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Maize (*Zea mays* L.) Seed System Analysis in China: A Case Study of Hebei Province, North China

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Abstract: ***The main objective of this study was to assess maize seed system in Hebei Province. The primary data collected from 324 respondents randomly selected from six locations. Descriptive and non-parametric statistics used to analyse primary data. The results show that 73.1 percent of farmers were males and 48.1 percent of farmers attended primary school. The study revealed that 73.1 percent of farmers preferred high yielding maize varieties and 73.8 percent sourced seed from agro dealers. In addition, 59.6 percent of farmers produced maize for both consumption and market, and while 53.1 percent used Urea fertilizer. Study shows that 34.7 percent of farmers sourced information from media, radio and television. While 33.3 percent and 57.4 percent of farmers were seed secure and 6-months seed security period, respectively. At least 70 percent of farmers had positive perception towards seed price, seed source, seed quality and maize varieties. The Kruskal-Wallis H test showed that there is a statistically significant difference in area, seed price and seed rate among the six locations. In conclusion, promoting a good seed system and encouraging stakeholder involvement in the seed system will increase seed availability and sustainability of the hybrid maize seed to the users.***

Keywords: Hybrid, Maize, Seed System, Management

1. Introduction

Maize (*Zea mays*) originated in central Mexico. It contains about 10% protein, 4% fat and 72% starch, supplying density energy of 365 Kcal /100 g and grown in different climate condition throughout the world. China is the second largest country producing maize in the world. it processed into a diversity of industrial goods and food uses, including starch, oil, beverages, glue, sweeteners, manufacturing alcohol and fuel ethanol [1].

In China, maize used as a raw material for feed and industrial products. Maize processed into various traditional foods such as popcorn, pancake, and steamed cake, by traditional techniques especially in the countryside [2]. In northern part of China, the crop is well adapted to the different climate conditions, with high stable yield [3].

Seed system is an open system influenced by other systems such as ecological, economic, social and political systems [4]. Successful seed systems have a possibility to increase production quickly and economically. Informal seed systems models are not delivering with good association and effectiveness needed. For example, farmers often rely on seed circulation from their member farmers, which is just too slow for new varieties to have a major impact, formal seed systems, tend to focus on a few advantageous seed crops such as vegetable and maize seed, leaving other seed of legumes, including beans, largely by the wayside [5].

A sustainable seed system will guarantee that high quality seeds of a wide range of varieties and crops are produced and fully available in time and reasonable to farmers and other stakeholders. However, in several developing countries farmers have not been able to completely profit from the using of quality seed due to a mixture of factors, including ineffective seed distribution, quality assurance, and production systems, as well as bottlenecks caused by lack of good seed policy on key issues such as access to credit for inputs. Furthermore, unequal food prices and climate change creates additional challenges [6]. Therefore, main objective of this present study was to assess maize seed system in Hebei Province.

2. General Objective

The main objective of this study was to assess maize seed system in Hebei Province. The specific objectives are:

a) To identify demographic characteristics of farmers;
b) To identify source of maize seed and information;
c) To assess seed availability to farmers;
d) To determine constraints of the seed system in Hebei Province; and,
e) To assess location differences in the maize seed system.

2.1 Research Hypothesis

H_0, there is no statistically significant differences on area, seed price and seed rate by location.
H_A, there is statistically significant differences on area, seed price and seed rate by location.

3. Literature Review

Seed is an essential input for agricultural production and the most affordable external input for many household farmers [28]. To boost agricultural productivity, the availability of high quality seed of well-adapted varieties is very important, to reduce poverty leading to high farmers' income, and improved food security [29]. Seed system represents different stakeholders such as individual organization, and institution associates with the development, seed processing, seed multiplication, storage, distribution and marketing of seed of any crop. There is a formal and informal seed system [30]. Agricultural research and plant breeding in China is mostly public managed. Organized Public seed companies only allowed multiplying and selling cereal seed, while breeding was restricted to research institutes in the national agricultural research system. The seed industry consisted of public county seed companies whose responsibility to conduct regional yield trials and screen adaptation varieties multiplying and selling seed and carry out extension activities. County seed companies monopolized local seed markets, where nonpublic seed companies and organizations excluded from marketing seed of any major crop, including maize. The most significant change brought about by the new seed law was the elimination of the market monopoly by seed companies in the public seed system [20]. Therefore, this study aimed at assessing maize seed system in Hebei Province.

4. Methodology

The study carried out in Hebei Province in 2017/2018 cropping season. A case study used in combination with qualitative and quantitative methods. The six locations purposively sampled for investigation and collecting data, namely Shijiazhuang, Handan, Baoding, Hengshui, Tangshan and Zhangjiakou (Figure 2). In this study, six seed companies from each location purposively selected.

4.1 Study area

Hebei is a province of People's Republic of China, located in the northeast part of the country (longitude 113°30 - 119°54 E, Latitude 36°6 - 42°36 N). It has an area of 187,693 km^2 and a population of 72.8 million, with 170 administrative counties [7]. It borders Inner Mongolia to the north, Liaoning to the northeast, Shanxi to the west, Henan to the south, and Shandong to the southeast. It surrounds Tianjin and Beijing municipalities (Figure 1 and Figure 2). Most of southern and central parts lie within the North China Plain. The western part rises into the Taihang Mountains (Taihang Shan), while the Yan Mountains (Yan Shan) run through northern part, throughout northern part the Great Wall cuts from east to west as well, briefly entering the border of Beijing Municipality, and terminates at the sea coast of Shanhaiguan in northeastern part. The highest peak is mountain Xiao wu tai in northwestern, with an altitude of 2882 m [8].

Figure 1: Map of China and Hebei Province Location

Figure 2: Map of Hebei province (Location of the study areas)

4.2 Climate of the study area

Hebei has a continental monsoon climate, with cold, dry winters, and hot, humid summers. The average temperatures (-16 to -3) °C in January and (20 to 27) °C in July; the annual precipitation ranges from 400 to 800 mm, concentrated heavily in summer [8].

4.3 Farming system of study area

Double cropping wheat maize is the most important cropping system in Hebei province [9]. The plain area in Hebei Province is one of the three major parts of North China Plain, alongside Henan and Shandong [9]. Moreover, maize production in Hebei Province is very special in China, the transition area between spring and summer maize planting area is located in Hebei Province. Spring maize planting area in north area Chengde, north part of Tangshan and Qinhuangdao, Northwest area is Zhangjiakou, and west area among the Taihang Mountain, Spring and Summer Transition planting area major area are Beijing, Tianjin, south part of Tangshan and Qinhuangdao sowing season April~July planting pattern is early spring, late spring. Summer direct sowing, summer relay cropping, Summer planting area, Piedmont plain area are West part of Shijiazhuang, Baoding, Xingtai and Handan Lower Plain are Cangzhou, Hengshui, east part of Baoding, Xingtai and Handan, [10].

4.4 Data Collection

Both quantitative and qualitative data collected from the various stakeholders, through questionnaires. Secondary data collected from unpublished and published papers, journals, magazines, official websites and news bulletins. For quantitative and qualitative data used household survey in order to assess demographic aspect of the farmers, varieties preferences, information for maize seed and constraints related to seed access in the study areas, seed availability, seed security, seed storage method, farmer's seed quality perception and management, farmers' seed source, and information on major fertilizer associated with maize seed.

4.5 Sampling procedure and layout

The actual number of respondents from each location was determined based on the proportional random sampling method during the survey. The questionnaire and the checklist designed and pre-tested from randomly selected farmers in Shijiazhuang before the actual data collection. The qualitative and quantitative data collected from farmers. Table 1 presents distribution of the farmers in the study areas.

Table 1: Farmers' distribution in the study areas

Location	County	Village	Total
Shijiazhuang	2	4	100
Tangshan	1	1	25
Baoding	2	4	100
Zhangjiakou	1	1	25
Handan	1	2	50
Hengshui	1	1	24
Total	8	13	324

4.6 Data analysis

The primary data collected from 324 respondents, and analyzed using descriptive statistics and Kruskal-Wallis H test in SPSS version 23 program.

5. Results and Discussion

The results obtained from data analysis, included household demographic characteristics, and existing seed system on farmer's variety choice, farmer's fertilizer uses that associated with maize production, farmer's seed source, farmer seed storage, farmer's information source, farmers' seed perceptions, seed security and security period, and seed availability.

5.1 Demographic Characteristics of Farmers

5.1.1 Gender

Table 2 shows that 73.1% of farmers were male and 26.9% were female. This result supported by [11], found that men headed about 99% of households, in maize seed system in Ethiopia. Moreover, [12] showed that men grow significantly more mats for all banana cultivars than women do. In similar way, gender assumed to be a potential factor influencing quantity of seed to be purchase. However, this result is contradicting with [13], who found that in Duan county of North West part of Guanxi providence 90% of household respondents were female. A high number of male households respondents in Hebei province means that majority of male are engaged in agriculture especially maize production, and female are obligated to domestic work, and less engaged in maize production.

5.1.2 Age

The study found that 43.6% of farmers were in the age between 40 and 50 years old and only 2.2% were in the age between 20 and 30 years old. Present study show that majority of farmers in Hebei Province were aged between 40 and 50 years old. This result is similar to [11] in western Oromia, Ethiopia where farmers involved in maize seed system reported that the average age of farmers was between 40 and 48 years. Furthermore, pervious research finding by [14] in Ethiopia, 60 % of farmers were aged from 40 to 50 years in Godere District from formal maize seed users, this is because most of young people were engaged in green employment in urban area, while experience farmers were engaged in maize production, and therefore they easily adopt new technology. Moreover, [15] reported that there was a positive and significant relation between age group and improved maize variety of CMS 870 in Cameroon. Early adopters of CMS 8704 were mostly adults.

5.2.2 Education level

Table 2 shows that 48.8% of farmers attended primary level of education, 24.1% attained high school education and 11.1% have illiterate level of education. This implies that farmers are able to access and acquire agricultural technology in Hebei province. This in turn might improve their maize seed utilization and adoption with recommended modern agronomic practices and methodologies. This finding is similar to [16], which

showed that levels of education attained was varying considerably across the different five maize agro ecological regions in China, the largest share of the population in most villages completed middle school. Moreover, this finding corresponds with [17] found that education to have positive effect to adoption of improved maize varieties in West Shoa, Ethiopia. Furthermore [11], [18] found that farmers in Bako Tibe, Ethiopia found that 54% of farmers finished primary or secondary education.

Table 2: Household Demographic Characteristics

Variable	Category	Frequency	%
Gender	Male	237	73.1
	Female	87	26.9
Age Years	20-30	7	2.2
	30-40	67	21
	40-50	139	43.6
	50-60	75	23.5
	>60 Years	31	9.7
Education Level	Illiterate	36	11.4
	Adult	49	15.5
	Primary	152	48.1
	High School	76	24.1
	College	3	0.9

5.2 Source of Maize Seed and Information Source

5.2.1 Farmer determinant(s) of variety

Table 3 below shows the result of reasons for farmer variety determinants. It reveals that 73.1% of farmers selected variety based on high yield and 34.6 % selected based on marketing output of variety. Study shows that, majority of farmers determine variety based on high yielding capacity, this is because high yield generate more income, which is necessary for farmers livelihood. A past study by [11] contended that hybrid maize was preferred for its yield advantage, and it performs well under favourable environment. Moreover, [16] indicated that high yield was the highest ranked characteristic in almost every farmer group across all agro ecological regions, in addition farmers also determines drought tolerance, and lodging resistant being important characteristics for farmers to determine variety. Therefore, present study contends that, farmers in Hebei province they prefer high yield to determine maize variety.

Table 3: Determinant(s) of variety of sample farmers

Variable	Frequency	%
Yield	237	73.1
Disease Tolerance	103	31.8
Drought Tolerance	74	22.8
Maturity Period	43	13.3
Marketing Output	112	34.6
Others	18	5.6

Note: The total more than 324 and percentage more than 100 indicated multiple responses

5.2.2 Farmers' seed source

Table 4 below show farmers' seed sources; it indicates that 73.8% of the farmers source their seed from agro dealers, and 3% obtain seed from government. This finding indicated that most of the farmers in Hebei province were getting their hybrid maize seed from agro dealers. This result is similar to [16], which contend that in China, the primary reason for not using other sources was concern over seed quality. Furthermore, [19] reveal that hybrid maize cover 97% of total national planting areas, which contributes 40% of grain yield increase in China. Therefore, study asserts that most of the farmers are getting maize seed from agro dealers.

Table 4: Farmers seed source cropping season 2017- 2018

Seed Source	Frequency	%
Seed company	73	22.5
Government	1	0.3
Agro dealer	239	73.8
Recycled seed	11	3.4
Total	324	100

5.2.3 Purpose of maize production

Table 5 below show that 59.6% of farmers produce maize for both marketing and consumption, and 0.3% produce maize for seed only. Finding shows that both marketing and consumption were the main purposes of maize production in the study areas. This is because of increasing demand of animal feeds and other industrialization purposes. This result is similar to [20], in previous research found that most of the increase in maize production over the last 20 years utilized as feed, meaning that the consumption of maize as food has decreased sharply, and while utilization of maize as feed rising rapidly. Moreover, maize consumption per capita in urban areas is significantly lower than in rural areas. Also{1] found that maize is still a staple food for many people, especially in Africa, maize has food and feed industrial uses and it is a major component of livestock feed. Furthermore, [14] found that in Lare, 81% of sampled farmers produce maize for consumption and market purpose.

Table 5: Purpose of maize production

Purpose of maize production	Frequency	%
Consumption	33	10.2
Market	96	29.6
Both market & consumption	193	59.6
Seed only	1	0.3
No response	1	0.3
Total	324	100

5.2.4 Farmers' fertilizer uses

Table 6 below show that 53.4% of farmers use Urea as main fertilizer for maize production, and 13.3% combine both Urea and DAP (Diammonium Phosphate) and 20.1% use animal manure. Therefore, results show that majority

of farmers prefer urea for maize production. The reasons behind this are that corn is very sensitive to nitrogen deficiency, and application of urea increases crop yield. This result supported by [9], who reported that in field crops research, farmers apply less nitrogen on wheat and more nitrogen on maize and increase applications of phosphorus to wheat and potassium to maize. Moreover, the finding is similar to [16] who found that there were few differences observed across maize systems in the five regions with respect to the application of chemical fertilizers. In addition to the base fertilizer applied at planting by all farmers, most farmers also use DAP and green manure for increasing soil fertility. Furthermore, [11] found that the use of fertilizer by farmers in western Oromia in Ethiopia showed that they applied more fertilizer to local maize than improved maize.

Table 6: Fertilizer uses for maize production

Fertilizer	Frequency	%
Animal manure	65	20.1
Compost	46	14.2
Urea	173	53.4
*DAP	152	46.9
Both Urea & *DAP	43	13.3

Note: more than 100% there was multiple responses.
*DAP = Diammonium Phosphate

5.2.5 Accessibility and Source of Information

Table 7 below show that 58.64% of farmers are getting information for maize seed and 40.74% have no source of information. However, the information sources vary as shown in Table 7. Study shows that 34.7% of farmers obtained information from radio and television. This result is similar with [11] who found that most farmers who owned a radio in Chaliya (75%) listened to agricultural education programs. However, [16] reported that government extension stations and agricultural input companies are the major source of technological information for farmers in northwest region; while in the northeast, farmers rely heavily on other farmers for their information. Furthermore, [14] found that 11.1% of samples farmers got awareness from radio and television.

Table 7: Accessibility and Source of Information

Variables	Response	Frequency	%
Accessibility	Yes	190	58.64
	No	132	40.74
	No Response	2	0.62
	Total	324	100
Information Sources	Radio & TV	66	34.7
	Research	2	1.1
	Extension/MOA	8	4.2
	Relatives	15	7.9
	Neighbours	23	12.1
	Other farmers	35	18.4
	Training course	36	19.0
	Field days	5	2.6
	Total	190	100

5.3 Assess seed availability to farmers

5.3.1 Seed security and security period

Table 8 below show that 58% of farmers were not seed secure and only 33% were seed secure. In addition, it indicates that seed security period varies from 3 months to above 6 months, with respective percentages as shown Table 8. The study finding show that majority of farmers are vulnerable to seed security. This is because most of maize production consumed as food and feed. Results matched the previous report by [21], which reveals that China is self sufficient in wheat, corn, and, rice, and produces 80% of the vegetable and fruit seeds. Farmers are relying less on saved seeds and are instead using government subsidy programs to purchase higher quality commercial seeds**.** Meaning that farmers in the study areas following the same trend in getting seed by less relying on saved seeds for maize production in Hebei province.

Table 8: Seed security and security period

Parameter		Frequency	%
Seed security	Yes	108	33
	No	188	58
	No response	28	9
	Total	324	100.0
Seed security period	3 Months	29	26.9
	6 Months	62	57.4
	<6 Months	15	13.8
	No response	2	1.9
	Total	108	100.0

5.3.2 Maize variety produced in study areas

Table 9 shows that 26.9% of farmers produce Zheng duan958 varieties, and Nongda 108 and Han Yu 66 are less used by the farmers. Result show that majority of the farmers choose Zheng duan958 Maize seed variety and Xianfeng335 because of high yielding capacity and drought tolerance characteristics, this finding is similar to [2], found that in previous research, the common maize varieties were Zhengdan 958, Xianyu 335 and Suyan 485, were collected from Shijiazhuang. Zhangjiakou, and Handan in Hebei province, in October 2013 and October 2014. Meaning that the varieties, which household respondents selected, were very common and well known to the farmers in Hebei province. Furthermore, [11] found that farmers in western Oromia grew 16 maize cultivars. The popular varieties in 1992 were Shashemene, Burrie, and Kenya. In 1996, the popularity of these improved OPVs decreased due to the introduction of improved maize hybrids particularly BH-660. Also [22] reported that, six hundred corn varieties in China were registered in 2015 while only 472 varieties were registered in 2014.

Table 9: Farmers' variety choice

Variety	*Frequency	*%
Tongshuai001	8	3.7
Nongda108	5	2.3
Huanong18	6	2.7
Jun dan20	12	5.5
Liancheng21	6	2.7
Xianfeng335	35	16.0
Zhong xin338	21	9.6
Xian yu508	6	2.7
Nongxi518	10	4.6
Deng hai605	13	5.9
Han yu 66	5	2.3
Weike702	9	4.1
Jinong858	8	3.7
Dadi916	6	2.7
Zheng duan958	59	26.9
Zhendan985	10	4.6
Total	219	100.0

*Based on the first 16 preferred maize varieties out of 75

5.3.3 Farmers' seed storage management

Table 10 shows the management system of maize seed, it reveals that among the respondents, 23.2% store seed separately, 18.8% they select seed from total harvest, and 15.4% they do seed treatment using different chemical as a management method. The finding shows that most farmers store their seed separately as a kind of seed management to improve their quality and viability. This finding agrees with [16], found that in previous research in areas of the North and Northwest regions in China, seed of local varieties, often hung outside the house, due to climatic and insect problems, seed generally stored in closed containers kept inside the house. Farmers in one village in the Southwest rainfed spring region commented that they stored maize seed separately from maize grain in the safest and driest place in the house. Moreover [23] in previous research mentioned that many farmers in different parts of Africa traditionally did dry and store their maize on the cob with husk in open maize storage facilities.

Table 10: Farmers seed storage management

Seed storage method	Frequency	%
Store Seed Separately	75	23.2
Seed Treatment	50	15.4
Selected Seed	61	18.8
Other methods	45	13.9
No response	93	28.7
Total	324	100

5.3.4 Farmers` perception of seed system

Table 11 below show that 96.3% were satisfied with maize seed varieties and 95.1% satisfy with the seed quality, furthermore 96% are accepting seed from formal system, and 84% agreed with the seed price level. Therefore, study found that farmer has a good perception of seed system of Hebei province. Research finding show that most of the farmer's household respondents were confident and satisfied with maize seed varieties, quality, formal source and seed price. This result contradicts with the result finding by [24] in Tigrai National Regional State, Ethiopia that most of the hybrid maize seed beneficiary farmers are less likely to determine on the type of variety, price, needed quantity, time to purchase, and the seed supplier because of domination of private sector. This implies that seed system in Hebei province, are much better than Tigrai National State.

Table 11: Farmers` perception of seed system

Power to determine	Decision	Frequency	%
Confident with maize seed varieties	Yes	312	96.3
	No	10	3.1
	No response	2	0.6
	Total	324	100
Satisfied with maize seed quality	Yes	308	95.1
	No	12	3.7
	No response	4	1.2
	Total	324	100
Accept formal seed source	Yes	311	96
	No	8	2.5
	No response	5	1.5
	Total	324	100
Satisfied with maize seed price	Yes	271	84.0
	No	50	15.0
	No response	3	1.0
	Total	324	100

5.4 Determine Constraints of the Seed System in Hebei Province

5.4.1 Farmers' Land hold size (Ha)

Figure 1 show that 47.8% of farmers have land size between 0.33 and 0.67 Ha, 42.3% possess land size of less than 0.33 Ha, and 9.9% have land size above 0.67 Ha. This result is similar to [16] found that farm size varies significantly by agro ecological region, national and regional averages, with larger farm sizes in the Northeast region and much smaller ones in the Southwest region. Average farm sizes ranged from 0.2 Ha in the Southwest irrigated spring maize area to a high of over 1.1 Ha in the Northeast. Per capital arable land ranged from 0.06 Ha in the southwest to 0.3 Ha in the northwest rain-fed spring maize system. Moreover, finding by [11] the average land holding was between 12 to 15 timmad (1 timmad = 0.25 ha) in Ethiopia. Furthermore, study by [25] found that farm sizes vary throughout the three top corn-producing regions in China. The average farm size of Heilongjiang region is about 2.2 ha.

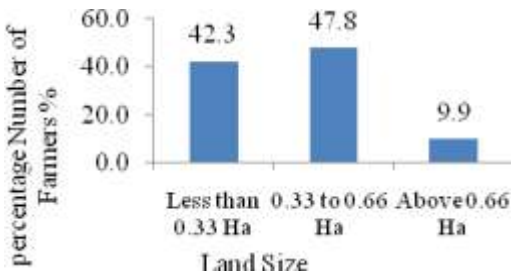

Figure 1: Farmers' Land Holding Size (Ha)
Note: (Mu) is Chinese measurement 1 ha = 15 Mu

5.4.2 Percentage of Seed Price

Figure 2 below show percentage of seed price recorded by the respondents across the study areas, 52.5% of the farmers indicated that seed price ranged from 10 to 20 Yuan per 0.5kg and 8.6% indicated above 20 Yuan per 0.5kg. Therefore, present study indicated that seed price is affordable. Seed price is an important element as agricultural input for the farmers everywhere. A previous study by [11] found that price of hybrid maize seed purchased from Ministry of Agriculture was about US$ 1 per kg in Chaliya and Bila Sayo, Ethiopia.

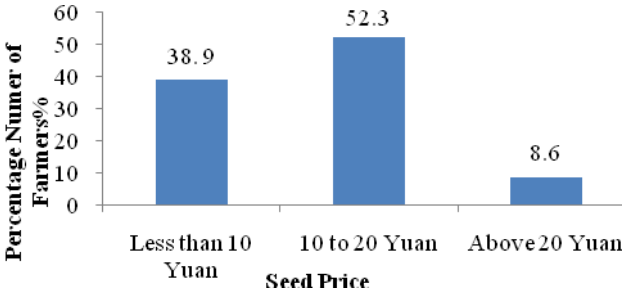

Figure 2: Percentage of Seed Piece (Yuan /0.5 kg)
Note: (Yuan) is Chinese currency 1 US Dollar = 6.4 Yuan. Jin Chinese measurement 1 kg = (2 Jin).

5.4.3 Percentage of Seed Rate (Kg)

Seed rate (planting density) is an important factor for seed production and grain as well, through the survey household, found different planting density and amount of seed used in a unit area (Ha). Figure 3 show that 41.4% of surveyed farmer's use 2.3 to 2.5 kg/Ha and 3% use less than 1.5 kg/Ha. Meaning that most of the farmers are using 2.3 to 2.5 kg/Ha seed rate. According to [9], found that farmers tend to use sub-optimal seed rate and therefore, possibly contributing to differences in seed rate by location.

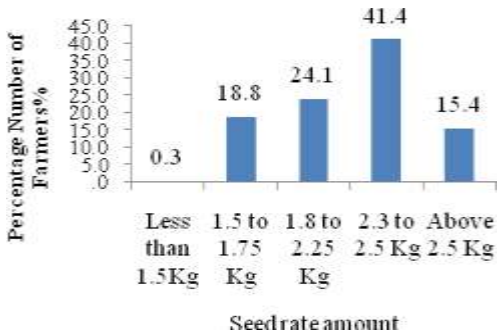

Figure 3: Percentage of seed Rate (Kg) of sample farmers
Jin Chinese measurement 1 kg = (2 Jin)

5.5 Location Differences in the Maize Seed System

5.5.1 Kruskal-Wallis H Test

A Kruskal-Wallis H test conducted instead of a one-way ANOVA because the continuous variables did not met the assumptions of normality test and homogeneity of variance test. The Kruskal-Wallis H tested the null hypothesis that there are no statistically significant differences on area, seed price and seed rate by location (Table13). Table 12 provides the mean rank scores of area, seed price and seed rate across the six locations.

Area: The Kruskal-Wallis H test showed that there was a statistically significant difference in area mean score among the different locations, $H(5) = 57.932$, $p < 0.001$, with area mean rank scores of 137.67 for Baoding, 153.71 for Handan, 219.71 for Hangshui, 137.55 for Shijiazhuang, 242.56 for Tangshan and 236.78 for Zhangjiakou (Table 13). According to [27] found similar findings that households with larger land holdings allocated more land to improve maize production. Therefore, the differences in land holding for maize production by location attributed to differences in land hold size for each farm household.

Seed Price: The seed price mean score was statistically significant different among the different locations, $H(5) = 78.426$, $p < 0.001$, with seed price mean rank scores of 117.45 for Baoding, 138.79 for Handan, 140.17 for Hangshui, 182.30 for Shijiazhuang, 221.20 for Tangshan and 273.66 for Zhangjiakou (Table 13). This result supported by [26] who found that in the U.S corn seed market research, corn seed prices vary significantly across the study areas. It appears that seed companies are able to price discriminate across regions, reflecting spatial differences in farmers' willingness to pay, and their demand elasticity. Also mentioned seed price rises from south to north, reaches a peak near the center of the Corn Belt and then declines when moving further north. This confirms significant differences in seed prices between the center of the Corn Belt and fringe regions.

Seed Rate: The seed rate mean score was statistically significant different among the different locations, $H(5) = 160.57$, $p < 0.001$, with seed rate mean rank scores of 204.62 for Baoding, 65.16 for Handan, 167.50 for

Hangshui, 195.92 for Shijiazhuang, 20.60 for Tangshan and 186.65 for Zhangjiakou (Table 13). According to [9], found that farmers tend to use sub-optimal seed rate and therefore, possibly contributing to differences in seed rate by location.

Table 12: Mean Rank Score of Area, Seed Price and Seed Rate

County	Area	Seed price	Seed rate
	Mean Rank	Mean Rank	Mean Rank
Baoding	137.67	117.45	204.62
Handan	153.71	138.79	65.16
Hangshui	219.71	140.17	167.50
Shijiazh	137.55	182.30	195.92
Tanshan	242.56	221.20	20.60
Zhangjia	236.78	273.66	186.65

Table 13: The Kruskal-Wallis H Test

Variable	N	df	H statistic	p-value
Area (ha)	324	5	57.932	0.001**
Seed price	324	5	78.426	0.001**
Seed rate	324	5	160.570	0.001**

** Significant at 1% level of significance

6. Conclusions

In conclusion, seed is a basic input in agricultural production and development. It is quite clear that Hebei Province is self-sufficient in hybrid maize seed and different locations have different area, seed rate and seed prices. Therefore, an efficient seed system should be in place to support the existing seed system. There is need to improve farmers' skills and knowledge in seed storage and seed quality management for marketing. Extension service could assist create demand of new hybrid varieties, through varietal promotion, on farm demonstrations and seed exhibitions to raise awareness and encourage farmers to purchase more quality seed. Seed suppliers should conduct follow up programs to assess their varietal performance on farmers' fields with technical services and develop feedback mechanism.

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References

[1] P. Ranum, J. P. Pena-Rosas, M. N. Garcia - Casal, "Global maize production, utilization, and consumption," Annals of the New York Academy of Sciences, 1312, pp. 105 -112. 2014.
[2] Z. Liu, G. Zhang, Y. Zhang, Q. Jin, J. Zhao, J. Li, "Factors controlling mycotoxin contamination in maize and food in the Hebei Province, China," Agronomy for Sustainable Development, XXXVI (39), pp. 1-10, 2016.
[3] W. Tao, L. Changhe, Y. Bohua, "Production potential and yield gaps of summer maize in the Beijing-Tianjin-Hebei Region," Journal of Geographical Sciences, XXI (4), pp. 677-688, 2011.
[4] R. Hammond, L. Dube, "A systems science perspective and trans disciplinary models for food and nutrition security". Proceedings of the National Academy of the Sciences in the United States of America (PNAS), CIX (31), pp. 12356-63, 2012.
[5] PABRA, "Seed Systems," pabra-africa.org. [Online]. Available:http://www.pabra-africa.org/seeds-systems/. [Accessed: Jan. 6, 2018.
[6] FAO, "What are Seed Systems?" fao.org. [Online]. Available:http://www.fao.org/agriculture/crops/thematic-sitemap/theme/compendium/tools-guidelines/what-are-seed-systems/en/. [Accessed: Jan. 4, 2018].
[7] Y. Zhang, D. Chun, L. Jiping, X. Shouzhi, A. Tinghua, K. Fengguang, "Gridded population distribution map for Hebei province of China," Journal of Environmental Engineering and Management, XIV (3), pp. 673-680, 2015.
[8] www.Hebei.gov.cn. [Accessed: Dec. 10, 2017]
[9] L. Wei-li, C. Peter, W. Gui-yang, L. Runhui, L. Hongzhan, X. Aiping, 2011. "Quantifying the yield gap in wheat maize cropping systems of the Hebei Plain, China," Journal of Field Crops Research, CXXIV (2), pp.180 -185, 2011.
[10] Y. Cui. (2016). Maize production in china Lecture for international postgraduate student. Hebei Agricultural University.
[11] A. Gemeda, G. Aboma, H. Verkuijl, W. Mwangi, Farmers' Maize Seed Systems in Western Oromia, Ethiopia, CIMMYT, Mexico, 2001.
[12] S. Edmeades, D. J. Panuef, M. Simale, M. Renkow, "Modeling the Cop Variety Demand of Semi-subsistence Households: Banana in Uganda," Journal of Agricultural Economics, LIX (2), pp. 329-349, 2008.
[13] Y. Song, "New" Seed in "Old" China": Impact of CIMMYT Collaborative Program on Maize Breeding in Southwestern China," PhD Thesis, Wageningen, 1998.
[14] B. Goal, "Seed System and Quality Analysis of Maize (*Zea mays* L.) in Lare and Godere Districts, Gambella National Regional State Ethiopia," Unpublished Thesis, College of Agriculture, Department of Plant Sciences, School of Graduate Studies, Harmaya University, 2012.
[15] S. Etoundi, B. K. Dia, "Determinants of the adoption of improved varieties of Maize in Cameroon: Case of CMS 8704," In Proceedings of the African Economic Conference, pp. 397- 413, 2008.
[16] E .C. H. Meng, H. Ruifa, S. Xiaohua, Z. Shihuang, Maize in China: Production Systems, Constraints, and Research Priorities, CIMMYT, Mexico, 2006.
[17] A. Alene, D. Poonyth, R. Hassan, "Determinants of the Adoption and Intensity of Use of Fertilizer," 2000.
[18] G. K, Bekele, "Formal and Informal Seed Systems of Maize in Eastern Wollega," Master's Thesis, Haramaya University, Ethiopia, 2010.

[19] J. Li, "Production, Breeding and Process of Maize in China," in Handbook of Maize: Its Biology, J. L. Bennetzen and S. C. Hake (eds.), Springer, New York NY, 2009.
[20] J. Huang, S. Rozelle, "China: Policies, trade and incentives," in Maize Policies in Asia, A. Gulati and J. Dixon (eds.), Forthcoming, 2006.
[21] GAIN, "Planting Seeds," Report No.CH15084, Beijing, China, 2015.
[22] GAIN, "China's Planting Seeds Market Continues to grow," Report No.CH16066, Beijing, China, 2017.
[23] W. G. R. Meikle, H. Markham, C. Nansen, N. Holst, P. Degbey, K. Azona, S. Korie, (2002), "Pest Management in the Traditional Maize Stores in West Africa: Perspective," Journal of Entomology, XCV (5), pp. 1079-1088, 2002.
[24] G. Tesfamaryam, "Seed Marketing and Supply Chain Management Tigrai National Regional State: Challenges and Opportunities," Unpublished Master's Thesis, Department of Management, Mekelle University, Ethiopia, 2014.
[25] X. Hu, Y. Zimmer, "China's Corn Production Where to establish," Agri benchmark Farms in Corn, Beijing/Braunschweig, 2013.
[26] G. Sui, C. Jean, S. Kyle, "An Analysis of the Pricing of Traits in the U.S. Corn Seed Market," In Proceedings of the 8th INRA-IDEI Conference on Industrial Organization and the Food Processing Industry, Toulouse, France, 2010.
[27] A. Kiross, "Comparative Analysis of Direct Hybrid Maize Seed Marketing and Conventional Seed Distribution System in Eastern Wellega Zone: The case of Sibu Sir and Gobu Seyo Woredas," Unpublished Master's Thesis, School of Graduation, Haramaya University, Ethiopia, 2015.
[28] S. McGuire, "Rethinking seed system analysis and reform for sorghum in Ethiopia," Master's Thesis, Wageningen University, the Netherlands, 2005.
[29] T. Abdoulaye, D. Sanogo, A. Langyintuo, S. A. Bamire, A. Olanrewaju, "Assessing the constraints affecting production and deployment of maize seed in DTMA countries of West Africa," International Institute of Tropical Agriculture, Ibadan, Nigeria, 2009.
[30] FAO. "Seed multiplication by resource poor famers," Rome, Italy, 2004