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# Integrating Indigenous with Scientific Knowledge for the Development of Sustainable Agriculture: Studies in Shaanxi Province

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## ABSTRACT

*Smallholder farmers are the main stakeholders in agricultural development in China. Their agricultural knowledge (indigenous knowledge) influences their decisions and behaviors both directly and indirectly. However, the importance of smallholder-farmers' indigenous knowledge is often ignored and not considered by influential actors, such as the government and scientists. This paper examines smallholder-farmers' perspectives of agricultural knowledge use and acquisition, including their indigenous knowledge and scientific knowledge disseminated by government's extension system. Both questionnaire and interview methods are applied. This study sheds light on smallholder-farmers' perspectives on agricultural knowledge. We strongly argue that farmers should not be treated as passive followers in the development of agricultural knowledge.*

**Keywords:** indigenous knowledge, scientific knowledge, agricultural development, small-holding farmers, sustainable agriculture

**JEL Classification:** O13, Q13

## INTRODUCTION

Knowledge defines how people comprehend the world surrounding them (Arce and Long 1992). The natural and social worlds are complex and uncertain, thus different types of knowledge are needed to solve various types of existing problems (Conklin 2001). Knowledge is heterogeneous—diversified knowledge can provide people with different perspectives to contextualize problems. This paper focuses on indigenous and scientific knowledge in the context of agriculture.

Indigenous and scientific knowledge have both similar and different characteristics. Both are important ways for people to observe the world and form corresponding solutions. Observation is an important method for both indigenous and scientific knowledge (Berkas and Berkas 2009). In scientific knowledge, observation plays a vital role in scientific data. Scientists interpret and analyze the data to support or oppose their hypotheses and theories. In the case of indigenous knowledge, people can gain knowledge after repeated observations. For instance, the calendar of Chinese 24 solar terms (24 *Jie Qi* in Chinese)<sup>1</sup> is an important lunisolar calendar in China. It is based on farmers' observations of the position of the sun and the moon, and climate conditions. Even until now, Chinese farmers arrange their farming activities according to 24 *Jie Qi* (see Appendix 1). Chinese farmers also created the song of 24 solar terms, which summarized the

24 solar terms into 28 words.<sup>2</sup>

Nonetheless, indigenous and scientific knowledge have distinctly different characteristics (Berkas and Berkas 2009); the former is traditional, language-based, qualitative, oral, approximate, and local; while the latter is modern, number-based, documental, quantitative, precise, and universal. In addition, to some degree in modern society, people consider indigenous knowledge to be informal while scientific knowledge is formal (Blaikie et al. 1997). In terms of the transfer of information, scientific knowledge is characterized by a top down approach led by experts and government, while the transmission of indigenous knowledge follows a bottom-up direction.

Some studies observed that in the modernized development of human society, indigenous knowledge is unprecedentedly futureless because, first, scientific knowledge and technology extension have stronger political support. In recent decades, poverty reduction has been the main goal of developing countries, and the main paradigm to develop agriculture is through scientific knowledge extension, including technology transfer. Thus, in the knowledge system, scientific knowledge occupies the highly superior position and has higher stature (Sen 2005; Sillitoe and Marzano 2009). Second, scientific knowledge is deemed more economically effective. Indigenous knowledge lacks systematic structure, improvement, and innovation to meet economic needs that seek to improve productivity and income. Consequently, there is a view that high economic benefit from agriculture may be difficult to achieve with indigenous knowledge. However, scientific knowledge, undoubtedly, cannot solve all complex natural and social

1 24 *Jie Qi* pertains to the following: start of spring, rainwater, awakening of insects, vernal equinox, clear and bright, grain rain, start of summer, grain in full, grain in ear, summer solstice, minor heat, major heat, start of autumn, limit of heat, white dew, autumnal equinox, cold dew, frost descent, start of winter, minor snow, major snow, winter solstice, minor cold, and major cold. 24 *Jie Qi* was created by farmers' human senses: eyesight (e.g., dew, rain, snow), hearing (e.g., sounds of insects), and feelings (i.e., of temperature such as minor heat and major heat).

2 Song of 24 *Jie Qi*: Chun Yu, Jing Chun, Qing Gu Tian, Xia Man, Mang Xia, Shu Xiang Lian, Qiu Chu, Lu Qiu, Han Shuang Jiang, Dong Xue, Xue Dong, Xiao Da Han (春雨惊春清谷天，夏满芒夏暑相连。秋处露秋寒霜降，冬雪雪冬小大寒)。

problems (Cullen-Unsworth et al. 2012; Raymond et al. 2010). Scientific knowledge helps people to be the master of nature, and measures the social operation on the basis of efficiency and time, even as environmental pollution and ecological disequilibrium can be serious consequences from the perspective of the resilience of nature (Holling 1996). In China, the predominantly top-down approach tends to neglect the “local voice” in the agricultural knowledge extension system.

This paper seeks to shed light on how to integrate indigenous knowledge into the agricultural extension system together with the top-down approach of scientific knowledge to more effectively respond to the problems of environmental pollution and ecological disequilibrium in agricultural development. The main objectives of this paper are to:

- describe the current Chinese agricultural knowledge extension system;
- study farmers’ perspectives on their agricultural knowledge acquisition and use, including scientific knowledge and indigenous knowledge; and
- consider how to integrate farmers’ indigenous knowledge with government’s top-down agricultural knowledge extension system.

### **Indigenous and Scientific Knowledge in China**

In the context of agriculture, there are kinds of indigenous knowledge that are vanishing, which coincide with the surfacing of serious ecological problems during the modernization process in developing countries. There is a similar trend for agricultural knowledge, characterized by a seeming departure from indigenous to scientific knowledge. Similarly, in the agricultural system, there is a corresponding inclination away from the traditional system toward the modern system (Lwoga, Ngulube,

and Stilwell 2010). The traditional agricultural system is generally characterized as low-input-low-output, while the modern agricultural system is high-input-high-output (McGuire, Morton, and Cast 2013).

Intensive and meticulous farming characterizes the Chinese traditional agricultural system. Farmers behaved according to the notion of “three materials” (三才观) of the natural environment: climate, topographic forms, and people. Agricultural production is seen as an integration of elements of climate atmosphere, soil, topographic forms, and farmers. In this relationship, the agricultural productive activity was built on the basis of the reproduction of nature, which reflected the integrated relationship between economic production and natural reproduction (Li 2000). Atmosphere and soil are the natural elements of agricultural production. In addition, in order to have a bumper harvest, farmers proactively make adjustments according to the changes of the natural elements. In this process of farming, people are neither slaves nor masters of nature. Their role in the whole natural production and evolution process is to sow and harvest.

Cyclic knowledge is another important agricultural knowledge. A case in point is that fertilizer inputs in agricultural production come from waste in the internal agricultural system, combined with fertilizer from the external environment. In cyclic knowledge, farmers saw agriculture as a subsystem of the whole natural system. No other country has something comparable with the unbroken Chinese agrarian history that has survived across numerous generations (Li 2000). Chinese people’s knowledge of intensive and meticulous farming contributes to sustainable agriculture. The core characteristic of Chinese traditional agriculture is in ensuring that agricultural development is consistent with the evolution of the natural environment.

However, scientific knowledge is prevalent and indigenous knowledge is downplayed in current Chinese agriculture. Traditionally, farming in China connotes low social status and farmers are seen as “low-quality” people (Schneider 2014). Farmers are commonly perceived to be lacking in knowledge and have inferior economic and cultural status. To dispel this low perception of farming, the Chinese government aimed to transform traditional agriculture into modern and industrialized agriculture (He 2014b; Huang 2014). However, this process of modernizing agriculture has resulted to serious environmental issues in rural areas. Chinese farmers were confronted with environmental degradation and ecological imbalance, such as water and soil pollution resulting from excessive use of chemical fertilizers and pesticides, and soil erosion due to the heavy use of plastic sheeting (Zhao et al. 2008). There was sharp upward trend in the amounts of fertilizers and pesticides used in agricultural production, to the point where China has become the heaviest fertilizer user in the world (Ma et al. 2009). In fact, about 10 percent of farmlands in China are polluted (Economy 2007). It appears that Chinese indigenous knowledge is not given enough importance. To some degree, the marginalization of indigenous agricultural knowledge puts Chinese agriculture at risk of deviating from the long Chinese history of sustainable intensive and meticulous farming, and risks homogenization of agricultural knowledge (Li 2000).

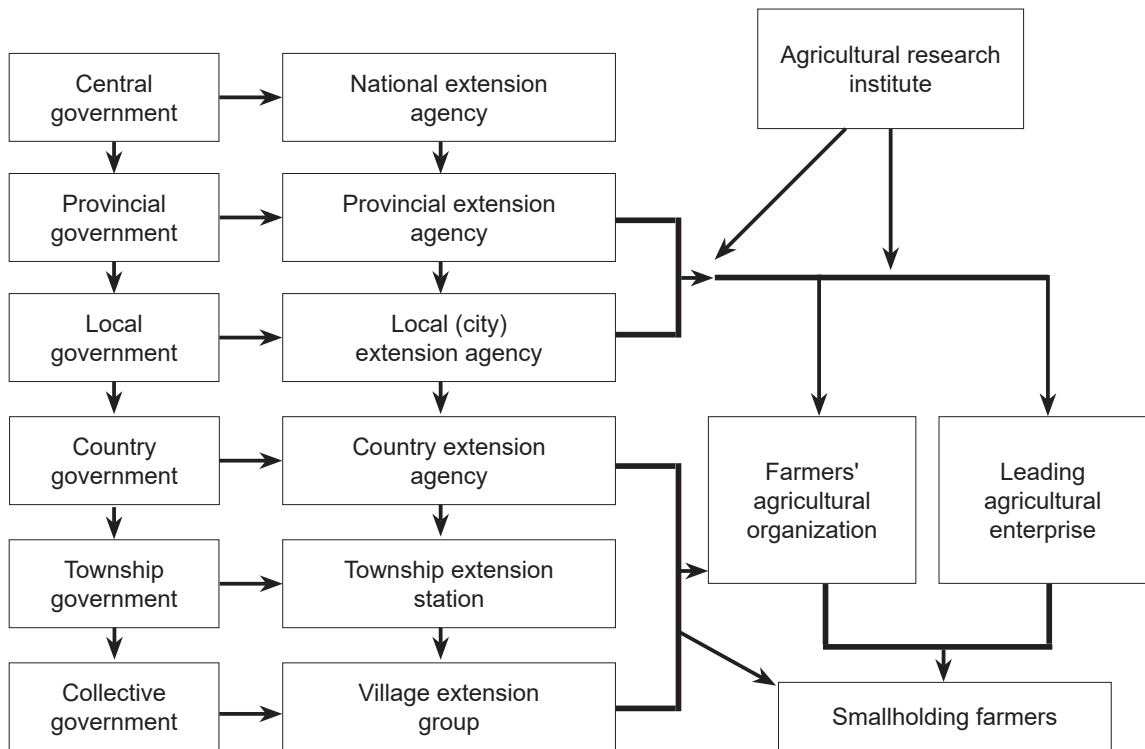
### **Passive Followers in the Agricultural Knowledge Extension System**

The Chinese agricultural extension system is designed and organized according to a hierarchy system, which adopts a top-down approach to disseminate scientific

knowledge and technology. Both central and local governments have their own agricultural extension agencies (the high-level government) or stations (the township government) (See figure 1 below).

The different levels of government and the agricultural extension agencies work together with agriculture-related education or research institutes and take an extremely top-down approach to disseminate scientific knowledge and technology to farmers (see Figure 1). Specifically, the agricultural research or education institutes directly work with provincial or local extension systems. The provincial and local extension agencies direct or train the county extension agency hierarchically. The lower level extension agencies (i.e., county, township, and village) mainly disseminate the agricultural knowledge or technology to professional farmers’ organizations or leading agricultural enterprises. Farmers are the last recipients in the whole agricultural extension process.

It is commonly accepted that agricultural knowledge is produced by scientists and applied by farmers (Lwoga, Ngulube, and Stilwell 2010). It is shown clearly in the agricultural knowledge extension system that farmers are treated as passive followers and as people who lack agricultural knowledge. In addition, scientific knowledge is endorsed with political power. The extension of agricultural knowledge is manipulated by government and by scientific agricultural research institutes. The flow of agricultural knowledge is of a homogenous direction from top to bottom (Figure 1). In this linear agricultural knowledge system, farmers are merely receivers and their voice is neglected by governments, scientific research centers, and agriculture-related institutes, which are the disseminators of agricultural knowledge.

**Figure 1. The flowchart of agricultural knowledge extension (Kong, Xu, and Shi 2009 )**

However, this rigidly top-down agricultural extension system has two main deficiencies. First, the disseminated agricultural knowledge or technology is often not accepted and applied by the farmers in their farming activities. Nonetheless, this is not an inherent problem of scientific knowledge. On the other hand, scientific knowledge disseminated through the agricultural extension system deviates from farmers' reality. Based on this top-down extension system, the high-level government and research institutes typically do not have an in-depth understanding of what type of knowledge are needed by farmers to address their particular problems. The agricultural extension system will only work when it is accepted and supported by the key decision makers in farming activities, i.e., the farmers, themselves.

Indigenous knowledge is not given

adequate attention in the agricultural extension system, and has no effective transmission route. Farmers are treated “outsiders” in the agricultural knowledge system, even when farmers have direct experience in farming and are the most important “insiders” (Sillitoe and Marzano 2009). However, there is no bottom-up feedback mechanism to balance scientific and indigenous knowledge in the extension system. Even as farmers are the main stakeholders of the agricultural extension system, their own local indigenous knowledge is marginalized in the agricultural knowledge system (Cullen-Unsworth et al. 2012), which is not helpful in coping with current agricultural problems.

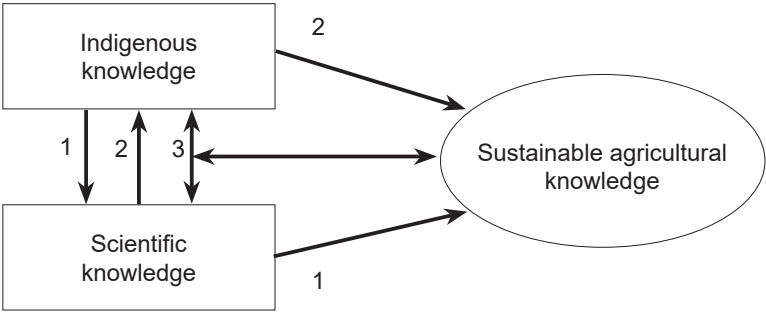
Indigenous knowledge is an important part of culture that tells people what has happened and what worked in the past, providing experiences to draw upon (Triandis 1994). Indigenous knowledge builds upon inhabitants'

agricultural life and people’s minds, and exists throughout their lives (Luo 2006). Sustainable agricultural needs heterogeneous knowledge, i.e., both indigenous knowledge and scientific knowledge.

Development is widely seen to be mainly a modernizing process, the aim of which is to transfer tradition (Scoones and Thompson 1994). The path of knowledge development is from traditional to modernized

knowledge. On the other hand, sustainable agricultural knowledge should recognize three different paths to knowledge development: (1) indigenous knowledge to scientific knowledge; (2) scientific knowledge to indigenous knowledge, and (3) integration of traditional with modern knowledge. In short, the integration of indigenous knowledge and scientific knowledge forms sustainable agricultural knowledge (Figure 2).

**Figure 2. Different routes to sustainable agricultural knowledge**



METHODOLOGY

**Study Area and Survey**

The survey was conducted in the Guanzhong Plain, located in the middle part of Shaanxi, a province in central China. The Guanzhong Plain is the basin of the Wei River and has very favorable conditions for agriculture due to its flat terrain, fertile fluvial soils, and semi-humid climate. It is nationally recognized as a grain producing area, with maize and winter wheat as dominant crops, thereby representative of agriculture in the North China Plain, the major agricultural production region of China. Agriculture in the Guanzhong Plain is relatively well-developed, with high levels of irrigation and agrochemical inputs, and high yields.

The survey was conducted in July and August 2014 involving 24 villages across the

Guanzhong Plain. Seven respondents were randomly chosen from different farming households. Some 180 questionnaires were sent out, 165 of which were retrieved. The survey respondents were smallholder farmers, composed of 82 male and 83 female farmers, making the gender groups balanced. As to age distribution, 58.2 percent of the respondents belonged to middle-aged group (between 41 and 60 years old), 30.3 percent were young farmers (between 21 and 40 years old), and 8.5 percent were above 60 years old. In terms of educational attainment, 26.1 percent finished primary school, 57 percent finished middle school, 9.7 percent had a college degree, and the rest (7.3%) were not literate (the questionnaire was read to them by the interviewers). All questions were related to the use and acquisition of agricultural knowledge.



### **Case Study in Donghe Village**

To have a deep understanding of the important role of indigenous knowledge, a case study of organic agriculture in Donghe village was conducted. The field work started with a two-week stay in Donghe village in August 2013 for the researchers to familiarize themselves with village life and to gain a better understanding of the village context. For the period April to May 2015, 17 farmers (see Appendix 3) were interviewed. The researchers interviewed the village leader first; the rest of the respondents were identified by walking through the village and requesting them for interviews until a sufficiently large and balanced selection of respondents was obtained. The target was to interview at least 15 persons from different households, with a 50/50 gender balance and a representative distribution of age groups. The interviews were semi-structured, addressing a limited set of predefined topics, such as indigenous knowledge of organic agriculture, scientific equipment for organic agriculture, net income of conventional agriculture, net income of organic agriculture, and farmers' perspectives of their indigenous knowledge. All interviews were audio-recorded, transcribed in full in Chinese, and then translated into English. After reading all transcripts, a qualitative content analysis was conducted by coding the text with the MAXQDA software program.

## **RESULTS AND DISCUSSION**

### **Survey of Guanzhong Plain**

Indigenous knowledge plays an indispensable role in farming activities in Guanzhong Plain of Shaanxi Province. The first question addressed the type of agricultural knowledge in farming work. The largest proportion of respondents (44.8%) indicated that they used indigenous knowledge in their

farming activities; 35.2 percent of respondents integrated indigenous with scientific knowledge; and 20 percent indicated that they were purely dependent on scientific knowledge. Nonetheless, 55.2 percent of respondents expressed willingness to integrate indigenous with scientific knowledge in their farming activities in the future.

The Chinese government emphasizes that scientific knowledge should play a pivotal role in increasing agricultural yield and income. In recent years, the government and its local agricultural extension stations have conducted annual agricultural knowledge training courses in rural areas. However, more than half of the respondents (58.8%) indicated that they did not use the knowledge gained from agricultural training courses organized by the government and the local agricultural extension system. Furthermore, the farmers applied only few scientific knowledge disseminated through the agricultural extension system. Some 41.8 percent of the respondents indicated that they were not satisfied with their agricultural knowledge. Moreover, the agricultural knowledge and technology disseminated by government and local agricultural extension system deviated from farmers' reality; thus, the farmers' need for agricultural knowledge was not satisfied.

As to the farmers' perception of the relationship between scientific experts and local farmers, about half of the respondents (49.1%) had expected for interactive learning. This implies that local farmers learned scientific knowledge from experts, while the latter learned indigenous knowledge from farmers and understood their real need for scientific knowledge. However, in reality, the training course was used by agricultural experts as a strategy to provide farmers with only scientific lessons and ignored smallholder-farmers' indigenous knowledge. Ironically, while farmers are the most important actors who



will apply agricultural knowledge in farming activities, they have no voice in the agricultural knowledge extension system. In addition, majority of respondents (56.4%) expressed preference for learning agricultural knowledge in the crop fields rather than in lectures or seminars. However, it is the government and agriculture-related institutes, rather than local farmers, that decide what, when, where, and how agricultural training courses are held.

There are correlations between farmers' satisfaction with their agricultural knowledge, farmers' opinion on the training courses (useful or not), and their enthusiasm for taking part in agricultural scientific knowledge training courses (see Table 1 and Appendix 2). First, there is a significant negative correlation between farmers' satisfaction with their knowledge and farmers' opinion of agricultural

training courses. The more farmers are satisfied with their agricultural knowledge, the less useful they think agricultural training courses are. Second, there is a significant negative correlation between the farmers' satisfaction with their knowledge and the enthusiasm for knowledge to be gained from training courses. This indicates that the more satisfied farmers are about their agricultural knowledge, the less willing they are to take part in agricultural training courses. Third, based on Table 1, there is a strong positive correlation between farmers' opinion of agricultural training courses and their enthusiasm to take part in these learning activities. Farmers argued that agricultural training courses were not useful for them, hence had low enthusiasm to participate in agricultural training courses.

**Table 1. The correlations of farmers' satisfaction with their agricultural knowledge, opinion of training courses, and enthusiasm to participate in agricultural scientific knowledge training courses**

		Farmers' satisfaction of their agricultural knowledge	Farmers' opinion about the training courses (useful or not)	Enthusiasm to participate in training courses
Farmers' satisfaction of their agricultural knowledge	Correlation Coefficient	1.000	-0.178*	-0.301**
	Sig. (2-tailed)	-	0.023	0.000
Farmers' opinion about the training courses (useful or not)	Correlation Coefficient	-0.178*	1.000	-0.360**
	Sig. (2-tailed)	0.023	-	0.000
The enthusiasm of agricultural scientific knowledge training courses	Correlation Coefficient	-0.301**	-0.360**	1.000
	Sig. (2-tailed)	0.000	0.000	-

Notes: \*\*Correlation is significant at 0.01 level (2-tailed); \*Correlation is significant at 0.05 level (2-tailed)

### Case Study of Donghe Village

The case study of Donghe village provided an example of the integration of indigenous knowledge with scientific knowledge to develop organic agriculture. Since 2013, the farmers in Donghe village, in cooperation with a privately-owned enterprise, Xinxin Rice Company, have been engaged in an organic rice production project. The company and interested farmers annually signed a contract for organic rice production. The company provided production inputs that included organic rice seeds, organic fertilizer, pest-killing lamps, and ducks (Figure 3). In return, the farmers were obliged to sell their produce to the company. During the first year of implementation in 2013, the yield of organic rice was about 150 kg/mu,<sup>3</sup> lower than the yield of conventional rice. Subsequently, farmers were provided with seeds of an improved variety of organic rice and, in 2014, the difference in yield with conventional rice was reduced to 50-100 kg/mu. Ducks and pest-killing lamps (PV-powered light-trap) are the main approaches to control pests and weeds, as organic alternatives to synthetic biocides. The use of ducks is based on the concept of

“rice-duck mutualism,” which was developed 400 years ago. In the “mutualism” practice, the ducks are allowed to roam freely in the paddy fields and eat weeds and pests. The feeding habit of the ducks loosens the soil and improves absorption of fertilizer, and duck manure provides additional fertilizer and enhances the organic matter content of the soil. Thus, even as yields were lower than those obtained with conventional rice farming, cash costs were also much lower. In sum, the organic agriculture system in Donghe village integrated indigenous with scientific knowledge to improve quantity and quality of paddy rice, as well as introduce an economical way to improve farmers’ income via lower costs of production.

Local farmers were interviewed to get their perspectives on use and acquisition of knowledge. Since 2013, the organic agriculture project rapidly expanded in Donghe village. Based on their indigenous knowledge of “rice-duck mutualism”, farmers showed preference for organic agriculture; local farmers preferred to practice the traditional and environment-friendly way of farming.

According to a 60-year-old male farmer, he

**Figure 3. Farming systems in Donghe village**



a. Terrace field



b. Rice-duck mutualism

<sup>3</sup> 1 mu = 0.067 ha

does not need pesticide during the cultivation process, adding that it is more environment-friendly. He knows that the cultivation of conventional rice requires pesticide, which he thinks is harmful to people's health. Despite not applying pesticide, the farmer said that there are only a few pests in the paddy field because of ducks and pest-killing lamps. A 26-year-old female farmer said that her parents-in-law plant organic rice and they also use farm manure instead of chemical pesticide to spray the vegetables. An older (50 year-old) female farmer plans to cultivate organic rice. She added that it would not require pesticide and chemical fertilizer, which she believes is safer for the environment and healthier for the local residents. A 66-year-old male farmer said that although chemical fertilizer is more efficient, there is a need to apply manure-based fertilizer in the long run. He combines chemical fertilizer with manure-based fertilizers because he believes that using purely chemical fertilizer would harden the soil. A 23-year-old female respondent said that villagers were introduced by village officials to organic rice. This took place when the local government and the local firms visited farmers in their houses to persuade them to participate in organic agriculture program. The implementation of the organic agriculture program in Donghe village is mainly driven by the local government and organic agriculture companies. A top-down rather than a bottom-up transition, the decision-making process in the development of organic agriculture does not involve farmers.

It has been observed that the expansion of organic production is not driven by governmental policies stimulating a bottom-up transition, but top-down by large commercial companies looking for the most profitable opportunities for production in China (Kuehl and Liu 2014). It is likely that Donghe will be outcompeted in that respect, given the mountainous terrain, which hampers

mechanization of farming. As for the farmers in Donghe, organic production is something more or less "imposed" on them, without much attention for training and internalization of the associated values. Therefore, they are likely to easily switch back to conventional farming when the price advantage and other assets offered by the contracting company disappear.

## CONCLUSION

In China, the agricultural extension system is typically developed by the government and experts in research institutes in a top-down manner. Top-down agricultural extension system will cause the problem of "the last mile"<sup>4</sup>, in which agricultural knowledge-related courses that are organized and implemented by the government in a hierarchical, one-way approach, is not necessarily accepted and adopted by farmers. Farmers are the most important entities in agricultural development. However, in the agricultural extension system, there is an absence of the farmers' voice particularly about indigenous knowledge and what they need from the experts. There is no bottom-up feedback mechanism, and farmers are treated as passive recipients and their voices are largely ignored.

In practice, based on the findings of the field research, the majority of respondents stressed that they applied their own indigenous knowledge to their farming activities. They claimed that the scientific knowledge disseminated by the agricultural extension system is not suitable to their farming reality.

4 The Last Mile (Zui Hou Yi Gong Li 最后一公里) was created and used in 2001 in China to describe the problem of the agricultural knowledge and information extension system. "The last mile" describes that knowledge and information are disseminated from the beginning (agricultural experts) to the end (farmers), using top-down transmission of knowledge.

In addition, farmers expressed preference for an equitable relationship with the experts. Thus, agriculture policymakers and experts need to change the mindset that farmers are "less qualified and poor." To better match high-level agricultural extension system and on-the-ground services with needs of farmers, more in-depth research is needed to elicit the farmers' perspectives of their situation and need for agricultural knowledge.

The integration of indigenous with scientific knowledge is the way to form sustainable agricultural knowledge. Local farmers learn and form their indigenous knowledge based on their long-term farming experience. From the case study of Donghe village, it was found out that the indigenous knowledge contains abundant ecological wisdom, which could provide solutions to agriculture-related environmental problems. China's present agricultural system can draw lessons from traditional agriculture practices.

Scientific knowledge plays an important role in improving agricultural productivity and farmers' income from the economic aspect. There is need for more scientific research to examine the scientific underpinnings for indigenous knowledge, particularly on their ecological implications. The integration of indigenous with scientific knowledge can thus balance the economic and ecological dimensions of sustainable agricultural development. In terms of integrating indigenous with scientific knowledge, more in-depth and participatory field research in rural areas is needed to deepen researchers' integrated understanding and interpretation of the respective roles of scientific and indigenous knowledge.

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**Appendix A. The 24 Jie Qi and their meanings**

	<i>Jie Qi</i>	Translation	Meaning	Time
立春	( <i>li chun</i> )	Start of Spring	The beginning of the Spring	February 3-5
雨水	( <i>yu shui</i> )	Rain Water	The gradual increase of rainfalls	February 18-20
惊蛰	( <i>jing zhe</i> )	Awakening of Insects	Temperature rise and possible spring thunders	March 5
春分	( <i>chun fen</i> )	Vernal Equinox	The equal length of day and night	March 20
清明	( <i>qing ming</i> )	Pure and Brightness	Pure skies, fresh air, warm weather and lush plants	April 20
谷雨	( <i>gu yu</i> )	Grain Rain	The increase of rainfalls, which is good for grain crops	April 20
立夏	( <i>li xia</i> )	Start of Summer	The beginning of summer	May 5
小满	( <i>xiao man</i> )	Grain Full	The seeds of summer crops are getting plump but not ripe yet	May 21
芒种	( <i>mang zhong</i> )	Grain in Ear	The ripening of crops and beginning of busy farming	June 6
夏至	( <i>xia zhi</i> )	Summer Solstice	The extreme of summer in astronomical terms	June 21
小暑	( <i>xiao shu</i> )	Minor Heat	The hottest days are yet to come	July 7
大暑	( <i>da shu</i> )	Major Heat	The hottest time of the year	July 23
立秋	( <i>li qiu</i> )	Start of Autumn	The beginning of autumn	August 7
处暑	( <i>chu shu</i> )	Limit of Heat	Summer is coming to an end	August 23
白露	( <i>bai lu</i> )	White Dew	There are dewdrops on grass and trees in the morning	September 7
秋分	( <i>qiu fen</i> )	Autumnal Equinox	The equal length of day and night	September 23
寒露	( <i>han lu</i> )	Cold Dew	Lower temperature, dew in the air and cold feeling	October 8
霜降	( <i>shuang jiang</i> )	Frost Descent	The appearance of frost	October 23
立冬	( <i>li dong</i> )	Start of Winter	The beginning of winter	November 7
小雪	( <i>xiao xue</i> )	Minor Snow	The beginning of light snowfalls	November 22
大雪	( <i>da xue</i> )	Major Snow	The beginning of heavy snowfalls	December 7
冬至	( <i>dong zhi</i> )	Winter Solstice	The extreme of winter in astronomical terms	December 22
小寒	( <i>xiao han</i> )	Minor Cold	The weather is getting colder, but the coldest days are yet to come	January 5
大寒	( <i>da han</i> )	Major Cold	The coldest time of the year	January 20

Source: Jian (2014)



**Appendix B. The general description of the survey**

Question	Answer keys	%
What type of agricultural knowledge do you use in your farming work?	a. Traditional agricultural knowledge, which was learned from older generations, by observation or orally	44.8
	b. Scientific knowledge, which was obtained through agricultural knowledge and technology training	20.0
	c. A combination of traditional agricultural knowledge and scientific knowledge	35.2
How do you obtain agricultural knowledge?	a. I obtain agricultural knowledge through government-organized farmer training in the village	22.4
	b. I obtain agricultural knowledge very actively. For example, I gain information by watching TV programs and reading agricultural books	40.6
	c. I obtain agricultural knowledge not in a structured way. For example, by hearing about some information from relatives and friends	33.3
	d. Other	3.6
What is your opinion about traditional agricultural knowledge?	a. Negative, because the efficiency and income of traditional agriculture are low	32.7
	b. Neutral, I haven't considered the issue seriously	26.7
	c. Positive, traditional agriculture causes has only limited impact on the environment, although the efficiency is low	39.4
Comparing traditional agricultural knowledge with modern scientific agricultural knowledge, what is your choice and opinion?	a. I tend to give up traditional agricultural knowledge and fully accept scientific knowledge	16.4
	b. I tend to use traditional agricultural knowledge	18.2
	c. I tend to combine the traditional agricultural knowledge and scientific agricultural knowledge	55.2
Are you satisfied with your current agricultural knowledge?	a. I am satisfied with my current agricultural knowledge	24.2
	b. Neutral	33.9
	c. I am not satisfied with my agricultural knowledge and looking forward to learning more scientific and technological agricultural knowledge	41.8
Do you think agricultural knowledge training is useful?	a. It is very useful, because it helps us to do farming in a modern scientific way and to improve agricultural productivity	58.8
	b. It is not useful	37.6
	c. Other	3.0
Do you want to take part in agricultural knowledge training courses?	a. Very willing to participate	4.2
	b. Willing to participate	20.6
	c. Neutral	21.2
	d. Unwilling to participate	41.8
	e. Very unwilling to participate	11.5

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**Appendix B. Continuation**

Question	Answer keys	%
Which factors will influence your willingness to participate in agricultural knowledge training courses? (multiple choices possible)	a. When knowledge is provided which relates to my own agricultural practice	56.7
	b. When the trainers give guidance to farmers in the crop field instead of just giving a lecture	49.4
	c. When the agricultural knowledge is popularized and supported by government	31.7
	d. When it can help me to improve my agricultural income	55.5
	e. When there are many surrounding farmers in the village who also would like to participate	20.7
What do you think about the function of rural technology promotion stations?	a. They play practically no role in farmers' practices	25.5
	b. They stimulate farmers to participate in training courses and provide farmers with agricultural technology guidance	28.5
	c. They do demonstration tests to promote new agricultural technology	21.8
	d. They provide some agricultural information services	16.4
	e. Other	0.6
What do you think about the relationship between farmers and technical training personnel?	a. The relationship is 'to guide and to be guided'	32.1
	b. It should be an interactive learning relationship	49.1
	c. It must be a relationship of cooperation; both farmers and technical trainers are participants in agricultural production	17.6
	d. Other	1.2
Who should play the main role in promoting farmers' acquisition of new agricultural technology and knowledge?	a. Farmers should learn agricultural knowledge actively by TV and reading	23.6
	b. The government should lead and organize farmers to obtain new agricultural knowledge	37.0
	c. Farmers' professional organizations should take the lead	8.5
	d. Agricultural experts and agricultural knowledge trainers should take the lead	11.5
	e. This should not be dependent on one single actor. The promotion of farmers' agricultural knowledge acquisition should be accomplished by the cooperation of farmers, government, agricultural experts, and farmers' professional organizations.	19.4

**Appendix C. Characteristics of the interviewees in Donghe village**

Name	Age	Gender	Marital status	Farm size (mu)*	Children (education and work)	Job situation
1. Feng	60	Male	Married	6 mu (3 mu dry and 3 mu paddy land)	Two sons (no university education) are migrant workers in Guangdong and Jiangsu Provinces.	Farmer
2. Pang	27	Male	Unmarried	5 mu	No children; no university degree	Returned migrant worker; no farm work; building a new house in Donghe
3. Sun	58	Male	Married	3 mu (2 mu dry and 1 mu paddy land)	One daughter (no university education), married, lives in Zhejiang Province.	Returned migrant worker
4. Zhang	35	Female	Married	3 mu (1 mu dry and 2 mu paddy land)	Three daughters are in primary and middle schools.	Farmer
5. Feng	48	Male	Married	3.3 mu (3 mu dry and 0.3 mu paddy land)	One son just finished university a year ago; he stays at home and tries to find a job.	He is the village leader and operates a farm-hotel.
6. Feng	34	Male	Unmarried	6 mu (3 mu dry and 3 mu paddy land)	No children	No job due to mine disaster
7. Feng	23	Female	Married	7 mu (3 mu dry and 4 mu paddy land)	Pregnant	Returned migrant worker; no farm work; pregnant
8. Lin	54	Female	Married	6 mu (4 mu dry and 2 mu paddy land)	Has two daughters and one son; son works in Ningbo City, Zhejiang Province (with university education), but will return to Hanyin county	Returned migrant worker; takes care of her granddaughter; bought an apartment for her son
9. Wu	40	40	Married	8 mu (5 mu dry and 3 mu paddy land)	Has three sons: 20, 5, and 3 years old; eldest is a construction worker (no university education)	Farmer
10. Feng	66	66	Married	3.2 mu (2 mu dry and 1.2 paddy land)	Has two daughters and had one son (no university education); a daughter is running a garage; another daughter is married and lives in a village in Henan Province. His son died.	Farmer

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**Appendix C. Continuation**

<b>Name</b>	<b>Age</b>	<b>Gender</b>	<b>Marital status</b>	<b>Farm size (mu)*</b>	<b>Children (education and work)</b>	<b>Job situation</b>
11. Yang	26	26	Married	No data	No children	Returned migrant worker with no farming work; married
12. Yuan	50	50	Married	5 mu (3 mu dry and 2 mu paddy land)	Has one son and two daughters (no university education); her son is a migrant worker in Guangzhou City	Farmer; takes care of her granddaughters
13. Feng	78	78	Married	5 mu (2 mu dry and 3 mu paddy land)	Four daughters (no university education); two daughters are migrant workers; other two daughters stay in the village	Farmer; keeps two head of cattle
14. Wu	43	43	Married	5 mu (2 mu dry and 3 mu paddy land)	Two daughters and one son are in middle and primary schools.	Farmer; operates a farm hotel
15. Fu	58	58	Married	1 mu paddy land	Has three daughters and one son (no university education); son is 36 years old and works in Suzhou City	Returned migrant worker; takes care of two granddaughters
16. Wu	75	75	Married	7 mu (4 mu dry and 3 mu paddy land)	Has three sons and three daughters (no university education); eldest son is a construction worker in Fujian Province; the second son is operating a farm hotel in Donghe village; youngest son is deaf and a fulltime farmer	Farmer
17. Feng	80	Male	Married	3 mu (1 mu dry and 2 mu paddy land)	Has two sons and two daughters (no university education); two sons are migrant workers in Shanxi Province	Farmer

\* 1 mu = 0.067 ha

