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Analysis on Factors Influencing Organic Fertilizer Use in China –A case study on wheat farmers in six eastern provincial–level regions

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The overuse and residue of chemical fertilizer are becoming big problems in food safety and negatively affect the environment in China Organic fertilizer is considered less harmful to food safety, soil quality and environment than chemical fertilizer; however, it is not as widely used as chemical fertilizer The main research objective in this study is to examine the factors influencing organic fertilizer use in China In this research, the farmers who sell less agricultural products are measured as more willing to use organic fertilizer while those who do less off–farm work use more organic fertilizer Meanwhile, higher income is found to make farmers more willing to use organic fertilizer and farmers with larger farming scale are more willing to use organic fertilizer Finally, education level, age and yield of wheat are not identified as significant factors effecting farmers usage of organic fertilizer.

Key words: china, environment, organic fertilizer, wheat

INTRODUCTION

China is the biggest chemical fertilizer producer in the world since 2000 (International Statistic Yearbook 2010). The rapid growth in China's per hector chemical fertilizer application has contributed significantly to the growth in grain production. Nevertheless, it also caused many environment problems simultaneously, such as groundwater and underground water pollution. The improper use and residue of chemical fertilizer are becoming big menaces to food safety, and negatively affecting the environment. (Wu 1991, Liu *et al*., 2010).

According to Ministry of agriculture in China, the proper use ratio of chemical fertilizer among N, P and K is 1: 0.37: 0.25. While the real ratio is 1: 0.34: 0.24, implying that the chemicals used in China is not in well–balance, especially the nitrogen is being overused (Table 1). Based on research data from Henan Agricultural Bureau, only 1/3 of the chemical fertilizer is absorbed by the plants, 1/3 gets into the air and 1/3 gets into the soil, and the chemical fertilizer pollute both soil and air. (Wang *et al*., 2011)

On the other hand, the organic fertilizer use is decreasing. In 2004, the share of organic fertilizer use is only 25% of total fertilizer use in China, and 2005; the share is only 20%. Less organic fertilizer use and more chemical fertilizer use caused a lot of problems, such as lack of Potassium in the soil and plants, harmful to the environment and increase the cost of agro–products (Liu *et al*., 2010). Thus proper application of chemical fertilizers and encourage more organic fertilizer use are drawing unprecedented public concerns.

Table 1. Chemical fertilizer use in China

Year	All chemical fertilizer	N	P	K	Compound fertilizer	Ratio N:P:K
2003	44.11	21.49	7.13	4.38	11.09	1:0.33:0.20
2004	46.36	22.21	7.36	4.67	12.04	1:0.33:0.21
2005	47.66	22.29	7.43	4.89	13.03	1:0.33:0.22
2006	49.27	22.62	7.69	5.09	13.85	1:0.34:0.22
2007	51.07	22.97	7.73	5.33	15.03	1:0.34:0.23
2008	52.39	23.02	7.80	5.45	16.08	1:0.34:0.24
2009	54.04	23.29	7.97	5.64	16.98	1:0.34:0.24

Unit: Million ton
Source: China yearbook 2004–2010
Note: the requested ratio by MOA among N, P and K is 1:0.37:0.25

Organic fertilizer includes both naturally occurring fertilizer and processed organic fertilizers. Naturally occurring organic fertilizers include manure, straw, worm and so on. Processed organic fertilizers mainly refer to compost blood meal, humic acid, etc. In China, according to Ministry of Agriculture, organic fertilizer is also called as farmyard–manure, mainly refer to manure and straw based on harmless treatment e.g. compost, (Ministry of Agriculture of China, Organic fertilizer industry standard– 2005). In this research, most organic fertilizer is made from animal manure.

Besides, the Chinese government encourages more organic fertilizer use among farmers in recent years. According to the Central Committee Document of China

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Table 2. The top 5 chemical fertilizer user in China in 2009

Rank	Place	Use of chemical fertilizer	N	P	K	Compound fertilizer	Ratio N:P:K
1	Henan	6.287	2.394	1.166	0.598	2.129	1:0.49:0.25
2	Shandong	4.729	1.650	0.514	0.465	2.100	1:0.31:0.28
3	Jiangsu	3.440	1.818	0.488	0.210	0.932	1:0.26:0.12
4	Hubei	3.403	1.536	0.672	0.285	0.909	1:0.44:0.19
5	Hebei	3.162	1.530	0.474	0.263	0.894	1:0.31:0.27

Unit: million ton
Source: China yearbook 2010

from 2005, promoting organic fertilizer use has become one important agricultural policy.

In this study, the main research objective is to examine what kind of factors influence farmers' organic fertilizer use behavior in China. Thus the findings are helpful for the policymakers to understand farmers' behavior and promote use of organic fertilizer the in current situation.

RESEARCH METHOD AND SURVEY DATA

Model and variable choose

This research is based on the farmer behavior theory and the principle of profit maximization and risk aversion. We assume the sample farmers are rational farmers. Since rational farmers seek profit maximization and risk averse, they would choose to apply organic fertilizer or not by considering their own socio–economic situation, crop situation and others.

Based on above theory framework, a series of variables affecting farmers' behaviors on using organic fertilizer are mainly chosen from 2 aspects, farmers' social–economic characteristics and features related to agricultural itself.

Those previous researches believe that some social–economic characteristics such as education level, income level and others would positively affect farmers' behavior on protecting agri–environment (Coady, 1995; Huang and Rozelle, 1995; OECD, 2008). Meanwhile, crop situation and agri–products features such as use of chemical fertilizer; sowing areas, production selling ratio and others are also believed to have strong relationship with their organic fertilizer use.

A binary Logit Regression model is adopted in this research.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_k X_k + \mu \quad (1)$$

While the distribution function of y is:

$$F(y) = Py(1 - P)1 - y, y = 0,1 \quad (2)$$

While farmers using organic fertilizer y=1; otherwise, y=0, While, x are a series variables affect farmers' behaviors on using organic fertilizer (Table 3 and Table 4), u is the random error. The model is calculated by using SPSS 13.0 for Windows.

Table 3. Socio–economic characteristics of sample farmers

Gender	Male	82.1%
	Female	17.9%
Age	20–30	4.4%
	30–40	18.7%
	40–50	35.1%
	50–60	28.4%
	Over 60	13.4%
Education level	Illiterate	17%
	Elementary school	26%
	Junior high–school	43%
	Senior high school	17%
	Undergraduate and higher	4%
	No response	6%
Income level (annual household income)	Less than 10,000 RMB	12%
	10,000RMB ~30,000 RMB	32.5%
	30,000RMB ~50,000 RMB	33.4%
	More than 50,000 RMB	21.3%
	No response	1%

Source: field survey 2011 N=134, 6.8RMB=1$

Study areas

To understand the situation and farmers' perceptions on agricultural pollution, a survey was conducted with questionnaire–based personal interviews to collect first–hand data as used in many previous studies. In January to March, 2011, the survey was conducted in both North areas and South areas including Beijing, Hebei Province, Shandong Province, Shanghai, Jiangsu Province and Zhejiang Province. And 560 samples were collected from 21 villages during the survey. The sampled area covers 3 major grain–growing provincial regions and rural regions affiliating to the top two metropolises in China. It is not suitable to use all sample farmer to check organic fertilizer use considering there are big difference in fertilizer use, yield, products selling ratio and other index among different crops. In those six provinces and cities, farmers grow different crops, and farmers grow the same crop are considered as suitable to do current research. Farmers in both south areas and north areas plant wheat; and hence

Table 4. Farm information of sample farmers

Category	Unit	Mean	Minimize	Maximize	S.D.
Yield of wheat	Kg/Mu	419.85	90	1000	116.53
Sowing area of wheat	Mu[1]	3.73	0.3	30	3.43
Use of chemical fertilizer	Kg/Mu	54.88	0	115	27.36
Ratio of selling products	%	49.98	0	100	49.68

Source: field survey 2011. N=134
[1] 15 Mu = 1 Hectare

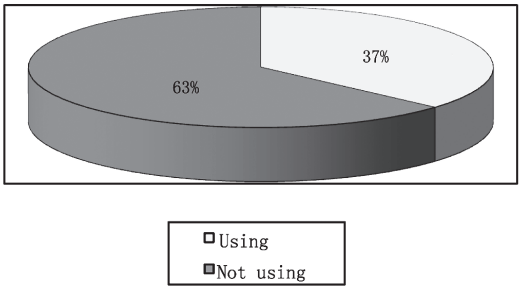
wheat farmers are picked in this study. Although 134 farmers are sampled as growing wheat, only 49 of them responded as using organic fertilizer.

Table 3 shows the socio–economic characteristics of sample farmers. Farmers who have been interviewed are household head and most of them are male, which shows that family decision is usually made by male. The average age of the sample famers is 49.6 and more than half of the sample farmers are older than 40 years old, which implies that young people do not want to be engaged in agriculture. Sample farmers do not have good education level. Most farmers only finished junior high–school or even less.

Table 4 shows the farming information of sample farmers, the mean of each index is considered as reasonable and accordance with annual statistic data. However, the differences among yield, sowing area, use of chemical fertilizer and products selling ration are quite large.

RESULTS AND DISCUSSION

According to Figure 1, in the research areas, organic fertilizer use is not as popular as chemical fertilizer use. Among 134 sample farmers, there are only 49 (about 37% of the sample farmers) farmers are using organic fertilizer. There are several reasons caused farmers use less organic fertilizer. Comparing with chemical fertilizer, organic fertilizer cost more labor. Usually, much more organic fertilizer is more needed in unit area. It is not easy to get organic fertilizer for farmers, only if there are livestock farms nearby or farmers grow animals by themselves to provide manure as source of organic fertilizer. However, in this study, there are no many livestock farms in sample villages.



Source: field survey 2011. N=134

Fig. 1 Farmers using organic fertilizer.

Compare with organic fertilizer, chemical fertilizer is much more widely used in all the surveyed agro–products. In the sampled farms, the average chemical fertilizer used in wheat is 823.2 Kg/ha (equal 54.88 Kg/Mu), which is much less than that of the other products. However, within the three main grain crops, wheat is applied with the largest amounts of chemical fertilizer.

Among all kinds of chemical fertilizer, the nitrogen fertilizers are most widely used, which is 518.85Kg/ha (equal 34.59 Kg/Mu). Although many compound fertilizers contain all the macro–elements, the general fertilizing trend of rich nitrogenous is testified to from the survey data.

In this research, factors influencing farmers' organic fertilizer use such as wheat yield, chemical fertilizer use, products selling ratio, gender of household head, age of household head, education level of household head, doing off–farm work or not, cultivated area of wheat household income and location (South area or North area) are examined in the model.

After run the model, several variables such as gender and location of the farm are removed. Finally, there are 4 variables are significant. Selling ratio, off–farm work and income are significant at 1% level and the cultivated area of wheat are significant at 10% level (Table 5). Products selling ratio and doing off–farm work have negatively affected farmers' organic fertilizer use while cultivated area and household income have positively affected the organic fertilizer use. However, education level, age, chemical fertilizer use yield of wheat and other variables are not significant in this model. The chi–square of the model is 41.249 and significant at 1% level, and the Nagelkerke R square is 0.364, which is considered as acceptable.

In the model, it shows that the products selling ratio has negatively affected farmers' organic fertilizer use, implying that those farmers who sell less their product are using more organic fertilizer. Farmers with lower commodity rate are more willing to use organic fertilizer. Farmers tend to use less chemical fertilizer and use more organic fertilizer instead on the products they would consume by themselves. Meanwhile, it also shows that doing off–farm work has negatively affect farmers' organic fertilizer use. It implies that those farmers who do less off–farm work use more organic fertilizers. This can be explained as farmers who more focus on agriculture than off–farm work are more willing to use organic fertilizer. However, it is not suitable to

Table 5. The results of Binary Logit Regression Model

	B	S.E.	Wald	df	Sig.
Yield	.002	.002	.923	1	.337
Fertilizer	–.011	.008	2.176	1	.140
Selling ratio	–2.022***	.600	11.350	1	.001
Area	.118*	.071	2.748	1	.097
Off farm work	–2.379***	.739	10.348	1	.001
Age	.028	.024	1.450	1	.228
Edu	–.092	.317	.085	1	.770
Income	1.096***	.303	13.031	1	.000
Constant	–3.480*	1.876	3.440	1	.064

Dependent variable: whether use organic fertilizer or not, use=1, other=0
Omnibus tests of model coefficients: Chi–square(4)=41.249, Sig=0.000***
Case included in analysis: 134, total case selected: 134
Nagelkerke R square=0.364
Overall percentage correct: 74.4%

Source: self–calculation based on field survey 2011
Software: SPSS 13.0 for windows. Note: ***, ** and * represent statistical significance in level of 1%, 5% and 10%, respectively

Table 6. Comparison between the organic fertilizer users and non–organic fertilizer users

		Organic fertilizer users	Non–organic fertilizer users
Age		47.18	50.57
Education level		2.85	2.9
Annual Income level		2.59	2.26
Yield	(Kg/Mu)	438	409
Areas	(Mu)	3.66	3.78
Chemical fertilizer use	(Kg/Mu)	51.12	57.05
Selling ratio		39%	56.10%
Off–farm work		8.10%	36.50%

Source: self–calculation based on field survey 2011
Note: there is not unit for both education level and annual income level.
Education level from 1 to 5 refer to illiterate, elementary school, junior high–school, senior high–school and undergraduate and higher, respectively.
Annual income level from 1 to 4 refer to less than 10000RMB, 10000–30000 RMB, 30000–50000 RMB, and more than 50000 RMB, respectively.

imply that professional farmers are more willing to use organic fertilizer. On the other hand, household income and cultivated area have positively affected the organic fertilizer use on 1% and 10%, respectively. It implies that higher income farmers and farmers with larger scale of farm are more willing to use organic fertilizer.

Table 6 shows the comparison between the organic fertilizer users and non–organic fertilizer users. It is consistent with the previous results. Organic fertilizer users do less off–farm work, sell less their products, use less chemical fertilizer but have a higher yield than non–organic fertilizer. But others such as education level, area show no big difference between organic fertilizer users and non–organic fertilizer users.

CONCLUSION AND RECOMMENDARION

In China, the chemical fertilizer elements are not well–balanced. More Nitrogen fertilizer is applied. And less organic fertilizer is used compare with chemical fertilizer. Although the government provides accurate soil testing techniques and recommend referential standardized fertilizing amounts to farmers with different land properties and planting structures, farmers have less idea about this information or knowledge. More extension service is needed to help farmers use fertilizer in a proper way. Strengthening social education on scientific fertilization is necessary.

Within the farmers applied organic fertilizer, those who sell less agricultural products are found to be more willing to use organic fertilizer. Meanwhile those farmers who do less off–farm work use more organic fertilizer, i.e., farmers focus more on agriculture than off–farm work. Higher income farmers are more willing to use organic fertilizer, while education level, age and yield of wheat are measured as not significant in affecting farmers' usage of organic fertilizer. However, in this research, most farmers only own a small amount of average cultivated land of 3.73 Mu per household. Thus it is not easy to simply conclude which kind of farmers, professional farmers or not, is more willing to use organic fertilizer than the others so far in this research.

According to above conclusion, since those farmers who focus more on agriculture than off–farm work are willing to use organic fertilizer, the government should provide some subsidies to encourage farmers to concentrate on agriculture and use organic fertilizer instead of chemical fertilizer. Meanwhile, according to above findings, organic–fertilizer users get a higher yield than non–organic fertilizer users, the government may encourage farmers use organic fertilizer by getting better yield and also encourage researchers to do related research to improve current organic fertilizer to increase yield.

There are still spaces for improvement in future researches. For instance, variables about price of chemical fertilizer and organic fertilizer can be included, and thus be checked as whether they can strongly affect farmers' adoption of organic fertilizers.

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