Based on the Internet plus the Safety of Agricultural Products Traceability Research

Xiong Zhou
Fujian Vocational College of Agriculture, Fuzhou, Fujian, P R China
328475505@qq.com

Xujuan Zhou
University of Southern Queensland, Australia
xujuan.Zhou@usq.edu.au

Fang Zheng
Fujian Vocational College of Agriculture, Fuzhou, Fujian, P R China
43433519@qq.com

Raj Gururajan
University of Southern Queensland, Australia
gururaja@usq.edu.au

Enxing Zhou
School of Life Science
Beijing Normal University, P.R. China
znx9821@163.com

KC Chan
University of Southern Queensland, Australia
KC.Chan@usq.edu.au

Zhangguang Wu
Fujian Chuanzheng Communications College, Fuzhou, Fujian, P R China
122365690@qq.com

***Abstract*— The purpose of this research is to explore the emergence and implementation of agricultural security traceability systems in the agricultural products supply chain in China and to understand what benefits that an agricultural security traceability system based on "Internet+" can provide to the agricultural products supply chain in China. This research made three hypothesis about big data and technology, platforms and other means for product quality and safety of agricultural products traceability. In order to verify the accuracy of these three assumptions, regression analysis were used to construct five models for verification of three hypothesis. The results show that based on "Internet+" , using big data, big technology and big platform can significantly increase the accuracy of agricultural products traceability system hence improve consumer acceptance of the safety of agricultural products.**

Keywords—Agricultural products supply chain; Traceability systems; Internet+

I. INTRODUCTION

This quality and safety of agricultural products is the most important concerns for end customers and has a great impact on the stable development of national economy and society. In recent years, Chinese government has put great efforts to improve the quality and safety of agricultural products. However, there are still some agricultural product safety incidents that cause consumer panic and has had a negative impact on the life of people and social stability.

Many developed countries, such as USA, Canada, Japan, have established standardized food quality and safety traceability system [1]. In the European Union, as early as 2002 in the "general food law" traceability systems have been enforced. The EU Food and Feed Safety Regulation, issued and implemented in 2006, stipulates that the whole process of food from farm to table must be controlled, managed and traceable. In the United States, food safety is subject to mandatory regulation through the issue of Food Safety tracking regulations, and in 2006, all food-related enterprises established traceability system for product quality [2]. Compared with the developed countries, the research on the traceability system of agricultural products supply chain in China is still in the primary stage.

The traceability systems of agricultural product supply chains should be able to set up each link of agricultural product supply chain in detail from many levels, through the understanding of each link information. After collection, a highly sensitive database related to changes in agricultural product market demand is established to increase the collation and control of the agricultural product supply chain and to optimize the supply basis of agricultural products. Therefore, under the influence of the concept of information sharing, when designing the incentive mechanism of traceability systems of agricultural product supply chains, we should emphasize strengthening the overall consciousness of all partners in the agricultural product supply chain and after using the traceability system within their respective business scope, it can be quickly and accurately traced the supply links of agricultural production through sales. This will allow them to find the varieties, scale and reasons of the problems in the operation of the supply chain of agricultural products, and create corresponding solutions through the analysis thereof.

Internet Plus (Internet+) is proposed by China's Prime Minister Li Keqiang in his Government Work Report on March 5, 2015 [3]. "Internet+" represents a new economic form. It refers to the use of Internet-based information technology to achieve the integration of the Internet and traditional industries. This could have transformative economic effects through the optimization of production factors, update of business systems, and reconstruction of business models. Internet+ could integrate various internet based technologies (mobile Internet, cloud computing, big data or Internet of Things) into existing productive industries and would aid business development in China [4].

The "Internet+" based agricultural security trace- ability system could collect information about agricultural products in the production and circulation stages then transmit this information between the main bodies of supply chain. In this context, Internet+ could effectively solve the problem of information asymmetry during agricultural products trading and therefore improve the quality and safety level of agricultural products.

The purpose of this study is to explore the emergence and implementation of product traceability systems in the agricultural products supply chain in China. In particular, to understand what benefits that a traceability system that based on "Internet+" can provide to the agricultural products supply chain in China.

II. RELATEDWORK

The definition of traceability in one of most cited scientific papers is "Traceability is the ability to track a product batch and its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales" [5]. In the Chinese guidelines for traceability of Agricultural products (NYR / T 1431-2007), traceability is defined as "the ability to identify the source of a product or product component from the end of the supply chain (product user) to the beginning (product producer or raw material supplier) that means the ability to trace the history, location, etc. of agricultural products by recording or marking." The commonality in all these definitions and the underlying rationale behind adopting them is that traceability systems are meant to preserve information about the origins of agricultural products throughout the whole process from farm to fork.

Since the 1990s, the relationship between agricultural product safety and supply chain management has been an important topic of interest in related research fields, including governance relationship, signal transmission, traceability systems and so on. At the governance research level, Thankappan [6] used the case of the fresh fruit and vegetable industry to discuss the impact of private sector and consumer requirements on food regulation in the UK. Their research results show that businesses, private interests, Consumers and other stakeholders have an important function of accountability for agricultural food supply chain management in the UK. At the level of signal transmission, many scholars generally agree that brands can effectively solve the problem of information transmission for agricultural products. Sonesson et al. [7] gave detailed descriptions, life cycle assessment (LCA) evaluations, and consequence assessments of supply chains for six commodities, i.e., milk, cheese, beef, pork, chicken, and bread, in a Swedish region. The results for the pork supply chain show that a change in the supply chain can easily lead to the change of all kinds the properties of the products in the system [7]. Considering the influence of the "Internet" on the agricultural supply chain leads to the construction of the "trinity" of internet based quality supervision. The information service used by the supply chain affects the quality of behavior in the supply chain so the construction of a unified network system platform are put forward [4]. Countries such as the United States, Canada, Japan, the United Kingdom, France, the Netherlands have already established standardized food quality and safety traceability systems which provides information on the origin of food, processing processes, logistics, transportation and market flow, etc., to track the whole supply chain. Traceability systems in this context reduce the loss of food producers and ensure the reasonable rights and interests of consumers [8, 9].

III. Research Hypothesis

A. Big data and Agricultural products Safety traceability system

To solve the problem of asymmetric agricultural product information areal-time monitoring and warning system for agricultural products has been constructed This has the potential to create social and ecological benefits the quality of agricultural products and brand effects to promote industrial transformation and upgrading to achieve significant economic benefits, to increase the added value of agricultural products and market competitiveness to promote the enthusiasm of farmers in scientific production. Strict control of pesticides and fertilizer use in order to benefit the sustainability of the agricultural ecological environment. Accordingly, the following assumptions are made:

H1: Internet big data supports agricultural product safety traceability system.

B. Big Technology and Agricultural Safety traceability system

When agricultural products enterprises form irreplaceable technological advantages in the market, they can effectively reduce their costs and increase their sales volume. The value of technology in the Internet era to the safety traceability system of agricultural products is mainly reflected in the integration of the Internet technology into the agricultural products business process and operation. It can be measured by the degree of application and accuracy of traceability of agricultural products. So, if you want to use the big technology of the Internet in agriculture, for enterprises in goods and services, there will be higher precipitating costs and lower incremental costs in the initial development of major Internet technologies; in subsequent operations, enterprises will apply the Internet technology to agricultural products scale service to make the marginal returns of agricultural products increase continuously and realize the profit of agricultural products through strong scale effect. Accordingly, the following assumptions are made:

H2: Internet technology supports agricultural safety traceability system.

C. Big Platforms and Agricultural Safety traceability system

At present, the agricultural product safety traceability system platform is mainly established by government departments. These bodies mainly function as repositories of agricultural product data and engage in information transmission and release but critically lack communication and contact with consumers. Even when the consumers demonstrate a demand for agricultural product traceability, the capacity of government departments to solve the problem appears lacking. The proposal of "Internet+" integration would enable the establishment of a large interactive platform allowing the dissemination of supply chain information amongst government management, production and sales, and social consumption. This would essentially make transparent the existing repositories of information of government information to engage consumer need and would reduce the operating costs of production and sales as well as improve the efficiency of logistics and distribution. Consumers would enjoy increased product quality and price diversification as a direct result of this newfound transparency. Accordingly, the following assumptions are made:

H3: Internet big platform supports agricultural product safety traceability system.

IV. Materials and Methods

A. Data samples and sources

The Internet-based agricultural products enterprises in the Shanghai and Shenzhen stock markets from 2013 to 2017 were selected as the sample population. The data is from the "Wind" database and the annual reports published by the

Shanghai and Shenzhen stock exchanges. Given that the problems such as mixed good and bad enterprises, and incomplete information disclosure from some enterprises. The sample data are processed as follows:

1) those enterprises with the incomplete data are eliminated.

2) those enterprises with losses for three consecutive years are eliminated.

3) Those enterprises that generated revenue from the Internet less than 10% are eliminated.

A total of 78 enterprises were selected, including 30 productive enterprises, 28 processing enterprises and 20 service enterprises.

B. Selection and definition of variables

In this section, we selected suitable variables and define said variables.

- Dependent variable : traceability accuracy. It is used to measure the traceability accuracy of the agricultural products in the supply chain when the benefit of the parties is maximized; and is expressed by the cost function of the responsibility.
- Independent variable: big data, if the enterprise has established or uploaded the agricultural product information database to take 1, otherwise take 0; the big platform, if the enterprise has established or joined the agricultural product interactive platform to take 1, otherwise takes 0; the big technology, if the enterprise has the research and development input to take 1, otherwise takes 0.
- Control variable: enterprise size and capital structure. It is represented by the natural logarithm of the total assets of the enterprise at the end of the year.

C. Establishment of Regression Model

This paper selects the following models to determine the factors influencing the traceability of agricultural products in the supply chain:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \alpha_0 + \alpha_1 x_{1j} + \alpha_2 x_{2j} + \cdots + \alpha_i x_{ij} + \varepsilon_i$$

where:

$$P_i = \frac{1}{1+\exp^{-(\alpha_0+\sum_{i=1}^{n}\alpha_i x_{ij})}} + \varepsilon_i$$

P_i is the degree of accuracy of traceability information; x_{ij} denotes the j index in the i factor; α_0 is constant, α_i is the regression coefficient of independent variable; ε_i is a random error. When $\alpha_i > 0$, the j index has a positive effect on the traceability of agricultural products whereas $\alpha_i < 0$, the j index has a negative effect on the traceability degree of agricultural products.

V. EMPIRICAL STUDY

A. Statistical analysis

The SPSS software is used to analyses the sample data and the statistical characteristic results are reported in Table 1. As can be seen from Table 1:

1) The average cost of liability in the overall sample is 0.883, and only one sample has a cost value of responsibility greater than 1 and a frequency of 1.28%, indicating that most of the Internet-based agricultural products enterprises tend to apply traceability systems.

2) 74.3%, 76.5% and 77.7% of the total sample of productive, processing and service enterprises respectively are willing to integrate the data, technologies and platforms with traceability systems and keen to increase R&D investment to maintain stronger market competition.

B. Regression analysis

As can be seen from table 1, the correlation coefficient of each indicator is between 0.537 - 0.734, which indicates that the differentiation between indicators is obvious, the possibility of index variation is relatively small, and the relevant data can better reflect the content of their respective indicators. Three hypotheses are tested by regression analysis, and the results of regression analysis are shown in Table 2. From Table 2, we can see that

(1) Model One was built based on the control variable of enterprise size and capital structure and a regression analysis of responsibility cost can be made to explain the variation of 37.6% of the variables.

(2) On this basis, big data index was added and form Model Two. The regression analysis with Model Two can explain the variation of 46.4% variables, and the standardized regression coefficient is 0.343 that has strong significance and indicates that the hypothesis H1 can be confirmed on the basis of Model One.

(3) Big technology index was added into Model One and form Model Three. The regression analysis with Model Three can explain the variation of 49.8% of variables, and the standardized regression coefficient is 0.274 that has strong significance and indicates that hypothesis H2 can be established.

(4) On the basis of Model One, Model Four is formed by adding big platform indicators. The regression analysis with Model Four can explain the variation of 47.9% variables and standardized regression coefficient is 0.395 that has strong significance and shows that the hypothesis H3 can be verified.

(5) Similarly, in order to further verify the above hypothesis, three indicators of big data, big technology, big platform and the control index of enterprise size and capital structure are added to Model One then form Model Five, which can explain the variation of 67.4% variables and indicates that Model Five effectively supports the regression analysis results of the above four models.

TABLE 1. TRACEABILITY STATISTICAL RESULTS MATRIX FOR INTERNET AGRICULTURAL ENTERPRISES.

Index	Responsibility Cost	Big Data	Big Technology	Big Platform	ES&CS
Responsibility Cost	1.000				
Big Data	0.0.583	1.000			
Big Technology	0.617	0.713	1.000		
Big Platform	0.734	0.537	0.632	1.000	
ES&CS	-0.354	-0.542	-0.315	-0.238	1.000
Mean Value	0.883	0.734	0.765	0.777	0.693
Standard Deviation	0.541	0.435	0.531	0.573	0.397

TABLE 2. RESULTS OF REGRESSION ANALYSIS OF INTERNET AGRICULTURAL PRODUCTS ENTERPRISES.

Independent Variable	Responsibility Cost				
	Model One	*Model Two*	*Model Three*	*Model Four*	*Model Five*
Big Data	-	0.436	-	-	0.343
Big Technology	-	-	0.383	-	0.274
Big Platform	-	-	-	0.389	0.395
ES&CS	-0.427	-0.434	-0.319	-0.342	-0.287
R^2	0.387	0.466	0.501	0.491	0.683
Revised R^2	0.376	0.464	0.498	0.479	0.674
F statistics	15.438	14.292	13.457	12.177	12.733
Whether hypotheses are established	-	H1 Yes	H2 Yes	H3 Yes	-

a. ES&CS = Enterprise Size and Capital Structure

VI. CONCLUSION

In this paper, we have discussed the traceability accuracy of product quality and safety from the responsibility cost of enterprises. Based on the results of the above regression analysis, it is found that big data, the big technology and the big platform under the "Internet" network can significantly affect the traceability accuracy of the product safety quality of the Internet agricultural products enterprises. The main reason is that big data can provide socialized and networked information, big technology can increase knowledge value orientation and social capital, and large platform can make various industries realize more interactive experience.

REFERENCES

[1] EU Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety Official Journal of the European Communities, 2002, 31, 1-24.

[2] FAO/WHO Codex Alimentarius. Joint FAO/WHO Food Standards Programme 1997.

[3] Li, K. China unveils targets for 2015: Li Keqiang's speech as it happened. South China Morning Post, 2015.

[4] Qin, C. A Chinese concept of Internet Revolution: a Need for Traditional Industries to be Reborn with New Bones. https://justrecently.wordpress.com/2015/04/17/a-chinese-concept-of-internet-revolution-a-need-for-traditional-industries-to-be-reborn-with-new-bones/, 2015.

[5] Moe, T. Perspectives on traceability in food manufacture. Trends in Food Science & Technology 1998 , 9, 211–214.

[6] Thankappan, S. European food regulation and accountability: the interplay of influences shaping the new regulatory terrain. In Ethics, Law and Society; Routledge, 2016; pp. 81–116.

[7] Sonesson, U.G.; Lorentzon, K.; Andersson, A.; Barr, U.K.; Bertilsson, J.; Borch, E.; Brunius, C.; Emanuelsson, M.; Göransson, L.; Gunnarsson, S.; others. Paths to a sustainable food sector: integrated design and LCA of future food supply chains: the case of pork production in Sweden. The International Journal of Life Cycle Assessment 2016, 21, 664–676.

[8] Marucheck, A.; Greis, N.; Mena, C.; Cai, L. Product safety and security in the global supply chain: Issues, challenges and research opportunities. Journal of Operations Management 2011, 29, 707–720.

[9] Charlier, C.; Valceschini, E. Coordination for traceability in the food chain. A critical appraisal of European regulation. European Journal of Law and Economics 2008, 25, 1–15.