

Empirical Research on Factors that Influence the Behavior Decision of Repeated Seed Purchase for Farmers – Field investigation based on 519 vegetable farmers in Wuhan City

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Abstract. This article makes an analysis on the factors and impact on decision of repeated seed purchase behavior for farmers by using the field investigation data from 519 vegetable farmers around Wuhan City and the binary Logit model and ordered Logit model. It is found from the research that: repeated seed purchase is a common phenomenon as 84% of sample farmers have this behavior: the factors, such as education degree, risk attitude, Perceived Value, seed quality, seed purchase convenience, relationship trust and obstacle transfer, will influence the behavior or willingness of farmers to repeatedly purchase the seeds. The farmers with higher education degree or risk preference are more willing to try out new varieties; Improving farmer's Perceived Value for the purchased seeds and the trust in distributors, as well as the relatively high seed quality, will increase farmer's willingness for repeated seed purchase; While the higher costs for information seeking, costs for technical study and other transfer obstacle factors have a significant prohibitive effect on the farmers to prevent them from purchasing new varieties of seeds, and they tend to make decision of repeated seed purchase.

Keywords. farmer; behavior decision; repeated purchase; vegetable growing

Crops seeds are the national strategic, basic and core industry. They are fundamental to boost the long-term stable development of agriculture and ensure the national safety of food. The massive seed market introduces many transnational leading seed enterprises, and they gradually take the dominant position in the market of seeds like vegetable and corn^[1]. The domestic seed enterprises shall not only understand the improvement space for existing crop varieties and cultivate new varieties based on the advantages of seed quality, but also take the local advantages, find the thought and purchase preference of seed consumers and develop target marketing activity to acquire the advantageous position in the market competition. In the perspective of farmers, this article investigates the farmer's seed purchase decision and its impact factors, as well as discovers the consumption and purchase preference, for the purpose of improving the enterprise competitiveness and providing decision reference for vegetable seed enterprise and vegetable seed cultivation institution.

1 Reference review

Seed purchase decision refers to the behavior selection of farmers, driven by interest, with maximum benefit based on their own resources, experience and environmental limitation according to the natural condition and social economy condition. According to the current references, the studies on behavior decision of farmer's seed (seedling) purchase mostly focus on the seed value^[2,3], agricultural subsidy policy implications^[4] and seed purchase influence factor^[4-8].

In the perspective of farmers, Yanjun Li and Lingxin Cai have researched the seed value, thinking that the elements of seed value can be divided according to the importance: inner core value, service, inner general value, brand, appearance and advertisement. They also suggest that the enterprise should focus on the development of seed variety, strengthen the brand construction and carry out services based on the behavior preference of farmers^[2,3]. Qifeng Cui uses Probit model to fit the impact of comprehensive subsidy policy on farmer's seed purchase behavior, and suggests to classify the subsidies for different varieties of farmers^[4]. Chengbing Chu applies Heckan selection model to analyze the behavior of cognition and acceptance for GMO technology, thinking that the householder's education degree, social capital, frequency of communication with villagers, fine breed subsidy and technical training have significantly positive impact on the cognition and acceptance, but with negative impact on the price of insect-resistant cotton seed^[5]. Shiyin Zhu uses Logistic model to study the cognition and willingness of growing GM rice for rice farmers, thinking that the willingness of growing is influenced by both the self and external factors^[6]. Some experts notice the impact of agricultural cooperatives on the agricultural material purchase of farmers. In view of game theory, Xu Deyun has discussed about the dynamic game among farmer, production cooperation organization and agricultural material sellers, thinking that the farmers who join the production cooperation organization will efficiently avoid the risk of fake agricultural material so as to reach the Pareto Optimality^[9]; But there are also some empirical studies indicating that most of the professional farmer cooperatives are just formalities without due effect. A large part of above references use Logistic or Probit model to conduct multiple regression analysis to study the influence factors that influence the farmer's decision of seed (seedling) purchase^[5-8].

Therefore, based on the existing results, this article makes a deep investigation on the decision of seed purchase behavior for vegetable farmers and its influence factors. First, this article uses binary Logit model to analyze which factors will influence the repeated seed purchase behavior of farmers, and then applies ordered Logit model to further discuss about the influence degree of these factors on the repeated seed purchase decision of farmers, expecting to obtain valuable results.

2 Research hypothesis and research method

2.1 Research hypothesis

According to existing research results and relevant theories, as well as the detailed features of vegetable growing, this article divides the factors that influence the seed purchase behavior of vegetable farmers into the following three varieties.

(1) Basic features of householder. Basic features of householder include householder's age, time spent in growing vegetables, education degree, risk attitude, etc. ①. Householders of different ages have varied conceptions in seed purchase because they are different in physiology, mentality and social experience. The older farmers tend to be conservative and unwilling to try out new varieties when purchasing seeds.②. The varied time spent in growing vegetable induces different production experience for farmers. The experienced farmers tend to select seeds based on experience.③. The farmers with higher education degree will have a stronger ability to use the external information. They will be fully aware of the potential profits and risks in a new variety of seed when purchasing seeds, and are likely to have higher initiatives to try out new varieties of

seeds.^④ The risk attitude of farmer will influence his trying out on the new varieties. The farmer repelled by risk tends to refuse something new and is more willing to purchase the seeds which were previously grown.

(2) Business features of farmer. The business features of farmer include, among other things, vegetable growing area, vegetable income proportion, vegetable growing mode and purpose, and whether to join the cooperatives.^① When purchasing seeds, the farmers with larger vegetable growing area and with higher investment in the early stage of production tend to be more conservative; when purchasing seeds, the farmers with higher proportion of vegetable income in the total family income will tend to be more careful. This conservative and careful thought will mostly appear to be a repeated purchase behavior as the farmers fail to get adequate and efficient information. The small-scale growers that plant vegetables as food for their own families will be relatively casual about purchase of seeds.^② The cooperatives have a certain right of speech in the process of purchasing production goods. Some of them uniformly purchase the seeds, fertilizers and other production goods, and the other recommend the brand of production goods for farmer's reference.

(3) Seed marketing factors. These factors include variables such as customer satisfaction, relationship trust and transfer obstacle.^① Customer satisfaction mainly includes sensation for the seed value and the satisfaction degree to seed quality, service quality, brand reputation and purchase convenience. The brand reputation wins a public praise for the seed company or seed brand, and the farmers will recommend their neighbors about the brand, which increases the attraction and credibility of seeds. The distribution marketing theory says the customer satisfaction is the most leading factor that influences the behavior decision.^② Relationship trust refers to the trust of farmers to distributors and the services provided thereby. The marketing theory says the customers tend to purchase or even repeatedly purchase the products from businesses with higher credibility.^③ The transfer obstacle can be construed as the risks and costs the farmers face and realize when they purchase other varieties of products. When purchasing seeds, the farmers will consider a wide range of costs, expenses and risks brought by changing the variety of seeds, and they will make decisions after weighing the gains and losses. The larger transfer obstacle will lead the farmers to have more willingness in second purchase, more possible to prevent them from purchasing new varieties of products. While, if the new products can bring or be expected to bring more profits, the farmers may be willing to try out the new products instead of repeatedly purchasing the original ones.

2.2 Research method

This study divides the farmer's behavior decision of seed purchase into the following two aspects: firstly, which factors will influence the farmer's behavior decision of repeated seed purchase; secondly, the influence degree of different factors on repeated seed purchase willingness. There are two possibilities in farmer's purchase decision: repeated seed purchase and trying out on new product. Use binary Logit model analysis to verify the factors that influence the farmer's behavior decision.

Establish the function expressions for odds of influencing the farmer's repeated seed purchase:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 x_{i1} + \dots + \beta_j x_{ij} + \dots + \beta_n x_{in} + \mu_i \quad (1)$$

In formula (1), p_i refers to probability of farmer's repeated seed purchase; β_j ($j=0, 1, \dots, n$) are coefficients to be estimated; μ_i refers to random error term. According to the previous hypothesis, the explanatory variable x_{ij} refers to respectively the householder's age, education degree, year spent in vegetable growing industry, risk attitude, vegetable growing area, growing mode, vegetable income proportion, participation in cooperative, Perceived Value, seed quality, brand reputation, seed purchase convenience, service quality, relationship trust and transfer obstacle.

This article uses Likert scale of willingness to divide the farmer's seed purchase behavior decision into 5 levels, and applies the ordered Logit model in sorting probability model to analyze the influence degree of each factor on farmer's behavior decision of repeated seed purchase. The detailed function expression is as follows:

$$y_i^* = \beta_0 + \beta_1 x_{i1} + \dots + \beta_j x_{ij} + \dots + \beta_n x_{in} + \mu_i \quad (2)$$

In formula (2), β_j ($j=0,1, \dots, n$) are coefficients to be estimated; μ_i refers to random error term. y_i^* refers to latent variable corresponding to a ranked variable y_i . If the number of observed sample is set as N , y_i will mean the rank 1 appears for n_1 time, rank 2 for n_2 times..... rank 5 for n_5 times. According to the research methods of Dongmei Li and Luan Luo, this article uses maximum likelihood estimation function to estimate the ordered Logit function. Then, the maximum likelihood function of model (2) is as follows:

$$L = [P(y_i = 1 | X_i)]^{n_1} [P(y_i = 2 | X_i)]^{n_2} [P(y_i = 3 | X_i)]^{n_3} [P(y_i = 4 | X_i)]^{n_4} [P(y_i = 5 | X_i)]^{n_5} \quad (3)$$

3 Data source and sample description

3.1 Data source

The data used in the research of this article was obtained through field investigation in concentrated vegetable growing villages and towns in suburbs of Wuhan by research group. As a vegetable base for suburbs of large city, the suburban district of Wuhan plays an important role in improving the self-sufficiency of vegetable and adjusting the vegetable price in Wuhan City. Based on the investigation design, this article selects regular vegetable farmers in 6 suburban districts in Wuhan (Eastern and Western Lake District, Xinzhou District, Caidian District, Huangpo District, Jiangxia District and Hannan District) as the objectives and randomly selects villages and vegetable farmers in the main vegetable production villages and towns (streets) for investigation. Field investigation was made between March-June 2013. We used question-answer method and delivered 600 questionnaires, of which 548 were returned, with 519 valid ones, validity rate 86.5%. The varieties of vegetables grown by investigated objectives include root vegetables, onion ginger garlic, Chinese cabbage, cabbage, leafy vegetables, melons and vegetables, eggplant, bean class, etc..

3.2 Sample description

In the samples, male accounts for 66.3%, female for 33.7%. To get more accurate information in the actual investigation, the farmers we selected were the ones that actually purchase the seed in the vegetable farmer families, so it indicated the males took dominant place in seed purchase, a result similar to the conclusion of other scholars^[10-12]. According to the samples, the basic conclusion for the vegetable farmers around Wuhan is that most of them are at middle age (45-59) (accounting for 48.4%) who accepted junior high school education (accounting for 42.8%. The couples (accounting for 78.0%) grow vegetables for sales (accounting for 97.6%), which are mainly grown in steel-framed greenhouse (accounting for 52.0%), and the vegetable growing scale is below 0.4hm² (accounting for 59.0%). A similar conclusion will be drawn from Table 1; There are almost only three vegetable selling modes, namely "personally going to market for retail", "personally delivering to fixed retailers for sale" and "retailers going to farms for purchase", while there are few selecting to sell the vegetables in cooperatives or by orders (accounting for 1.9%). It also reflects that the vegetable cooperatives do nothing in seed purchase, vegetable sales and other aspects related to the big market.

Farmer's Perceived Value (1 item), seed quality (6 items), brand reputation of seed (2 items), convenience of seed purchase (1 item) will be measured by Likert purchase satisfaction scale; Service quality (8 items) will be measured by service satisfaction scale for seed sellers; Reputation trust (8 items), transfer obstacle (7 items) and willingness of second purchase (4 items) will be

measured respectively by relationship trust scale, transfer obstacle scale and purchase willingness scale. The relationship trust measures the credibility of farmers towards distributors and the service provided thereby in five dimensions, namely reliability, permanence, integrity, relationship network and enterprise brands; The transfer obstacle measures the transaction costs of purchasing seeds of other brands for farmers in four dimensions, namely transfer expense, transfer risk, sunk costs and study costs. The average of scores of each variable is above 3, and 84% of the vegetable farmers choose to purchase the seeds of the same brand for a second time.

Table 1. Model variables selection and description of its process

Name of variables	Variable measure	Average	Standard deviation
Age of householder	Actual age	51.63	10.29.
Number of labor force	Number of people	2.07	0.56.
Education degree	Primary school and below=1; junior high school=2; senior high school and above ^a =3	1.79	0.72.
Year spent in vegetable growing	Farmer's actual year spent in vegetable growing (year)	20.11	11.47.
Risk attitude	Preferential=1; neutral=2; repelled=3	2.40	0.85.
Area	Farmer's actual area for vegetable growing (mu)	12.00	29.84.
Growing mode	Greenhouse=1; simple small greenhouse=2; field growing=3	1.38	0.67.
Purpose of growing	Food for self=0; for sale=1	1.00	0.06.
Income proportion%	Actual proportion of vegetable growing income in the total family income	83.25	20.69.
Participation in cooperatives	Yes=1, No=0	0.32	0.47.
Perceived Value	Likert 5 scale	3.78	0.62.
Seed quality	Likert 5 scale	3.81	0.37.
Brand reputation	Likert 5 scale	3.79	0.54.
Convenience	Likert 5 scale	3.94	0.56.
Service quality	Likert 5 scale	3.11	1.01.
Relationship trust	Likert 5 scale	3.69	0.54.
Transfer obstacle	Likert 5 scale	3.39	0.82.
Willingness of second purchase	Likert 5 scale	3.71	0.60.
Repeated purchase	Yes=1, No=0	0.84	0.37.

4 Analysis on the result estimated by model

4.1 Analysis on whether the farmers will repeatedly purchase the seeds

As the age of householders is closely related to the years they spent in vegetable growing (relevant coefficient is 0.7), these two variables are to measure the social experience of householders, and the variable of householder's age will be deleted from the model.

(1) Influence of basic features of householder on repeated seed purchase of farmers. Two variables, the education degree and risk attitude, of householder have a significant impact on repeated seed purchase behavior of farmers. The education degree of householder has a positive impact on behavior decision of repeated seed purchase, and the influence of three education

^a There are only 5 respondents with education degree of college and above, so this option is combined with education degree of senior high school and changed into education degree of senior high school and above.

degrees is much different. The householders with education degree of junior high school and above have a preference for repeated seed purchase. The householders with preference for risks have a high probability in repeated purchase than the ones with neutral or repelled attitude to risks, which is compliant with what we expected. While the householders with neutral or repelled attitude to risks almost have no difference in behavior decision of repeated purchase. Furthermore, the years spent in vegetable growing does not have significant effect on the willingness of farmers to repeatedly purchase the seeds.

(2) Influence of business features of farmer on repeated seed purchase of farmers. Either greenhouse or simple small greenhouse are used by farmers to grow vegetables, and both will have no significant effect on repeated seed purchase. Vegetable growing area, proportion of vegetable income in the total family income and whether the farmers will join the cooperatives also have no significant effect on repeated seed purchase. It indicates the business features of farmer are not the main influence factors of farmer's seed purchase, or we can say, the business features of farmer requires other mediating variables to affect the behavior description of repeated seed purchase. It is not what we expected, and maybe the possible reason is related to the sample selection. The samples this article selected were the farmers from suburb in Wuhan. They have many information sources with smooth channels, which may in part offset the impact of business features of farmer on repeated seed purchase decision.

Table 2. Estimated results from model of whether the farmers will repeatedly purchase the seeds

Variable	Coefficient	Standard error	Z value	Probability
Primary school education and below	1.7459	0.5026	3.4738	0.0005
Junior high school education	2.4188	0.4450	5.4360	0.0000
Year spent in vegetable growing	0.0272	0.0179	1.5244	0.1274
Risk preference	-0.9986	0.3752	-2.6613	0.0078
Neutral to risk	0.9527	0.6879	1.3849	0.1661
Growing area	-0.0025	0.0079	-0.3176	0.7508
Vegetables in greenhouse	0.8460	0.7187	1.1771	0.2392
Vegetables in small greenhouse	-0.0432	0.7829	-0.0552	0.9560
Income proportion	-0.0110	0.0095	-1.1556	0.2478
Participation in cooperatives	-0.0898	0.3952	-0.2272	0.8203
Perceived Value	1.7450	0.3566	4.8937	0.0000
Seed quality	0.4077	0.4975	0.8195	0.4125
Brand reputation	0.1212	0.4350	0.2785	0.7806
Convenience	-0.8186	0.3711	-2.2057	0.0274
Service quality	-0.1792	0.1471	-1.2179	0.2233
Relationship trust	0.9834	0.3648	2.6955	0.0070
Transfer obstacle	0.8188	0.3219	2.5437	0.0110
Intercept term	-10.4315	3.0072	-3.4689	0.0005
McFadden R ²	0.3874	Logarithmic value for maximum likelihood	-139.6384	

(3) Influence of seed marketing factors on repeated seed purchase of farmers. As shown in the estimated result in Table 2, most of the marketing factors have significant impact. The Perceived Value factor has the largest influence among all the marketing factors. The probability of repeated purchase of farmers with stronger Perceived Value for the purchased seeds will also be larger. Relationship trust and transfer obstacle has a positive impact on the behavior decision of repeated

seed purchase. It indicates that the customers tend to repeatedly purchase the products from seed distributors with higher credibility. And if the transaction fee generated when farmers purchase the new varieties is higher, the probability to repeatedly purchase the original variety will also be larger. The convenience and service quality of distributors have a negative impact on the farmer's repeated seed purchase. It may be related to some convenience provided by distributors for farmers to purchase the seeds when the new varieties come into the market, but the impact of service quality is not so significant, which may be caused by the fact that the professional technical service level currently provided by a large part of seed distributors is relatively low. The seed quality and brand reputation have a positive impact on farmer's behavior decision of repeated purchase, but it's not significant. It may be caused by the fact that the qualities of vegetable seeds are not so different in the current market, and the brand effect has not been formed in relevant enterprises.

4.2 Analysis on the influence degree of different factors on farmer's willingness of repeated seed purchase

It can be found through comparison with Table 2 that the factors influencing farmer's behavior of repeated seed purchase also have an impact on the willingness of repeated seed purchase. Furthermore, the marks of influence factors significant both in Table 2 and Table 3 are the same, which shows the farmers are rational in the process of repeated seed purchase and the behavior of repeated seed purchase is a rational behavior limited by existing conditions even though repeated purchase of the same product is not conducive to promoting the new technology.

Table 3. Estimated results from the model of the influence degree of different factors on farmer's willingness of repeated seed purchase

Variable	Coefficient	Standard error	Z value	Probability
Primary school education and below	2.2198	0.4306	5.1555	0.0000
Junior high school education	1.8041	0.3591	5.0243	0.0000
Year spent in vegetable growing	-0.0145	0.0125	-1.1615	0.2455
Risk preference	-0.5112	0.3089	-1.6550	0.0979
Neutral to risk	0.2281	0.3964	0.5754	0.5650
Growing area	-0.0072	0.0057	-1.2763	0.2019
Vegetables in greenhouse	-0.6716	0.5046	-1.3309	0.1083
Vegetables in small greenhouse	-1.0743	0.5252	-2.0456	0.0408
Income proportion	-0.0036	0.0068	-0.5362	0.5918
Participation in cooperatives	0.0999	0.2933	0.3406	0.7334
Perceived Value	1.7472	0.2403	7.2708	0.0000
Seed quality	0.8225	0.3724	2.2087	0.0272
Brand reputation	-0.0282	0.3127	-0.0902	0.9281
Convenience	-0.2064	0.2437	-0.8472	0.3969
Service quality	-0.1199	0.1311	-0.9150	0.3602
Relationship trust	1.4975	0.2704	5.5381	0.0000
Transfer obstacle	0.5392	0.2193	2.4591	0.0139
Pseudo-R ²	0.2758	Logarithmic value for maximum likelihood	-306.5583	

(1) Influence of basic features of householder on farmer's willingness of repeated seed purchase. Compared to the result in Table 2, the householder's education degree and risk features remain the significant factors. Lower education degree of householder leads to stronger

willingness to repeatedly purchase the seeds, and the willingness of householders with risk preference to repeatedly purchase the seeds is obviously lower than that in other risk types. Years spent in vegetable growing have no significant impact on farmer's willingness of repeated seed purchase.

(2) Influence of business features of farmer on farmer's willingness of repeated seed purchase. Vegetable growing area, proportion of vegetable income in the total family income and whether the farmers will join the agricultural cooperatives also have no significant effect on repeated seed purchase. The growing mode will influence farmer's willingness of repeated seed purchase. Compared to field growing, the facility vegetable growing with sunk costs will reduce the willingness of farmers to repeatedly purchase the seeds. (Require comparison with conclusions in other references. If it's not compliant with the general research conclusion or common sense, it shall be deeply explained and interpreted).

(3) Influence of seed marketing factors on farmer's willingness of repeated seed purchase. The farmer's value sensation for purchased seed and the seed quality have a positive impact on farmer's willingness of repeated seed purchase, and if the Perceived Value is higher or the quality of purchased seeds is better, the farmer willingness of repeated seed purchase will also be stronger. Relationship trust and transfer obstacle has a positive impact on farmer's willingness of repeated seed purchase. It indicates that the customers tend to repeatedly purchase the products from seed distributors with higher credibility. And if the transaction fee generated when farmers purchase the new varieties is higher, the probability of willingness to try out new product will also be lower. Furthermore, the brand reputation, convenience and service quality has no significant impact. Of all the marketing factors, the farmer's Perceived Value and the relationship trust to distributors have the largest impact on farmer's willingness of repeated seed purchase.

5 Research conclusion and policy inspiration

5.1 Main research conclusion

This article uses investigation data from vegetable farmers around Wuhan to empirically analyze farmer's behavior decision of repeated seed purchase and its influence factors. It is found from the investigation that most of the sample farmers have a behavior of repeated seed purchase, and there's a difference in the degree of repeated seed purchase for farmers. The education degree, risk attitude and other householder's basic features, as well as seed quality, convenience, relationship trust, transfer obstacle and other marketing factors have a significant impact on the willingness of repeated seed purchase, but the business feature factors of farmers have no significant impact. The farmers with higher education degree or risk preference features are more willing to try out new varieties. Improving farmer's Perceived Value for the purchased seeds and the trust in distributors, as well as the relatively high seed quality, will increase farmer's willingness for repeated seed purchase; While the higher costs for information seeking, costs for technical study and other transfer obstacle factors have a significant prohibitive effect on the farmers, which prevents them from purchasing new varieties of seeds and hinders the promotion of new varieties.

5.2 Policy inspiration

The following policy inspirations will be obtained according to the above research conclusion: Firstly, the seed cultivation enterprises shall invest more in scientific research and market survey, make development and production according to demand of farmers, improve seed conclusion level by agricultural biotechnology, increase farmer's satisfaction with seed quality and improve farmer's Perceived Value for seeds. Secondly, the seed enterprises shall facilitate the brand construction, improve relationship marketing, establish and maintain the close and long-standing relation with farmers. Thirdly, the seed enterprises shall step up the publicity, and shall reduce the transfer obstacle and facilitate the promotion of new varieties by methods like voluntarily

providing the farmers with sufficient seed supply information and growing technology through various channels.

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A Study on Vegetable Price Fluctuation and Transmission Mechanism based on Dynamic CGE Model Simulation.

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