Farmers' Cognition of Circular Agriculture and its Influencing Factors: A Case Study of Wannian County in Jiangxi Province

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Abstract Based on the current situation of agricultural development and agricultural material utilization in Wannian County of Jiangxi Province, we mainly use the form of questionnaire survey and design the relevant questions, to study the farmers' awareness of circular agriculture and its influencing factors. The study results show that some factors have a significant impact on farmers' awareness of circular agriculture, such as householders' age, education level, the proportion of agricultural income to household income, having attended agriculture-related lectures, and whether to be concerned about the information related to agriculture. Through the study in this article, we aim to provide better theoretical reference for the development and study of circular agriculture in Wannian County of Jiangxi Province.

Key words Circular agriculture, Cognition, Influencing factors

The circular agricultural economy focuses on the use of agricultural resources, coordinates the economic development and environmental protection, and organically combines the economic activity process of agricultural system into an economic cycle chain of resources - products - consumption - wastes - resources. It changes the traditional mode of simple production of resources - products - consumption - wastes, and converts the pollutants and wastes in the previous agricultural economic link into the new resources in the next agricultural economic link through appropriate treatment, thereby forming a closed loop circular system of agricultural resource utilization.

The circular agriculture takes "two types of zero growth" as the development goals: one is the zero growth of agricultural resources and agricultural energy consumption, and the other is the zero growth of agricultural ecological environment degradation rate. It aims to achieve efficient and sustainable use of agricultural resources and virtuous circle of ecological environment, which will be of important significance to the future agricultural development in Jiangxi Province.

Farmer is a unit with social function and economic function. It is the economic organization engaged in agricultural business and agricultural production, with social and economic functions of production, consumption, fertility, education, accumulation, and culture. The farmers are engaged in the agricultural production activities always out of certain goals or interests. From economic perspective, farmers' goals can be divided into economic goals and non-economic goals. Economic goals are the economic motives for the farmers to be engaged in agricultural production, namely to get the most basic subsistence, improve their living conditions and pursue the maximum economic profit; non-economic goals mainly include ensuring stability and security in life, responding to the national policy, meeting the leisure needs, protecting the regenerative capacity of resources and so on.

From the current pattern of behavior of farmers in China, it was still based on the pursuit of economic goals (Kong Zhifeng, 2006). The farmers mainly aim to pursue the economic goal, farmers are the direct production subject engaged in the agricultural activities and the relevant agricultural policies and decisions made by the government need to be implemented by the farmers.

Therefore, the analysis of farmers' cognition of circular agriculture is of great significance. On the one hand, it is conducive to the promotion and implementation of circular agriculture, the positive response to the national policy, and comprehensive implementation of the guidelines of scientific development concept, so as to achieve the coordinated development of rural ecological environment and rural economy. On the other hand, it will help improve the overall quality of farmers, and actively guide them to carry out reasonable agricultural production, in order to improve overall economic efficiency of agriculture, and make agricultural subject to get more benefits.

Jiangxi Province is the country's major agricultural province, located in the central region of China. In 2010, the arable land area was 2.19×10^{10} m^2; the total agricultural output value reached as high as 70 billion yuan; there were 8.319 million agricultural households, and there was a agricultural population of 33.898 million; the planting area of major crops reached $5.332.19 \times 10^{10}$ m^2. The agricultural economic development in Jiangxi Province plays a decisive role in China. The traditional mode of agricultural production wastes a lot of resources, and at the same time, results in the deteriorating ecological environment in rural area; the rural production conditions and living conditions have not been improved.

In the production process, due to the excessive use of chemical fertilizers, pesticides, plastic sheeting and other agricultural resources (Table 1), it has led to a large area of water eutrophication. Meanwhile, it also makes the water quality of Poyang Lake

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deteriorate and biodiversity dwindle. People's living water and agricultural irrigation water are also severely polluted, and a vicious cycle of agricultural production system is gradually formed. The soil fertility is declining, and we can only fall back on more fertilizers to increase crop yield.

There is an increase in the area of rural and urban building and a decrease in the area of arable land. In addition to the soil erosion, the area of arable land is getting smaller. The standard of living in rural areas is increasingly high, and the rural living material consumption is growing. The white trash is littered everywhere; the sewage is discharged arbitrarily; the rapid development of fish breeding and poultry raising causes the manure pollution to the environment. Coupled with improper handling, it makes the surrounding rural living environment get worse. With the widespread application of pesticides, the pesticide residues in agricultural products increase, and food safety has become a huge risk.

Meanwhile, the use of farm machinery and wide application of petroleum fuels (Table 1), increase the pollution to air. For the sustainable use of agricultural resources, comprehensive implementation of the scientific concept of development and construction of a more harmonious society, we must strengthen resource conservation and management, improve resource protection capability and environmental protection, strengthen ecological construction and anti-disaster system, and comprehensively enhance the capacity for sustainable development of agriculture, to achieve the smooth and healthy development of circular agriculture. The development of circular agriculture in Jiangxi Province is closely related to farmers' cognitive behavior.

1 Object of study and research methods

1.1 Object of study: with Wannian County as the scope of study Wannian County is located in the northeast of Jiangxi Province, only 90 hm^2 away from the provincial capital, Nanchang. It is in the southeast of Poyang Lake, and one of the 38 core counties in Poyang Lake Ecological Economic Zone, with a land area of 1140.76 hm^2.

In 2010, there was an arable land area of 2.07×10^8 m^2; there was a waters area of 7.33×10^7 m^2; there was a grain sowing area of 4.2×10^8 m^2 in Wannian County. The total grain output was about 2.5×10^8 kg; there was a total population of 394879, including 301301 agricultural population and 165716 agricultural labor force. The total output value of industry and agriculture was 5 680.73 million yuan, and the total output value of agriculture was 1829.99 million yuan; the total sown area of crops was 5.07×10^8 m^2.

The main agricultural industries include farming (crops mainly based on rice), animal husbandry (mainly pig breeding industry), agricultural mechanization industry and other agricultural industries.

It is the birthplace of the world's rice culture, and has a long history of rice cultivation. It is the hometown of Chinese Tribute Rice, and also known as "Town of Pearl" and "Town of Milk and Honey". Wannian County is a pilot county of national industrialization of agriculture, and the major industries in the process of industrialization of agriculture are tribute rice, pig and pearl. Jinxing Farming Company in Wannian County is the pig breeding base with the largest single scale in China.

Table 1 The consumption of fertilizers, pesticides, plastic sheeting, and agricultural diesel oil in Jiangxi Province during the period 1993 -2008

Year	Usage amount of chemical fertilizer //10^7 kg	Usage amount of pesticides //10^3 kg	Usage Amount of agricultural films //10^3 kg	Usage amount of agricultural diesel oil //10^3 kg
1993	93.8	34 000	16 932	13.3
1994	$10^5.2$	38 098	20 500	12.4
1995	112.1	41 932	21 785	13.9
1996	112.8	44 482	21 10^5	14.1
1997	120.4	45 259	24 792	15.1
1998	113.1	48 704	27 509	16
1999	116.7	54 502	30 256	16.3
2000	106.9	61 479	28 599	16.8
2001	109.7	51 384	30 778	16.5
2002	112.5	57 323	35 407	16.7
2003	110	53 470	33 930	17.3
2004	123.5	66 273	42 828	20
2005	129.4	75 305	45 010	19.9
2006	132.6	75 955	40 854	24.4
2007	132.7	88 833	38 071	22.3
2008	133	96 662	41 645	23.8

Note: The data are from Jiangxi Agricultural Statistics.

The agricultural GDP in Wannian County is growing continuously, and the development of circular agriculture pattern is promoted and implemented in different regions. Especially in recent years, the government and society have paid more and more attention to the development of circular agriculture. However, there is no significant decreasing trend of utilization of agricultural materials, especially for the use of agricultural pollution sources.

For example, the total amount of fertilizer applied amounted to 20337 tons in 2010; the amount of plastic film applied amounted to 7.5×10^4 kg; the amount of pesticides applied amounted to 7.39×10^5 kg; the amount of diesel oil applied amounted to 6.6×10^4 kg.

The ecological environment and living conditions in rural areas have not been greatly improved, and the farmers have little knowledge and understanding of circular agriculture, so in order to promote the development of circular agriculture, cognitive behavior of farmers can not be ignored.

1.2 Research method: questionnaire survey With Wannian County in Jiangxi Province as the research scope, this article chooses the townships with typical development of circular agriculture, mainly including Shangfang Township, Suqiao Township, Huyun Township, and Wangjia Township.

In this process, through the expert interviews, county and village cadres interviews, home visit and other random sampling methods, we obtain relatively true and accurate information about

farmers' living environment, different models of circular agriculture, application of new agricultural technology, the overall economic income, agricultural economic income, agricultural production input, types of agricultural products, planting and breeding varieties, and the commodity rates.

From the various above aspects, we understand the farmers' cognition and implementation of circular agriculture, and analyze the farmers' behavior in different regions of Wannian County and the development pattern of circular agriculture, in order to raise farmers' awareness of circular agriculture development.

The survey lasted for a month, and the survey time was in July 2012. A total of 450 questionnaires were distributed to farmers, and a total of 410 questionnaires were collected from the farmers. Excluding some samples with incomplete information or missing samples, a total of 375 valid questionnaires were collected from the farmers (10^5 questionnaires collected in Shangfang Township, 90 questionnaires collected in Suqiao Township, 87 questionnaires collected in Huyun Township, and 93 questionnaires collected in Wangjia Township).

The questionnaire survey on farmers was carried out taking the way of question – and – answer between the researchers and local farmers, village cadres; the survey on County Farm Bureau leaders and experts was carried out by visits and discussions.

2 Results and analysis

2.1 Description of householder characteristics Householder characteristics include respondents' characteristics and householder family's characteristics. The respondents' characteristics include respondents' gender, age, education, occupation, etc.; householder family's characteristics include householder family's total population, farming population, total income, agricultural income and sources of agricultural income, etc. These factors are all closely linked to farmers' cognition of circular agriculture.

By calculating the frequency number and frequency of sample, we now make a descriptive analysis of the householder characteristics, to know the distribution of samples in each variable. Then some specific indicators can be used to reflect the basic characteristics of the farmers, in order to provide accurate data for the analysis of correlation between various variables and farmers' cognition of circular agriculture.

2.1.1 Analysis of respondents' characteristics.

(i) Analysis of respondents' gender and age. There are 287 male respondents, accounting for 76.5%; there are 88 female respondents, accounting for 23.5%. As for the respondents' age structure, there are a total of 17 people aged between 20 and 30 years, accounting for 4.5%; there are a total of 37 people aged between 30 and 40 years, accounting for 9.9%; there are a total of 154 people aged between 40 and 50 years, accounting for 41.1%; there are a total of 142 people aged between 50 and 60, accounting for 37.9%; there are a total of 19 people aged between 60 and 70, accounting for 5.1%; there are a total of 6 people aged between 70 and 80, accounting for 1.6%.

During the interview, the majority of men are more willing to cooperate with us on the survey, showing higher sensitivity to this survey when compared with women. Some women expressed support to this, but the degree of woman's participation in this survey is not as high as the degree of man's participation in this survey, possibly because the agricultural development in some families is mostly managed and controlled by men, and the women have not in-depth understanding of the agricultural development and operation in the family, less sensitive to the income and expenditure figures, having long formed the habit of mainly relying on men to manage farming.

In terms of the age structure, there are few respondents aged between 20 – 40 years; most people at home are the middle-aged people or the elderly aged between 40 and 60 years, as well as the children. In the inquiry process, we know that the majority of young adults go out to work in Zhejiang, Guangdong, Fujian and other coastal areas.

(ii) Analysis of respondents' education and occupation. As to the education level of respondents, there are 32 uneducated people, accounting for 8.5%; there are a total of 99 people with the education level of primary school, accounting for 26.4%; there are a total of 198 people with the education level of junior high school, accounting for 52.8%; there are a total of 9 people with the education level of technical secondary school, accounting for 2.4%; there are a total of 26 people with the education level of senior high school, accounting for 6.9%; there are a total of 7 people with the education level of junior college, accounting for 1.9%; there are a total of 4 people with the education level of regular college, accounting for 1.1%.

The survey results show that in the education level composition, the proportion of education level of junior high school is the highest; the respondents' education level is mainly concentrated in the stage of junior high school education, followed by the primary education stage. Some respondents are never educated, and we know that most of them are middle-aged women by the interview.

There are fewer people with technical secondary school education than the people with senior high school education. By the interview, we know that most of the people with the senior high education are aged between 35 and 45 years.

The majority of people with the technical secondary school education are young people aged 20 – 30 years, and through the interview, we know that if they fail to seek a stable job after graduating from the technical secondary school, they will go home for farming. A handful of them have received the junior college education, and they choose to return home to farm if the job they seek after graduation is not satisfactory.

During the interview, there are few respondents with the undergraduate degree, and they aim to start an undertaking in the hometown. The main direction of entrepreneurship is the large-scale farmland contracting, three-dimensional cultivation and planting. They have played an exemplar role in leading the development of circular agriculture in the village, and become the

emerging force for the development of circular agriculture in the village, which are a much-needed shot in the arm for the development of circular agriculture in rural areas.

2.1.2 Analysis of characteristics of respondents' families.

(i) Analysis of the respondents' total family population and farming population. In the total family population of the farmers surveyed, the average total family population per household is 5.12, the smallest total family population is 2 and the largest total family population is 10.

There are a total of 6 households with the total family population of 2, accounting for 1.6%; there are a total of 39 households with the total family population of 3, accounting for 10.4%; there are a total of 89 households with the total family population of 4, accounting for 23.7%; there are a total of 10^7 households with the total family population of 5, accounting for 28.5%; there are a total of 74 households with the total family population of 6, accounting for 19.7%; there are a total of 38 households with the total family population of 7, accounting for 10.1%; there are a total of 12 households with the total family population of 8, accounting for 3.2%; there are a total of 6 households with the total family population of 9, accounting for 1.6%; there are a total of 4 households with the total family population of 10, accounting for 1.1%.

As for the family farming labor force, the average number of farming labor force per household is 2.16, the smallest number of farming labor force is 1 and the greatest number of farming labor force is 6.

There are a total of 80 households with 1 farming labor force in the family, accounting for 21.3%; there are a total of 215 households with 2 farming labor forces in the family, accounting for 57.3%; there are a total of 39 households with 3 farming labor forces in the family, accounting for 10.4%; there are a total of 27 households with 4 farming labor forces in the family, accounting for 7.2%; there are a total of 9 households with 5 farming labor forces in the family, accounting for 2.4%; there are a total of 5 households with 6 farming labor forces in the family, accounting for 1.3%.

The survey results show that most of farmers have agricultural registered permanent residence, and a small number of farmers have non-agricultural registered permanent residence (mainly vegetable growers, the former laid-off workers, close to the county).

The total family population is concentrated in about 5, and few of families have population of smaller than 3 or larger than 8. The number of farming labor force in the family is mainly about 2, and the survey shows that their age is 40 –50 years. For the family with few farming labor forces, there is only one engaged in farming, aged mainly between 50 and 60 years.

From the survey, it is found that the majority of young men work outside the home, leaving the elderly at home. The main body of farming is mainly men, and the main task for women is to take care of children and do housework. In some major growers' families, there are many people engaged in farming.

(ii) Respondents' annual family income, agricultural income and sources of agricultural income in 2011. In terms of family income, farmers' family income was mostly between 10 000 yuan and 50 000 yuan in 2011, and there were a total of 206 households at this level, accounting for 54.9%; there were few households with family income of 5 000 to 10 000 yuan (a total of 7 households), accounting for 1.9%; there were many households with family income of 50 000 to 100 000 yuan. The households with the family income of over 200 000 yuan were rare, and some of them were large farming households.

In terms of the family's agricultural income, there were 112 households with the agricultural income of 1 000 to 5 000 yuan, accounting for 29.9%, and they were mainly the small farming households. There were also some households with the agricultural income of 10 000 to 50 000 yuan (96), accounting for 25.6%, which operated a relatively large area of land. There were few households with the agricultural income of over 100 000 yuan, and they were mainly the large farming households.

In terms of the source of agricultural income, the farming income accounted for the highest proportion (75.7%), and there were a total of 184 households, and the income from a combination of breeding and farming also occupies a large proportion. There were 21 households engaged in breeding, accounting for 5.6% (mainly partnership farming operation).

2.2 Analysis of farmers' cognition of circular agriculture

2.2.1 Farmers' attention to agriculture-related information and the channels for them to obtain the information. The survey results on farmers' attention to agriculture-related information show that the proportion of respondents often paying attention to the agriculture-related information is 53.6%; the proportion of respondents basically giving no attention to the agriculture-related information is 33.9%; the proportion of respondents paying attention to the agriculture-related information only in their spare time is 12.5%.

As for the channels for farmers to obtain the information, 76.9% of them obtain the information via television; there are also many farmers obtaining the information by radio, accounting for 7.6%; only 5.3% of them obtain the information via Internet.

Table 2 Farmers' attention to agriculture-related information and the channels for them to obtain the information

Questions	Options	Percentage//%
Whether to often pay attention to information of agriculture	Often concerned	53.9
	Basically not concerned	15.2
	Occasionally concerned	30.9
The channels for farmers to obtain information of agricultural development	TV	76.9
	Broadcasting	7.6
	Newspaper	5.5
	Magazine	3.1
	Internet	5.3
	Others	1.6

Through the survey, it is found that as to the farmers' attention to the information related to agricultural development, the majority of farmers are very concerned about the agriculture-related

information, because the agricultural development, after all, is related to the vital interests of farmers. In the main body paying close attention to agriculture-related information, some of them often participate in various kinds of farming training and agricultural policy meetings, and they show great enthusiasm and activity. And some people are occasionally concerned about the agriculture-related information. It is known in the survey that due to busy farming, and the constraint of education level, knowledge structure, the traditional concept and information channels, these people have low sensitivity to the information related to the agricultural development. In addition, there are some people basically not concerned about agriculture-related information, and it is found that these people hold "indifferent" attitude towards agricultural development, and they are only engaged in their own farming, without paying attention to the collective and national agricultural development.

2.2.2 Farmers' circular agriculture lecture attendance and promotion of agricultural technology seminars. As for the question of whether having heard about circular agriculture, there are only 8.8% of respondents having heard about circular agriculture; there are 91.2% of respondents having not yet heard about circular agriculture. As for the question of whether having attended the lectures about agriculture or circular agriculture, there are 20.3% of respondents having attended the lectures about agriculture or circular agriculture while there are 79.7% of respondents having not yet attended the lectures about agriculture or circular agriculture. As for the frequency of attending the lectures about agriculture or circular agriculture, there are 79.5% of farmers once attending 1 lecture, and there are 7.7% of farmers once attending 6 lectures. As for the units sponsoring the lectures of agriculture or circular agriculture, the agricultural extension organizations account for 75.1%, and the government departments account for 24.9%.

Table 3 Farmers' cognition of circular agriculture

Questions	Options	Percentage//%
Whether having heard of circular agriculture	Yes	8.8
	No	91.2
Whether having attended the lectures about the related agricultural technology	Yes	20.3
	No	79.7
The number of lectures attended	1	79.5
	2	5.9
	3	2.9
	4	2.7
	5	1.3
	6 or more	7.7
Lecture organizational units	Agricultural extension stations	75.1
	Governmental departments	24.9

It is found from the survey that the majority of respondents have not heard of circular agriculture. Although there are some people listening to lectures of agriculture or circular agriculture, most of the lectures only involve agriculture, and circular agriculture is only occasionally touched upon in the lecture. Therefore, farmers have little understanding of circular agriculture, and even if they have heard of it, it only lingers on the simple and superficial knowledge of words "circular agriculture"; they do not literally fathom the true and deep meaning of circular agriculture. Many people have attended 1 lecture, but never listen to another one subsequently; there are more farmers attending 2 lectures than farmers attending 3, 4 or 5 lectures, and they never attend any lecture after listening to 2 lectures; there are many people attending 6 lectures or more. It is found from the survey that most of people have listened to the lectures by Agricultural Bureau or other governmental departments, but the lectures are rare. The selected farmer representatives or township or village leaders have listened to more than 6 lectures, because they regularly or irregularly go to the county agricultural departments to take part in some lectures related to agriculture, agricultural meetings and agricultural technical training. The lecture sponsors are generally the agricultural extension stations. It is found from the survey that compared with the county or township government, the agricultural extension stations frequently convey information on agricultural information, and often convene the farmer representatives to hold meetings related to agriculture or carry out agricultural technology training.

2.2.3 Farmers' cognition of the benefits of circular agriculture. The survey results on farmers' cognition of the benefits of circular agriculture show that most people do not know the benefits of circular agriculture development, accounting for 73.7%; 10.9% of people believe that it can reduce the environmental pollution; 5.9% of people think there is not any benefit; there are 4.5% of people believing that it can improve the sanitation in rural areas.

Table 4 Farmers' cognition of the benefits of circular agriculture

Questions	Options	Percentage//%
What benefits can be obtained from the development of circular agriculture?	Do not know	73.7
	Nothing good	5.9
	Improve crop yields	1.1
	Reduce the use of chemical fertilizers, pesticides and films	0.8
	Reduce environmental pollution	10.9
	Improve rural sanitation	4.5
	Others	3.1

From the survey results, we can find that most people do not know the benefits of the development of circular agriculture. The respondents only have heard of the simple and superficial knowledge of words "circular agriculture", and they do not literally fathom the true and deep meaning of circular agriculture. Some people even think that there is no advantage. Among the people thinking that there is benefit, most of them think that it can reduce environmental pollution, possibly because in recent years, the state or government has attached great importance to the environ-

mental problems and propaganda. The respondents are highly sensitive to the environmental problems. For the respondents who think that it can improve the health conditions in rural areas, they may have relatively strong desire to improve the health conditions in rural areas, and wish the development of circular agriculture to help improve the health conditions in rural areas. For improving production, farmers do not have too much knowledge and expectation. There are very few people thinking that it can reduce the use of fertilizer, pesticide and plastic film, mainly because farmers' cognition of circular agriculture is little, and they do not understand the objective of developing circular agriculture.

2.3 The logistic regression analysis of farmers' awareness of circular agriculture In this paper, the purpose of using logistic regression analysis is to examine the assumed major factors influencing farmers' awareness of circular agriculture, and judge whether the influencing factors are significant, as well as the direction of impact of the explanatory variables on the variables to be explained, and the force of contribution to the events. In statistics, logistic regression or logit regression is a type of probabilistic statistical classification model. It is also used to predict a binary response from a binary predictor, used for predicting the outcome of a categorical dependent variable (i.e., a class label) based on one or more predictor variables (features). That is, it is used in estimating empirical values of the parameters in a qualitative response model. The probabilities describing the possible outcomes of a single trial are modeled, as a function of the explanatory (predictor) variables, using a logistic function. Frequently "logistic regression" is used to refer specifically to the problem in which the dependent variable is binary – that is, the number of available categories is two – and problems with more than two categories are referred to as multinomial logistic regression or, if the multiple categories are ordered, as ordered logistic regression. Logistic regression measures the relationship between a categorical dependent variable and one or more independent variables, which are usually (but not necessarily) continuous, by using probability scores as the predicted values of the dependent variable. As such it treats the same set of problems as does probit regression using similar techniques.

In this paper, the value of variables to be explained (dependent variables) is 1 and 0, indicating that the set variables to be explained are discrete random variables. In the discrete random model, we select binary logistic regression model to carry out modeling and analysis of factors influencing farmers' awareness of circular agriculture. Logistic regression model is as follows:

$$p_i = \frac{1}{1+e^{-(a+bx_i)}} = \frac{e^{a+bx_i}}{1+e^{a+bx_i}}$$

where P_i is the probability of the corresponding event i when the explanatory variables x_1, x_2, …, x_i are given; a is the regression intercept; b is the regression coefficient.

The variable to be explained (namely dependent variable) P_i is a nonlinear function composed of one explanatory variable (namely independent variable) x_i, so it can be converted to a linear function.

The probability of the event not to occur is as follows:

$$1-p_i = 1-\frac{e^{a+bx_i}}{1+e^{a+bx_i}} = \frac{1}{1+e^{a+bx_i}}$$

The event ratio is expressed as:

$$\frac{p_i}{1-p_i} = e^{a+bx_i}$$

If taking logarithm of the ratio of the event, we can get the following linear function. The function is expressed as:

$$\ln\left(\frac{p_i}{1-p_i}\right) = a+bx_i$$

In the binary regression model, the question of whether the farmers know circular agriculture can be expressed as:

$$p_i = F(c_i) = \frac{1}{1+e^{-c_i}} = \frac{e^{c_i}}{1+e^{-c_i}}$$

where p_i is the probability of event to occur; $1-p_i$ is the probability of event not to occur.

That is, p_i is the probability of event of farmers knowing circular agriculture; $1-p_i$ is the probability of event of farmers not knowing circular agriculture.

In this article, the binary regression processing of the sample data is done with SPSS19.0 statistical software. This article will use Enter method to select variables into the model. The significance level of variables into the model is 0.05, and the significance level of excluding variables from the model is set as 0.1.

The predictive power of the regression model is mainly evaluated through obtaining the maximum likelihood estimation table. It mainly uses regression coefficients, standard deviation, Waldx_2 statistic and regression coefficients to estimate the level of significance.

The positive value of regression coefficient means that for each additional one unit of independent variable, the corresponding occurrence ratio will increase; conversely, the negative value of regression coefficient means that for each additional one unit of dependent variable, the corresponding occurrence ratio will decrease.

In the model, Waldx_2 statistic indicates the relative weight of each independent variable, and is mainly used to evaluate the contribution of independent variables to the prediction of the event.

To effectively evaluate the model and reflect the matching degree of variable and model observation data, the goodness of fit test of binary logistic regression model on farmers' awareness of circular agriculture mainly selects the Homsmer Lemeshow index (HL) for test.

If the Homsmer Lemeshow statistic is significant, the model is not fitted well; on the contrary, if the Homsmer Lemeshow statistic is not significant, the model is fitted well.

Homsmer Lemeshow index formula is expressed as:

$$HL = \sum_{g=1}^{G} \frac{(y_g - n_g\hat{p}_g)}{n_g\hat{p}_g(1-n_g\hat{p}_g)}$$

where G is the number of groups ($G \leqslant 10$); n_g is the number of cases in group g; y_g is the number of observations of group g; $\hat{p}g$

is the probability of event of group g; $n_g\hat{p}_g$ is the number of predicted events.

In the independent and dependent variables, farmers' awareness of circular agriculture is set to be the variable to be explained. Farmers knowing circular agriculture is assigned with value of 1, and farmers not knowing circular agriculture is assigned with value of 0. So in the analysis process, farmers knowing circular agriculture or not knowing circular agriculture, is regarded as the dependent variable.

The selected explanatory variables (namely the introduced independent variables for analysis) include the following categories:

(i) The respondents' own characteristics. The respondents' gender (x_1), respondents' age (x_2) and respondents' education level (x_3) are regarded as the explanatory variables;

(ii) The respondents' household characteristics. The farming population in the farmers' family (x_4) and the proportion of farmers' agricultural income to household income (x_5) are regarded as the explanatory variables;

(iii) Farmers' attention to the agricultural information. Whether the farmers often pay attention to information of agriculture (x_6), whether the farmers have attended agricultural technology lectures (x_7) and the number of agricultural technology lectures that the farmers have attended (x_8).

The binary logistic regression model estimation results for farmers' awareness of circular agriculture are shown in Table 5.

Table 5 The binary logistic regression model estimation results for farmers' awareness of circular agriculture

Variables	B	S.E,	Wals	Sig.	Exp (B)
Education level	0.868	0.163	28.473	0.000*	2.383
Age	-0.215	0.040	28.663	0.000*	0.807
Gender	0.540	0.636	0.721	0.396	1.716
Rural farming population	-1.250	0.350	12.774	0.000*	0.286
The proportion of farmers' agricultural income to household income	0.755	0.239	9.942	0.002*	2.127
Whether the farmers often pay attention to information of agriculture	1.620	0.625	6.709	0.010*	5.053
Whether the farmers have attended agricultural technology lectures	6.772	3.082	4.828	0.028*	873.219
The number of agricultural technology lectures that the farmers have attended	3.509	1.231	8.127	0.004*	33.414
Model test statistic			HL = 12.912	P = 0.115	

Based on the above model results, it shows that householder's age (x_2), education level (x_3), family farming population (x_4), the proportion of farmers' agricultural income to household income (x_5), the number of agricultural technology lectures that the farmers have attended (x_8), whether the farmers often pay attention to information of agriculture (x_6), and whether the farmers have attended agricultural technology lectures (x_7), have a significant impact on farmers' awareness of circular agriculture. The impact of gender (x_1) is not significant, indicating that this factor has no significant effect on farmers' awareness of circular agriculture.

The regression coefficients show that the value of the factors of householder's education level education level (x_3), the proportion of farmers' agricultural income to household income (x_5), the number of agricultural technology lectures that the farmers have attended (x_8), whether the farmers often pay attention to information of agriculture (x_6), and whether the farmers have attended agricultural technology lectures (x_7) is positive, indicating that these independent variables have a positive impact on farmers' awareness of circular agriculture.

For each additional unit of these influencing factors with positive value, farmers' awareness of circular agriculture will increase accordingly based on a certain coefficient.

Conversely, the value of householder's age (x_2) and the family farming population (x_4) is negative, indicating that the two independent variables have a negative impact on farmers' awareness of circular agriculture, and when the variable is reduced by one unit, farmers' awareness of circular agriculture will be increased accordingly based on a certain coefficient.

The Wals statistic estimation results show that the statistic of householders' age (x_2) is 28.663; the statistic of education level education (x_3) is 28.473; the statistic of family farming population (x_4) is 12.774; the statistic of proportion of farmers' agricultural income to household income (x_5) is 9.942; the statistic of number of agricultural technology lectures that the farmers have attended (x_8) is 8.127.

They are important explanatory variables, and the contribution of these explanatory variables to event prediction is large. The statistic of householder's gender (x_1) is only 0.721, indicating that it is not an important explanatory variable for the event, and the contribution of this explanatory variable to event prediction is small.

From the Hosmer Lemeshow test value of the model (HL = 12.912, P = 0.115), the statistical test is not significant, indicating that the model well fits the data, and the matching degree between variables and model observed data is large.

In householder's own characteristics, the two influencing factors of age and education level have a significant impact on the cognition of circular agriculture. It is found from the survey process that there are few young labor forces engaged in farming, and respondents' age is mostly 40 - 60 years. And the majority of people farming at home are not well educated, mainly concentrated in the stage of junior high school education. However, the understanding of agricultural knowledge is closely linked to age and education level.

In terms of farmers' household characteristics, the proportion of farmers' agricultural income to household income has a signifi-

cant impact on the awareness of circular agriculture. It is found from the survey process that it is mainly caused by the large family farming population, indicating that the overall education level of the family is not very high, and thus the education level also has an impact on the awareness of circular agriculture.

It is found from the survey that the most of the households with high proportion of agricultural income to household income are major growing households and breeding households. The farm contracting requires some ability to operate. Compared with the ordinary farmers, they have a more comprehensive understanding of farming techniques or breeding techniques, agricultural operating costs, agricultural business channels, and agricultural business philosophy. Their attention to this information will increase the frequency of understanding and knowing the circular agriculture.

Farmers' participation in technical seminars, whether the farmers have attended agricultural technology lectures, and the number of agricultural technology lectures that the farmers have attended, also have a significant impact on farmers' awareness of circular agriculture.

It is found that the county agricultural extension stations, agricultural machinery stations or county and township governments regularly convene the village cadres and major farming households, to convey the information related to agriculture, hold meetings related to agricultural development and offer technical guidance of farming. In this process, it also increases farmers' understanding of circular agriculture.

The agricultural economic interests are the main driving force for the farmers to carry out agricultural activities. People regard food as their prime want, and good harvest is the greatest wish for farmers. So, most farmers are concerned about the information which is related to agricultural development.

Some farmers have many channels to understand, so they can get more information. It increases the frequency of attention to agricultural development, and at the same time, also increases the frequency of attention to circular agriculture.

3 Conclusions and discussions

From the frequency analysis in this article, it is found that there are few farmers knowing circular agriculture, and the awareness is very low. From the regression analysis results, the main factors affecting farmers' awareness of circular agriculture, include householders' age (x_2), education level education (x_3), family farming population (x_4), proportion of farmers' agricultural income to household income (x_5), number of agricultural technology lectures that the farmers have attended (x_8), whether the farmers often pay attention to information of agriculture (x_6), and whether the farmers have attended agricultural technology lectures (x_7).

To raise farmers' awareness of circular agriculture, it is necessary to improve farmers' integrated quality, and workforce aging and low education level are the key issues to be tackled. The related agricultural departments should increase the publicity and promotion of circular agriculture, to make the farmers understand the circular agriculture. At the same time, there is a need to strengthen the training of planting and breeding technology for farmers, increase the frequency of training and number of lectures, and promote healthy production, to form a favorable system of circular agriculture.

References

[1] REN ZX. An introduction to agricultural cycle economy[M]. Beijing:China Economic Publishing House, 2007. (in Chinese).

[2] HU ZH, QIN C. The research of "circulation agriculture"[J]. Public Communication of Science & Technology, 2010(23): 16 - 18. (in Chinese).

[3] XING MH, ZHANG JB, HUANG GT. Analysis on the environmental protection cognition of farmers who did not take part in circular agriculture and its influencing factors ——Based on the investigation of Shanxi and Hubei Provinces[J]. Chinese Rural Economy, 2009(4): 72 - 79. (in Chinese).

[4] XU WT, ZHANG JB, LI SM, *et al*. Behavioral analysis of reducing investments for farming families in circular agriculture: A case study on Shanxi, Shandong, and Hubei Provinces based on the investigation of chemical fertilizer input[J]. Resources Science, 2010(12): 2407 - 2412. (in Chinese).

[5] XU WT, ZHANG JB, LI SM. Analysis of influencing factors on farmer participating in circular agricultural project[J]. China Population Resources and Environment, 2010(8): 33 - 37. (in Chinese).

[6] WANG YJ, CHEN SB, BI YY, *et al*. External environment analysis of circular agriculture based on farmer household perspective ——A case study from Hubei Province[J]. Chinese Journal of Agricultural Resources and Regional Planning, 2009, 30(5): 54 - 59. (in Chinese).

[7] KUAI XG. Study on the factors affecting political participation of rural residents——A case study of rural households in 30 villages of 5 counties in Nanjing[J]. Chinese Agricultural Science Bulletin, 2009(1): 290 - 298. (in Chinese).

[8] CHU BJ, LU YJ, ZHANG LY. On factors influencing informal borrowing decisions——Taking the case of Sihong County of Jiangsu Province[J]. Jianghuai Tribune, 2008(3): 58 - 62. (in Chinese).