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Key Factors Affecting Farmers' Choice of Corn Reduction under the China's New Agriculture Policy in the 'Liandaowan' Areas, Northeast China

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Abstract: Farmers are the main land managers, and their production decisions crucially affect crop outputs and farmland preservation. Understanding the motivations and factors underlying farmers' decision making is a fundamental to implementation polices of government. This study analyzed factors that influence farmers' choice of corn reduction under the China's new agriculture policy in the 'Liandaowan' areas of Northeast China. This study collected data from 106 randomly selected households in 34 villages in 'Liandaowan' areas of Northeast China using a semi-structured questionnaire. Results showed that the Chinese corn structural adjustment plan confronted with many constraints, and most of farmers insist on planting corn. Drought and low accumulated temperature, no suitable substitution crop, farmers' preferences, farmers' education and age, relatively high comparative benefit of corn, the availability of machinery and technical assistance, subsidies and low family incomes all influence farmers' choice of corn substitution. Based on our experimental results, we derived important policy implications for promoting corn structural adjustment incorporate increase crop diversity, promote soybean and corn rotation, provide adequate agricultural extension services, and increase the corn substitution subsidies and improve farmers' income.

Keywords: agriculture policy; crop choice; decision making; impacts; Northeast China

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1 Introduction

Food security is the common concern of all countries in the world. The Chinese government always focuses on food security, especially after entry into WTO. In order to promote the development of agriculture and meet the needs of upgrading consumer food consumption, the Chinese government takes raising grain output as the first task. Since 2004, the Chinese government issued 13 No.1 central documents to promoting agricultural structure adjustment and increase grain production. Besides, the China government introduced direct subsidies to farmers and phase out agricultural tax in 2006. And in 2007, in order to stabilize the price of corn market, increase famers' income and effectively solve the problem of farmers' grain selling, China started a nationwide purchase policy of temporary storage for corn, soybean, and rapeseeds in major crop area. Under the guidance of

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subsidies and price policies, the production of grain, cotton, oil, sugar and other bulk agricultural products has gradually concentrated in the most suitable areas, and the output has steadily improved with the increasing of grain production form 430 million t in 2003 to 620 million t in 2017. The production of top three cereals, rice, wheat and corn reached 210, 130 and 220 million tons in 2017, which were 1.3, 1.4 and 1.8 times of 2003, respectively. Meanwhile, amounts of grain import and stock increased at the same time. However, the export volume is declining year by year. The government faces significant financial burden due to high procurement prices and storage cost. Supply and demand of some agricultural products is out of balance. Especially, soybean is in short supply, and corn is overproduced which leads to excessive stocking, accounting for almost 58% of the world's stock in 2015 (U.S. Department of Agriculture, 2018) (Fig. 1). Over the past 15 yr, growth in corn production has been driven largely by expansion of harvested land in grasslands, deserts, on mountainsides and marshes, which caused detrimental impacts on the local ecological environment (Wu and Zhang, 2016).

In order to solve the problems of imbalance in the supply and demand of agricultural commodities, and trying to reform agriculture towards a more efficient and market driven sector, the Chinese government initiated a supply-side structural reform in agriculture and put forward a series of policies. In November 2015, China's Ministry of Agriculture issued the 'Guidance of corn structural adjustment in 'Liandaowan' area'. The goal is to reduce more than 3.33 million ha of corn harvest area

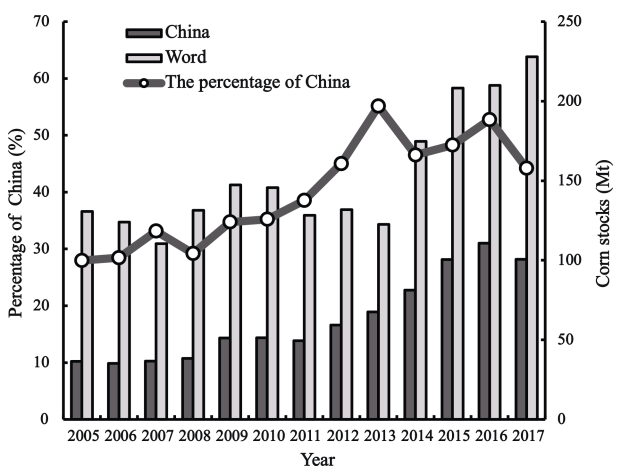

Fig. 1 Corn stocks in China. Source: U.S. Department of Agriculture

in the unsuitable planting regions. This unsuitable planting region is distributed from northeast to north of China, south-west and northwest, and shaped like a sickle. The vacated areas will be encouraged to rotating corn and soybean, planting spring wheat, sorghum, millet, sunflower, other coarse grains, and fodder crops for livestock farming. In March 2016, China's government used another effective weapon for corn reduction. The Economy and Trade Office of the National Development and Reform Commission announced that temporary reserve policy in northeastern provinces and Inner Mongolia replaced by a new mechanism of 'market-oriented purchase + subsidy'.

That means the Chinese government use both administrative measures and market-based mechanisms to cut corn production and storage. According to National Bureau of Statistics of China (2018), area planted in corn decreased 7% from 38.1 million ha in 2015 to 35.4 million ha in 2017. China has completed 80% of the corn reduction goal in two years. It seems that China's corn area reduction policy is progressing smoothly. But what is the actual situation? Corn growing reduction is very difficult according to a reporter from Chinese village voice (Han et al., 2016). What problems exist during the corn reduction progress? Which factors affect farmers' planting decision? So it is important to find the key actors affect farmers' decision making. And find the existing problems to further improve policy and better promote the supply-side structural reform of agriculture.

The factors of influencing farmers' cropping-plan decision-making have been studied by numerous authors. These factors include physical factors, economic factors, and personal views of the farmer, crop profiles, and availability of resources and so on. Physical factors are the primary determinants of crop selection for farmers. Saito et al. (2006) found that soils directly affected both the crops and the varieties of farmer planted. In Rwanda, farmers planted the demanding crops on the best soils and less demanding crops on less fertile soils (Habarurema and Steiner, 1997). In recent years, the influence of climate change on crop choice is gradually concerned by scholars. Moniruzzaman (2015) found that crop choice is climate-sensitive in Bangladesh, farmers in the high rainfall areas select rain-fed Aman rice as their chief crop while households of low rainfall areas choose irrigation based Boro rice. Seo and Mendelsohn (2008) noted that both precipitation and temperature

affect the crops selection in South American, and global warming lead farmers to switch away from maize, wheat, and potatoes towards squash, fruits and vegetables.

A second set of factors suggested as influencing crop chosen are crop characteristics, such as yields, resistance to pests/drought, cycle period and maturity dates. It has been argued that different crop has different diseases, fertility requirements and pests that make the production of the crop difficult or too risky for the farmer (Jaffe, 1989). In Haiti, Jaffe (1989) observed farmers no longer increase grow yams owing to the declining fertility and rising levels of infestation. Lee et al. (2016) found that temporal fluctuations of crop yield has a strong influence on farmers' revenue, and multiple crop selections can enhance revenue in South Korea. The intrinsic properties of a crop is fundamental to decision making (Huylenbroeck and Damasco-Tagarino,1997).

Some studies deemed economic factors as fundamental. Under the current socio-economic context, farmers are changing a lot with highly fluctuating crop prices (Lee et al., 2016). In Indonesia, farmers shift from coffee to cocoa production owing to higher output volumes and more favorable commodity prices for cocoa than coffee (Klasen et al., 2013). In Kansas, Fewell et al. (2016) reported that no set markets exist for bioenergy feedstocks outside of very localized geographic locations and households may not willing to grow switchgrass without contracts that help reduce uncertainty and risk.

Also many studies regard farmers' personal factors as determinants. As farmers are the main actors promote agricultural production and contribute to food security. During the farming practice, it is the farmer who decides what to grow and how much of their land to allocate to different crops. In Kansas, Caldas et al. (2014) found that farmer's perceptions play an important role in the willingness to plan biofuel crops. While Kallas et al. (2009) argued that farmer's objectives are determinant factors of organic crop cultivation.

The fifth category regarded as influencing crop selection is the government policy. In Romania and the European Union, Popescu et al. (2016) found that the series of land policy applied in the CEEs has had a deep impact on the farm crop choices. Pradhan and Ranjan (2016) tested the impact of Bore Pool Sharing program on the crop choices of farmers in drought prone districts of Andhra Pradesh and Telangana states and found participation in the bore pool sharing collective increases the share of water intensive crops grown. Kurosaki (2007) analyzed within-village variations in cropping patterns and discovered that the acreage share of non-lucrative paddy crops was higher for farmers who were under tighter control of the local administration owing to their political vulnerability.

Liandaowan' areas of Northeast China are the main region of corn reduction. In order to find the key factors affecting farmers' choice of corn reduction, in June 2017 the authors carried out a questionnaire survey in 'Liandaowan' areas of Northeast China. These results may have important implications for China's corn structural adjustment plan in 'Liandaowan' areas.

2 Materials and Methods

2.1 Study area

The study was conducted in the 'Liandaowan' area in Northeast China, and refers to more than 67 counties. According to the 'Guidance of Corn Structural Adjustment in 'Liandaowan' Area', this region incorporates northeastern cold zone and northeastern pastoral zone which are all in poor climate conditions. Northeastern cold zone is located in high latitude and cold regions, including the fourth, fifth accumulating temperate zone in Inner Mongolia, Heilongjiang and the mountain areas of eastern Jilin. Winter is long and cold, and summer is short, frost free period is only more than 90 d, day and night temperature changes sharply. Crop production in this region is vulnerable to cold, frost and other disasters. Owing to the continuous cropping of corn for many years, soil consolidation and too much herbicide residue affect the increase of crop yield and quality. Main objective is through market guidance and policy cut corn production and promotes corn and soybeans rotation, develop spring wheat, corn silage, expand forage grass and rape planting. By 2020, vacated corn planting areas will reach 0.67 million ha.

Northeastern pastoral zone is a transition area connecting cropland and grassland. Semi-arid and semi-humid climate, abundant land resources, good light and heat conditions. However, water resource is in shortage, soil desertification, high frequency of disaster. Combined with livestock development needs, and taking the traditional advantages of cultivating soybeans, pea-

nuts, coarse grains and beans, expanded grow corn silage, grain and soybean rotation, peanuts and coarse grains and forage. The objective is with the other northern provinces, such as Shanxi, Hebei, Shanxi and Gansu to reduction sown area of corn 2 million ha.

Major crop production in 'Liandaowan' area of Northeast China is presented in Table 1. The area harvest of corn only 2.5 million ha in 2003, while in 2015 the area harvest has reached 6.3 million ha. Corn became the dominant crop, percentage of area harvest accounted for 65.2% of grain and percentage of yield has reached 78.6%. However, this region is an ecological fragile area. Wetlands started shrink, grassland reclaimed for the cultivating, and the grain production became low and unstable and many ecological problems are beginning to emerge along with the rapid expansion of corn (Chen et al., 2016).

After the Ministry of Agriculture published 'guidance of corn structural adjustment in 'Liandaowan' area, the local governments in Northeast China have made effort to achieve the reduction goals. According to the government work report in 2017, corn harvest area in Northeast China has vacated 2.2 million ha.

2.2 Methods

We conducted the fieldwork in June 2017. A total of six counties (Fuxin and Changtu in Liaoning Province, Zhaluteqi and Kezuozhongqi in Inner Mongolia, Changling in Jilin Province and Kedong in Heilongjiang Province) were visited (Fig. 2). The six counties are typical counties for adjusting corn planting structure in the western part of Northeast China. Such as Changling is the National Pilot county for replacing corn with fodder crops. A sample of 106 farmers were randomly selected from 34 villages in 'Liandaowan' area of Northeast China. At each village, questionnaires were administered face-to-face to the heads of households. Respondents were asked about their willing to cultivate corn, farmers' personal characteristics, farmland, crops production, costs and returns, changes to income, contract farming, crop subsidy, crop insurance, willingness to lease or expanding the farm land, availability of agricultural technology services, reasons for continue or stop growing corn, methods to increase income, minimum accept price for planting corn and social welfare. The demographic characteristics of the respondents were typical of rural Chinese.

3 Results

3.1 Farmers' willingness to grow corn

After the Economy and Trade Office of the National Development and Reform Commission announced elimination temporary reserve policy, price of corn in China significantly drop down. Purchasing price of corn in Northeast China has reached 2.25 yuan (RMB)/kg in 2014 (National Food and Strategic Reserves Administration, 2014). However, the price deceased by 37% in 2016 to 1.42 yuan/kg (National Food and Strategic Reserves Administration, 2016). Moreover, the released

Table 1 Grain production in 'Liandaowan' area in Northeast China, 2003–2015

Year	Yield (million t)				Percentage of corn yield (%)	Area harvest (million t)				Percentage of corn area harvest (%)
	Rice	Corn	Soybean	Grain		Rice	Corn	Soybean	Grain	
2003	2.4	14.1	2.3	21.7	64.8	0.3	2.5	1.5	5.7	43.3
2004	3.1	17.3	3.3	26.3	65.8	0.3	3.0	1.9	6.7	44.9
2005	4.1	20.9	3.9	32.8	63.6	0.4	3.1	2.0	6.9	44.3
2006	3.4	21.4	3.3	32.4	66.0	0.4	3.2	2.0	7.2	44.9
2007	4.0	20.7	2.7	31.4	65.8	0.5	3.4	1.9	7.4	46.1
2008	4.4	27.0	3.7	40.7	66.4	0.5	3.7	1.9	7.6	48.3
2009	4.0	24.6	3.6	36.8	66.9	0.5	4.2	2.3	8.7	49.0
2010	4.7	30.4	4.2	45.6	66.6	0.6	4.4	2.2	8.9	49.3
2011	5.1	34.5	3.7	50.5	68.4	0.7	4.9	1.8	9.2	53.2
2012	6.0	39.3	3.1	56.4	69.6	0.8	6.2	1.5	9.5	65.0
2013	4.8	41.0	2.8	54.5	75.4	0.8	5.8	1.5	9.4	62.2
2015	5.3	42.0	2.9	53.4	78.6	0.8	6.3	1.5	9.6	65.2

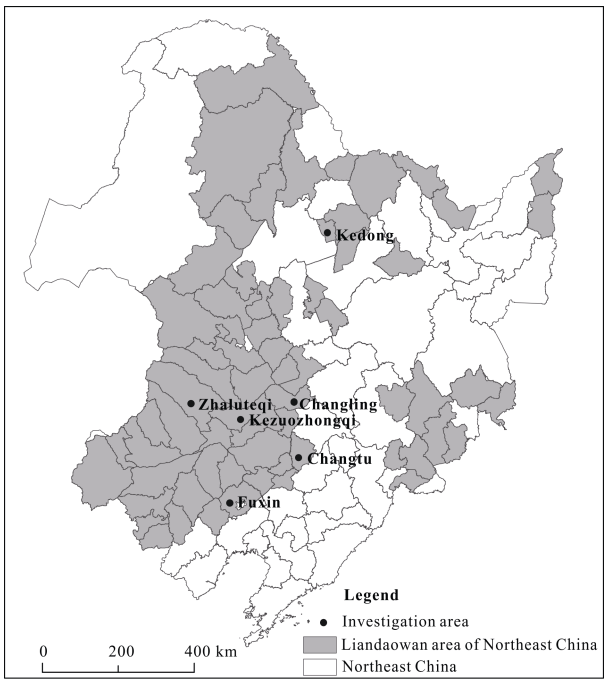

Fig. 2 Location of study area

corn price is the price above the third national standard level of corn quality (Fig. 3). The corn selling price is significantly low from the farmers far away from the market and their quality has not reached national standard. Fig. 4 displayed farmer's selling price of corn in the investigation counties. Corn selling price in different counties are varied. In 2015, Changtu got the highest price, 1.75 yuan/kg, while the lowest was found in Kedong with 1.31 yuan/kg. In 2016, the price in Kedong is still the lowest with 0.79 yuan/kg. Although the corn price decreased in recent years, our results showed that 85.8% of farmers choose to continue to grow corn, and 14.2% expressed they do not want to grow corn or rent out land to other people.

3.2 Factors underlying corn substitution

3.2.1 Crop profiles

Owing to the low accumulated temperature and arid climate, suitable crops for substitution are limited. Corn is disaster-tolerant and yield is relatively high and stable. Therefore, corn became the favorite crop of farmers in northeastern China. One respondent stated that he will insist on planting corn. Because last year he cultivated Stevia, all were destroyed by a hail storm. Farmers adjusted crop variety to fit their local climate conditions, and avoided planting crops with uncertain outcome. These results are consistent with the findings of Asrat et al. (2010) who found both environmental adaptability and yield stability are important features for farmers'choice of crop varieties and households are willing to give up some extra yield or income to gain a more stable and environmentally adaptable crop variety. Besides, good seeds of other crops that suitable for this area are rare. Local varieties of coarse grains gradually disappeared or degenerated (Yu, 2013). Impacted by the imported soybean, non-transgenic soybean in Northeast China lacks comparative advantage. High quality soybean seeds are in short supply in this region. According to the general manager of Jilin Fengzheng Soybean Food Company, soybean varieties with protein content more than 40% are scarce. In the past five years, corn recommended varieties has increased from 20 species to 100 species and soybean varieties decreased from 42 species to 20 species in Dunhua. No suitable crop seeds for substitution directly affect the farmers' willingness to adjust the planting structure.

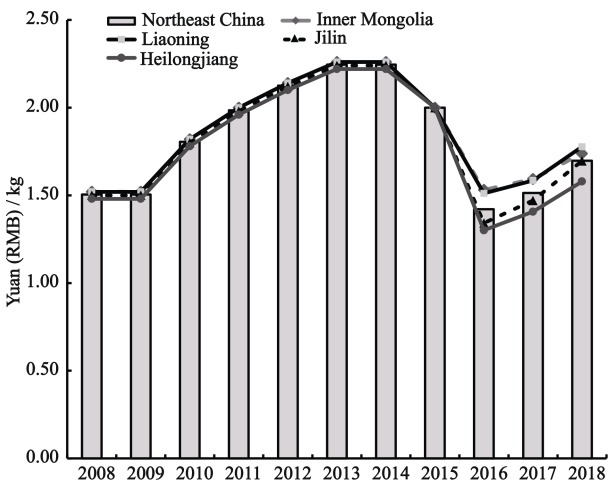

Fig. 3 Purchasing price of corn in Northeast China (price from 2011to 2015 is temporary reserve price of Chinese government)

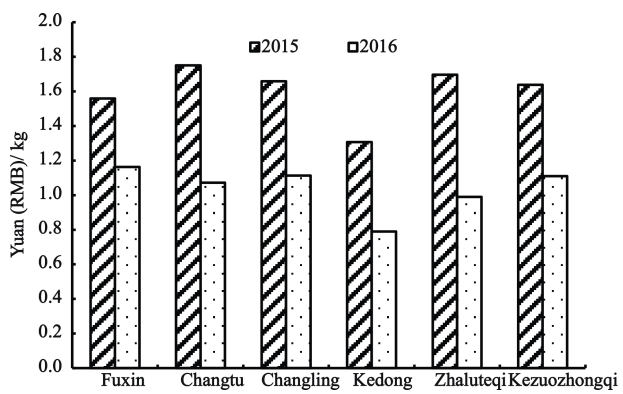

Fig. 4 Farmer's selling price of corn in the investigation counties

3.2.2 Personal factors

Our survey results also showed that framers' personal preferences appeared to play an important role in farmers' willingness to plant corn. The 33% of farmers choose to continue planting corn because the planting process of corn is relatively simple. Sowing, fertilizing, pesticide and harvesting are all mechanized. The only part that needs labor input is extirpating weed. If the farmer cultivate other crop they need to hire more labors and increased the cost. Another reason is that with the development of China's urbanization, more and more rural young farmers moved into cities, leaving only the elderly and women in agricultural production. Tables 2 and 3 reveals farmers' age structure and education in the investigation counties. The survey results indicated that agricultural production labor in the area is mainly the elderly left at home. The 32.1% of the farmers are at the age of 50–60 and farmers over 60 years old are accounted for 22.6%. Only 18.9% of the labor force under 40 years old. Farmers' education level in this area is not very high, most farmers had a primary school and middle school degree (Table 3). Farmers cultivating a new crop need to learn a large number of new agronomy technology such as pest control, fertilization which increase the difficulty of the farmers to change crop varieties in Liandaowan area. Farming experience is another factor influence farmer's crop choice. 17% of farmers reported that they have not planted other crops before. Farmers with more years of corn planting experience may not be willing to undertake the risk of try a new crop. Our results confirmed the findings of Rahman (2008) and Ortega et al. (2016) who stated that farmers' education, farming experience, labor constraints and the amount of free time allowed by the crop all positively affect farmer's preferences for crop.

Table 2 Farmers' age structure in the investigation counties (%)

Counties	20–30	30–40	40–50	50–60	>60
Fuxin	0.0	7.1	21.4	7.1	64.3
Changtu	0.0	18.8	6.3	37.5	37.5
Changling	0.0	9.5	33.3	42.9	14.3
Kedong	5.6	5.6	38.9	27.8	22.2
Zhaluteqi	10.7	28.6	17.9	35.7	7.1
Kezuozhongqi	0.0	11.1	55.6	33.3	0.0
Sum	3.8	15.1	26.4	32.1	22.6

Table 3 Farmers' education level in the investigation counties

Counties	Illiterate (%)	Primary school (%)	Middle school (%)	High school (%)	College degree (%)
Fuxin	0.0	50.0	42.9	7.1	0.0
Changtu	0.0	37.5	62.5	0.0	0.0
Changling	0.0	42.9	52.4	4.8	0.0
Kedong	5.6	61.1	33.3	0.0	0.0
Zhaluteqi	0.0	28.6	60.7	10.7	0.0
Kezuozhongqi	0.0	33.3	66.7	0.0	0.0
Sum	0.9	41.5	52.8	4.7	0.0

3.2.3 Physical factors

'Season' is an important determinant of crop selection (Greig, 2009). Owing to the high latitude, crops in northeast China are all one crop per annual. Temperature gap between winter and summer is more than 30℃. Annual average temperature in most area are no more than 20℃ (Fig. 5). Rainfall is mainly concentrated in summer and annual rainfall is no more than 500 mm in most region of the Liandaowan region (Fig. 5). 23.6% of farmers complained that climatic condition is poor and they have to choose drought resistant crops. 14 farmers in Fuxin reported that dry weather has lasted three years and drinking water has become a problem. Most investigation area has no irrigation facilities. According to the Statistical Yearbook of Heilongjiang (2017) and Jilin province (2017), area irrigated (% area equipped for irrigation) in Liandaowan area is very limited and area irrigated in Nenjiang, Xunke, Sunwu, Beian is only 5.78%, 6.46%, 13.74% and 9.16%, respectively, which are far below the national irrigated level of 48.8%. Fig. 6 and Fig. 7 exhibited farmers corn filed. Corn growth is obviously limited due to drought and lack of irrigation facilities in Fuxin. One reported that if he had access to more water he would grow some cash crops. However, in some region of Changling although they have wells, there is no electricity and also can not irrigate their land. Some farmers try to convert the dry land into paddy field. However, they deterred the idea when they found converting 1 ha of dry land into paddy fields they should invest 8000–10000 yuan. And in Zhaluteqi some farmers complained about the high cost of water about 695 yuan/ha one time. It seems that farmers will not choose to grow other crops if the corn adjustment requires a heavy capital investment. So in dry areas, the availability of water is crucial to crop selection,

this finding is in agreement with the results of Greigc (2009) who reported that farmers tend to grow vegetables and fruit if they could access to more water in Tanzania.

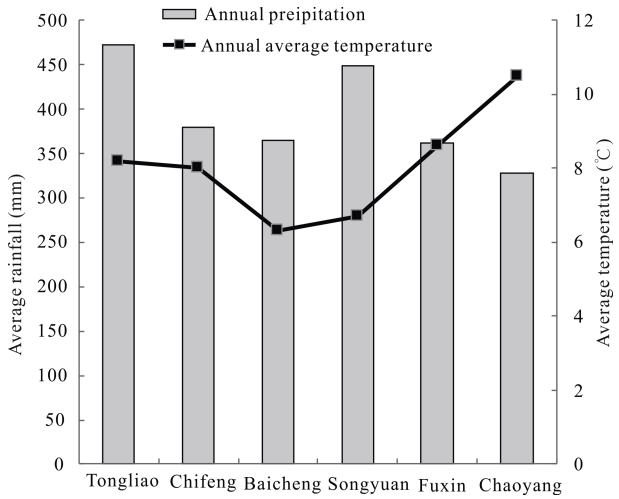

Fig. 5 Climate of some prefecture level city in Northeast 'Liandaowan' area

Fig. 6 Farmers corn filed in Fuxin (2017.06.15, Photographed by authors)

Fig. 7 Farmers' corn filed in Kedong (2017.06.14, Photographed by authors)

3.2.4 Economic factors

Whether crop is marketable is an important factor affecting farmers' crops selection in Liandaowan area. As Jaffe (1989) reported farmers are willing to grow crops that have a predictable market price and easy to sell. The survey results showed that almost all farmers expressed that selling corn is very easy. After the corn harvest many traders will visit their home to purchase so that they do not need to travel a long way to the town. The 24.5% of farmers reported that they did not grow other crops except corn because they worried about new agricultural products cannot be sold out. Uncertainty of financial returns should decrease farmer's attitude to plant new crops. Three farmer in Changling said that they planted watermelons in 2016. However, many watermelons were unsold and left rotten. Because insufficient income, the whole family was close to unable to sustain their daily livelihoods this year. Table 4 shows main crop yield, price and income in the investigation counties. It seems that even corn prices declined in recent years, planting corn still has competitive advantage over other crops. Production per planted ha such as soybean and mung bean are too low. 'Sunflower are profitable in some years because of the high price, but the price is unstable and has a risk' one farmer in Zhaluteqi said. This response indicated that farmers tend to choose crops that can bring stable profit. Moreover, crop production costs and price also affect farmers' decision making. The main reason for most farmers not willingness to continue growing corn is the decrease of corn price and high production cost. In China corn production costs is higher than soybean (Fig. 8). Some farmers in Kedong compared costs and returns of different crops planned to start cultivating soybean. This result is generally consistent with that of Katundu et al. (2014) in the Tanzania, who found lower input costs make groundnut became the third most important crop and crop production costs become an important factor to affect smallholder farmers crop choice.

Table 4 Main crop yield, price and income in the investigation counties

Crop	Production per planted hectare (kg/ha)	Price (yuan/kg)	Revenue (yuan)
Soybean	1500–2250	4	6000–9000
Corn	9750–13500	0.8	7800–10800
Mung bean	375–600	8	3000–4800
Sorghum	2250–3000	1.6	3600–4800
Sunflower	750–3000	4.8	3600–14400

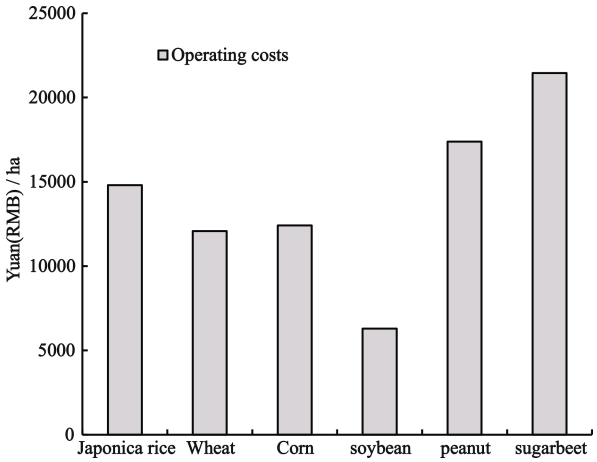

Fig. 8 China's main crop production costs in 2016

3.2.5 The availability of resources

The availability of resources has been shown related to the selection of crops (Dury et al., 2013). The survey results showed that farmers in Liandaowan area are disadvantaged due to the unavailability of resources. At present, farmers' machineries are all related to corn planting, as Fig. 9 shows. If they choose another crop to grow, they have to buy new machine for new crop and left the corn machine unused. Moreover, farmers have invested a lot of money purchasing corn machinery and financial situation of the family does not allow they buy new machinery. The availability of machinery is a problem need to be solved when the farmer decides to grow a new crop. Since more and more young farmers migrant to cities, the availability of labors has become strained. One farmer in Fuxin reported that only himself in the whole family engaged in agriculture and he had no ability to grow new crops. Another finding is that official service is inadequate in this area. The 83% of the respondents claimed that they have never received any technical help and only 8 farmers have received technical assistance. However, most of technical assistance comes from seeds and fertilizer dealers who want to sell their products to them. Only one farmer in Zhaluteqi has received help from government's agricultural technology promoters. The city government has organized technical lectures and all farmers can attend. However, farmers need to pay for their own transportation and accommodation costs, and it is too expensive for most farmers. When questioned on what techniques they most want to learn, 16% respondents stated that they want to learn cultivation techniques, 28.3% fertilization technology, 12.3% disease and pest control technology,

Fig. 9 Farmers' corn planting machinery in investigation counties (Photographed by authors)

2.8% herbicidal Technology, 5.7% agricultural machinery operation, and 2.8% film mulching technology. In future, the government needs to provide more agricultural services for farmers.

3.2.6 Subsidies

Subsidy is a powerful tool for government adjusts farm structure. Yu et al. (2016) studied the effects of the premium subsidies on crop acreage after the 2014 Farm Bill and found U.S. crop insurance premium subsidies lead to farmers expand planting insured crops. Wu and Cai (2010) discovered that grain subsidies have a significant impact on farmers' planting behavior and a 1% increase in the subsidy causes a 0.096% increase in crop acreage. Since 2004 China has introduced subsidies to farmers. But the per capita subsidy amount is very small, Chinese officials describe the subsidies as 'sprinkled like salt'. Peng (2017) calculated per capita subside income, and found that the amount is only 234.5 yuan in 2015, accounting for 2.2% of the per capita net income of farmers. To replace the state stockpiling program，in June 2016 China adopted a direct payment corn subsidy policy tied to planting acres. China's Ministry of Fi-

nance allocated 39 billion yuan to corn subsidy to farmers in four provinces in Northeastern China which account for more than 44% of China's corn production, in the 2016–2018 crop year. According to China's Ministry of Finance's requirement, the province governments should formulated specific plan for utilize the subsidies, such as determine who can get the subsidies and subsidy standard per hectare. So the payment in each provinces are varied. Fig. 8 exhibited subsidies for corn producers in investigation counties. Changtu's corn producer subsidize is highest, and about 2456 yuan/ha. While Zhaluteqi is the lowest and only 1931 yuan/ha. The corn subsidy of one ha accounts for about 24% of the total corn income of one ha (Fig. 10). Therefore, to some extent the 2016–2018 year's corn subsidy policy alleviated the impact of corn price decline on farmers' income, which led some farmers to slow down the planting for cultivating other crops.

On the other hand, subsidies for planting other crops are very limited. Besides corn, Chinese government has not introduced special subsidies for other crops. Only four provincial governments in Northeast China allocated 10% of the corn subsidy funds for other crop cultivate. The survey results showed that only some farmers in Zhaluteqi received crop substitution subsidies at about 2250 yuan/ha if they grow coarse cereals. In Kedong, soybean planting area more than 6.7 ha can receive 2250 yuan/ha corn soybean rotation subsidy. Since most farmers are unable to reach the required sown area, redirecting the vacated areas seems difficult to achieve. In China, only corn, rice, wheat, cotton, potato, oil and sugar have insurance subsidies. And the survey result showed that farmers' income is very low in this area and most of them do not have the consciousness to buy insurance. That means if the farmer want to cultivate another crop they should confronted with dual risks of nature and market. In consideration of the bad weather in this area, most of farmers do not want to grow other crops.

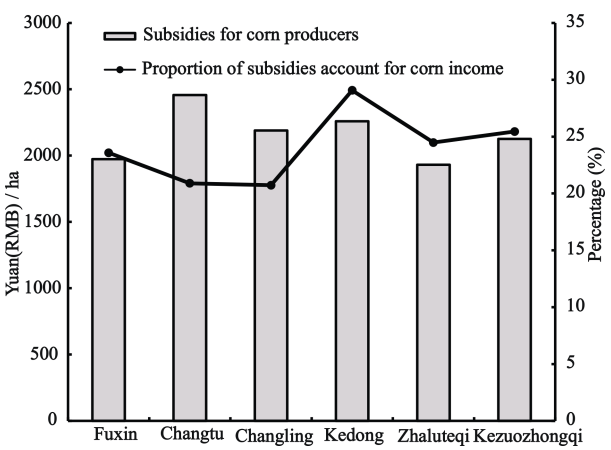

Fig. 10 Corn subsidies for farmers in investigation counties

3.2.7 Family income

Besides the factors discussed above, family income is also an important factor affecting farmers' crop decision-making. According to the statistical yearbook of Heilongjiang (2016), Jilin (2016), Liaoning (2016) and Inner Mongolia (2016), per capita net income of farmers was only 9717.4 yuan in 'Liandaowan' area which lower than the provincial average rural residents income in 2015 (10775.9 yuan in Inner Mongolia, 12056.9 yuan in Liaoning, 11326.2 yuan in Jilin, and 11095.2 yuan in Heilongjiang). The survey results showed that the per capita income of farmers in Fuxin is 5340 yuan, Changtu 11832.9 yuan, Changling 7516.7 yuan, Kedong 6298.7 yuan, Zhaluteqi 9029.9 yuan, and Kezuozhongqi 5884.5 yuan (Fig. 11). Compared with 2015, the annual average income of farmers was decreased about 30% in 2016. 63.81% of the farmers expressed that farming income cannot meet the daily consumption demand, and 35.24% of the households pronounced that farming income is just meet the family living expenses, and only 0.95% of the farmers declared have surplus. Some farmers complained that corn prices decreased in 2016 which directly reduced family income and they will return to poverty if the condition sustained. New crop need new input such as new machine, new technology which also a big investment. Our survey result showed that 51.89% of the household's family income mainly depended on cultivating crops, 18.9% depended on crop and animal cultivating, 21.7% of the farmers depended on crop planting and find a temporary work, 1.89% depended on crop planting and open a new store, 3.8% depended on crop and animal cultivating and temporary work, and other 1.9% depend on crop planting, open a new store and cultivating animal or find a temporary work. Farmers' incomes in this area are low and unstable. Take into account the revenue situation of the family, many farmers expressed that they have no extra money to invest a new crop. Our results confirmed the findings of Lee et al. (2016) who pointed out that farmer's decisions on crop choice were influenced by socio-economic background of farmers such income and farm asset.

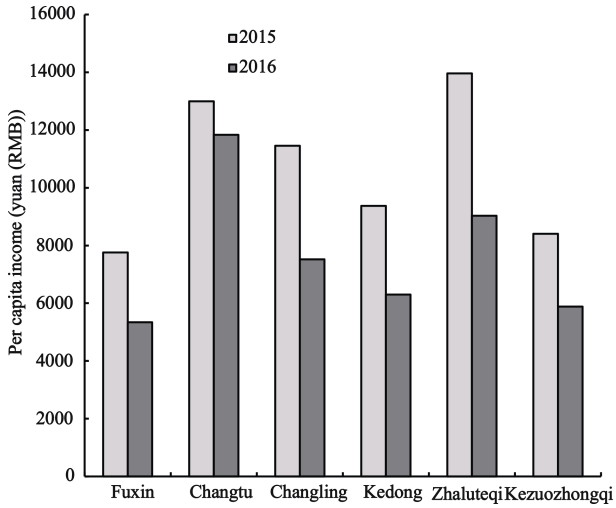

Fig. 11 Per capital income in investigation counties

4 Conclusions

This study has examined farmers' willingness to grow corn after Chinese government published policy of corn structural adjustment in 'Liandaowan' area and canceled the policy of corn storage. The results indicated that the effect of Chinese corn structural adjustment plan is not satisfactory. This plan can not effectively mobilize the enthusiasm of farmers to change their crops. Corn reduction confronted with many constraints and most of farmers insist on planting corn. Based on a sample household survey conducted in 2017, this paper distinguished the main factors underlying farmers' corn reduction. Physical factors is an important determinant of crop selection, drought and low accumulated temperature in 'Liandaowan' limited the diversity of crops that can be cultivated. From the crop profiles, farmers in this area have not found suitable crop to substitution corn. Personal factors such as farmers' preferences, the problem of rural ageing and uneducated labor force also affect farmers' decision making. Furthermore, although corn prices are decreasing, corn is still profitable compared with other crops. The availability of machinery and technical assistance proved fundamental to new crop cultivation. Subsidies for corn producers in 2016-2018 also proved further influential, since subsidies for planting other crops are very limited. Besides, new crop means new investment and low family income decrease farmer's desire to plant crops with uncertainty of financial returns. Especially, this may not be the case if the adjustment requires a heavy capital investment.

These results have important implications for China's corn structural adjustment plan, farm land conservation, subsidies and household choices of adaptation strategies in 'Liandaowan' areas.

5 Policy Discussion

5.1 Increase crop diversity

Farmers in the 'Liandaowan' area face various types of risks in crop production incorporating climate change and price fluctuations. The fluctuate of the world prices for agricultural products makes farmers more vulnerable. These fluctuations, especially large and unexpected, can threaten the stability of framers' income and sustainable livelihoods. Crop diversity is considered as one of the countermeasures to mitigate the risks and uncertainties that farmers face (Lee et al., 2016). Diversification can help a farmer to balance low price in one or two crops with reasonable prices among other products (Mandal, 2014). In India, Mahesh (1999) observed that farmers diversify their cropping pattern to minimize price risk. And in low precipitation area of Italy (Di Falco and Chavas, 2006) and in Ethiopia (Di Falco et al., 2010) producers use crop diversity reduced the variance of crop production. Since most of the areas in 'Liadaowan' are in poor natural conditions, and increasing crop diversity is helpful for combating current corn price fluctuation. Crop diversity can provide an opportunity for farmers to compensate for the loss of income caused by the decrease of a certain crop price or yield. Therefore, the government should encourage farmers in the 'Liandaowan' area try to plant other crops such as coarse cereals, fruits and Chinese medicinal materials. It not only can stabilize the income but also can implement the national corn reduction plan.

5.2 Promote soybean and corn rotation

Crop rotation is a common method for agricultural systems to maintain crop productivity. Corn-soybean rotation resulted in higher corn and soybean yields than the respective monocultures. In the US Corn Belt, 2-year corn–soybean rotation (≈65%) are the dominant cropping systems (Grassini et al., 2015). Corn-soybean rotation has a number of advantages for both farmers and environment, including nitrogen fixation, soil nutrients improvement, increases soil carbon content and reduc-

tion diseases and weed and insect populations (Grabau and Chen, 2016; Manda et al., 2017). In northeast China, most of areas are continuous maze cultivating. Under long-term continuous corn cropping, mollisol organic matter structure became aliphatic and simple, the protection abilities of aggregates and mineral association decreased, which can't benefit for the stability and storage of organic matter (Zhang et al., 2016). Since 2016, the Chinese government started a pilot project for land fallow and rotation. In 2018, the pilot area has reached 1.6 million hectares. However, owing to limited funds, the land rotation subsidy is mainly obtained by large farms and farmers' cooperatives. The vast majority of Chinese farmers received little or no rotation subsidies. Another important policy action the Chinese government needs to do is publicizing the benefits of rotation to farmers and let themselves carry out corn and soybean rotation voluntarily. Beside, ensure that all rotation farmers are subsidized.

5.3 To increase the corn substitution subsidies

Agricultural subsidies are payments by the central government to producers of agricultural commodities for the purpose of stabilizing food prices, guaranteeing adequate food production, ensuring farmers' basic incomes, and strengthening the agricultural sector of the national economy. The impacts of subsidies on agricultural production, input allocation and income distribution have been well studied in many literatures (Rizov et al., 2013). In the United States, Goodwin et al. (2004) found that crop insurance subsidies do incentivize cropping, and increased participation in crop insurance is indeed related to the additional acreage in wheat. Since the corn substitution subsidy is insufficient in 'Liandaowan' areas. The Chinese government should ensure farmers planting sorghum, millet, potato, sunflower and other substitution crop can get producer subsidies. Especially, expansion of agricultural insurance coverage and types, ensuring some coarse grain such as millet and sorghum can be included in the insurance subsidy program, and guaranteeing areas with high production risk receive larger crop insurance payments.

5.4 Provide adequate agricultural extension services to help the farmers

Agricultural extension services plays an important role in promoting agricultural productivity, increasing food security, improving rural livelihoods, and promoting agriculture as an engine for promoting the economic growth of the poor. Providing of agricultural extension service is an important foreign-political instrument to stimulating the development of agricultural production. Agricultural extension service must provide effective link between producers, agricultural research and other sources of information (Živković et al., 2009). In China, the agricultural production services for farmers such as the provision of farmers with knowledge, information, experiences and technologies are far from adequate. Since most farmers in 'Liandaowan' area of Northeast China have not got any technical service help, and it is important to increase farmers' technical training that confront the technical needs of producers. In view of the drought climate in northeast pastoral zone, local governments need to increase financial investment to improve the agricultural infrastructure in this region and extension water saving irrigation techniques, such as sprinkler irrigation, micro irrigation. In the USA, the federal government contributes 43 percent, states 39 percent and counties 18 percent to the financing of the Cooperative Extension Service (Obiora and Emodi, 2013). China should learn from the experience of the United States and legislate an agricultural extension policy which guarantees cooperation, collaboration and financial support by the three tiers of government –central, provincial and county to the extension service.

5.5 Improving Farmer Livelihoods

In Northeast China, many farmers have become dependent on government support to stay profitable. In 2016, the Chinese government canceled temporary reserve policy and price support policies for all commodities except wheat and rice. Farmers' family income is generally declining. In rural China, despite significant rise of income from off farm employment, agriculture still contributed to about 42% of average rural households in 2014 Therefore, the Chinese government need to offer more job opportunities in urban areas for farmers in 'Liandaowan' areas and ensuring farmers to master more job skills through training. The government should set up a special fund help the farmers for reducing the blindness of migrant, providing legal assistance services, ensuring the rights and interests of migrant farmers, and supporting the youth in poverty families. The ultimate goal is to avoid the farmers pov-

erty-returning as the result of corn prices decreased.

There is considerable scope for expanding on this research. Given the comparatively low per capita net income of farmers in our case study, it would be interesting to undertake a new study in areas of assessment sustainable livelihoods of different farmers. Further researches should be carried out such as the effects of new corn policy 'market-oriented purchase + subsidy' on farmers' crop decisions in Northeast China and assess the differences in the decision-making process between subsistence and commercial farmers and farmers' cooperatives, and discuss the dynamic effects of agricultural supply-side reform on structural change in northeast China agriculture. Besides, more statistical method such as Principal Components Analysis (PCA), Multinomial Probit Model can be used analyze the relationships among these variables and planting willingness of different crops.

References

Asrat S, Yesuf M, Carlsson F et al., 2010. Farmers' preferences for crop variety traits: lessons for on-farm conservation and technology adoption. *Ecological Economics*, 69(12): 2394–2401. doi: 10.1016/j.ecolecon.2010.07.006

Caldas M M, Bergtold J S, Peterson J M et al., 2014. Factors affecting farmers' willingness to grow alternative biofuel feedstocks across Kansas. *Biomass and Bioenergy*, 66: 223–231. doi: 10.1016/j.biombioe.2014.04.009

Chen Yujie, Zhang Pingyu, Liu Shiwei et al., 2016. The spatio-temporal pattern change and optimum layout of grain production in the west of northeast China. *Scientia Geographica Sinica*, 36(9): 1397–1407. (in Chinese)

Di Falco S, Chavas J P, 2006. Crop genetic diversity, farm productivity and the management of environmental risk in rainfed agriculture. *European Review of Agricultural Economics*, 33(3): 289–314. doi: 10.1093/eurrag/jbl016

Di Falco S, Bezabih M, Yesuf M, 2010. Seeds for livelihood: crop biodiversity and food production in Ethiopia. *Ecological Economics*, 69(8): 1695–1702. doi: 10.1016/j.ecolecon.2010.03.024

Dury J, Garcia F, Reynaud A et al., 2013. Cropping-plan decision-making on irrigated crop farms: a spatio-temporal analysis. *European Journal of Agronomy*, 50: 1–10. doi: 10.1016/j.eja.2013.04.008

Fewell J E, Bergtold J S, Williams J R, 2016. Farmers' willingness to contract switchgrass as a cellulosic bioenergy crop in Kansas. *Energy Economics*, 55: 292–302. doi: 10.1016/j.eneco.2016.01.015

Goodwin B K, Vandeveer M L, Deal J L, 2004. An empirical analysis of acreage effects of participation in the federal crop insurance program. *American Journal of Agricultural Economics*, 86(4): 1058–1077. doi: 10.1111/j.0002-9092.2004.00653.x

Grabau Z J, Chen S Y, 2016. Influence of long-term corn–soybean crop sequences on soil ecology as indicated by the nematode community. *Applied Soil Ecology*, 100: 172–185. doi: 10.1016/j.apsoil.2015.12.016

Grassini P, Specht J E, Tollenaar M et al., 2015. High-yield maize–soybean cropping systems in the US corn belt. In: Sadras V O, Calderini D F (eds). *Crop Physiology*: *Applications for Genetic Improvement and Agronomy*. 2nd ed. Amsterdam: Academic Press, 17–41.

Greig L, 2009. An analysis of the key factors influencing farmer's choice of crop, kibamba ward, Tanzania. *Journal of Agricultural Economics*, 60(3): 699–715. doi: 10.1111/j.1477-9552.2009.00215.x

Habarurema E, Steiner K G, 1997. Soil suitability classification by farmers in southern Rwanda. *Geoderma*, 75(1–2): 75–87. doi: 10.1016/S0016-7061(96)00078-X

Han X, Jin J J, Zhang Y P, 2016. Difficulties of structural adjustment: farmers' enthusiasm for planting corn is hard to reduce in Inner Mongolia. http://news.nongji360.com/html/2016/11/213404.shtml.

Heilongjiang Provincial Bureau of Statistics Survey Organization of Heilongjiang of NBS, 2016. Heilongjiang Statistical Yearbook 2016. Beijing: China Statistics Press.

Heilongjiang Provincial Bureau of Statistics Survey Organization of Heilongjiang of NBS, 2017. Heilongjiang Statistical Yearbook 2017. Beijing: China Statistics Press.

Huang J K, Yang G L, 2017. Understanding recent challenges and new food policy in China. *Global Food Security*, (12):119-126. doi: org/10.1016/j.gfs.2016.10.002.

Inner Mongolia Autonomous Regional Bureau of Statistics, 2016. Inner Mongolia Statistical Yearbook 2016. Beijing: China Statistics Press.

Jaffe J, 1989. Land use, soil degradation, and farmer decision-making: a sondeo report of Cavalier, Despa, Kols, and Saut Mathurine, Haiti. http://www.doc88.com/p-6611598905999.html,11 Jan 2018.

Jilin Provincial Bureau of Statistics Survey Organization of Jilin of NBS, 2016. Jilin Statistical Yearbook 2016. Beijing: China Statistics Press.

Jilin Provincial Bureau of Statistics Survey Organization of Jilin of NBS, 2017. Jilin Statistical Yearbook2017. Beijing: China Statistics Press.

Kallas Z, Serra T, Gil J M, 2009. Farmer's objectives as determinant factors of organic farming adoption. In: *Proceedings of the 113th Seminar European Association of Agricultural Economists*. Chania, Crete, Greece: EAAE. http://purl.umn.edu/58035, 23 Apr 2018.

Katundu M A, Mhina M L, Mbeiyererwa A G et al., 2014. *Socio-Economic Factors Limiting Smallholder Groundnut Production in Tabora Region*. Research Report 14/1, Dar es Salaam: REPOA. http://www.repoa.or.tz/documents/REPOA_RR_14.1.pdf, 15 May 2018.

Klasen S, Priebe J, Rudolf R, 2013. Cash crop choice and income

dynamics in rural areas: evidence for post-crisis Indonesia. *Agricultural Economics*, 44(3): 349–364. doi: 10.1111/agec.12015

Kurosaki T, 2008. Crop choice, farm income, and political control in Myanmar. *Journal of the Asia Pacific Economy*, 13(2): 180–203. doi: 10.1080/13547860801923582

Lee H, Bogner C, Lee S et al., 2016. Crop selection under price and yield fluctuation: analysis of agro-economic time series from South Korea. *Agricultural Systems*, 148: 1–11. doi: 10.1016/j.agsy.2016.06.003

Liaoning bureau of statistics survey organization, 2016. Liaoning statistical yearbook 2016. Beijing: China statistics press.

Mahesh R, 1999. *Causes and Consequences of Change in Cropping Pattern*: *A Location-Specific Study*. Discussion Paper No. 11, Thiruvananthapuram: Kerala Research Programme on Local Level Development Centre for Development Studies.

Manda J, Alene A D, Mukuma C et al., 2017. Ex-ante welfare impacts of adopting maize-soybean rotation in eastern Zambia. *Agriculture*, *Ecosystems & Environment*, 249: 22–30. doi: 10.1016/j.agee.2017.07.030

Mandal R, 2014. Flood, cropping pattern choice and returns in agriculture: a study of Assam plains, India. *Economic Analysis and Policy*, 44(3): 333–344. doi: 10.1016/j.eap.2014.08.001

Moniruzzaman S, 2015. Crop choice as climate change adaptation: evidence from Bangladesh. *Ecological Economics*, 118: 90–98. doi: 10.1016/j.ecolecon.2015.07.012

National Bureau of Statistics of China, 2018. China statistical yearbook 2018. Beijing: China statistics press.

National food and strategic reserves administration, 2016. Northeast China corn purchase price monitoring information. http://www.lswz.gov.cn/html/zt/ymsczdgg/2018-06/14/content_236741.shtml. Cited 22 Dec 2017.

National food and strategic reserves administration, 2014. Notice of the purchase of temporary storage corn in Northeast China in 2014. http://www.lswz.gov.cn/html/tzgg/2018-06/12/content_215302.shtml. Cited 22 Dec 2017.

Obiora C J, Emodi A I, 2013. Restructuring the agricultural extension service for effective agricultural transformation agenda in Nigeria. *Greener Journal of Agricultural Sciences*, 3(6): 511–517. doi: 10.15580/GJAS.2013.6.061013660

Ortega D L, Waldman K B, Richardson R B et al., 2016. Sustainable intensification and farmer preferences for crop system attributes: evidence from Malawi's central and southern regions. *World Development*, 87: 139–151. doi: 10.1016/j.worlddev.2016.06.007

Paulrud S, Laitila T, 2010. Farmers' attitudes about growing energy crops: a choice experiment approach. *Biomass and Bioenergy*, 34(12): 1770–1779. doi: 10.1016/j.biombioe.2010.07.007

Peng Chao, 2017. Basic framework of agricultural subsidies, policy performance and the direction of conversion in China. *Theoretical Exploration*, (3): 18–25. (in Chinese)

Popescu A, Alecu I N, Dinu T A et al., 2016. Farm structure and land concentration in Romania and the European Union's agriculture. *Agriculture and Agricultural Science Procedia*, 10: 566–577. doi: 10.1016/j.aaspro.2016.09.036

Pradhan D, Ranjan R, 2016. Achieving sustainability and development through collective action? An empirical analysis of the impact of the bore pool sharing program on farm incomes and crop choices. *World Development*, 88: 152–174. doi: 10.1016/j.worlddev.2016.07.015

Rahman S, 2008. Determinants of crop choices by Bangladeshi farmers: a bivariate probit analysis. *Asian Journal of Agriculture and Development*, 5(1): 29–41.

Rizov M, Pokrivcak J, Ciaian P, 2013. CAP subsidies and productivity of the EU farms. *Journal of Agricultural Economics*, 64(3): 537–557. doi: 10.1111/1477-9552.12030

Saito K, Linquist B, Keobualapha B et al., 2006. Farmers' knowledge of soils in relation to cropping practices: a case study of farmers in upland rice based slash-and-burn systems of northern Laos. *Geoderma*, 136(1–2): 64–74. doi: 10.1016/j.geoderma.2006.02.003

Seo S N, Mendelsohn R, 2008. An analysis of crop choice: adapting to climate change in South American farms. *Ecological Economics*, 67(1): 109–116. doi: 10.1016/j.ecolecon.2007.12.007

U.S. Department of Agriculture, 2018. World Agricultural Supply and Demand Estimates. https://usda.library.cornell.edu/concern/publications/3t945q76s?locale=en. Cited 23 Jan 2018.

Van Huylenbroeck G, Damasco-Tagarino D, 1998. Analysing crop choice of Philippine vegetable farmers with multicriteria analysis. *Journal of Multi-Criteria Decision Analysis*, 7(3): 160–168. doi: 10.1002/(SICI)1099-1360(199805)7:3<160:AID-MCDA186>3.0.CO;2-L

Wu Liancui, Cai Honghui, 2010. Positive study on the effect of grain subsidy policy on farmers' planting behavior. *Technology Economics*, 29(6): 68–73. (in Chinese)

Wu Q R, Zhang W D, 2016. Of maize and markets: China's new corn policy. *Ag Decision Maker*, 21(2): 1–6. Cited 6 Oct 2017.

Yu Baifu, 2013. Present situation and development countermeasures of the coarse grain industry in Baicheng. *Modern Agricultural Science and Technology*, (12): 303–304. (in Chinese)

Yu J S, Smith A, Sumner D A, 2016. The effects of the premium subsidies in the U.S. federal crop insurance program on crop acreage. In: *Proceedings of 2016 Annual Meeting*. Boston, Massachusetts: Agricultural and Applied Economics Association.

Zhang Futao, Qiao Yunfa, Miao Shujie et al., 2016. Chemical structure characteristics of all fractionations in mollisol organic matter under long-term continuous maize cropping. *Scientia Agricultura Sinica*, 49(10): 1913–1924. (in Chinese)

Živković D, Jelić S, Rajić Z, 2009. Agricultural extension service in the function of rural development. In: *Proceedings of the 113th EAAE Seminar* '*The Role of Knowledge, Innovation and Human Capital in Multifunctional Agriculture and Territorial Rural Development*'. Belgrade, Republic of Serbia: EAAE. https://ageconsearch.umn.edu/bitstream/57507/2/Zivkovic%20Dragic%20cover, Cited 22 Jun 2018.