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Analysis on Farmers' Straw Marketization Behavior and Its Influence Factors: A Case Study of Hubei Province

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Abstract Crop straw has huge resource potential. It has an important significance for realizing waste recycling and improving eco-environment to perfect straw marketization system and sufficiently stimulate farmers' straw marketization behavior. Based on 427 copies of investigation data on farmers, influence mechanism framework of farmers' straw marketization behavior is constructed, and key factors of farmers' straw marketization behavior are analyzed. Results show that farmers joining in straw marketization account for 42.1%; in influence factors of farmers' straw marketization behavior, cultivated land area, market price level, logistics satisfaction and air quality perception have significantly positive impacts on farmers' straw marketization behavior, while education degree, agricultural income proportion and traffic convenience have significantly negative impacts on farmers' straw marketization behavior. Therefore, it needs strengthening propaganda intensity, carrying out reasonable subsidies and support, encouraging and breeding new type of organization, and establishing and improving the price mechanism of straw marketization to perfect straw marketization construction.

Key words Straw, Farmers' marketization behavior, Logistic model, Influence factors, Hubei Province

1 Introduction

When Chinese agriculture quickly develops by "continuous twelve-increase", agricultural eco-environment also faces larger and larger pressure. Waste utilization of agricultural resources is an important content of rural environmental governance, and crop straw with huge value and abundant reserves is the focus of development and utilization. Farmers are objects and subjects of crop straw, and farmers' market participation behavior is the first step of large-scale straw utilization. At present, a lot of researches on straw resource utilization are conducted, which mainly concentrate in straw resource utilization potential^[1-2], straw resource utilization path^[3], cost – benefit analysis of straw processing manner^[4-6], farmers' straw processing behavior^[7-8], policy excitation of comprehensive straw utilization^[9], thereby forming systemic and rich results. Meanwhile, the existing researches show that crop straw has huge market value and resource potential, but straw industrialization development is limited by raw material supply, and market constraint becomes an important restriction factor of comprehensive straw utilization. At present, there is less literature on influence factors of farmers market participation behavior containing farmers into market research as straw production subject from the view of straw commercialization angle. Therefore, it is necessary to explore market participation behavior of crop straw production subject from the angle of empirical analysis. On this basis, farmers' market participation behavior is analyzed, and influence factors of market participation behavior of crop straw production subject are analyzed by using Logistic regression model.

2 Research hypothesis

2.1 Human capital (i) Sex. Sex could be used to distinguish and understand people's behavior pattern and psychological characteristics, and sex difference could affect farmers' behavior. (ii) Age. Due to different physiology, psychology and social experiences, different-age farmers have different sensitivity to outside information. The elder farmers could select traditional straw processing manner and have weaker perception ability on other processing manners. Therefore, their participation activity in straw market is lower. It is predicted that age has negative impact on market participation behavior of crop straw production subject. (iii) Education degree. Education degree reflects the size of individual human capital stock^[10-11]. The higher the householder's education degree, the stronger the information's acceptance ability^[12]. Farmers with higher culture degree could rationally understand the prospect and benefit of straw market, and then their participation activity in straw market may be higher. Therefore, it is predicted that education degree has positive impact on market participation behavior of crop straw production subject.

2.2 Family characteristics (i) Quantity of labor force. Human resources endowment in peasant household family has significant difference, and the difference of labor force number could cause different family production and management decisions^[13-14]. The family with more labor forces could meet the labor force and time of straw harvest and reserve process, and the possibility of straw commercialization is larger. (ii) Family cultivated land area. Marketability of products provided by farmers could be affected by household management scale. Under the general situation, the larger the farmers' household management scale, the larger the supply elasticity; on the contrary, the supply elasticity is smaller^[15]. When household management scale is larger, straw production amount is more, and marketability is high-

er. Therefore, it is predicted that household management scale has positive impact. (iii) Agricultural income proportion. When the proportion of agricultural income to total household income is larger, it illustrates farmers' dependence on agricultural income is stronger, and they are more sensitive to various-aspect information related to agricultural production. Therefore, agricultural income proportion has positive impact.

2.3 Economic factors (i) Market transaction price. In the theory, farmers' behavior could be studied from the aspects of producer, consumer and factor owner. In this paper, it is defined as factor owner and supplier. According to supply rule, there is a positive proportion between the price and the supplied quantity. Therefore, it is predicted that market price has positive impact. (ii) Traffic convenience. Traffic transportation has an important impact on the site, type and number of agricultural product transaction^[16-17]. Wu Hao also puts forward that traffic transportation affects transaction efficiency and cost of agricultural product^[18]. Therefore, it is predicted that traffic convenience has positive impact. (iii) Logistics demand. Logistics is strong support of scale and industrialization development of modern agriculture. In marketization process of crop straw, when farmers' demands on logistics are stronger, farmers will support the commercialization and industrialization development of straw. Therefore, logistics demand has positive impact on market participation behavior of crop straw production subject. (iv) Income increase level. Rational economic man supposes that individual behavior is a rational choice and is self-interest. Therefore, when farmers' predicted benefit is higher, their market participation possibility is larger.

2.4 Environmental cognition Rural eco-environment belongs to public goods. As participation subject of rural eco-environment protection, perception of farmers' behavior on rural environment is an important premise of ecological improvement. The perception of air change is main aspect of ecological welfare perception of farmers, while serious air pollution brought by straw burning declines

farmers' welfare. Therefore, when the farmers' cognition on that straw commercialization could improve air quality is stronger, farmers could actively select the straw commercialization. If farmers value health, when they recognize that the behavior could obviously improve human health, farmers could carry out straw commercialization under the guidance of market mechanism.

3 Research methods

3.1 Data source The investigation on farmers was conducted during October – November 2015. Comprehensively considering terrain, planting crop and economic development level, Yichang and Xiangyang of Hubei Province were selected for investigation. Investigation manner contained random sampling and typical investigation. In the investigation, 18 administrative villages of 10 towns were selected, and 30 copies of questionnaires were issued for each administrative village. In the investigation, 540 copies of questionnaires were issued, and 493 copies of questionnaires were recovered. After eliminating some invalid questionnaires lacking a lot of data or answering arbitrarily and further analyzing questionnaire's effectiveness, 427 copies of effective questionnaires were obtained finally, with effective rate of 86.6%.

3.2 Variable selection Based on prior theory analysis and research target, independent variables are divided into four kinds: human capital, family characteristics, economic factors, and environmental cognition. Considering that high correlation may occur among some variables, representative variables should be selected as much as possible. Therefore, sex, age, education degree, agricultural labor force number, cultivated land area, agricultural income proportion, market price satisfaction, transportation difficulty, logistics demand, income increase degree, improvement degree of air quality, and beneficial degree of human health are taken as independent variables, while farmers' straw marketization behavior is taken as dependent variable (Table 1).

Table 1 Definition and assignment of variables

Variable		Sign	Definition and assignment
Dependent variable	Whether participating in straw marketization	Y	0 = No, 1 = Yes
Human capital	Sex	X ₁	0 = Female, 1 = Male
	Age	X ₂	1 = 30 years old and less, 2 = 30 – 40 years old, 3 = 40 – 50 years old, 4 = 50 – 60 years old, 5 = 60 years old and more
	Education degree	X ₃	1 = Illiteracy, 2 = Primary school, 3 = Junior high school, 4 = Senior middle school or polytechnic school, 5 = Junior college and more
Family characteristics	Number of agricultural labor force//person	X ₄	Number of family labor force
	Cultivated land area//ha	X ₅	Family cultivated land area
	Agricultural income proportion//%	X ₆	The proportion of agricultural income of 2014 to total household income
Economic factors	Market price satisfaction	X ₇	1 = Very dissatisfied, 2 = Less satisfied, 3 = General, 4 = Satisfied, 5 = Very satisfied
	Transportation difficulty	X ₈	1 = Without difficulty, 2 = Difficult but not large, 3 = General, 4 = Greater difficulty, 5 = Very great difficulty
	Logistics demand	X ₉	0 = Unwanted, 1 = Uncertain, 2 = Required
	Income increase degree	X ₁₀	1 = No, 2 = Smaller, 3 = General, 4 = Larger, 5 = Very large
Environmental cognition	Beneficial degree of human health	X ₁₁	1 = Without help, 2 = Little help, 3 = General, 4 = Larger help, 5 = Very large help
	Improvement degree of air quality	X ₁₂	1 = With help, 2 = Little help, 3 = General, 4 = Larger help, 5 = Very large help

3.3 Model selection Logistic model is a kind of binary discrete choice model taking logical distribution as probability distribution

of random error term, and is the most ideal model in analyzing individual decision-making behavior, which is applied widely^[10-12].

Farmers' straw marketization behavior is a binary choice problem, namely participating or not participating, and it is a typical binary decision-making problem. Therefore, binary Logistic regression model is used to analyze. Concrete function form of the model is as below.

$$\rho = F(y = 1 | X) = \frac{1}{1 + e^{-x}} \quad (1)$$

where y indicates market participation behavior of crop straw production subject. If farmers participate in the market, $y = 1$; on the contrary, $y = 0$. X shows the influence factors of market participation behavior of crop straw production subject. P shows market participation probability of crop straw production subject.

Based on the formula (1), opportunity ratio of market participation behavior of crop straw production subject is obtained.

$$\frac{\rho}{1 - \rho} = \frac{1 + e^x}{1 + e^{-x}} = e^x \quad (2)$$

y is linear combination of variable x .

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_i x_i \quad (3)$$

Logarithmic transformation of formulas (2) and (3) is conducted, and Logistic function formula is obtained.

$$y = \ln\left(\frac{\rho}{1 - \rho}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_i x_i + \mu \quad (4)$$

where β_0 is constant item; $x_i (i = 1, 2, \dots, i)$ shows the i^{th} factor affecting farmers' straw market participation behavior; $\beta_i (i = 1, 2,$

$\dots, i)$ shows regression coefficient of the i^{th} influence factor; μ is random disturbance term and reflects other influence factors which could not be observed and data statistical error.

4 Results and analysis

4.1 Sample analysis Seen from Table 2, 64% of investigated farmers are male, with average age of 40 – 60 years old. Farmers with the education degree of illiteracy, primary school, junior high school, senior middle school or polytechnic school, junior college and more respectively account for 5.8%, 32.4%, 37.7%, 15.2%, and 8.9%. Transportation difficulty degree is 2.31, illustrating that traffic is an important problem. Income increase degree is 2.87, illustrating farmers' income increase degree is not obvious due to straw transportation cost and price. Average farmers' family cultivated land area is 0.357 ha, illustrating most of farmer family cultivated land is smaller-scale management. Agricultural income proportion is 0.77, illustrating that farmers' family income is dominated by agricultural income, and agriculture has larger influence on family income. At environmental perception aspect, beneficial degree of human health and improvement degree of air quality are respectively 3.50 and 3.56, illustrating farmers' environmental cognition degree by straw marketization behavior is larger, which is conducive to providing larger possibility for straw marketization.

Table 2 Illustration of variable characteristic values

Variable	Mean	Standard deviation	Maximum	Minimum
Whether participating in straw marketization	0.52	0.50	1	0
Sex	0.64	0.48	1	0
Age	3.66	1.12	5	1
Culture degree	2.47	0.99	5	1
Family labor force//person	2.90	1.43	9	1
Cultivated land area//ha	5.35	3.59	22.50	0.30
Agricultural income proportion//%	1.77	0.75	1.00	0.07
Market price satisfaction	3.35	0.68	5	1
Transportation difficulty	2.31	1.27	5	1
Logistics demand	1.17	0.81	2	1
Income increase degree	2.87	1.15	5	1
Beneficial degree of human health	3.50	1.25	5	1
Improvement degree of air quality	3.56	1.18	5	1

4.2 Analysis on farmers' straw marketization Seen from Table 3, farmers of straw marketization only account for 42.1% of total sample number, and residual 57.9% of farmers do not participate in straw marketization. The investigation on farmers' straw commercialization channel shows that 59.0% of farmers transport the waste to acquisition point for transaction, and it is dealt with by themselves; 40.3% of farmers show that there is purchaser for door-to-door acquisition; enterprise purchase only accounts for 0.7%. The investigation finds that 84.6% of farmers are willing to participate in the straw marketization, while 15.4% of farmers are not willing to participate in the straw marketization. It illustrates that farmers' desire of crop straw marketization is very strong. It lacks effective supply – demand mechanism between market and farmer. Meanwhile, government's supporting and guid-

ance mechanism at policy, fund and information aspects between farmer and enterprise is not yet sound.

4.3 Analysis on influence factors of farmers' straw marketization behavior Before regression analysis on the model, tolerance, VIF and CI are used to carry out multiple collinearity test of independent variables of model. Finally, 12 variables are used for regression analysis, and they are sex, age, education degree, number of agricultural labor force, cultivated land area, agricultural income proportion, market price satisfaction, transportation difficulty, logistics demand, income increase degree, improvement degree of air quality, and improvement degree of human health. Log likelihood value of farmers' straw marketization behavior model is 450.201, which passes likelihood ratio test. It indicates that at least one independent variable is significantly related to farmers'

straw marketization behavior in the model. Chi square test of the model illustrates that fitting effect of the model is better, and effectiveness is significant. On this basis, culture degree, family culti-

vated land area, agricultural income proportion, market price level, transportation difficulty and improvement of air quality all pass significance test (Table 4).

Table 3 Analysis on farmers' straw marketization

Farmers' straw marketization behavior			Commercialization channel of straw		
Option	Number of farmer	Proportion//%	Option	Number of farmer	Proportion//%
Yes	101	42.1	Dealt with by themselves	210	59.0
			Middleman acquisition	144	40.3
No	139	57.9	Cooperative acquisition	0	0

Table 4 Analysis on influence factors of farmers' straw marketization behavior

Variable		Farmers' straw marketization model		
		β	Standard error	Wald value
Human capital	Sex	0.006	0.118	0.003
	Age	-0.126	0.131	0.912
	Culture degree	-0.223 *	0.132	2.876
Family characteristics	Number of labor force	-0.151	0.117	1.676
	Family cultivated land area	0.259 **	0.119	4.754
	Agricultural income proportion	-0.287 **	0.120	5.716
Economic factors	Price level satisfaction	0.244 **	0.122	3.995
	Transportation difficulty	-0.210 *	0.117	3.244
	Logistics satisfaction	0.226 *	0.118	3.661
	Income increase degree	0.099	0.128	0.599
Environmental perception	Recognition on beneficial to human health	-0.119	0.170	0.488
	Perception of air quality	0.380 **	0.170	4.990
Constant item		0.083	0.112	0.552
-2 times of log likelihood		450.201		
Chi square test value		44.233 ***		

Note: *, ** and *** respectively show that variable is significant at the statistical levels of 10%, 5% and 1%.

4.3.1 The influence of human capital. Regression results show that culture degree has significantly negative correlation with farmers' market participation behavior, illustrating that the possibility of farmers with lower education degree joining in straw market is larger, which is contrary with the anticipation. Maybe it is because that rural concurrent phenomenon is general at present. Most of young labors migrate, and most of respondents are elders, and respondents more than 50 years old account for 51.3%. This part of people have lower education degree, and they are dominated by primary school and junior high school. At present, under the situation that rural environment increasingly deteriorates by rural straw number increase, straw burning and discarding, and farmers' production and living manners transform, if the straw could be sold, farmers could actively join in.

4.3.2 The influence of family management endowments. Regression results display that family cultivated land area has significantly positive correlation with farmers' market participation behavior. Statistical results display that farmers with more than 0.333 ha of family cultivated land area account for 47.3%, and 57% of this part of farmers' agricultural income proportion exceeds 50%. When family cultivated land area is larger, crop straw yield is relatively more. Chen Xinfeng points out that straw output value generally accounts for 10% - 15% of grain production output value^[19]. Therefore, under the situation of larger planting area, when farmers select selling crop straw, relatively substantial economic bene-

fits could be obtained. Agricultural income proportion has significantly negative correlation with farmers' market participation behavior, which is contrary with anticipation. It shows that when farmers' agricultural income proportion is lower, farmers are willing to participate in the market. Maybe it is because that the region has stable straw buy-back point, which is convenient to farmers participating in straw sale. At present, main income source of most farmers is not agricultural income but other concurrent income or property income, which is consistent with that farmers' concurrent behavior is general.

4.3.3 The influence of economic factors. Regression results display that market price level has significantly positive correlation with farmers' market participation behavior. According to the investigation results, it is found that most of farmers satisfying straw market could select straw commercialization, which is consistent with the hypothesis of farmer economic rationality. Transportation difficulty shows negative correlation with farmers' market participation behavior. According to variable assignment situation, it is obtained that when transportation is difficult, farmers could not select straw commercialization; on the contrary, farmers could select straw commercialization. Might reasons are as below. On the one hand, the difficulty of transporting crop straw to transaction market is larger, and loss is more in transportation process. Seen from the angle of cost benefit, if transportation cost is larger than the benefit brought by crop straw sale, farmers could give up the behavior. On

the other hand, unblocked road also could affect information circulation, and is not conducive to farmers understanding and grasping market information of crop straw. Logistics demand shows positive correlation with farmers' straw commercialization behavior. Might reasons are as below. On the one hand, professional harvest, storage and distribution logistics enterprises help buying or transporting straw, which could decrease time cost, labor cost and transportation cost of straw processing by farmers to a certain extent, and obtain certain benefit. On the other hand, real-time processing of field crop straw could decline the influence of stubble on crop emergence rate, and is conducive to farming in the next quarter.

4.3.4 Influence of environmental cognition degree. Regression results show that the perception on local air quality has significantly positive correlation with farmers' market participation behavior. At present, rural straw burning phenomenon is general. Investigation results display that 88.5% of farmers burnt straw, and people's direct perception on the behavior is the declining of air quality. Straw commercialization decreases the number of straw burning, and its direct influence is the improvement of rural air quality. Meanwhile, accompanied with the improvement of living level, farmers are not only pursuing a single economic interest, and their ecological environment protection consciousness is improved gradually.

5 Conclusions and suggestions

5.1 Conclusions In this paper, the influence factors of market participation behavior of straw production subject are analyzed by using binary Logistic regression model, and the obtained main conclusions are as below. Firstly, farmers' participation degree in straw marketization is lower, and farmers carrying out straw marketization account for 42.1%, with single sale channel and less new organization, dominated by the means of sold by themselves and middleman purchase. Secondly, at the influence factors of farmers participating in straw marketization behavior, family cultivated land area, market price level, logistics demand and recognition on air quality improvement all have significantly positive influences on market participation behavior of straw production subject, while education degree, agricultural income proportion, and transportation difficulty have significantly negative influences on market participation behavior of crop straw production subject.

5.2 Suggestions (i) Carry out wide and effective publicity. It should widely propagate resource and commercialization attributes of straw in various forms, and enhance farmers' recognition on ecological and economic values of straw resources. (ii) Make the related supporting policies, and give corresponding subsidy to farmers and enterprises. It should give fund support and tax relief at different degrees, and discuss the feasibility of price subsidy. At farmer aspect, it should give certain incentive subsidy to improve farmer's activity. (iii) Encourage and cultivate new type of organization. It should vigorously breed straw harvest and storage enterprises, and impel collection and logistics systems of straw, thereby realizing full-process mechanization of straw storage and transportation, and effectively solving seasonal and structural surplus problem of straw. (iv) Establish and strengthen price mechanism of

straw marketization. It should establish rational and effective price mechanism, thereby realizing that straw acquisition enterprises fairly and rationally price on the basis of comprehensively considering straw availability and transportation collection cost.

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