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EXPERT JUDGEMENT ON THE EFFECTS OF THE GRAIN MARKETING SYSTEM ON GRAIN PRODUCTION IN CHINA: A SURVEY^{1,2}

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1. INTRODUCTION

Grain is of critical importance to China and increasing its production has been a very important priority. However, grain production in China has fluctuated markedly in recent years and has increased only slowly. As a result, per capita grain output has not increased and is no higher than the level in 1984 (see Figure 1). This could be attributed to a number of factors and the understanding of the extent to which such factors had affected grain production are important in formulating policies to stimulate domestic production. This research investigates the extent to which some important factors affect grain production with emphasis on factors relating to the operation of the grain marketing system (GMS) in China. This was achieved by conducting a survey of Chinese experts. Three years, i.e., 1979, 1985 and 1989 were selected for the survey. In these three years, some notable changes were made to the GMS; either procurement prices were increased significantly or some structural changes were made.

2. RESEARCH OBJECTIVES AND HYPOTHESES

There are two objectives to this study.

- (1) To investigate the effects of factors relating to the operation of the GMS on grain production in China; and
- (2) To draw policy implications from the research findings.

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² The data in this paper should be treated as confidential and cannot be used or quoted without the permission of the author.

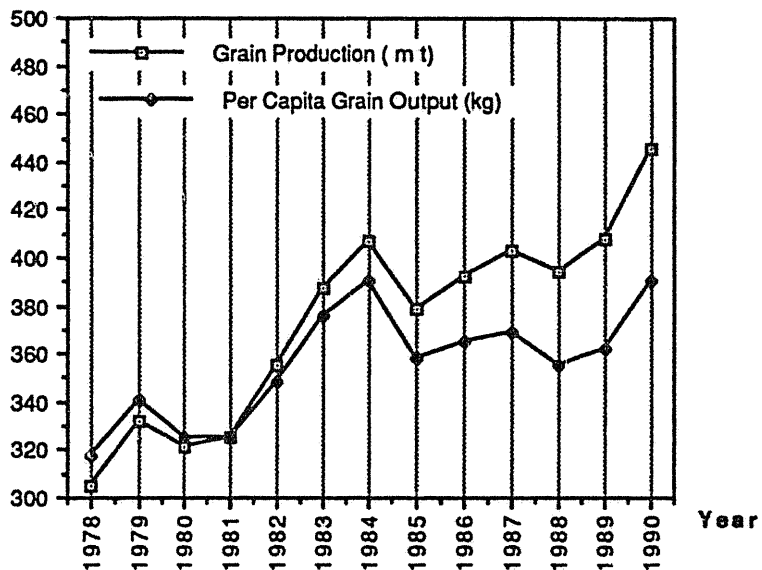


Figure 1: Grain Production and Per Capita Grain Output (1978-90)

Source: Chinese Statistical Yearbook 1991, p. 79, p. 346.

The hypothesis formulated for this research is:

Notable changes in the grain marketing system in China will affect grain production.

The following operational hypotheses are also formulated to verify the above general hypothesis:

Operational hypotheses related to the year of 1979

In 1979, the major changes in the GMS were an increase of 20 percent in the grain procurement price and an increase in the above-quota premium from 30% to 50%. In addition, a free grain market was officially allowed by the government. Thus the operational hypotheses are:

- (1) The grain procurement price increase of 20 percent in 1979 had a positive effect on grain production.
- (2) The increase in the above-quota price from 30 percent to 50 percent over the quota price in 1979 had a positive effect on grain production.
- (3) The restoration of a free grain market had a positive effect on grain production.
- (4) Prices in the free grain market had a positive effect on grain production.

Operational hypotheses related to the year of 1985

In 1985 the unified grain procurement system was replaced by the contractual procurement system, which represented a major structural change to the grain marketing system. Accompanying this, the old quota and the above-quota prices were replaced by a single "30-70" ratio procurement price³. A grain support price was introduced. More non-government grain marketing channels were opened.

- (5) The "30-70" ratio procurement price had a negative effect on grain production.
- (6) The procurement methods under the contractual system had a negative effect on grain production.

³ The new price was set to be equal to a weighed quota and above quota prices, with the former accounting for 30 percent and the latter 70 percent. This decision was based on the fact that the above quota procurement already accounted for 70 percent of the government's total procurement in 1984; with such a 30-70 ratio price, the average price would be kept at the previous level and was 35 percent higher than the former quota price. However, farmers would receive the same average price only when they sold exactly the same amount of grain to the government in 1985 as in 1984. If they sold more to the government in 1985 than in 1984, the total revenue would be lower than that they would receive in 1984, because the marginal price was 10 percent lower compared with the above quota sale in the previous year. Taking the former quota price as a standard, a farmer would receive only a 35 percent price premium for each extra unit, which otherwise would be a 50 percent premium in 1984.

- (7) The introduction of a grain support price had a positive effect on grain production.
- (8) The existence of non-government grain marketing channels had a positive effect on grain production.

Operational hypotheses related to the year of 1989

There was a substantial increase (18%) in the procurement price.

- (9) The increase in the contractual procurement price by 18 percent had a positive effect on grain production.

Operational hypotheses are also formulated to see whether the effects of some factors which underwent some significant changes are similar to the effects of the same factors in another year.

1985 over 1979

- (10) The means of the "grain procurement prices" in 1985 and 1979 are statistically different.
- (11) The means of the "procurement methods" in 1985 and 1979 are statistically different.
- (12) The means of the "non-government grain marketing channels" in 1985 and 1979 are statistically different.

1989 over 1985

- (13) The means of the "grain procurement prices" in 1989 and 1985 are statistically different.

3. THEORETICAL CONSIDERATIONS

Figure 2 briefly shows the factors which affect grain production in those developing economies with large subsistence agricultural sectors, such as China where some 70 percent of grain produced are consumed by the farmers themselves (MAPRC 1989, pp. 410-11). In this schema, it is assumed that farmers have the autonomy to make their own decisions and that their economic activities are confined to the rural areas or the rural economy. Production resources are assumed to be used for grain production or other rural economic activities with little opportunity for investment in urban industrial activities.

Figure 3 shows the general structure of the grain marketing scheme in China which provides more detailed information on the factor "Grain Marketing System" in Figure 2.

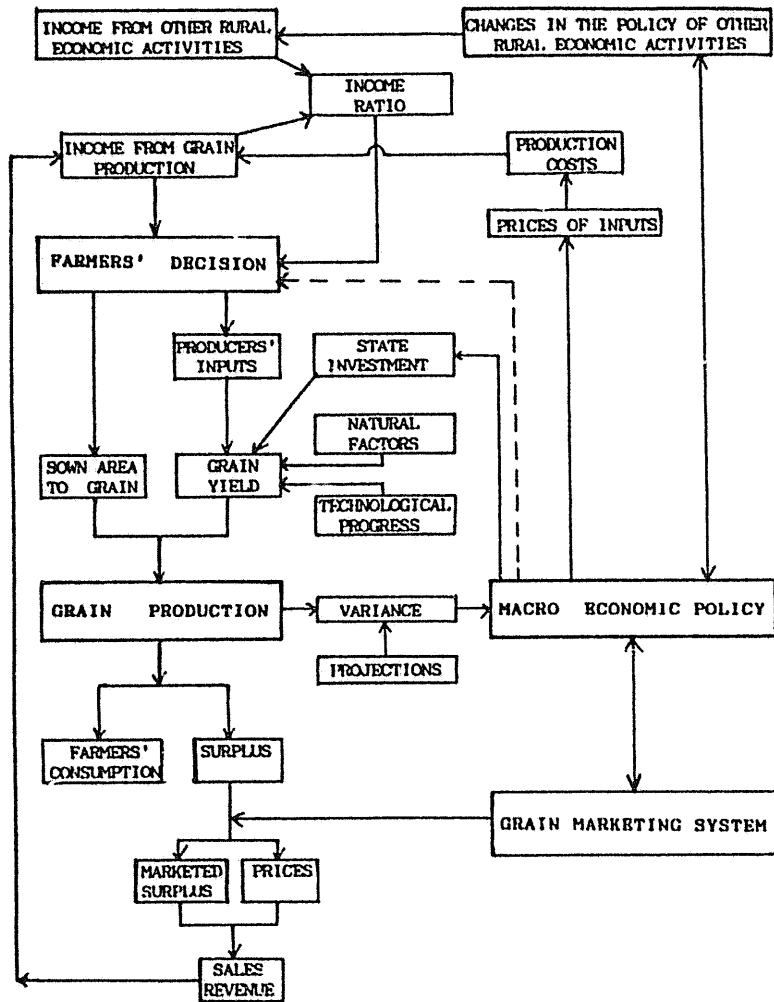


Figure 2. A Brief Illustration of Factors Affecting Grain Production

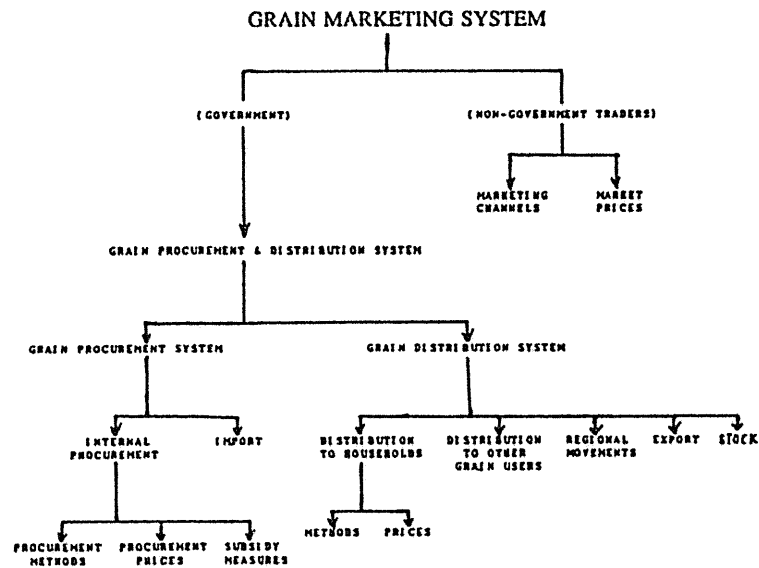


Figure 3. General Structure of Grain Marketing System

Grain production is a product of sown area to grain and average yield. From Figure 2, it can be seen that the yield is affected by producer inputs, government investment, natural factors and technological progress. Of these, government investment and natural factors are beyond the farmer's control. The contribution of technological progress is dependent on the degree of adoption of new technologies by farmers. If the cost of using new techniques is thought to be higher than the benefit from using them, the farmer may not use them⁴. The contribution of producer inputs clearly depends on the level and quality of the inputs and this depends in turn on the farmer. Thus, the yield depends importantly on the farmer's willingness to increase it. The sown area to grain is also determined by the farmers.

The farmer's decisions to allocate production factors between grain crops and other rural economic activities are mainly influenced by the expected incomes obtained from grain production and from other rural economic activities. Income from grain production is determined largely by the prices received by farmers. The prices may be free market prices or government procurement prices.

Besides prices, other components of a grain marketing system may affect grain production. If farmers are not paid promptly by the government, or are instead given IOUs, it could reduce their trust in the government. Moreover, it would reduce their capacity to purchase production inputs for the next season, thereby reducing the yield or sown area and therefore future production. Another factor affecting grain production is the down-payments for grain production. If the down-payments are not handed to the producers in time, this could prevent them from buying inputs for grain production at the right time.

When a government takes major responsibility for feeding its people and subsidises grain consumers, the prices at which it sells procured or imported grain to consumers also affect grain production. So do the prices at which it moves grain from one region to another. This is because a government's budget is limited. If the subsidy for grain increases, the state investment allocated to grain production from the budget may be reduced.

4. SURVEY INSTRUMENT

Many factors affect grain production. A questionnaire survey cannot include all of them. Table 1 on the next page lists some important factors affecting grain production, most of which have been identified in Figures 2 and 3. They are included in the questionnaire. They have been placed into two groups as being directly related to the operation of a GMS and as other factors (e.g., weather conditions). It should be noted that the listing is somewhat arbitrary.

A few words need to be said about the selection of variables. At first, it was intended to include only those several variables relating to a grain marketing system on which the

⁴ Also, a lack of understanding regarding new farming techniques and newly-invented production inputs may increase the perceived risk of that style of farming. Thus agricultural extension has an important role to play.

research is focused. However, it was felt that, by doing so, it may result in a misleading or biased result from the respondents because they may pay much attention only to those factors directly related to the operation of a GMS, while neglecting the importance of the effects of other factors. Hence, it was decided to include most of the major variables affecting grain production as now presented in Table 1. The respondents were accordingly told that this was research into the determinants of grain production rather than just the effects of a GMS on grain production.

The effects of some factors on grain production may be either direct or indirect, cumulative or one off and some factors may not be strictly mutually independent. There are also varying lags in the effects that different factors have on grain production. An early version of the questionnaire included a detailed explanation of these factors to facilitate communication with the experts. However, it was decided not to include it because experts would be aware of the problems and it would have increased the size and complexity of the questionnaire. Nevertheless, an explanation of the ways in which some of the listed factors may affect grain production was included as BACKGROUND INFORMATION in the questionnaire.

The questionnaire finally took the shape as shown by the following example (answering sheet only).

Example:

EFFECTS OF SOME FACTORS ON GRAIN PRODUCTION IN 1979

Show the extent to which each of the factors in the left column of the following matrix table affected grain production in 1979. Please circle the number you think is the most appropriate. If other factors played an important role in influencing grain production, please specify them in the space provided.

Factor	Large -ve Eff.	Med. -ve Eff.	Small -ve Eff.	No Eff.	Small +ve Eff.	Med. +ve Eff.	Large +ve Eff.
1. Weather conditions	-3	-2	-1	0	+1	+2	+3
2. Agricultural research	-3	-2	-1	0	+1	+2	+3
3.	-3	-2	-1	0	+1	+2	+3
.	-3	-2	-1	0	+1	+2	+3
.	-3	-2	-1	0	+1	+2	+3

Likert-style scaling was used (de Vaus 1990, p. 87). By doing so, the answer sheet has been condensed as much as possible, thus helping to reduce the size of the questionnaire. The 7-point scale used was:

Table 1 Classification of Factors Affecting Grain Production

Factors relating to a GMS	Other factors
1. Grain procurement price	1. Weather conditions
2. Grain support price	2. Agricultural research
3. Grain procurement methods	3. Agricultural extension
4. Subsidy to grain producers	4. Government investment in grain production
5. Subsidy to urban dwellers	5. Agricultural credit policy
6. Subsidy to other grain users	
7. Grain movement between regions by the central government	
8. Non-government grain marketing channels	
9. Free market grain prices	
10. Transpiration conditions	
11. Grain storage capacities	
12. Marketing information services	
13. Price policy on agricultural inputs	
14. Market prices of non-grain agricultural products	
15. Government policy on non-grain rural economic activities	

- 3: a large negative effect on grain production;
- 2: a medium negative effect on grain production;
- 1: a small negative effect on grain production;
- 0: no effect on grain production;
- +1: a small positive effect on grain production;
- +2: a medium positive effect on grain production;
- +3: a large positive effect on grain production.

Respondents indicated their choice by circling the appropriate score.

5. DATA ANALYSES

Each returned instrument was examined before transferring the responses to form the data structure. The response to an unanswered factor was treated as a missing value. The few incorrect answers (e.g., two answers to the same factor) were also treated as missing values.

As space was provided in the instrument for respondents to specify factors other than those listed in the questionnaire, most experts did specify additional factors, which were recorded. It was found that these additional factors were quite scattered; often fewer than five respondents named the same factor. Thus most of them were not included in the data for analyses but recorded only for obtaining extra information to facilitate the explanation of the changes in grain production in a particular year. However, two factors were mentioned by more than ten of the Chinese experts for the year 1979. They were "rural economic reform" and "introduction of agricultural production responsibility system", both of which have been included in the data structure for analysis.

Based on the survey data, we carried out statistical analysis to verify the operational hypotheses formulated for the study⁵. In the first instance, hypotheses testing was carried out to verify whether each of those selected factors had an effect on grain production. Then tests were performed to determine in which direction and to what extent each of the factors had affected grain production. Finally, tests were carried out to see if the magnitude of the effect of each factor was similar over years. The method used for this purpose was tests for difference of means of paired samples. The data was formatted into pairs of observations so that where a respondent gave a valid answer to the same factor for both years, the two answers were treated as a pair of observations.

⁵ Effort was made to employ some non-parametric testing methods to the data to obtain a comparison with the results from the t-tests. Unfortunately, such tests were not performed as few of the non-parametric methods are applicable to the data obtained from the survey. This is because there are a large number of identical observations. The reasons why a large number of identical observations make most of the non-parametric methods less applicable were detailed in, for example, Neave and Worthington (1988) and Sprent (1989).

6. RESEARCH FINDINGS

The survey was conducted in early 1991. Sixty copies of the questionnaires were sent to experts in China. These respondents were carefully chosen after consultation with researchers in the area of grain economies. Results from the survey are reported below with a view to verifying the above hypotheses. Presented first is the response to the survey and then a brief description of the characteristics of the respondents.

6.1 Response to the Survey and the Respondents

A total of 50 Chinese experts responded to the survey, a response rate of 83 percent. The initial contact yielded 39 responses while a second request generated an additional 11 responses.

Background information on the respondents has been presented in Appendix, Tables A1-A4. Thirty seven of the respondents (or 74%) are from research institutions (e.g., research institutes, universities and colleges, academic associations) and 13 (or 26%) from governmental departments (Table A1). Almost 60 percent of the respondents work in the areas of agricultural marketing, prices and costs, agricultural policy, food and nutrition, grain development strategy, and grain economics. For more information on the distribution of respondents' research areas, see Table A3. Fifty four percent of them have worked in these fields for more than 20 years (Table A4).

Some respondents enclosed valuable comments and suggestions along with the returned questionnaire. One pointed out that a time period other than a single year should have been selected: "In agriculture, it is weather conditions which have crucial effects on output in a single year. The effects of various policy factors (including price policy and other sorts of policies) on, say, grain output, are not always notable during a short period (e.g., a year). Therefore, it would be better not to select single years for analysis. Instead, it would be better to divide a number of years into several time periods" (B.S. Ke, personal communication 1991). Another respondent commented that "the variation in grain output is a reflection of the dynamic process which is affected by a combination of many factors. The effect of some of these factors on grain output is cumulative. This point should be closely kept in mind when analysing and examining a single year's situation" (L.Z. Zhang, personal communication 1991).

6.2 Results from the Survey with Chinese Experts

From the descriptive statistics given in Tables A5-A7, some general impressions on the responses were captured, e.g., the extent to which a factor may have had an effect on grain production (reflected by the mean), the variation in respondents' judgements (standard deviation and coefficient of variation), the lowest and highest values from the 7-point scale

used by the respondents on each factor (maximum and minimum), and the point in the 7-point scale which received most response (mode).

For example, Table A5 shows that in 1979 most of the 23 listed factors (17) had positive effects on grain production. A few factors (6) had negative effects (although the extent was quite small; no factor had a negative effect exceeding -1). Experts' judgements were quite varied on some factors, such as "large quantity grain import" and "government policy on other rural economic activities", and quite uniform on others, such as the two factors regarding the increase in procurement price. Moreover, it is not unexpected that experts would believe that the rural economic reform taking place in 1979 had a large effect on grain production, and so did the introduction of the agricultural production responsibility system (APRS). These two factors were not listed in the questionnaire sent to the experts but were added by a significant number of the respondents.

Similarly, we can obtain general impressions from the responses for 1985 and 1989 by examining the descriptive statistics in Tables A6 and A7.

Inferential analysis was then conducted. Carried out first was the hypotheses testing concerning whether a factor had an effect on grain production in a particular year. The results are given in Table 2⁶, and show that most of the selected factors had varying effects on grain production in all three years.

Further tests were performed to reveal the direction and the extent that a factor had affected grain production. That is, to test whether the population mean of a factor is less or greater than or equal to (\leq or \geq) a hypothesised population mean which is the integer below the sample mean in absolute value. By using the integer below the sample mean (in absolute value) as the hypothesised population mean, we would not over-state the effect (either positive or negative) of a factor on grain production. The results are presented in Table 3.

The following observations for 1979 can be made from Table 3. Most of factors in the "other factor" category had a positive effect (small to medium) on grain production. Overall, as reflected by the effects of the "other" factors (temporarily ignoring effects of factors relating to the GMS), the economic environment and the weather conditions were favourable for grain production and contributed positively to the increase in grain production.

As far as factors related to the GMS are concerned, it can be seen that "market prices of non-grain agricultural products" and "government policy on other rural economic activities" had little effect. This was because in 1979 the income difference between grain and non-grain business was relatively small. As argued in Section 3, factors such as "subsidy to urban dwellers", "subsidy to other grain users" and "grain movements between provinces by the central government" may affect grain production adversely when heavy subsidy is provided

⁶ For neatness, three factors are not included in Table 2, and Table 3 below, namely, "large quantity grain import", "introduction of APRS" and "rural economic reform". They are presented in Appendix, Tables A8 and A11. They had positive effects on grain production. Especially the latter two factors played an important role in providing farmers with incentives institutionally and in encouraging farmers to work land with more endeavour.

Table 2 Summary Statistics regarding the Effects of Selected Factors on Grain Production, China

Factor (X)	1979		1985		1989	
	Mean	t-stat	Mean	t-stat	Mean	t-stat
1. Weather conditions	1.367	7.262*	-1.375	-7.737*	0.592	2.094*
2. Agricultural research	1.000	8.146*	0.30	3.607*	1.298	10.697*
3. Agricultural extension	1.068	10.717*	0.778	4.085*	1.604	14.034*
4. Investment in agriculture	1.574	13.046*	-1.978	-16.171*	0.761	3.602*
5. Grain procurement price	2.612	28.591*	-0.500	-1.866	1.792	16.106*
6. Grain support price	2.694	32.253*	0.378	2.030*	0.805	5.126*
7. Procurement methods	0.170	0.916	-0.435	-1.892	-0.304	-1.319
8. Subsidy to producers	0.867	7.394*	0.227	1.495	1.417	11.267*
9. Subsidy to urban dwellers	-0.362	-2.849*	-0.708	-5.614*	-0.638	-4.290*
10. Subsidy to other grain users	-0.405	-3.167*	-0.651	-4.503*	-0.744	-5.257*
11. Grain movements between provinces by the GOC	-0.304	-2.254*	-0.804	-4.676*	-0.490	-2.473*
12. Non-government grain marketing channels	1.551	13.272*	1.400	12.034*	1.638	13.715*
13. Free market grain prices	1.449	12.804*	0.163	0.610	2.326	19.708*
14. Transportation conditions	-0.174	-1.308	-0.605	-3.624*	-0.378	-2.092*
15. Grain storage capacities	-0.208	-1.809	-1.156	-7.003*	-0.723	-4.519*
16. Marketing information services	0.152	1.265	-0.767	-4.724*	0.136	0.703
17. Price policy on agricultural inputs	0.542	3.641*	-1.563	-10.117*	-1.064	-4.831*
18. Market prices of non-grain agricultural products	-0.063	-0.369	-1.894	-15.452*	-0.574	-2.996*
19. Government policy on other rural economic activities	0.065	0.358	-1.609	-9.224*	-0.234	-1.213
20. Agricultural credit policy	0.848	7.575*	-0.818	-4.178*	0.489	2.486*

Notes:

1. * denotes the null hypothesis that the mean is equal to zero was rejected at 5 percent level of significance.
2. For 1979, factor 6 represents "above-quota price increased from 30% to 50%".

Sources: Extracted from Appendix, Tables A8-A10.

Table 3 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production, China ($H_0: \mu \leq \mu_0$ or $H_0: \mu \geq \mu_0$)

Factor (X)	1979			1985			1989		
	Mean	μ_0	t-stat	Mean	μ_0	t-stat	Mean	μ_0	t-stat
1. Weather conditions	1.367	1	1.951*	-1.375	-1	-2.110*	0.592	0	2.094*
2. Agricultural research	1.000	1	0.000	0.600	0	3.607*	1.298	1	2.455*
3. Agricultural extension	1.068	1	0.684	0.778	0	4.085*	1.604	1	5.286*
4. Investment in agriculture	1.574	1	4.760*	-1.978	-1	-7.997*	0.761	0	3.602*
5. Grain procurement price	2.612	2	6.701*	-0.500	0	-1.866*	1.792	1	7.117*
6. Grain support price	2.694	2	8.308*	0.378	0	2.030*	0.805	0	5.126*
7. Procurement methods	0.170	0	0.916	-0.435	0	-1.892*	-0.304	0	-1.319
8. Subsidy to producers	0.867	0	7.394*	0.227	0	1.495	1.417	1	3.314*
9. Subsidy to urban dwellers	-0.362	0	-2.849*	-0.708	0	-5.614*	-0.638	0	-4.290*
10. Subsidy to other grain users	-0.405	0	-3.167*	-0.651	0	-4.503*	-0.744	0	-5.257*
11. Grain movements between provinces by the GOC	-0.304	0	-2.254*	-0.804	0	-4.676*	-0.490	0	-2.473*
12. Non-government grain marketing channels	1.551	1	4.715*	1.400	1	3.438*	1.638	1	5.343*
13. Free market grain prices	1.449	1	3.968*	0.163	0	0.610	2.326	2	2.766*
14. Transportation conditions	-0.174	0	-1.308	-0.605	0	-3.624*	-0.378	0	-2.092*
15. Grain storage capacities	-0.208	0	-1.809*	-1.156	-1	-0.943	-0.723	0	-4.519*
16. Marketing information services	0.152	0	1.265	-0.767	0	-4.724*	0.136	0	0.703
17. Price policy on agricultural inputs	0.542	0	3.641*	-1.563	-1	-3.642*	-1.064	-1	-0.290
18. Market prices of non-grain agricultural products	-0.063	0	-0.369	-1.894	-1	-7.292*	-0.574	0	-2.996*
19. Government policy on other rural economic activities	0.065	0	0.358	-1.609	-1	-3.490*	-0.234	0	-1.213
20. Agricultural credit policy	0.848	0	7.575*	-0.818	0	-4.178*	0.489	0	2.486*

Notes:

1. $H_0: \mu \leq \mu_0$
 $H_1: \mu > \mu_0$
if the observed sample mean is positive;
- or $H_0: \mu \geq \mu_0$
 $H_1: \mu < \mu_0$
if the observed sample mean is negative.
- μ : mean of the population factor X_i , $i=1,2,\dots,20$.
- μ_0 : the hypothesised population mean of factor X_i ($i=1,2,\dots,20$), which is the integer below the sample mean in absolute value.
2. * denotes that the null hypothesis was rejected at 5 percent level of significance.
3. For 1979, factor 6 represents "above-quota price increased from 30% to 50%".

Sources: Extracted from Appendix, Tables A11-A13.

by the central government. Results in Table 3 concerning these three factors support this argument although the extent, as reflected by the means, was rather small. The two factors, "transportation conditions" and "storage capacities", also had a negative effect on grain production but again the extent is small. The effects of "procurement methods under the unified procurement system" and "marketing information services" are negligible.

Factors relating to procurement prices, however, had above-medium effects on grain production and the tests were statistically significant at the 1% level and may be even higher as the two means are close to +3 (large positive effect) with the coefficients of variation being small. In fact, if we look at their modes, some 70% of observations recorded the value "3" (see Table A5 in Appendix), indicating that most experts believe the price increase to have a large positive effect on grain production in 1979. In addition, the restoration of a free grain market and the existence of free grain market prices also had positive effects. The testing on these four factors indicates that we do not reject the operational hypotheses (1) to (4).

Contrary to the situation in 1979, most of the selected factors had a negative effect on grain production in 1985. Of the "other" factors, weather conditions imposed a small negative effect. The reduction in investment in agriculture had a medium negative effect.

"Market prices of non-grain agricultural products" and "government policy on other rural economic activities" had small negative effects on grain production. This is due to the policy change introduced early in that year where the government allowed most of non-grain farm products (except cotton) to be freely traded by the farmers with prices determined by the market. But the price farmers received for the majority of their surplus grain⁷ is determined by the government and set at a low level. As a result of the increase in input prices in 1985⁸, the factor "price policy on agricultural inputs" showed a negative effect (Table 3).

The factor "30-70 ratio price" had a small negative effect on grain production in 1985. Compared with the situation in 1979, however, it in fact had a large negative effect as the factor "procurement price" had a large positive effect on grain production in 1979 (This will be further assessed later by testing for the mean differences). The change in procurement methods had a small negative effect. Although the grain support price was low, the existence of such a price still had a small positive effect according to the experts. In 1985, the government allowed more marketing channels for the grain trade. Thus there was a small positive effect on grain production. As such, we do not reject the operational hypotheses (5) to (8).

⁷ A large percentage of their surplus grain has to be sold to the state, the rest can be sold on the free market or used for other purposes. According to a survey done in Jiangsu province, China, 77.5% of farmers had to sell more than 60% of their surplus grain to the state; of them 65.6% sold more than 80% of the surplus grain to the state. In contrast, 64.2% sold no grain on free market. (Z.Y. Zhou, Ph.D. thesis, in progress).

⁸ Some policy makers perceived that farmers had more money in hand after several years' good harvest in a row. The government could take some of this away from their hands through increasing input prices (Guo 1990, p. 16).

The effect of the factor "free market grain prices" was negligible. This was due to the fact that the market prices were relatively low as a result of the bumper harvest in 1984 and previous years and the government released a large quantity of grain into the free market. The effects of all other factors relating to the GMS were relatively small, except that "grain storage capacities" had a slight but significant negative effect. This was because consecutive good harvests in previous years resulted in an acute shortage of storage capacity. Farmers, especially those in major grain-producing areas, often had difficulty in selling grain and thus had their enthusiasm to produce grain reduced.

As the government's emphasis was refocussed on the grain issue after the setback in 1985, the situation changed notably in 1989. Coupled with slight favourable weather conditions, some factors which had negative effects in 1985 turned out to have positive effects on grain production or had the extent of their negative effect reduced. The increase in procurement price had a positive effect on grain production. Thus, we do not reject the operational hypothesis (9). The implementation of a "three-link" scheme, first introduced in 1987⁹, also had a positive effect (Table 3).

As has been seen from the above, the changes in the effects of most factors on grain production were quite obvious. Furthermore, the results of the hypotheses testing for the difference in the means presented in Table 4¹⁰ support this conclusion.

As mentioned earlier, in 1985 the external economic environments were not favourable for grain production. Added to this was the unfavourable weather conditions. Thus, the means of the difference of each paired observations were negative showing that the positive effects of all these factors on grain production were decreased (or that the negative effects of these factors were increased). The difference in the effects of all these factors on grain production between 1985 and 1979 is statistically significant at the 5% level, except for "non-government grain marketing channels" (Table 4). According to the results in Table 4, we do not reject the operational hypotheses (10) and (11). However, the difference of the effects of "non-government grain marketing channels" in 1985 and 1979 is statistically insignificant. Thus there is a lack of evidence to accept operational hypothesis (12).

In 1989, as was shown in Table 4, the positive effect of all these factors on grain production was increased except for "subsidy to other grain users". Thus we do not reject the operational hypothesis (13).

Looking further at the results in Table 4, we see that the negative effects of the three

⁹ In early 1987, to partly compensate low return from grain production and to encourage farmers to produce more grain, the government introduced a subsidy scheme. That is, the government supplies the grain producers with fertiliser and diesel at subsidised prices. Grain producers are also provided with a down-payment for the grain they will sell to the government. The quantum of such supplies is "linked" with the quantity of grain a farmer is going to sell to the government (State Council 1987a,b).

¹⁰ Only the results of the factors relating to the GMS are presented here for discussion. For the results of remaining factors, see Appendix, Tables A14-A15.

Table 4 Hypotheses Testing of the Difference between Means of Selected Factors, China

Factor (X)	1985/79		1989/85	
	D-mean	t-stat ¹	D-mean	t-stat ²
1. Grain procurement price	-3.149	-11.166*	2.348	8.182*
2. Grain support price			0.325	2.393*
3. Procurement methods	-0.659	-2.478*	0.114	0.503
4. Subsidy to producers	-0.659	-4.232*	1.163	7.462*
5. Subsidy to urban dwellers	-0.348	-2.779*	0.043	0.389
6. Subsidy to other grain users	-0.250	-2.130*	-0.119	-1.302
7. Grain movements between provinces by the GOC	-0.500	-3.172*	0.152	1.155
8. Non-government grain marketing channels	-0.045	-0.330	0.209	1.708
9. Free market grain prices	-1.333	-4.170*	2.125	6.755*
10. Transportation conditions	-0.415	-2.425*	0.186	1.091
11. Grain storage capacities	-0.932	-5.925*	0.341	2.291*
12. Marketing information services	-0.881	-5.149*	0.810	4.250*
13. Price policy on agricultural inputs	-2.064	-9.464*	0.532	2.299*
14. Market prices of non-grain agricultural products	-1.848	-7.551*	1.326	5.505*
15. Government policy on other rural economic activities	-1.600	-7.091*	1.348	5.835*

Notes:

- $H_0: \mu_{1985} = \mu_{1979}$
 $H_1: \mu_{1985} \neq \mu_{1979}$
- $H_0: \mu_{1989} = \mu_{1985}$
 $H_1: \mu_{1989} \neq \mu_{1985}$
 μ : mean of the population factor X_i , $i=1,2,\dots,20$.
D-mean denotes the mean of differences of paired observations;
D-s.d. denotes the standard deviation of the differences.
- * denotes that the null hypothesis was rejected at 5 percent level of significance.
- In 1979, there was no support price.

Sources: Extracated from Appendix, Tables A14-A15.

factors, i.e., "subsidy to urban dwellers", "subsidy to other grain users", and "grain movements between provinces by the central government", on grain production in the year 1985 over 1979 were increased and were statistically different at the 5% level of significance. The big increase in grain subsidy to consumers in 1985 over 1979 is partly responsible for this¹¹. Up to 1989, the change in such negative effects was not statistically significant. Thus the heavy subsidy for grain consumers in China in recent years has been imposing a continuous negative effect on grain production (refer to Table 3), although such negative effects can be indirect (e.g., via other factors such as investment in grain production, procurement prices, as has been discussed earlier in Section 3).

For the factor "procurement methods", Table 4 shows that its negative effect was increased in the year of 1985 over 1979 and that there was no significant change between 1989 and 1985 indicating that the procurement methods under the current contractual scheme has negative effects on grain production. (According to experts' judgement, "procurement methods" did not impose a negative effect on grain production under the unified procurement system.) However, the effect of this factor is relatively small and not significant (refer to Table 3). This indicates that, in China, under the current contractual system, procurement methods may have some negative effects on grain production but very small.

Changes in price policy on agricultural inputs affect grain production significantly as shown in Table 4. This is because, given that other conditions remain the same, such changes have an important impact on farmers' income levels. Likewise, in China, changes in "government policy on other rural economic activities" and "market prices of non-grain agricultural products" affect grain production to a great extent. This is because such changes may influence farmers' grain income level relative to other non-grain endeavours, and consequently farmers may shift their resources between grain and non-grain business.

However, given the present situation in China, the most important factor affecting grain production seems to be price received by grain producers; both the procurement price offered by the government and the free market prices. This is clearly shown in Table 4 with the magnitude of the means of observation differences (denoted D-mean) and t-statistics of these two factors. Given that other factors such as prices of agricultural inputs, market prices of non-grain farm produce do not change drastically, price factors are perceived to be the most important factors affecting farmers' income, thus farmers' decisions on grain production.

7. CONCLUSIONS AND POLICY IMPLICATIONS

To conclude, the results from the survey of Chinese experts support the analyses in Section 3. All the operational hypotheses except No. 12 are not rejected. As such, it seems we have enough evidence to come to the conclusion that, in China, notable changes in the grain

¹¹ Subsidy on grain (including cooking oil) was 7.33 billion yuan in 1979 and was 20.40 billion yuan in 1985 (Carter and Zhong 1988, p. 44).

marketing system have effects on grain production. Factors directly affecting farmers' income from grain, such as procurement prices, market grain prices and input prices, have most important effects on grain production. Factors such as market prices of non-grain farm produce and government policy on non-grain rural economic activities also have important effects on grain production only when they cause disparity between incomes from grain and non-grain products. Procurement methods do not seem to have much effect on production in China. Other factors relating to GMS also have varying effects on production.

The following two implications can be drawn from the above findings.

(1) Caution must be taken when making any, especially institutional, changes to the grain marketing system, which can induce notable changes to the income of grain producers. This is mainly due to the fact that Chinese farmers, to a great extent, are a very homogeneous group. They have very small land areas to work on and very limited chance to be engaged in non-agricultural business. Heavily depending on earnings from farming activities, Chinese farmers tend to shift their resources to crops with the highest returns. And most importantly, they tend to shift in the same direction at the same time because of the similarities of their economic features. That is why even a small alternation in policy may cause tremendous consequence in agricultural production. This is especially true in grain production due to a large number of farmers engaging in it. That is, small changes in returns from grain can result in great swings in total production. The drop in production in 1985 provides a good example to support this. In 1985 when farmers were allowed to have more choice in their farming activities and returns from grain were less than the previous year due to changes made to the GMS, millions of farm households reduced their efforts towards grain production resulting in a sharp drop in total production. Because of the homogeneity of the farmers, there is a lack of "buffer" effects in response to a policy change which may be in existence if the farming community was not homogeneous. Therefore any institutional changes in the GMS should be carefully and cautiously made in order to maintain a steady increase in grain production to meet the country's needs.

(2) Policy efforts should be made only after considering the likely effect on all the relevant factors affecting grain production. Given the current situation in China, attention should be paid to maintaining procurement prices at economic levels. Also the government should adopt various policy measures to balance returns from grain and non-grain business in order to keep enough grain growers staying in grain production. Although the extent of negative effects of factors regarding infrastructure was not very large, their importance should not be underestimated. Efforts should be made to improve grain distribution infrastructure, especially to improve grain storage condition. Given the extent that China relies on government control and direction rather than the market forces, the health of the rural economy is critically dependant on the government being fully aware of what factors affect production and the extent of that effect.

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Appendix

Notes:

- 1. In all the following tables regarding hypotheses testing, * denotes that the null hypothesis was rejected at 5 percent level of significance.**
- 2. Source of all the tables in this Appendix is from surveys with Chinese experts.**
- 3. In Tables A5-A7, C.V. stands for Coefficient of Variation.**

Table A1 Nature of the Respondents' Institution

	N	%
Research Institution	37	74
Government Department	13	26

Table A2 Title Held by the Respondents

Title	N	%
Professor (or equivalent)	24	49.0
Associate Professor (or equivalent)	12	24.5
Senior Economist (or equivalent)	5	10.2
Economist (or equivalent)	8	16.3

Table A3 Research Fields of the Respondents

Field	First (%)	Second (%)	Third (%)	Total (%)
Agricultural Marketing	2.2	8.9	4.5	5.2
Agricultural Prices & Costs	15.6	2.2	4.5	7.5
Agricultural Policy	28.9	13.3	9.1	17.2
Food and Nutrition	4.4	6.7	2.3	4.5
Grain Development Strategy	13.3	22.2	11.4	15.7
Grain Economics	4.4	13.3	9.1	9.0
Economic Development	6.7	13.3	9.1	9.7
Economic Theory	2.2	11.1	13.6	9.0
Econometrics		2.2	2.3	1.5
Production Economics	6.7		4.5	3.7
Forecasting	2.2		4.5	2.2
Agricultural Statistics	2.2			0.7
Resource Economics		4.4	2.3	2.2
Agricultural Finance			4.5	1.5
Farm Management	2.2	2.2	4.5	3.0
Other	8.9		13.6	7.5
	n=45	n=45	n=44	n=134

Table A4 Years the Respondents Have Worked in These Fields

Year	N	%
under 10 years	17	34
10 to under 20 years	6	12
20 to under 30 years	10	20
More than 30 years	17	34

Table A5 Descriptive Statistics from the Survey of Chinese Experts (1979)

Factor	No. of Obs.	Mean	S.D.	C.V.	Min.	Max.	Median	Mode	with No. of Obs.
1. Weather conditions	49	1.37	1.32	0.96	-1	3	2	2	17
2. Agricultural research	48	1.00	0.85	0.85	0	3	1	1	23
3. Agricultural extension	44	1.07	0.66	0.62	0	3	1	1	31
4. Investment in agriculture	47	1.57	0.83	0.53	0	3	2	2	22
5. Unified procurement price raised 20%	49	2.61	0.64	0.24	1	3	3	3	34
6. Above-quota price increased from 30% to 50%	49	2.69	0.58	0.22	1	3	3	3	37
7. Procurement methods under the unified procurement system	47	0.17	1.27	7.48	-3	3	0	1	14
8. Subsidy to producers	45	0.87	0.79	0.91	-1	3	1	1	23
9. Large quantity grain import	49	0.67	1.20	1.78	-2	3	0	0	23
10. Subsidy to urban dwellers	47	-0.36	0.87	-2.41	-3	1	0	0	23
11. Subsidy to other grain users	42	-0.40	0.83	-2.05	-2	1	0	0	22
12. Grain movements between provinces by the GOC	46	-0.30	0.92	-3.01	-3	1	0	0	21
13. Restoration of free grain market	49	1.55	0.82	0.53	0	3	1	1	23
14. Free grain market prices	49	1.45	0.79	0.55	0	3	1	1	27
15. Transportation conditions	46	-0.17	0.90	-5.19	-3	1	0	0	25
16. Grain storage capacities	48	-0.21	0.80	-3.83	-2	1	0	0	28
17. Marketing information services	46	0.15	0.82	5.36	-2	2	0	0	27
18. Price policy on agricultural inputs	48	0.54	1.03	1.90	-2	3	1	1	25
19. Market prices of non-grain agricultural products	48	-0.06	1.17	-18.79	-2	3	0	-1	17
20. Government policy on other rural economic activities	46	0.07	1.24	18.96	-3	3	0	1	14
21. Agricultural credit policy	46	0.85	0.76	0.90	-1	3	1	1	25
22. Introduction of APRS	14	2.07	0.73	0.35	1	3	2	2	7
23. Rural economic reform	13	2.46	0.66	0.27	1	3	3	3	7

Table A6 Descriptive Statistics from the Survey of Chinese Experts (1985)

Factor	No. of Obs.	Mean	S.D.	C.V.	Min.	Max.	Median	Mode	with No. of Obs.
1. Weather conditions	48	-1.37	1.23	-0.90	-3	1	-2	-2	18
2. Agricultural research	45	0.60	1.12	1.86	-3	3	1	1	21
3. Agricultural extension	45	0.78	1.28	1.64	-3	3	1	1	19
4. Investment in agriculture	46	-1.98	0.83	-0.42	-3	0	-2	-2	18
5. The "30-70" ratio price	48	-0.50	1.86	-3.71	-3	3	-1	-1	13
6. Grain support price	45	0.38	1.25	3.30	-3	3	0	0	19
7. Procurement methods under the contractual system	46	-0.43	1.56	-3.58	-3	3	-1	-1	15
8. Subsidy to producers	44	0.23	1.01	4.44	-2	2	0	0	19
9. Subsidy to urban dwellers	48	-0.71	0.87	-1.23	-3	1	-1	0	20
10. Subsidy to other grain users	43	-0.65	0.95	-1.46	-3	2	-1	-1	17
11. Grain movements between provinces by the GOC	46	-0.80	1.17	-1.45	-3	1	-1	-1	19
12. Non-government grain marketing channels	45	1.40	0.78	0.56	0	3	1	1	26
13. Free market grain prices	49	0.16	1.87	11.48	-3	3	1	1	14
14. Transportation conditions	43	-0.60	1.09	-1.81	-3	1	-1	0	14
15. Grain storage capacities	45	-1.16	1.11	-0.96	-3	1	-1	-1	14
16. Marketing information services	43	-0.77	1.07	-1.39	-3	1	-1	-1	14
17. Price policy on agricultural inputs	48	-1.56	1.07	-0.68	-3	1	-2	-1	18
18. Market prices of non-grain agricultural products	47	-1.89	0.84	-0.44	-3	0	-2	-2	17
19. Government policy on other rural economic activities	46	-1.61	1.18	-0.74	-3	1	-2	-1	14
20. Agricultural credit policy	44	-0.82	1.30	-1.59	-3	2	-1	-1	16

Table A7 Descriptive Statistics from the Survey of Chinese Experts (1989)

Factor	No. of Obs.	Mean	S.D.	C.V.	Min.	Max.	Median	Mode	with No. of Obs.
1. Weather conditions	49	0.59	1.98	3.34	-3	3	1	2	15
2. Agricultural research	47	1.30	0.83	0.64	0	3	1	1	23
3. Agricultural extension	48	1.60	0.79	0.49	0	3	2	2	20
4. Investment in agriculture	46	0.76	1.43	1.88	-3	3	1	1	21
5. Contractual procurement price increased by 18%	48	1.79	0.77	0.43	1	3	2	1	20
6. Grain support price	41	0.80	1.01	1.25	0	3	0	0	21
7. Procurement methods under the contractual system	45	-0.30	1.55	-5.08	-3	3	-1	-1	14
8. Subsidy to producers	48	1.42	0.87	0.61	0	3	1	1	25
9. Subsidy to urban dwellers	46	-0.64	1.01	-1.58	-3	1	0	0	20
10. Subsidy to other grain users	43	-0.74	0.93	-1.25	-3	1	-1	0	17
11. Grain movements between provinces by the GOC	49	-0.49	1.39	-2.83	-3	3	-1	-1	21
12. Non-government grain marketing channels	47	1.64	0.82	0.50	0	3	2	1	21
13. Free market grain prices	49	2.33	0.83	0.36	0	3	3	3	26
14. Transportation conditions	45	-0.38	1.21	-3.21	-3	2	0	0	14
15. Grain storage capacities	47	-0.72	1.10	-1.49	-3	2	-1	-1	17
16. Marketing information services	44	0.14	1.29	9.44	-3	3	0	1	15
17. Price policy on agricultural inputs	47	-1.06	1.51	-1.42	-3	2	-1	-1	14
18. Market prices of non-grain agricultural products	47	-0.57	1.31	-2.29	-3	2	-1	-1	22
19. Government policy on other rural economic activities	47	-0.23	1.32	-5.65	-3	2	0	1	17
20. Agricultural credit policy	47	0.49	1.35	2.76	-3	3	1	1	24

Table A8 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production in 1979 in China ($H_0: \mu=0$)

Factor (X)	No. of Obs. (n)	Mean	S.D.	t-stat
1. Weather conditions	49	1.367	1.318	7.262*
2. Agricultural research	48	1.000	0.851	8.146*
3. Agricultural extension	44	1.068	0.661	10.717*
4. Investment in agriculture	47	1.574	0.827	13.046*
5. Unified procurement price raised 20%	49	2.612	0.640	28.591*
6. Above-quota price increased from 30% to 50%	49	2.694	0.585	32.253*
7. Procurement methods under the unified procurement system	47	0.170	1.274	0.916
8. Subs'dy to producers	45	0.867	0.786	7.394*
9. Large quantity grain import	49	0.673	1.197	3.938*
10. Subsidy to urban dwellers	47	-0.362	0.870	-2.849*
11. Subsidy to other grain users	42	-0.405	0.828	-3.167*
12. Grain movements between provinces by the GOC	46	-0.304	0.916	-2.254*
13. Restoration of free grain market	49	1.551	0.818	13.272*
14. Free grain market prices	49	1.449	0.792	12.804*
15. Transportation conditions	46	-0.174	0.902	-1.308
16. Grain storage capacities	48	-0.208	0.798	-1.809
17. Marketing information services	46	0.152	0.816	1.265
18. Price policy on agricultural inputs	48	0.542	1.031	3.641*
19. Market prices of non-grain agricultural products	48	-0.063	1.174	-0.369
20. Government policy on other rural economic activities	46	0.065	1.236	0.358
21. Agricultural credit policy	46	0.848	0.759	7.575*
22. Introduction of APRS	14	2.071	0.730	10.616
23. Rural economic reform	13	2.461	0.660	13.442*

Table A9 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production in 1985 in China ($H_0: \mu=0$)

Factor (X)	No. of		S.D.	t-stat
	Obs.	Mean		
1. Weather conditions	48	-1.375	1.231	-7.737*
2. Agricultural research	45	0.600	1.116	3.607*
3. Agricultural extension	45	0.778	1.277	4.085*
4. Investment in agriculture	46	-1.978	0.830	-16.171*
5. The "30-70" ratio price	48	-0.500	1.857	-1.866
6. Grain Support price	45	0.378	1.248	2.030*
7. Procurement methods under the contractual system	46	-0.435	1.558	-1.892
8. Subsidy to producers	44	0.227	1.008	1.495
9. Subsidy to urban dwellers	48	-0.708	0.874	-5.614*
10. Subsidy to other grain users	43	-0.651	0.948	-4.503*
11. Grain movements between provinces by the GOC	46	-0.804	1.167	-4.676*
12. Non-government grain marketing channels	45	1.400	0.780	12.034*
13. Free market grain prices	49	0.163	1.875	0.610
14. Transportation conditions	43	-0.605	1.094	-3.624*
15. Grain storage capacities	45	-1.156	1.107	-7.003*
16. Marketing information services	43	-0.767	1.065	-4.724*
17. Price policy on agricultural inputs	48	-1.563	1.070	-10.117*
18. Market prices of non-grain agricultural products	47	-1.894	0.840	-15.452*
19. Government policy on other rural economic activities	46	-1.609	1.183	-9.224*
20. Agricultural credit policy	44	-0.818	1.299	-4.178*

Table A10 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production in 1989 in China ($H_0: \mu=0$)

Factor (X)	No. of Obs. (n)	Mean	S.D.	t-stat
1. Weather conditions	49	0.592	1.978	2.094*
2. Agricultural research	47	1.298	0.832	10.697*
3. Agricultural extension	48	1.604	0.792	14.034*
4. Investment in agriculture	46	0.761	1.433	3.602*
5. Contractual procurement price increased by 18%	48	1.792	0.771	16.106*
6. Grain support price	41	0.805	1.005	5.126*
7. Procurement methods under the contractual system	45	-0.304	1.547	-1.319
8. Subsidy to producers	48	1.417	0.871	11.267*
9. Subsidy to urban dwellers	46	-0.638	1.009	-4.290*
10. Subsidy to other grain users	43	-0.744	0.928	-5.257*
11. Grain movements between provinces by the GOC	49	-0.490	1.386	-2.473*
12. Non-government grain marketing channels	47	1.638	0.819	13.715*
13. Free market grain prices	49	2.326	0.826	19.708*
14. Transportation conditions	45	-0.378	1.211	-2.092*
15. Grain storage capacities	47	-0.723	1.097	-4.519*
16. Marketing information services	44	0.136	1.287	0.703
17. Price policy on agricultural inputs	47	-1.064	1.509	-4.831*
18. Market prices of non-grain agricultural products	47	-0.574	1.314	-2.996*
19. Government policy on other rural economic activities	47	-0.234	1.322	-1.213
20. Agricultural credit policy	47	0.489	1.349	2.486*

Table A11 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production in 1979 in China ($H_0: \mu \leq \mu_0$ or $H_0: \mu \geq \mu_0$)

Factor (X)	No. of Obs. (n)	Mean	S.D.	μ_0	t-stat
1. Weather conditions	49	1.367	1.318	1	1.951*
2. Agricultural research	48	1.000	0.851	1	0.000
3. Agricultural extension	44	1.068	0.661	1	0.684
4. Investment in agriculture	47	1.574	0.827	1	4.760*
5. Unified procurement price raised 20%	49	2.612	0.640	2	6.701*
6. Above-quota price increased from 30% to 50%	49	2.694	0.585	2	8.308*
7. Procurement methods under the unified procurement system	47	0.170	1.274	0	0.916
8. Subsidy to producers	45	0.867	0.786	0	7.394*
9. Large quantity grain import	49	0.673	1.197	0	3.938*
10. Subsidy to urban dwellers	47	-0.362	0.870	0	-2.849*
11. Subsidy to other grain users	42	-0.405	0.828	0	-3.167*
12. Grain movements between provinces by the GOC	46	-0.304	0.916	0	-2.254*
13. Restoration of free grain market	49	1.551	0.818	1	4.715*
14. Free grain market prices	49	1.449	0.792	1	3.968*
15. Transportation conditions	46	-0.174	0.902	0	-1.308
16. Grain storage capacities	48	-0.208	0.798	0	-1.809*
17. Marketing information services	46	0.152	0.816	0	1.265
18. Price policy on agricultural inputs	48	0.542	1.031	0	3.641*
19. Market prices of non-grain agricultural products	48	-0.063	1.174	0	-0.369
20. Government policy on other rural economic activities	46	0.065	1.236	0	0.358
21. Agricultural credit policy	46	0.848	0.759	0	7.575*
22. Introduction of APRS	14	2.071	0.730	2	0.366
23. Rural economic reform	13	2.461	0.660	2	2.520*

Note: $H_0: \mu \leq \mu_0$

$H_1: \mu > \mu_0$

if the observed sample mean is positive;

or $H_0: \mu \geq \mu_0$

$H_1: \mu < \mu_0$

if the observed sample mean is negative.

μ : mean of the population factor X_i , $i=1,2,\dots,23$.

μ_0 : the hypothesised population mean of factor X_i ($i=1,2,\dots,23$), which is the integer below the sample mean in absolute value.

Table A12 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production in 1985 in China ($H_0: \mu \leq \mu_0$ or $H_0: \mu \geq \mu_0$)

Factor (X)	No. of Obs. (n)	Mean	S.D.	μ_0	t-stat
1. Weather conditions	48	-1.375	1.231	-1	-2.110*
2. Agricultural research	45	0.600	1.116	0	3.607*
3. Agricultural extension	45	0.778	1.277	0	4.085*
4. Investment in agriculture	46	-1.978	0.830	-1	-7.997*
5. The "30-70" ratio price	48	-0.500	1.857	0	-1.866*
6. Grain Support price	45	0.378	1.248	0	2.030*
7. Procurement methods under the contractual system	46	-0.435	1.558	0	-1.892*
8. Subsidy to producers	44	0.227	1.008	0	1.495
9. Subsidy to urban dwellers	48	-0.708	0.874	0	-5.614*
10. Subsidy to other grain users	43	-0.651	0.948	0	-4.503*
11. Grain movements between provinces by the GOC	46	-0.804	1.167	0	-4.676*
12. Non-government grain marketing channels	45	1.400	0.780	1	3.438*
13. Free market grain prices	49	0.163	1.875	0	0.610
14. Transportation conditions	43	-0.605	1.094	0	-3.624*
15. Grain storage capacities	45	-1.156	1.107	-1	-0.943
16. Marketing information services	43	-0.767	1.065	0	-4.724*
17. Price policy on agricultural inputs	48	-1.563	1.070	-1	-3.642*
18. Market prices of non-grain agricultural products	47	-1.894	0.840	-1	-7.292*
19. Government policy on other rural economic activities	46	-1.609	1.183	-1	-3.490*
20. Agricultural credit policy	44	-0.818	1.299	0	-4.178*

Note: $H_0: \mu \leq \mu_0$

$H_1: \mu > \mu_0$

if the observed sample mean is positive;

or $H_0: \mu \geq \mu_0$

$H_1: \mu < \mu_0$

if the observed sample mean is negative.

μ : mean of the population factor X_i , $i=1,2,\dots,20$.

μ_0 : the hypothesised population mean of factor X_i ($i=1,2,\dots,20$), which is the integer below the sample mean in absolute value.

Table A13 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production in 1989 in China ($H_0: \mu \leq \mu_0$ or $H_0: \mu \geq \mu_0$)

Factor (X)	No. of Obs. (n)	Mean	S.D.	μ_0	t-stat
1. Weather conditions	49	0.592	1.978	0	2.094*
2. Agricultural research	47	1.298	0.832	1	2.455*
3. Agricultural extension	48	1.604	0.792	1	5.286*
4. Investment in agriculture	46	0.761	1.433	0	3.602*
5. Contractual procurement price increased by 18%	48	1.792	0.771	1	7.117*
6. Grain support price	41	0.805	1.005	0	5.126*
7. Procurement methods under the contractual system	45	-0.304	1.547	0	-1.319
8. Subsidy to producers	48	1.417	0.871	1	3.314*
9. Subsidy to urban dwellers	46	-0.638	1.009	0	-4.290*
10. Subsidy to other grain users	43	-0.744	0.928	0	-5.257*
11. Grain movements between provinces by the GOC	49	-0.490	1.386	0	-2.473*
12. Non-government grain marketing channels	47	1.638	0.819	1	5.343*
13. Free market grain prices	49	2.326	0.826	2	2.766*
14. Transportation conditions	45	-0.378	1.211	0	-2.092*
15. Grain storage capacities	47	-0.723	1.097	0	-4.519*
16. Marketing information services	44	0.136	1.287	0	0.703
17. Price policy on agricultural inputs	47	-1.064	1.509	-1	-0.290
18. Market prices of non-grain agricultural products	47	-0.574	1.314	0	-2.996*
19. Government policy on other rural economic activities	47	-0.234	1.322	0	-1.213
20. Agricultural credit policy	47	0.489	1.349	0	2.486*

Note: $H_0: \mu \leq \mu_0$

$H_1: \mu > \mu_0$

if the observed sample mean is positive;

or $H_0: \mu \geq \mu_0$

$H_1: \mu < \mu_0$

if the observed sample mean is negative.

μ : mean of the population factor X_i , $i=1,2,\dots,20$.

μ_0 : the hypothesised population mean of factor X_i ($i=1,2,\dots,20$), which is the integer below the sample mean in absolute value

Table A14 Hypotheses Testing of the Difference between Means for 1985 and 1979 of Selected Factors, China

Factor (X)	No. of		D-s.d.	t-stat
	Obs.	D-mean		
1. Weather conditions	47	-2.702	1.876	-9.877*
2. Agricultural research	45	-0.333	1.365	-1.638
3. Agricultural extension	41	-0.073	1.081	-0.433
4. Investment in agriculture	45	-3.489	1.218	-19.220*
5. Grain procurement price	47	-3.149	1.933	-11.166*
6. Grain support price				
7. Procurement methods	44	-0.659	1.764	-2.478*
8. Subsidy to producers	44	-0.659	1.033	-4.232*
9. Subsidy to urban dwellers	46	-0.348	0.849	-2.779*
10. Subsidy to other grain users	40	-0.250	0.742	-2.130*
11. Grain movements between provinces by the GOC	44	-0.500	1.045	-3.172*
12. Non-government grain marketing channels	44	-0.045	0.914	-0.330
13. Free market grain prices	48	-1.333	2.215	-4.170*
14. Transportation conditions	41	-0.415	1.095	-2.425*
15. Grain storage capacities	44	-0.932	1.043	-5.925*
16. Marketing information services	42	-0.881	1.109	-5.149*
17. Price policy on agricultural inputs	47	-2.064	1.495	-9.464*
18. Market prices of non-grain agricultural products	46	-1.848	1.660	-7.551*
19. Government policy on other rural economic activities	45	-1.600	1.514	-7.091*
20. Agricultural credit policy	43	-1.651	1.361	-7.957*

Note: $H_0: \mu_{1985} = \mu_{1979}$

$H_1: \mu_{1985} \neq \mu_{1979}$

μ : mean of the population factor X_i , $i=1,2,\dots,20$.

D-mean denotes the mean of differences of paired observations;

D-s.d. denotes the standard deviation of the differences.

In 1979, there was no support price.

Table A15 Hypotheses Testing of the Difference between Means for 1989 and 1985 of Selected Factors, China

Factor (X)	No. of Obs. (n)	D-mean	D-s.d.	t-stat
1. Weather conditions	47	1.894	1.992	6.518*
2. Agricultural research	45	0.667	1.348	3.317*
3. Agricultural extension	44	0.841	1.293	4.314*
4. Investment in agriculture	44	2.636	1.644	10.639*
5. Grain procurement price	46	2.348	1.946	8.182*
6. Grain support price	40	0.325	0.859	2.393*
7. Procurement methods	44	0.114	1.497	0.503
8. Subsidy to producers	43	1.163	1.022	7.462*
9. Subsidy to urban dwellers	47	0.043	0.751	0.389
10. Subsidy to other grain users	42	-0.119	0.593	-1.302
11. Grain movements between provinces by the GOC	46	0.152	0.894	1.155
12. Non-government grain marketing channels	43	0.209	0.804	1.708
13. Free market grain prices	48	2.125	2.179	6.755*
14. Transportation conditions	43	0.186	1.118	1.091
15. Grain storage capacities	44	0.341	0.987	2.291*
16. Marketing information services	42	0.810	1.234	4.250*
17. Price policy on agricultural inputs	47	0.532	1.586	2.299*
18. Market prices of non-grain agricultural products	46	1.326	1.634	5.505*
19. Government policy on other rural economic activities	46	1.348	1.567	5.835*
20. Agricultural credit policy	44	1.295	1.579	5.444*

Note: $H_0: \mu_{1989} = \mu_{1985}$

$H_1: \mu_{1989} \neq \mu_{1985}$

μ : mean of the population factor X_i , $i=1,2,\dots,20$.

D-mean denotes the mean of differences of paired observations;

D-s.d. denotes the standard deviation of the differences.