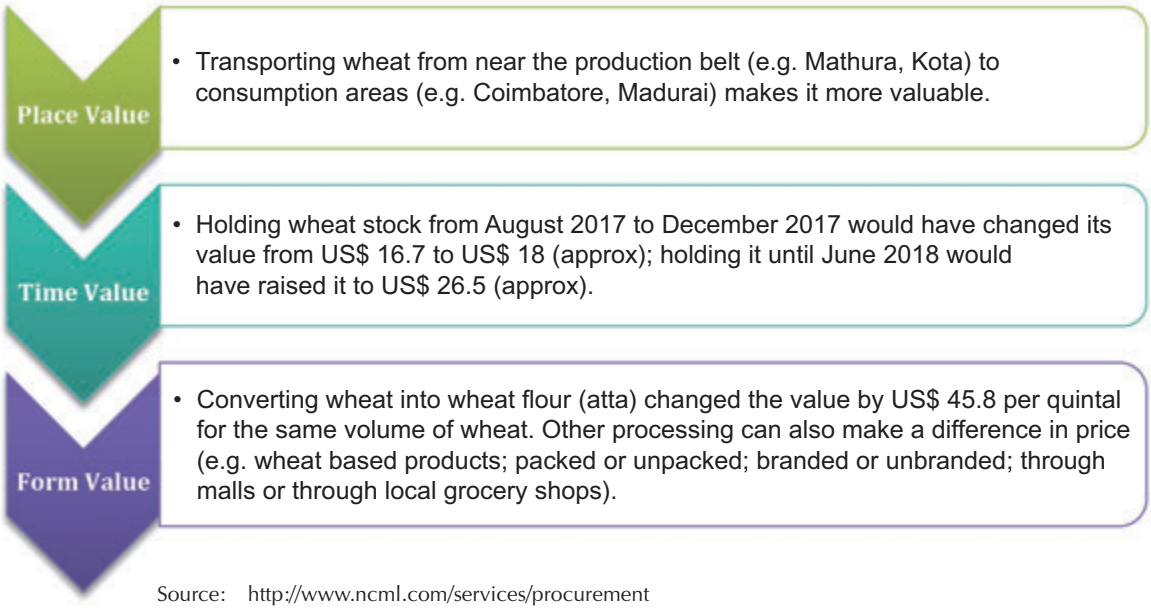
NCML's procurement services are provided through 40 regional offices, 500 centres/Mandis and 700 bank accounts. The procurement team consists of agri-professionals with experience in handling agricultural commodities in various parts of the country. NCML has over three years' experience in handling logistic-intensive procurement operations for the FCI, STC and private companies. In addition, NCML is also fully equipped to offer sourcing services to corporate players and traders.

Source: http://www.ncml.com/services/storage

3. Product offering

NCML specializes in post-harvest activities. The value of an agricultural product is a function of place, time and form (see Figure 22).

Figure 22: Three types of post-harvest value addition



Source: http://www.ncml.com/services/procurement

Where a product is sold affects its price. For example, in June 2018, the price of wheat in local markets (mandis) like Kota and Mathura hovered around US$ 24 per quintal for mill quality wheat, but it was US$ 34 per quintal in Chennai, Madurai and Coimbatore, even though the support price announced by the Government was US$ 27 per quintal, whereas the market prices dropped to US$ 17 per quintal in Kota, Mathura mandis.

When the product is sold affects its price. At harvest, there is typically a surplus of produce, so it commands lower prices; but products can gain value if stored until the off season when they are in higher demand.

The **form** of the product also affects its value, as processed goods are often more usable than unprocessed ones. Products like wheat flour (atta, maida) can command higher prices than raw grains.

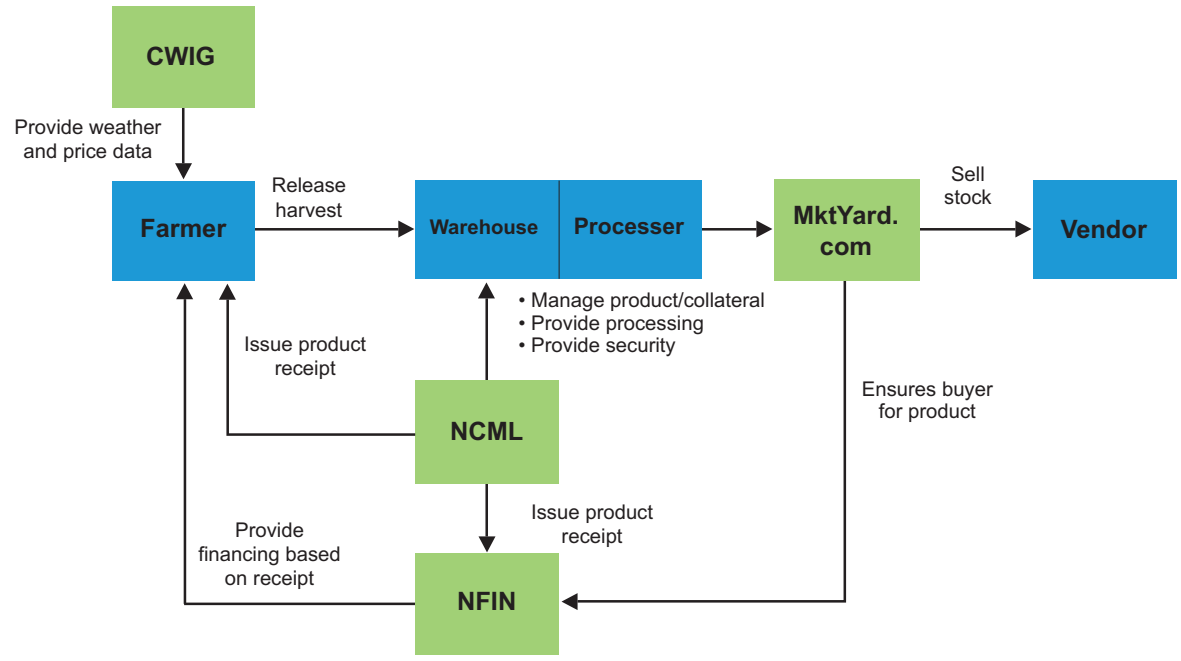
These types of value additions require storage, transportation and processing. NCML plays a critical role by providing such services.

As agricultural commodities change hands from farmer to trader to processor to consumer, they require careful attention, tracking and integrity at every stage. NCML provides end-to-end warehousing services that reduce risk, ensure quality and improve productivity due to price realization. These services include warehouse management, modern scientific storage spaces, preservation services, and stock management services through stock monitoring.

3.1 How it works

NCML model integrates into the Agriculture Value Chain to support the movements of commodities from producer to the downstream actors in the Value Chain (Figure 23).

Figure 23: NCML model and the AVC



Source: Illustration by editors

Beginning in the pre-harvest stage, **CWIG** provides *farmers* (and other stakeholders such as Insurers) with weather and pricing data which can aid in crop production. Once the *farmer* is ready to release the harvest, NCML has warehouse facilities available. As *warehouse operator*, **NCML** takes charge of the product, measures its quality and quantity, and provides additional processing services (cleaning, drying) as desired by the *farmer*. **NCML** issues a receipt for the product which certifies its value and secured status. With this quality assurance, **NFIN** can provide financing to the *farmer*, which alleviates the need for distressed sales and can provide resources for the value-add processing services in addition to capital for the next harvest. **MktYard.com** is an online sales platform which provides the *farmer* with access to multiple purchasers and further reduces the risk of financing as there are available buyers for the product. Once product is sold, proceeds are first used to repay the loan. Likewise, *vendors* and *traders* have greater access to products and can be assured of their quality. They pay a security deposit to ensure genuine interest in purchase. The platform allows for a closed and more efficient cycle with advantages for all AVC players.

3.2 Overview of product features

Table 12 provides an overview of how the AVC players benefit from the features of the **ESE™** platform.

Table 12: NCML model advantages

Player	Advantages
Farmers	• Avoid distressed sales • Use product as collateral • Gain access to financing • Take advantage of value-added processing services • Gain access to multiple buyers
FI	• Ensured product quality and quantity • Collateral management • Ensured buyers for product
Traders Vendors	• Greater access to sellers • Higher quality and quantity of product • Reduced need for middlemen, brokers

Better access to post-harvest finance: Without commodity finance, farmers have been forced to resort to distress sale at harvest when prices are low and investing in the next crop cycle is the immediate need. **NFIN** provides post-harvest finances for the farmers, who then can sell their produce at better prices without worrying about their next cropping cycle.

Better collateral management leads to more financing: Warehousing quality was below standard (crop weight losses, rat infestations). NCML, through its checks and balances, and by laying down the appropriate processes, provides better preservation of the produce received at their warehouses. By observing standard operating protocols, NCML has been able to provide assurance about product quality and quantity to both lenders and depositors. Lenders have more assurance about good products and farmers can take advantage of storage and processing services to increase price.

Better price realization: MktYard.com (sales) and **NFIN** (financing) ensure inclusion for all value chain stakeholders. **MktYard.com** facilitates better price realization. Traders have access to certification and photographs of the produce. Multiple buyers and sellers can participate, providing transparency and increasing competition.

3.3 Collateral Management

NCML provides lenders collateral management for agri-commodities using their own or third-party warehouses. NCML takes custody of the grains pledged and manages it as collateral on behalf of lending FIs. They issue warehouse receipts to the producers after a quality/quantity check on commodities received at the warehouse. This check is ensured by CommGrade[27], an independent body. NCML provides secured warehouse receipts to the FIs, enabling them to pledge the stocks and fund. Lastly, they provide lending FIs with advice on market prices, insurance coverage and adequacy which enables them to take adequate risk management practices to protect the underlying collateral during tenure of the loan.

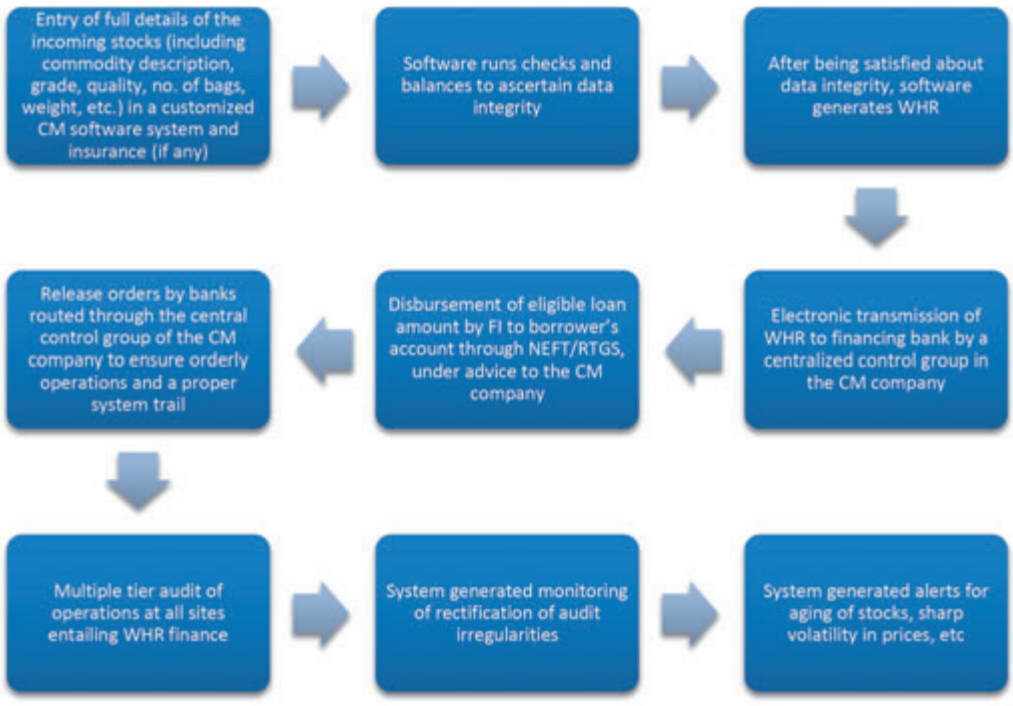
NCML supplies manpower and security at processing plants and factory premises to monitor and provide MIS to lending FIs on movement of raw materials, semi-processed goods and finished goods. This enables their partner FIs to keep watch on movement of the collateral under hypothecation.

Initially, NCML performed services at rented warehouses, but since 2011, it has invested in its own warehouses (with more than 40 locations). NCML manages these warehouses, maintaining its own standards for storage and preservation.

3.4 Warehouse receipt financing through NFIN

NFIN provides loans against the warehouse receipt for commodities kept in custody of NCML or other service providers. The collateral is the underlying commodity. This service is pivoted on robust technology aided systems and controls. The salient features of technology enabled safeguards in the Collateral Management (CM) facilitating WHR finance are shown in Figure 24.

Figure 24: Safeguard process in Collateral Management



Source: Illustration by authors

[27] Testing and Certification Services started in 2005 under the brand name "CommGrade". It performs Inspection and Testing of Food, Agricultural and allied products. It has a network of 32 locations where Quality Control Activities take place. There are 11 network labs supporting the central laboratory at Hyderabad. It supports and serves Farmers, Traders, Manufacturers, Exporters, Importers, Consumers and Government institutions.

3.5 Sale/Purchase through *MktYard*

India's agriculture commodity market is fragmented, with a number of local players, cartels and middlemen. Moving the whole nation to one platform with easy price discovery and information availability is critical. NCML was approached by various clients including traders, millers, banks, and processors needing a platform that offers transparent and cost-effective solutions for sale and purchase of stocks in the warehouses and CM locations. Such a system would bring logistic efficiency for the producers who store their stock in the warehouses and procurement companies. The bankers were facing a challenge with respect to stocks of NPA accounts. Because there were no seamless solutions for disposal of pledged goods, the banks were forced to carry these stocks and pursue closure of accounts with borrowers. Banks have been demanding a disposal solution integrated with the current collateral management service so that the bankers could auction the stocks and realize the loan outstanding without any hassle. Such a solution was sought since it was felt that it would improve the quality of lending and empower the bankers to a great extent.

Hitherto, the physical market brokers provided trade guarantee and settlement to banks. NCML believed that they could leverage their Pan India network and client base to offer a solution that would help their clients to procure or dispose through NCML without any additional hassles. Facilitating these transactions would not only increase traction to the NCML warehouses but would also make NCML a preferred collateral manager with the banks. By bringing in all the clients and their stocks in their warehouses and collateral management locations on a platform, NCML would be providing a critical volume and the necessary liquidity for a successful online model. Doing so would also increase the client stickiness with NCML and improve their engagement throughout the inventory cycle.

In 2016, established NCML MktYard Pvt., Ltd. (NMPL) as a subsidiary company. NMPL developed a commodity trading software platform called **Market e-Link**, which is a web-based auction platform that provides clearing and settlement capabilities. It is a transparent and reliable mode of offering procurement and disposal services. **Market e-Link** is supported by a stock registry module that facilitates transactions in non-NCML warehouses. Since **Market e-Link** is an internet-based application handling financial transactions, they receive the vetted applications through a reputed external agency. Doing so helps plug security loop-holes and meet the current and future needs of the clients.

The online auction + registry model offers producers and aggregators the opportunity to cut costs, increase revenues and enhance margins. It offers farmers and traders the opportunity to discover and reach new buyers – unrestricted by geography – giving them the surety of getting best rates for their commodities, or assured quality and quantity of the commodity for which price was paid. The seamless integration of funding against produce gives them the flexibility to decide time of sale, which helps avoid distressed sales. It also allows distant buyers to aggregate their purchase without involving middlemen or brokers.

NMPL completed its first full year of operations with a Gross Merchandise Value of over INR 500 crores (US$ 75 million) through e-procurement entailing payments made to farmers in the states of Uttar Pradesh and Jharkhand against paddy procured from them by NCML on behalf of the government. NMPL successfully conducted 45 e-auctions on behalf of banks to dispose of commodity stocks pledged to the banks, and helped the banks realize their dues against their long outstanding commodity loans.

MktYard.com leverages NCML's pan India network and client base. It enables commodity market participants to buy or sell commodities with minimum hassle. The platform is integrated with all of NCML's ICT systems to ensure a seamless flow of customer info, warehouse receipts, commodity info and other information. The platform combines a decade of physical market experience, domain expertise of commodity business and commodity risk management with the latest technology tools.

Figure 25: Key Features of MktYard.com

Source: Illustration by authors

The trading platform ensures price discovery, price risk mitigation and trade settlement. It directly connects clients (the sellers) and their stocks in warehouses and collateral management locations through the e-market. This solution completes the full cycle of procurement via a reverse-auction or e-tenders, trading of stocks via forward auctions (Figure 25).

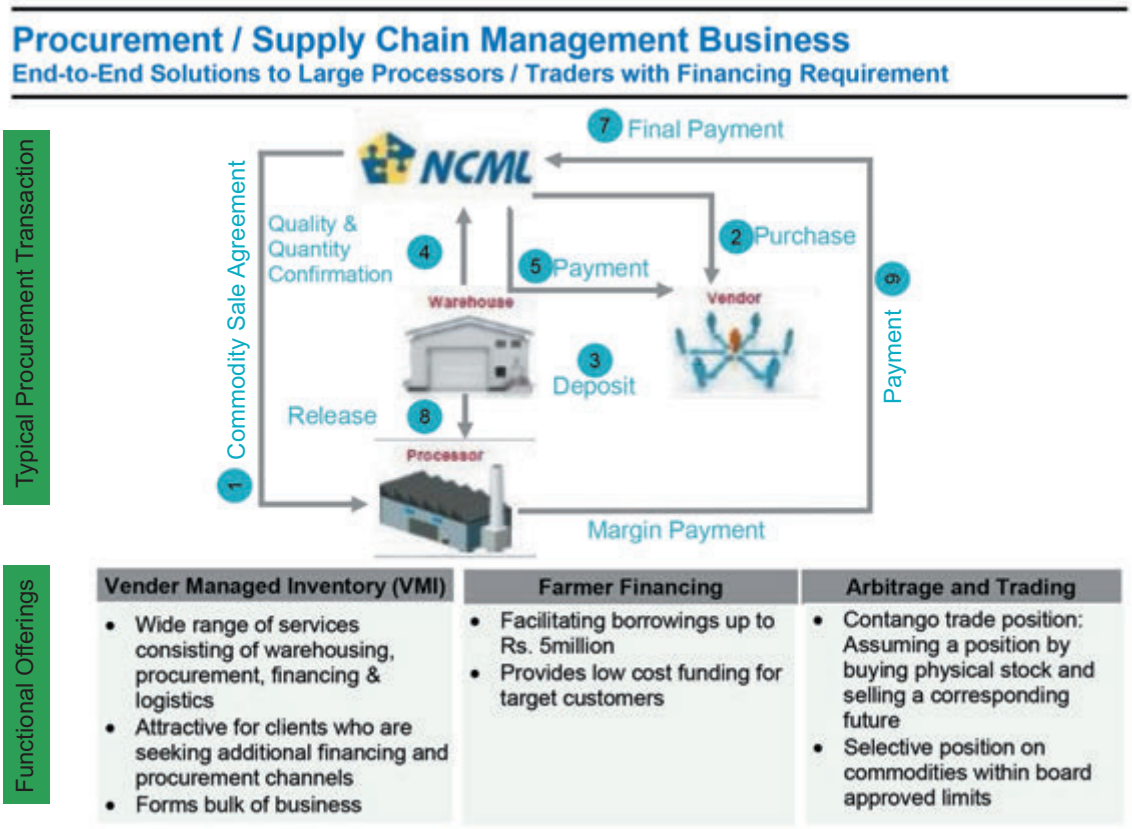
NCML has various relationships with banks, who can then dispose NPAs easily as NCML is already the collateral manager for that stock. Borrowers can sell their stock directly on **MktYard.com** without having to clear the pledge, as they will facilitate the whole deal, have an understanding with the bank and clearing the lien pre-delivery to the buyer.

3.6 Services for other agencies

NCML solutions help clients remain focused on their core competency with minimum resources spent on the complex task of coordinating with multiple service providers separately for procurement, quality testing, warehousing and logistic services. The aim is to ensure commodity stakeholders optimize their finances, time and manpower for processing and trading of commodities while NCML takes care of commodity handling and funding.

MktYard.com benefits commodity value chain participants – from bulk exporters and traders having large purchase orders, to start-ups or companies undergoing capacity expansion, exchange participants or arbitrageurs, industries that are based away from the origin of production or face supply difficulties due to poor procurement network, and industries requiring large captive consumption of commodities. The procurement process of NCML is graphically shown in Figure 26.

Figure 26: NCML procurement process



Source: http://www.ncml.com/services/procurement

3.7 Weather and crop intelligence

NCML also provides weather and crop intelligence through their **Crop, Weather and Price Intelligence Group (CWIG)**. This division offers weather data from chosen geographic locations. It provides a competitive advantage to pro-actively plan one's business well in advance. The near real-time weather and price data help farmers, agriculture insurance companies, trading professionals and other stakeholders. The single point access to weather data helps to mitigate risk and have an edge in the market.

3.8 Technology

The following are characteristics of NCML's ICT architecture (see Table 13).

The technology architecture has helped NCML in scaling up their operations securely by prevention of frauds. Like any business, commodity warehousing is susceptible fraud as a result of the following factors.

- Remoteness of locations: Warehouses are situated either in production centres or market centres, and these are situated only in rural areas. Because of this remoteness, supervision, inspection and audit is challenging.
- High value of commodity: On average, a 2,500 MT capacity warehouse stores commodity worth INR 5 crores (US$ 750,000). Securing such a high value commodity and maintaining its quality requires frequent supervision and inspection so that any fraud or quality/quantity variation is detected and appropriate corrective action can be taken.

Table 13: Characteristics of NCML's ICT Architecture

Feature	Advantages
Cloud-based applications and email	• System availability ensured at 99.9 percent since introduction (3 years) • Complexity in ICT system management has reduced considerably • Dynamic allocation of required RAM, CPUs and Diskspace results in optimum cost and effective utilization
Single technology	All applications are developed in Microsoft Technology (Windows Servers. Net based development, SQL server databases and Windows clients). The single-vendor policy reduces complexity, and increases manageability and inter-change of data between the scores of custom-developed applications.
Mobility	Many applications are accessible through Android-based mobile phones and tablets. Development is underway to ensure that all business and HR applications are also accessible through phones/tablets.
User access	• All business and HR applications are hosted in cloud and accessed through internet. Daily transaction details are captured by field staff in the appropriate application using the Desktop/Laptop provided to them. • Only authenticated users are given access to these applications • Appropriate access controls are in place for users • Clients can access their transaction data using unique User-ID and Password. • In MktYard application, users are empowered to make payment through payment gateway, are allowed to pledge and de-pledge goods deposited by them for auction dynamically • All users can access their stock, invoice details and their current status online

- ➤ Small number of employees: On average a single Collateral Manager is responsible for ten warehouses. Dual control over warehouse operations is typically not practiced since deployment of more man-power makes the CM business unviable. Employees are mostly local residents and they are, more often than not, likely to be influenced by a fraudulent depositor to short-change the commodities stored in the warehouses under their control.
- ➤ Poor documentary controls: Given the low literacy levels prevalent in rural locations, the documents pertaining to stored commodities and their movements cannot be elaborate. However, maintenance of even rudimentary documents is a huge challenge, and manual errors are common. Such a situation is a fertile ground for fraudulent documentation.

NCML addresses these issues through secured transaction data and invoice generation.

3.8.1 Secured Transaction Data

Employee Attendance module, **Collateral Management Transaction** modules and **Inspection and Audit** modules are mobile-enabled, and NCML is in the process of converting all its transaction processes to be mobile-enabled. Mobile applications allow users to Geo-Tag all transactions and to provide photographs linked to the transactions (Table 14). This data is reviewed by the Central Monitoring team before any transaction is approved. Risk profiling is also performed to ensure better audits.[28]

[28] A risk number is assigned to warehouses based on various parameters, such as the type of commodity stored, the risk profile of the location, last audit date, current shortage if any, the profile of the auditor who have audited the warehouse last, etc.

Table 14: Secured transaction data features

Feature	Benefit
Central Monitoring	All transaction data entered in the system are verified and approved by the Central Monitoring team so that clerical errors and mistakes in the documents are avoided.
Use of numbers and Holograms	All important documents (Warehouse Receipts, Cash Receipts, Deposit and Withdrawal acknowledgement forms) are affixed with Holograms with unique numbers so that documentary frauds are eliminated completely.
Audit System	• All audit details are captured in the mobile apps and uploaded to the central server automatically. • This enables the central audit team to identify the locations that are required to be audited in a given month based on its Risk profile.
CCTV	• CCTV-based monitoring of godown aids in monitoring the identified godown and controlling its operational risk

3.8.2 Error-free transaction data and invoice generation

Checks and balances in NCML applications ensure that the data entered are consistent and error free. Manual errors are avoided and reduced to an insignificant percentage. Invoice generation is automated, which results in accurate accounting of income and effective follow up for collection of dues.

Technology allows NCML to meet the stringent turnaround time expected by the market. When MSP procurement operations first began, physical cheques were issued, which resulted in delays for farmers in getting their sale proceeds. Today, NCML has linked farmer bank accounts in the procurement application so that funds are transferred on the day of procurement through NEFT, resulting in smooth delivery for both farmers and government agencies.

Because all relevant data are captured in the centralised database, management can make use of reports to make effective decisions. Data can be arranged business-segment wise, warehouse-wise, location-wise and as needed.

4. Lessons learnt

Lessons learnt include

- ➤ Post-harvest management requires domain expertise and on the ground expertise. It also requires a thorough understanding of commodity market dynamics. Such expertise was lacking, and NCML had to develop them in house through training and operating manuals.
- ➤ Managing risks in the commodity business is an ever-evolving process which requires a thorough understanding of numerous factors such as preservation, inspection, price movements, etc.
- ➤ Commodity markets are subject to price volatility which is attributable to numerous factors such as domestic and international developments, weather conditions, production levels (both actual and estimated), trade restrictions, stock limits, etc.
- ➤ Expansion of commodity finance portfolio is a function of anticipated bullishness in commodity prices, and problems arise when there are sudden price movements in the other direction.

Despite these issues, the NCML model appears sustainable. It does not tamper with the existing trade relations. It attempts to make the transactions by existing trade channels more efficient. It reduces the transaction costs for the farmers, aggregators, buyers, processors as well as regulators.

However, the cost of maintaining decentralized warehouses, especially managed by multiple parties, increases substantially. Warehousing can require huge investments, which owners often neglect. Maintenance cost of dispersed locations, especially for a country like India which faces climatic extremities, may affect the sustainability of this intervention.[29]

Maintenance cost reduction can only be achieved by making appropriate design decisions on the strategic characteristics of warehouse facilities. In particular, the location and the age of a building are relevant factors for breakdown maintenance, while the monthly volume of freight transiting the warehouse is a significant cost factor because damage increases as transit increases.

Two other issues to consider in judging the sustainability of this intervention are (1) Increasing competition due to ease of replicability of ICT systems and (2) increasing need for ICT security as a result of cyber crime and data tampering.

4.1 Challenges

As with any company, NCML has had its share of challenges. The Company has faced quality deterioration, quantity shortage, borrower fraud, field staff collusion with borrowers, insurance claims, among others. Fortunately, a majority of these issues have been resolved. With an on-going emphasis on processes and controls together with training, the Company has been able to contain risks to within manageable levels. There are also other challenges with the NCML intervention model.

Replication: The main finance portfolio of NFIN is fully collateralized by its parent institution NCML. While this relationship makes funds flow easier to the borrower, it necessitates a large institutional collaboration mechanism, with attendant large capital outlay. Given the large capital investment needed for NCML's model, replication may be difficult. Technical replicability is high, but as the work involves intermediation with—and collaboration among—multiple diverse parties (e.g. farmers, traders, buyers, lenders, warehouse owners, regulators), significant effort must be made to foster trust. Scalability will depend on bringing in multiple players; and while NCML enjoys first mover status, competition for clients will become greater.

Intermediaries: The primary security offered by NCML intervention comes from physical delivery of the stock to a designated warehouse. This situation places a limitation for very small producers to take the benefit of this arrangement, leading to emergence of some new intermediaries, who are neither registered with Agricultural Produce Market Committee (APMC), nor are they regulated by NCML. This might have impact on the penetration of the intervention. In order to reduce the number new intermediaries involved, NCML is engaging with Farmer Producer Organizations/Companies (FPOs/FPCs). The FPOs or FPCs act as aggregators for the produce, reducing the role of the intermediaries and allowing small and marginal farmers as members of the FPO to get better prices for their produce and loans for the next season.

Information Technology: The rapid change of technology and the cost of obsolescence must be accounted for to ensure sustainability of the NCML model. However, given the declining costs of technology coupled with the Company's scale of operations and profitability, its internal accruals year on year may take care of these costs.

[29] Thomas W. Speh, "Understanding Warehouse Costs and Risks." *Journal of the Ackerman Warehouse Forum*. Volume 24, no. 7 (June 2009).

CHAPTER 5

CHALLENGES AND WAY FORWARD

Agriculture is increasingly becoming more knowledge-intensive. Having access to timely, accurate information that is tailored to specific locations and conditions is critical in helping producers and other actors in the value chains make the most of their resources in often changing circumstances. Over the past few years the information technology-based software revolution has driven global development in an unprecedented way. Today it emerged as one of the transformative forces for good in socio-economic development. The compiled case reports on the usage of networked software platforms from China and India has all the merits to support the national, regional and global thinkers and policy makers to replicate the models which do have the potential in overcoming many barriers to enable broad and sustainable impact in agricultural development. The ICT based network platforms has the potential to meet the agricultural goals of the country more effectively in the areas such as (a) Agricultural extension and advisory services; (b) Promoting environmentally sustainable farming practices; (c) Disaster management and early warning system; (d) Enhancing market access; (e) Food safety and traceability; (f) Financial inclusion, insurance and risk management; (g) Capacity building and empowerment and (h) Regulatory and policies. However, these comes with some important challenges and there is an urgent need to overcome those and settle with the popular technological innovations and tailor them according to the capacity and need of the country.

5.1 Challenges in developing software platforms

Each of the ICT application in all the four cases documented has seen adequate success with their software platforms to improve efficiencies in the agricultural value chains. These interventions have proven capable of addressing the gaps in the movements of agricultural products and services showing significant promise of continuing to do so. Nevertheless, there are few major challenges in implementation, uptake and scaling which remained to be addressed.

5.1.1 Implementation challenges:

- Implementation requires significant capital investment, which can be difficult to secure as financiers do not understand the agricultural industry and are wary to invest in underdeveloped markets.
- The AVC is widely dispersed, with numerous links in the chain, making it difficult to understand and support all players and processes. Likewise, statutory and regulatory requirements can differ significantly across regions, which can require additional time to understand and harmonize.
- Language barriers exist across regions and across users of the solutions. Although making software available in multiple languages can mitigate this issue, not every process is easily translatable.
- The numerous AVC players require significant relationship management so that each player understands the role they play. The number and geographically dispersed nature of the players makes establishing such relationships time-consuming.

5.1.2 Acceptance and uptake challenges:

- Weak awareness of the internet makes product promotion difficult, especially among farmers who tend to be older and more set-in traditional farming methods.
- Digital device usage is low. Mobile devices are often too expensive for poor farmers; and devices that are available are often inadequate for use in data collection.
- Financial service providers have a poor understanding of the agricultural industry and have yet to develop suitable products to support it.
- The capacity of human resources will need to be expanded; they need to understand the AVC and to input and handle data correctly.
- Small farmers are often uninterested in digitizing their process, and even those who are interested can rarely afford it. Those who can afford it are usually unprepared to work with software technology. This challenge is somewhat alleviated by partnering with development organizations who typically have the financial and human capital needed to utilize such systems. These organizations in turn can implement the systems at the individual farm level.

5.1.3 Scaling challenges:

- Appropriate infrastructure is lacking, especially in remote and dispersed locations. Not only is internet access limited, storage and transportation services will need to be improved before software interventions can be brought to full potential.
- It is difficult to implement a truly closed value chain as online sales cannot completely replace traditional sales channels in the short term.
- There is limited access to appropriate mobile devices that can capture data, especially in areas that lack internet access.
- The model works better with larger industrialized farms as it is difficult to implement with dispersed players, and financing requires a lead firm, and problems with the lead firm can be passed down.
- Training and uptake can take time. Even skilled practitioners need training and continuous hands-on assistance.
- Data is not standardized across all areas of agricultural production, making it difficult to collect and integrate data. Typically, only a few data points (e.g. pig weight and quantity) are available.

Despite the above mentioned and other challenges, software interventions are a powerful tool for streamlining agricultural value chains in the countries with dominance of smallholder producers. It was also observed that these software-based interventions also support the value chain actors to access the finance while addressing the broader addressing the food security issues of the bourgeoning population. To overcome the challenges mentioned above, a greater collaboration and cooperation among the actors in up- and down-stream of the value chains will be required to pass on the information and help creating the database to support the software platforms. between various players in the value chain. The extent and structure of that collaboration will be a very important strategic decision to share the data.

5.2 Way forward

5.2.1 Holistic approach in developing ICT solutions

Bringing technology solutions to agricultural value chains shows great promise for improving efficiencies and providing traceability, marketing and direct financing. That said, even the successful companies discussed in this document have found the market to be challenging. ICT solutions are not a panacea to age old problems in agriculture such as poor information, management and markets

in the developing countries. The impediments already mentioned in this document need to be considered at the national level with the holistic approach for efficient use of the ICT network-based platforms. These platforms need to be developed in an inclusive manner, involving representatives of all agriculture and other stakeholders, will ensure that adequate capacity development needs are identified, awareness is raised and effective engagement of key stakeholders is achieved. In addition, the mentioned steps will also ensure that ICT network platform access challenges (including their coverage, costs and quality) posing hindrances to the adoption of use of these tools, notably in rural areas, are identified and tackled at higher levels in a systematic manner. Specific policy measures and incentives can then be taken, so that agricultural stakeholders are able to benefit from the potential of these initiatives at an affordable price. The following areas need to be taken care at the time of establishing ICT network-based platforms:

- **Awareness:** Especially in more rural areas, it can be difficult to show the value of technology. Public-private awareness campaigns may be needed to help people understand the benefits of linked services, especially as uptake will require effort on the part of the user. On the positive side, the number of mobile phone users continues to grow, and they are becoming more comfortable with apps and connectivity. The challenge will come in convincing people that the same devices can be used to facilitate business activities.
- **Network infrastructure:** Internet infrastructure is severely limited in remote and rural areas. Although the software solutions presented in this paper provide an "offline" mode for data collection, if that data cannot be uploaded easily, it will provide limited value. Public-private investment will need to be made in internet infrastructure so that users will be able to access cloud services.
- **Training and education:** Although software is an effective tool for managing a farm or other production process within the AVC, users will still need to learn how to use it. Literacy rates among small-scale farmers is low, and most are non-technical, which makes them slow to adopt technology; but even experienced people will need training and guidance on how best to use the tools. Education is essential, but it is a longer-term and on-going effort.
- **Financing and Pricing:** The SaaS model is designed to be less expensive, because the investment costs are greatly reduced. Nevertheless, procuring the needed desktop and mobile devices to run the software can be cost-prohibitive and beyond many AVC players. As technology advances rapidly, upgrading to the latest model can also be untenable. Financiers will need to be creative in helping farmers escape the trap of distressed spending so that they can begin to invest in their business.
- **Change management:** Ultimately, any change is difficult. Participants must see the value in change before they will embrace it. Some AVC players will resist change because they perceive it as too difficult, others will resist because they see it as a threat to their livelihood. Education and training can alleviate some issues, but real change takes time and significant interpersonal management, especially when issues and setbacks occur. It is a slow process.

5.2.2 Role of development agencies

Despite the above and other challenges not listed, investors and donors are encouraged by the national governments to move toward software interventions in agriculture value chains. Even small steps can have significant impact on the lives and welfare of poor farmers. For example, a public-private partnership operated jointly by a Government or a public sector entity and one or more private sector companies, non-governmental organizations or civil society organizations have the potentiality to develop tailor made solutions for the farming community. Some examples of public-private partnerships in Asia include the e-Choupal centres and LifeLines in India, the Grameenphone Community Information Centers in Bangladesh; and the e-Haat Bazaar in Nepal, among others. These models demonstrated how cooperation between a private company, rural entrepreneurs, state agricultural

universities and extension machineries of the Government of served to bolster the farmers' expertise and day-to-day awareness of what needs to be done to cope with myriad agricultural needs.

Policymakers and other stakeholders need to be aware of how appropriate ICT network-based platforms can help to influence agricultural practice as well as support efforts and initiatives to promote food security, sustainable agriculture and promotion of agricultural value chains. The development of AVC in the coming decades will entail more efficient and sustainable production systems, making optimal use of land, water and other natural resources which need to be precisely supported by the ICT platforms developed for the common farmers and will rely more on agricultural information management and communication technologies. It is critical that they are not left behind in the new and emerging economy. They should have the opportunity to participate fully in the growing market for their income enhancement and participation as partners in development.

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GLOSSARY

Agricultural inputs: Products that are needed to raise crops or livestock. Such products include seed and fertilizer (for crops) and feed and vaccinations (for livestock). It can also include equipment such as tractors and fencing or professional services such as veterinarians.

Agriculture Value Chain (AVC): The entire food production chain from farmer to consumer, including all of the intermediate players and processes.

Blue ocean market: The simultaneous pursuit of differentiation and low cost to open up a new market space and create new demand. It creates and captures uncontested market space, thereby making the competition irrelevant.

Cloud-based technology: Data and software that is shared and replicated among multiple servers (computers) over the internet rather than on a single local hard drive. This configuration allows the data and software to be accessible wherever there is an internet connection. Because the internet was often represented as a cloud on flowcharts, the technology is said to be "in the cloud."

Collateral: Valuable property that is pledged as security on the value of a loan.

Collateral management: Third-party caretaking of collateral. For agricultural products, this typically means certifying the quality of the product and ensuring it against loss from spoilage or wastage.

Hypothecation: To put in pledge by delivery as stocks given as security on a loan.

Internet of things: Networking individual devices and objects (e.g., equipment, appliances) such that they can share data (usage, need for maintenance, etc.).

Software-as-a-Service (SaaS): A software solution wherein the user pays for the service (features) and usage of the product but does not own the software. The vendor typically owns the software and is responsible for maintenance and enhancement. This model allows for multiple un-affiliated users on the same platform.

Warehouse receipt: On deposit of product at a warehouse, the producer is given a receipt which can be used to acquire credit with a financial institution.

Warehouse receipt financing: The process of acquiring financing based on the collateral that is stored in a warehouse. Storing food allows farmers and other sellers to time the market in order to receive a higher sales price.

Sannong: A term that refers collectively to agriculture, farmers, and the rural area.

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