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

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1. INTRODUCTION

Grain production in India fluctuates and in some years markedly as shown in Figure 1 on the following page. The fluctuation may be attributed to a number of factors. The understanding of what these factors are and how they affect grain production is important in policy formulation. Some research has been carried out from various perspective to examine those possible factors which could affect grain production and thus contributed to its fluctuation (for example, Lele and Mellor 1964; Ray 1970; Mehra 1981; Hazell 1982; Mahendradev 1987; and Ahluwalia 1991), but studies on the effects of the factors associated with the grain marketing system on grain production are not extensive. This research investigates the effects of factors related to the operation of the grain marketing system on grain production in India. This was achieved by conducting a survey of Indian experts. Four years, i.e., 1974/75, 1978/79, 1987/88 and 1988/89, were selected for the survey. In these years, some notable changes were made to the grain marketing environment in that procurement prices were increased significantly or structural changes were made. Based on the "expert judgement", this paper tries to verify the following three major research questions:

- (1) whether the grain marketing system has effects on grain production in India;
- (2) whether changes made to the grain marketing system induce changes in grain production; and
- (3) whether heavy subsidy to the grain consumers by the government impose a negative effect on grain production.

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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.

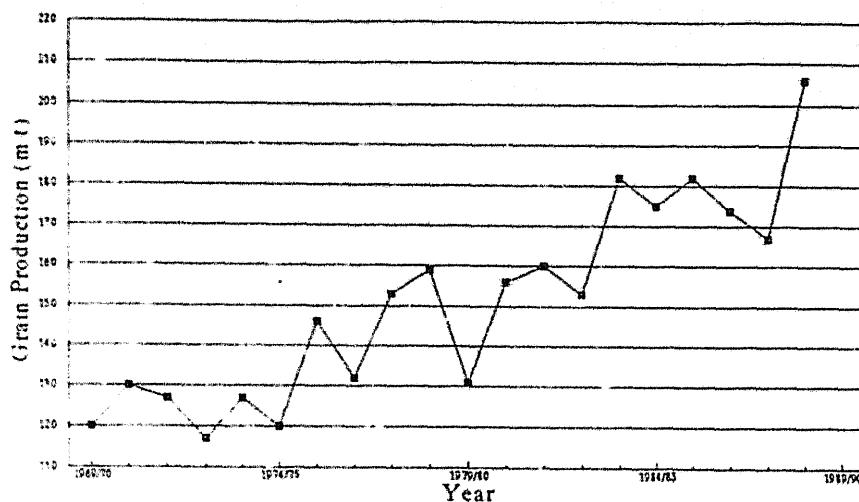


Figure 1 Grain Production in India, 1969/70 to 1988/89

2. THEORETICAL CONSIDERATIONS

Figure 2 shows the factors which affect grain production in developing economies with large subsistence agricultural sectors such as India where some 70 percent of grain produced is consumed by the farmers themselves (Rangarajan 1982; Chopra 1988, p. 234). In this scheme, 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 India which provides more detailed information on the factor "Grain Marketing System" in Figure 2.

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 factors. 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 them.³ 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.

³ 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.

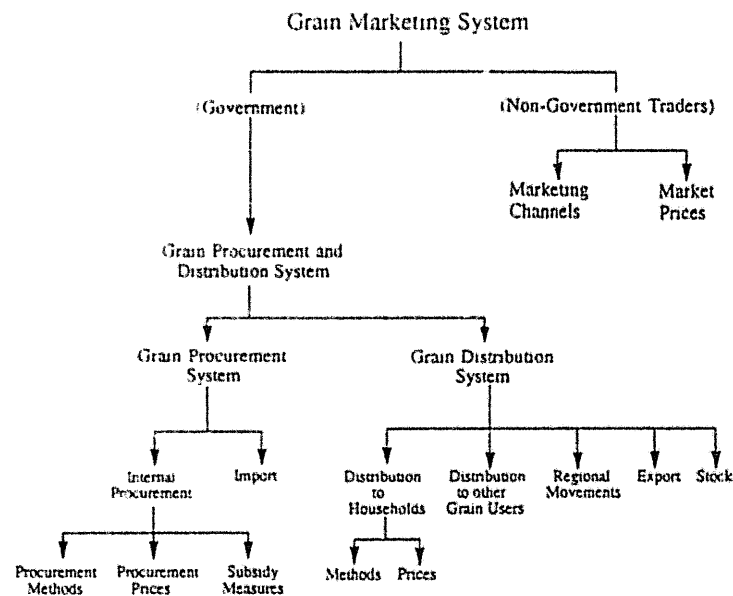
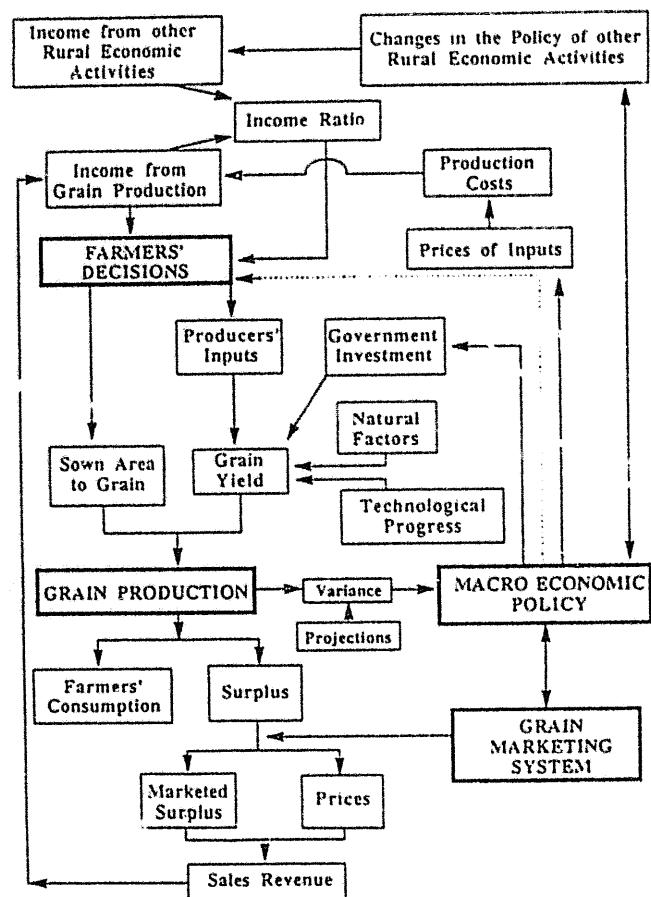


Figure 3 General Structure of the Grain Marketing System in India

Figure 2 A Brief Illustration of Factors Affecting Grain Production

The farmer's decision 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 and paid by farmers. The prices received by farmers may be free market prices or government grain procurement prices. The prices paid are those at which they buy production inputs.

Besides prices, factors such as procurement methods and subsidy to producers, may also affect farmers' economic returns and thus their decisions on grain production.

Other components within a grain marketing system may affect grain production. The limited availability of government grain storage capacities may discourage farmers from producing more grain if they encounter difficulties in marketing their products particularly when good harvests take place. Transportation conditions are obviously another important factor farmers may take into account in deciding whether to produce more grain. Poor road conditions may dampen their interest to produce more grain due to the troubles which may be involved in disposing of the products. Good marketing information services are supposed to have a positive effect on grain production.

When a government takes major responsibility for feeding its people and heavily subsidises grain consumers (as does India), the effect may be to limit the capacity of the government to support such things as grain production infrastructure thus having a negative effect on grain production.⁴

3. RESEARCH METHOD

3.1 Understanding the Effects of a GMS on Grain Production

A grain marketing system (GMS) is a complex and many factors in it can affect grain production. Previous discussions have considered and identified how some of those factors may affect grain production. Table 5.1 lists the factors selected as being directly related to the operation of a GMS which would be examined in this research. It should be noted that the listing can be somewhat arbitrary. It also includes other factors (e.g., weather conditions) which affect grain production.

To examine the effects of these factors on grain production, some econometrical approaches are not necessarily suitable due to technical difficulties in handling so many factors. The method of expert survey was chosen as being most appropriate in these circumstances.

⁴ The subsidies on the distribution of grains rose from Rs. 100 million in 1970-71 to Rs. 2720 million in 1974-75, and to Rs. 9440 million by 1982-83. By 1986-87, the total subsidy bill had exceeded Rs. 20000 million and by 1989-90, the total subsidy was Rs. 24500 million (FCI).

Table 1 Classification of Factors Affecting Grain Production

Factors relating to a GMS	Other factors
1. Grain procurement price	16. Weather conditions
2. Grain support price	17. Agricultural research
3. Grain procurement methods	18. Agricultural extension
4. Subsidy to grain producers	19. Government investment in grain production
5. Non-government grain marketing channels	20. Agricultural credit policy
6. Open market grain prices	
7. Price policy on agricultural inputs	
8. Market prices of non-grain agricultural products	
9. Government policy on non-grain rural economic activities	
10. Subsidy to urban dwellers	
11. Grain movement between states by the GOI	
12. Buffer stock by the central government	
13. Transpiration conditions	
14. Grain storage capacities	
15. Marketing information services	

Note: For convenience of data analysis, the factors in this table and Tables 2-4 were not in the order as in the survey questionnaire, but organised as four different groups under two categories, i.e., "factors relating to the GMS" and "other factors". Those under "factors relating to the GMS" are broadly classified into three groups. Factors 1-9, the first group, are those which relatively directly affect farmers' economic incomes or their decisions on grain production. The second group includes those (Factors 10-12) which are largely related to the grain subsidies to consumers provided by a government. The third group contains those (Factors 13-15) regarding marketing infrastructures. Factors 16-20 under the "other factors" category constitute the fourth group.

The expert survey method takes advantage of the wisdom and insight of people who have considerable expertise in the research area. It is a rapid and relatively efficient way to extract knowledge from a highly experienced group of people. It in addition has the advantage of anonymity among the participants. The experts never meet to discuss their views; a way of avoiding the effect of dominant individuals. The method of expert survey has been applied in various areas, for example, Goldberg (1968), Ashton (1974), Einhorn (1974), Joyce (1976), Carroll and Payne (1977), Lewis (1980), Fisher (1985).

The expert survey as an attempt to examine the effects of a number of factors on grain production, offers another advantage. That is, the number of factors for inclusion in the survey questionnaire is not seriously constrained.

Sixty experts were invited to participate in the survey. The general objective was to generate data on expert judgements about the effects of the factors listed in Table 5.1 on grain production in selected years. Emphasis was placed on those factors directly related to the operation of a GMS.

3.2 Selection of the Survey Years

The major criteria for year selection for the expert surveys was: (1) the years selected should not be far from the 1980s to avoid the difficulty caused by the short memory of human beings, and (2) the years selected should be those when some notable changes to the GMS took place to allow for the examination of the effects the changes in the GMS might have on grain production.

After consultation with Indian experts, the four years, 1974/75, 1978/79, 1987/88, and 1988/89 were selected. In 1974/75, grain procurement prices, especially for wheat, were increased substantially following implementation of the wholesale trade takeover and the levy of previous years⁵. The year 1978/79 was selected because all restrictions on private grain trading were lifted in October 1978. In 1988/89, procurement prices for major grain crops and minimum support prices for some other crops were increased substantially. The year 1987/88 was also included for comparison.

3.3 Survey Instrument

A questionnaire was developed and sent to three Indian experts for a pilot survey. Some modifications were made accordingly.

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

⁵ In early 1973, the GOI decided to take over the entire wholesale trade both in wheat and rice from the coming rabi season. According to this scheme, private traders were to be removed from the wholesale grain trade. Only public agents would be engaged in such business. In the rabi marketing season of 1973, the GOI put the policy of wholesale trade takeover in wheat into practice. The experiment in wheat was unsuccessful and the government decided not to extend the wholesale trade takeover to rice for the coming 1973-74 khari season. To facilitate the augmentation of procurement, policy modifications were made for the coming 1974-75 rabi season. Instead of continuing the strict takeover scheme which did away with private traders completely in the 1972-73 and 1973-74 rabi marketing seasons, private traders were allowed to be engaged in wheat wholesale business with a 50% levy being imposed on them.

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.

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

Example:

EFFECTS OF SOME FACTORS ON GRAIN PRODUCTION IN 1978/79

Show the extent to which each of the factors in the left column of the following matrix table affected grain production in 1978/79. 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:

- 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.

4. 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 they 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.

Based on the survey data, statistical analysis was carried out to verify the hypotheses regarding the effect of each of the factors on grain production.⁶ 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. RESEARCH FINDINGS

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

5.1 Response to the Survey and the Respondents

A total of 37 Indian experts responded to the survey, a response rate of 62%. The initial contact yielded 25 responses while a second request generated an additional 12 responses. However, five were invalid for various reasons although three provided some critical but useful comments. This resulted in 32 valid response, a net response rate of 53%.

The background information on the Indian respondents was summarised in Tables A.1-A.4 in Appendix. The majority of the experts have their first research interest in areas

⁶ 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).

closely related to the present research and that majority of them have worked in their research areas for many years. Thus the respondents have a rich diversity of expertise in the research area the present study covers, and it is appropriate to pool their "wisdom" so as to capture "expert judgement" on the effects of the grain marketing systems on grain production, which is presented in the following section.

5.2 Results from the Survey with Indian Experts

From the descriptive statistics given in Tables A.5-A.8, some general impressions about 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 (reflected by the mode).

For example, Table A.5 shows that in 1974/75 most of the listed factors (18/20) had positive effects on grain production. Only two of them had negative effects. The experts' judgements were quite varied on some factors, such as "grain movements between by the GOI" and "subsidy to urban dwellers through fair price shops", and relatively uniform on others, such as the two factors regarding agricultural research and extension. Similarly, we can obtain general impressions from the responses for other years by examining the descriptive statistics in Tables A.6 to A.8.

Inferential analyses, based on the pooled information of expert judgement, was used to verify whether the grain marketing system in India has effects on grain production and whether changes in the GMS causes changes in the effects it has on grain production. Carried out first was the hypotheses testing concerning whether a factor had effect on grain production in a particular year. The results are given in Table 2.

In the hypotheses testing presented in Table 2, all the null hypotheses are in the format that factor X_i had no effect on grain production in a selected year. In statistical language, that is to say, the mean of a factor based on the scores given by the experts equal to zero. According to the results in Table 2, it can be seen that most of the null hypotheses were rejected at the 10, 5, or 1 percent significance levels except in a few case, e.g., "procurement methods" in 1974/75; "transportation conditions" in 1974/75 and "grain storage capacities" in 1974/75 and 1978/79 (Table 2). These indicate that most of the selected factors had varying effects on grain production in the selected years.

The tests in Table 2 could only tell us whether a factor had an effect on grain production, but could not give us the information about how a factor may have affected grain production (i.e., positively or negatively) and the extent of such an effect. Further tests were thus performed to reveal such information. That is, to test whether the population mean of a factor is less than, greater than, or equal to a hypothesised population mean, which is the integer below the sample mean in absolute value. By using the integer

Table 2 Hypotheses Testing regarding the Effects of Selected Factors on Grain Production ($H_0: \mu=0$)

Factor (X)	1974/75		1978/79		1987/88		1988/89	
	Mean	t-stat	Mean	t-stat	Mean	t-stat	Mean	t-stat
Factors related to the GMS								
1. Grain procurement prices	0.857	6.662***	1.250	6.355***	1.000	4.461***	1.464	7.753***
2. Grain support prices	0.923	6.160***	1.115	5.975***	0.800	3.703***	1.080	5.418***
3. Grain procurement methods	0.346	1.563	0.704	3.425***	0.714	3.383***	0.893	4.753***
4. Subsidies to producers	1.185	5.380***	1.310	9.275***	1.103	5.870***	1.103	5.499***
5. Non-government grain marketing channels	0.464	2.458**	0.571	2.588**	0.607	3.360***	0.926	4.649***
6. Open market grain prices	0.786	3.386***	0.857	4.500***	0.857	4.500***	1.143	6.492***
7. Price policy on agricultural inputs	0.714	2.387**	1.393	8.862***	1.286	5.915***	1.250	7.128***
8. Market prices of non-grain agricultural products	0.179	0.723	0.393	1.890*	0.286	1.353	0.464	2.100**
9. Government policy on other rural economic activities	0.714	1.731***	1.037	6.309***	0.857	4.674***	1.111	6.476***
10. Subsidies to urban dwellers	0.222	1.237	0.250	1.491	0.107	0.619	0.286	1.441
11. Grain movements between states by the GOI	-0.071	-0.311	0.214	1.236	0.357	1.987*	0.607	3.117***
12. Operation of the buffer stock	0.481	2.229**	0.679	3.400***	0.607	3.232***	0.679	3.800***
13. Transportation conditions	0.250	1.045	0.464	1.995*	0.429	2.056**	0.593	2.940***
14. Grain storage capacities	0.250	1.045	0.321	1.611	0.750	3.576***	0.643	3.438***
15. Marketing information services	0.536	3.382***	0.607	3.360***	0.786	4.747***	0.885	5.527***
"Other factors"								
16. Weather conditions	-0.793	-2.167**	0.207	0.497	-0.897	-2.288**	1.833	5.894***
17. Agricultural Research	1.241	7.663***	1.321	8.538***	1.286	7.962***	1.321	9.053***
18. Agricultural extension	1.370	9.603***	1.643	10.523***	1.214	7.336***	1.429	9.567***
19. Investment in agriculture	1.138	5.299***	1.724	11.043***	1.250	7.128***	1.600	10.250***
20. Agricultural credit policy	1.321	6.853***	1.571	9.950***	1.414	9.234***	1.643	10.523***

Notes: 1.

$H_0: \mu=0$

$H_1: \mu \neq 0$

\bar{x} : mean of the population factor X_i , $i=1,2,\dots,20$.

2.

*, **, *** denote the null hypothesis was rejected at the 10, 5, and 1 percent significance levels respectively. The critical values are used for d.f. (n-1).

Source: Survey of Indian experts.

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.

Observing the results in Table 3, the direction of the effect (i.e., positive or negative) of all the selected factors was in accordance with assumptions proposed earlier, except in the case of two factors regarding subsidies to grain consumers, namely, "subsidy to urban dwellers" and "grain movements between states by the GOI". In a few years, it was believed that these two factors had positive effects on grain production (Table 3). This goes against the propositions regarding them made earlier. Further analysis and explanation on these results will be given later on.

Let us analyse the results by taking a few examples on those factors which experienced some changes in the selected years. But first, a brief recall on some important changes regarding the grain production and marketing environment in the selected years may be useful.

In 1974/75, the wholesale trade takeover policy was discontinued. Private traders were allowed to participate in the grain business although a levy was imposed. Grain procurement prices were raised, especially that of wheat, which was increased to 105 Rs per quintal (38%) after it had been kept unchanged at 76 Rs for the 6 years since 1968/69. In 1978/79, because of the improved grain situation, all restrictions on the private grain trade were lifted by the Indian government. In 1978/79 the subsidy on fertiliser use increased substantially.⁷ From 1978/79 to 1987/88, the grain marketing system in India remained relatively stable with no significant changes. During this time period, grain procurement prices and minimum support prices were raised regularly, but the price increments (in actual Rupee value per unit grain) became smaller in 1986/87 and 1987/88. Coupled with unfavourable weather conditions, grain production dropped in the two years adversely affecting grain supply. In 1988/89, procurement prices for major grain crops and minimum support prices for some other crops were increased substantially. The increases in procurement prices for major grain crops were between 10-22 Rs per quintal, which was the largest since 1983/84 and were 1.5 to 5.5 times of the price increments in the previous year. The minimum support prices for some minor grain crops were also increased by 10-35 Rs per quintal, which was also the largest since 1983-84 and the price increments were 3.5 to 10 times those in the previous year (GOI 1990, p. 106).⁸

⁷ Such subsidy on fertilisers was largely started from 1976/77. Data show that the subsidy on fertiliser was zero in 1974/75. It increased from 599 million Rs in 1976/77 to 3420 million Rs in 1978/79 (Chaudhri 1988).

⁸ In 1988/89, the introduction of the Special Foodgrains Production Program can also be a significant factor which could have overall improved grain production environment and hence contributed positively to the record grain production in that year. The program was implemented in 169 districts spread over 14 states. In the program areas, apart from the use of improved high yielding varieties of seeds, the possibility of increasing productivity through increased use of fertilisers (an increase by 20 kg of NPK per hectare) was explored. Better management of weeds and timely plant protection measures followed, along with efforts at efficient use of water. Increased flow of short-term and long-term credit was also arranged (Venkataramani 1989).

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

Factor (X)	1974/75			1978/79			1987/88			1988/89		
	Mean	μ_0	t-stat	Mean	μ_0	t-stat	Mean	μ_0	t-stat	Mean	μ_0	t-stat
Factors related to the GMS												
1. Grain procurement prices	0.857	0	3.662***	1.250	1	1.250	1.000	1	0.000	1.464	1	2.458**
2. Grain support prices	0.923	0	4.463***	1.115	1	1.115	0.800	0	3.703***	1.080	1	0.401
3. Grain procurement methods	0.346	0	1.863*	0.104	0	3.425***	0.714	0	3.383***	0.893	0	4.753***
4. Subsidies to producers	1.185	1	0.861	1.103	1	1.103	1.103	1	0.550	1.103	1	0.515
5. Non-government grain marketing channels	0.464	0	2.458**	0.111	0	2.988**	0.607	0	3.360***	0.926	0	4.649***
6. Open market grain prices	0.386	0	3.386***	0.857	0	4.500***	0.857	0	4.500***	1.143	1	0.812
7. Price policy on agricultural inputs	0.714	0	2.48**	1.493	1	2.500***	1.286	1	1.314*	1.250	1	1.426*
8. Market prices of non-grain agri. products	0.179	0	0.179	0.493	0	1.890**	0.286	0	1.353*	0.464	0	2.100**
9. Gov't policy on other rural econ. activities	0.714	0	3.34***	0.237	1	0.235	0.857	0	4.674***	1.111	1	0.648
10. Subsidies to urban dwellers	0.222	0	1.131	0.250	0	1.491*	0.107	0	0.619	0.286	0	1.441*
11. Grain movements between states by the GOI	-0.071	0	-0.311	0.214	0	1.236	0.357	0	1.987**	0.607	0	3.117***
12. Operation of the buffer stock	0.481	0	2.229**	3.619	0	3.400***	0.607	0	3.232***	0.679	0	3.800***
13. Transportation conditions	0.250	0	1.045	0.464	0	1.995**	0.429	0	2.056**	0.593	0	2.940***
14. Grain storage capacities	0.250	0	1.045	0.321	0	1.611*	0.750	0	3.576***	0.643	0	3.438***
15. Marketing information services	0.536	0	3.382***	0.607	0	3.360***	0.786	0	4.747***	0.885	0	5.527***
"Other factors"												
16. Weather conditions	-0.793	0	-2.167**	0.207	0	0.491	-0.897	0	-2.288**	1.833	1	2.679***
17. Agricultural Research	1.241	1	1.490*	1.121	1	2.077**	1.286	1	1.769**	1.321	1	2.202**
18. Agricultural extension	1.370	1	2.596***	1.643	1	4.118***	1.214	1	1.295	1.429	1	2.870***
19. Investment in agriculture	1.138	1	0.642	1.724	1	4.638***	1.250	1	1.426*	1.600	1	3.844***
20. Agricultural credit policy	1.321	1	1.667*	1.571	1	3.618***	1.414	1	2.703***	1.643	1	4.118***

- 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 $i=1,2,\dots,20$.
 μ_0 : the hypothesised population mean of factor X, ($i=1,2,\dots,20$), which is the integer below the sample mean in absolute value.
2. *, **, *** denote the null hypothesis was rejected at the 10, 5, and 1 percent significance levels respectively. The critical values are used for d.f. (n-1).

Source: Survey of Indian experts.

With these changes, the factors, "grain procurement prices", "grain support prices", "free market grain price", "non-government grain marketing channels", and "price policy on agricultural inputs", would have changed the extent of their effects on grain production.

Examining the effect of "grain procurement price" in Table 3, it can be seen that there was a positive effect on grain production in 1974/75 as was expected. It also had positive effect in all the other surveyed years. But the extent varies. As measured by the value of the means, it was not surprised that the extent of the effect in 1987/88 was smaller, but larger in 1988/89. The positive effect of "grain support prices" was also larger than that in 1987/88.

Due to the easing of restrictions on private grain business in 1974/75, the two factors, "free market grain price" and "non-government grain marketing channels", had positive effects on grain production as anticipated. As a result of the removal of all restrictions on private grain sector in October 1978, such positive effects were on increase in 1978/79 as shown in Table 3.

As expected, the experts believed that "price policy on agricultural inputs" had a much larger effect in 1978/79, when compared to that in 1974/75.

Considering the results of these factors, it may be said that some changes to them may induce changes in their effects on grain production. On the other hand, when taking all the factors in Table 3 into account (excluding natural factors, e.g., weather conditions), few factors are believed by the Indian experts to have changed the direction of their effects on grain production in all the years surveyed except for "grain movements between states by the GOI" in 1974/75. This means that they may have changed the extent of their effects on grain production but at the same direction, i.e., positively.

However, do the Indian experts believe that those factors which experienced some changes have different effects in two different years? Do they also have the same judgements for all the other factors? To find this out, hypotheses testing for the difference in the means was conducted. The results are presented in Table 4. In these tests, the null hypotheses were in the format that the experts would believe there was no difference in the effect of a factor on grain production in two proximate years. In other words, the mean of differences of paired observations is not statistically different from zero. The results in Table 4 indicate that the experts believed there were no significant differences in the effects of most factors on grain production over the years in question.

Let us have a look at the testing results of a few factors which experienced some changes. That is, the results of "non-government grain marketing channels" and "open market grain prices" in 1978/79 versus 1974/75 due to the removal of all restrictions on private traders; the result of "price policy on agricultural input" in 1978/79 versus 1974/75 due to the increase in subsidy on inputs, and the result of "grain procurement prices" in 1988/89 versus 1987/88 due to a big increase in prices. After such changes, it would be natural to expect that their positive effects would be larger than those in an earlier year.

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

Factor (X)	78/79 vs 74/75		87/88 vs 78/79		88/89 vs 87/88	
	D-mean	t-stat	D-mean	t-stat	D-mean	t-stat
Factors related to the GMS						
1. Grain procurement prices	0.393	1.488	-0.250	-1.368	0.481	2.801***
2. Grain support prices	0.120	0.721	-0.370	-1.496	0.291	1.273
3. Grain procurement methods	0.280	1.429	0.031	0.189	0.141	1.162
4. Subsidies to producers	0.148	0.724	-0.207	-1.440	0.000	0.000
5. Non-government grain marketing channels	0.107	0.570	0.036	0.297	0.346	2.087**
6. Open market grain prices	0.031	0.348	0.000	0.000	0.222	1.237
7. Price policy on agricultural inputs	0.679	2.748**	-0.107	-0.619	-0.037	-0.176
8. Market prices of non-grain agricultural products	0.214	1.140	-0.107	-0.648	0.185	1.727*
9. Government policy on other rural economic activities	0.259	1.369	-0.111	-0.769	0.231	1.656
10. Subsidies to urban dwellers	-0.037	-0.170	-0.143	-1.162	0.222	2.280**
11. Grain movements between states by the GSI	0.286	1.549	0.143	0.750	0.259	1.892*
12. Operation of the buffer stock	0.185	1.727*	-0.031	-0.570	0.037	0.440
13. Transportation conditions	0.214	1.140	-0.036	-0.441	0.231	1.539
14. Grain storage capacities	0.031	0.386	0.429	2.580**	-0.074	-0.440
15. Marketing information services	0.031	0.402	0.119	1.000	0.080	1.625
"Other factors"						
16. Weather conditions	1.000	1.613	-1.103	-1.784*	2.897	5.582***
17. Agricultural research	0.031	0.570	-0.036	-0.328	0.037	0.440
18. Agricultural extension	0.296	2.126**	-0.429	-3.057***	0.222	2.726**
19. Investment in agriculture	0.886	2.999***	-0.500	-3.550***	0.357	2.585**
20. Agricultural credit policy	0.250	1.888*	-0.143	-1.162	0.148	1.280

Notes: 1. $H_0: \mu_{1979} = \mu_{1975}$
 $H_1: \mu_{1979} \neq \mu_{1975}$
 $H_0: \mu_{1988} = \mu_{1979}$
 $H_1: \mu_{1988} \neq \mu_{1979}$
and $H_0: \mu_{1989} = \mu_{1988}$
 $H_1: \mu_{1989} \neq \mu_{1988}$

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

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

2. *, **, *** denote the null hypothesis was rejected at the 10, 5, and 1 percent significance levels respectively. The critical values are used for d.f. (n-1).

Source: Survey of Indian experts.

Examining the results for 1978/79 versus 1974/75 in Table 4, the effects of "non-government grain marketing channels" and "open market grain prices" are believed by the Indian experts to have had no significant difference in 1978/79 from those of 1974/75. This is probably due to the fact that the discontinuation of the takeover policy in 1974/75 and, the abandonment of a wheat levy on traders in 1975/76, had already allowed private traders much more freedom in doing their business. By the time the GOI removed the rest of the restrictions on private traders in October 1978, the private sector was probably already fully involved in grain marketing. Thus no significant changes in the effect brought out by the private traders could be felt.

There was a difference in the effect of the "price policy on agricultural inputs" in 1978/79 versus 1974/75. Subsidised inputs may have stimulated farmers to use more production resources.

Note the result of "grain procurement prices" for 1988/89 versus 1987/88. The D-mean is positive and is largest in value amongst all the factors related to the operation of the GMS. The test is statistically significant at the 1% significance level. This indicates that the experts believed a larger increase in procurement prices in 1988/89 had a larger effect on grain production.

In Section 2 it was suggested that a substantial subsidy to grain consumers may have the effect of limiting the capacity of a government to support grain production. In India, this does not seem to be the case. Results from the survey of Indian experts in Table 3 regarding the subsidy factors "subsidy to urban dwellers" and "grain movements between states by the central government" show that the consumer subsidies have very little or possibly a small positive effect on production. Heavy consumption subsidies do not seem to affect the government's capacity to invest in agriculture. Thus the increase in demand from consumers resulting from subsidies provides additional markets for producers and results in an increase in production.

Results in Tables 2 to 4 provide sufficient evidence to conclude that the grain marketing system in India had effects on grain production, and that the changes in the grain marketing system which affected the economic incentives conveyed to farmers have affected grain production. However, the survey results showed no support for the assertion that heavy government subsidy to consumers may impose a negative effect on grain production in the Indian context.

6. CONCLUSIONS AND IMPLICATIONS

The method of expert survey was employed in this research. Although it has its advantages, it should be noted that it also has its limitations. Relating to the present research, its ability to reveal the relative strength of the effect of various factors on grain production is limited because the investigation as such is essentially univariate in nature. In addition, the expert

survey method is not able to capture the fact that the effects of some factors on grain production may be either direct or indirect, cumulative or one-off and that some factors may not be strictly mutually independent. Varying lags in the effects are also not captured. Therefore, the results should only be used as approximation or indication of the effects of different factors on grain production. Nevertheless, the method allowed to "extract" and "pool" experts' judgements to gauge the effects of some factors on grain production. Such a method enables the size and direction of the effects of some factors on grain production to be assessed. Some conclusions based on the survey are drawn as follows.

According to the Indian experts, the grain marketing system in India has had a positive effect on grain production over the period investigated. Furthermore, the positive effect of most factors relating to the operation of the GMS has been increasing relatively steadily with some exceptions, mainly in 1987/88. This should be deemed as the result of the adoption of a stable grain marketing policy by the GOI which ensures a remunerative return to grain producers. Among all the factors related to the operation of the grain marketing system, factors regarding marketing infrastructure were believed to have some positive effects on grain production. Factors on subsidy to consumers were not believed to have a negative effect in India. Factors directly affecting farmers' income from grain, such as procurement prices, market grain prices, subsidy to producers, and input prices, are found to have the most important effects on grain production. The fact that "market prices of non-grain farm produce" and "government policy on non-grain rural economic activities" have a steady and positive effect on grain production is also important. This implies that government policy was slightly favourable to grain production and thus farmers' economic returns from producing grain were not disadvantaged, encouraging them to make continuous efforts in the grain industry.

It can also be concluded that "weather conditions" is still a crucial determinant of grain production in India. In Table 3, excluding "grain movements between states by the GOI", no other factors changed the direction of their effects over years except "weather conditions". Table 4 on the other hand reveals that the effects of "weather conditions" were also different over years in most cases. The effects of most other factors were, however, not different over years. If any difference, their positive effects were increased, except for two of them, e.g., "agricultural extension" and "investment in agriculture" in 1987/88 where the negative effects were increased but the extent of the increase in such negative effects was much smaller compared to that of "weather conditions" in the same year. Therefore weather conditions are mainly responsible for fluctuation in grain production. This conclusion agrees with existing studies such as Mahendradev (1987) and Ahluwalia (1991). The critical effect of weather conditions on grain production in India is due mainly to the variability of the monsoon.

Since the results of the survey indicate that most of the investigated factors have positive and steady effects on India's grain production, it would be desirable that a stable and consistent policy in relevant aspects of grain marketing is maintained.

Regarding grain movements between states by the central government, there may be a need to reduce the central subsidy involved. Preferably, given that the benefits to the state governments and farmers in the exporting regions are unaffected, such movements should be done on a no-gain no-loss basis to save resources for other purposes. Such a subsidy should only be provided for regions which are particularly poor and need help from the central government.

Because weather conditions are still the predominant factor affecting grain production in India, it is especially important that a reasonable amount of investment in agriculture be maintained by the central government. Some large-scale agricultural capital construction such as irrigation infrastructure can only be completed with the support of government investment. These large-scale constructions increase grain production's resistance to weather-related disasters, thus reducing the effect of weather disturbance on grain production. Such investment should be carried out smoothly. While a sharp increase in investment may not produce immediate results, a sharp decrease may quickly reduce the efficacy of previous investments.

APPENDIX

Note: The sources of all the tables in this Appendix are the survey of Indian experts.

Table A.1 Nature of the Respondents' Institution

	No.	%
Research institution	29	90.6
Government department	3	9.4

Table A.2 Title Held by the Respondents

Title	No.	%
Professor (or equivalent)	21	70.0
Associate professor (or equivalent)	2	6.7
Economist (or equivalent)	2	6.7
Other	5	16.6

Table A.3 Research Fields of the Respondents

Field	First (%)	Second (%)	Third (%)	Total (%)
Agricultural marketing	6.3			2.1
Agricultural prices & costs	15.6	6.3	10.0	10.6
Agricultural policy	37.5	6.3	10.0	18.1
Food and nutrition	6.3	9.4	3.3	6.4
Grain development strategy		3.1		1.1
Grain economics		12.5		4.3
Economic development	15.6	28.1	6.7	17.0
Economic theory	3.1	3.1		2.1
Econometrics	3.1	3.1		2.1
Production economics	6.3	9.4	3.3	6.4
Forecasting		3.1	3.3	2.1
Agricultural statistics	3.1		6.7	3.2
Resource economics	3.1	3.1	20.0	8.5
Agricultural finance		3.1	10.0	4.3
Farm management		9.4	13.3	7.4
Other			13.3	4.3
	n=32	n=32	n=30	n=94

Table A.4 Years the Respondent Have Worked in These Fields

Year	No.	%
10 to under 20 years	9	28.1
20 to under 30 years	15	46.9
30 years or more	8	25.0

Table A.5 Descriptive Statistics from the Survey of Indian Experts (Re. 1974/75)

Factor	No. of Obs.	Mean	S.D.	C.V.	Min.	Max.	Median	Mode with No. of Obs.
1. Weather conditions	29	-0.79	1.97	-2.48	-3	3	-1	-2 8
2. Agricultural research	29	1.24	0.87	0.70	0	3	1	1 12
3. Agricultural extension	27	1.37	0.74	0.54	0	3	1	1 18
4. Investment in agriculture	29	1.14	1.16	1.02	-2	3	1	1 14
5. Grain procurement prices	28	0.86	1.24	1.45	-2	3	1	1 12
6. Grain support prices	26	0.92	1.06	1.14	-2	3	1	1 13
7. Grain procurement methods	26	0.35	1.13	3.26	-1	3	0	0 10
8. Subsidies to producers	27	1.19	1.14	0.97	-1	3	1	2 9
9. Subsidies to urban dwellers through Fair Price Shops	27	0.22	0.93	4.20	-2	3	0	0 20
10. Grain movements between states by the GOI	28	-0.07	1.21	-17.01	-2	3	0	0 14
11. Operation of the buffer stock	27	0.48	1.12	2.33	-1	3	0	0 10
12. Non-government grain marketing channels	28	0.46	1.00	2.15	-1	2	1	1 11
13. Open market grain prices	28	0.39	1.23	1.56	-2	3	1	1 12
14. Transportation conditions	28	0.25	1.27	5.06	-2	3	0	0 9
15. Grain storage capacities	28	0.25	1.27	5.06	-2	3	0	0 9
16. Marketing information services	28	0.54	0.84	1.56	-2	2	0	0 13
17. Price policy on agricultural inputs	28	0.71	1.58	2.22	-3	3	1	1 10
18. Government policy on other rural economic activities	28	0.71	1.01	1.42	-2	2	1	1 15
19. Market prices of non-grain agricultural products	28	0.18	1.31	7.32	-2	3	0	1 8
20. Agricultural credit policy	28	1.32	1.72	0.77	-2	3	1	1 14

Table A.6 Descriptive Statistics from the Survey of Indian Experts (Re. 1978/79)

Factor	No. of Obs.	Mean	S.D.	C.V.	Min.	Max.	Median	Mode with No. of Obs.
1. Weather conditions	29	0.21	2.24	10.84	-3	3	0	3 6
2. Agricultural research	28	1.32	0.82	0.62	0	3	1	1 13
3. Agricultural extension	28	1.64	0.83	0.50	0	3	1	1 13
4. Investment in agriculture	29	1.72	0.84	0.49	0	3	2	1 12
5. Grain procurement prices	28	1.25	1.04	0.83	0	3	1	1 14
6. Grain support prices	26	1.12	0.95	0.85	0	3	1	1 12
7. Grain procurement methods	27	0.75	1.07	1.52	-1	3	1	1 10
8. Subsidies to producers	29	1.31	0.76	0.58	0	3	1	1 16
9. Subsidies to urban dwellers through Fair Price Shops	28	0.25	0.89	3.55	-1	3	0	0 19
10. Grain movements between states by the GOI	28	0.21	0.92	4.28	-1	3	0	0 12
11. Operation of the buffer stock	28	0.68	1.06	1.56	-1	3	1	1 10
12. Non-government grain marketing channels	28	0.57	1.17	2.04	-1	3	0	0 8
13. Open market grain prices	28	0.86	1.01	1.19	-1	3	1	1 10
14. Transportation conditions	28	0.46	1.23	2.65	-2	3	0	0 10
15. Grain storage capacities	28	0.32	1.06	3.29	-2	2	0	1 10
16. Marketing information services	28	0.61	0.96	1.57	-2	2	1	0 11
17. Price policy on agricultural inputs	28	1.39	0.83	0.60	0	3	1	1 14
18. Government policy on other rural economic activities	27	1.34	0.85	0.62	0	3	1	1 11
19. Market prices of non-grain agricultural products	28	0.39	1.10	1.80	-2	2	0	1 10
20. Agricultural credit policy	28	1.57	0.84	0.53	0	3	1	1 12

Table A.7 Descriptive Statistics from the Survey of Indian Experts (Re. 1987/88)

Factor	No. of Obs.	Mean	S.D.	C.V.	Min.	Max.	Median	Mode with No. of Obs.
1. Weather conditions	29	-0.90	2.11	-2.35	-3	3	-2	-3 9
2. Agricultural research	28	1.29	0.85	0.66	0	3	1	1 15
3. Agricultural extension	28	1.21	0.88	0.72	0	3	1	1 15
4. Investment in agriculture	28	1.25	0.93	0.74	-1	3	1	1 12
5. Grain procurement prices	28	1.00	1.19	1.19	-1	3	1	0 9
6. Grain support prices	26	0.80	1.08	1.35	-1	3	1	0 9
7. Grain procurement methods	28	0.71	1.12	1.56	-1	3	0	0 14
8. Subsidies to producers	29	1.00	1.01	0.92	-1	3	1	1 15
9. Subsidies to urban dwellers through Fair Price Shops	28	0.11	0.92	8.55	-2	3	0	0 19
10. Grain movements between states by the GOI	28	0.36	0.95	2.66	-2	3	0	0 17
11. Operation of the buffer stock	28	0.61	0.99	1.64	-1	3	0	0 13
12. Non-government grain marketing channels	28	0.61	0.96	1.57	-1	2	1	1 11
13. Open market grain prices	28	0.86	1.00	1.18	-1	3	1	1 12
14. Transportation conditions	28	0.43	1.10	2.57	-2	2	0	0 11
15. Grain storage capacities	28	0.18	1.11	1.48	-1	3	1	0 10
16. Marketing information services	28	0.79	0.88	1.11	-1	3	1	1 12
17. Price policy on agricultural inputs	28	1.29	1.13	0.89	-2	3	1	1 13
18. Government policy on other rural economic activities	28	0.86	0.97	1.13	-1	3	1	1 11
19. Market prices of non-grain agricultural products	28	0.29	1.12	3.91	-2	2	0	0 10
20. Agricultural credit policy	29	1.41	0.82	0.58	0	3	1	1 14

Table A.8 Descriptive Statistics from the Survey of Indian Experts (Re. 1988/89)

Factor	No. of Obs.	Mean	S.D.	C.V.	Min.	Max.	Median	Mode with No. of Obs.
1. Weather conditions	28	1.83	1.10	0.93	-3	3	2	3 15
2. Agricultural research	28	1.32	0.77	0.58	0	3	1	1 18
3. Agricultural extension	28	1.43	0.79	0.55	0	3	1	1 19
4. Investment in agriculture	28	1.60	0.86	0.53	-1	3	2	2 13
5. Grain procurement prices	28	1.46	1.00	0.69	0	3	1	1 13
6. Grain support prices	26	1.08	1.00	0.92	0	3	1	1 10
7. Grain procurement methods	28	0.89	0.99	1.11	-1	3	1	1 10
8. Subsidies to producers	29	1.00	1.08	0.98	-2	3	1	1 16
9. Subsidies to urban dwellers through Fair Price Shops	28	0.29	1.05	3.67	-2	3	0	0 16
10. Grain movements between states by the GOI	28	1.01	1.13	1.10	-2	3	0	0 14
11. Operation of the buffer stock	28	1.68	0.94	1.39	-1	3	0	0 13
12. Non-government grain marketing channels	27	0.93	1.04	1.12	0	3	1	0 13
13. Open market grain prices	28	1.14	0.93	0.82	-1	3	1	1 13
14. Transportation conditions	27	0.35	1.05	1.31	-2	2	1	0 10
15. Grain storage capacities	28	0.64	0.99	1.54	-1	2	1	1 11
16. Marketing information services	26	0.88	0.82	0.92	0	3	1	1 11
17. Price policy on agricultural inputs	28	1.25	0.93	0.74	-1	3	1	1 14
18. Government policy on other rural economic activities	27	1.11	0.89	0.80	-1	3	1	1 12
19. Market prices of non-grain agricultural products	28	0.46	1.17	2.52	-2	2	0	0 9
20. Agricultural credit policy	28	1.64	0.83	0.50	0	3	1	1 13

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