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WHEAT AREA PRICE RESPONSE IN IRAN, 1960-61 TO 1991-92

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ABSTRACT

The purpose of this study was to estimate the area price elasticities for irrigated and non-irrigated wheat. The Nerlovian partial adjustment model was used to estimate these elasticities. The short-run and the long-run irrigated wheat area elasticities with respect to wheat wholesale price were estimated to be 0.08 and 0.17, respectively. The corresponding elasticities with respect to the Country Grain Organization (CGO) price were estimated to be 0.06 and 0.15%, respectively. The estimated elasticities imply that the amount of land under cultivation of irrigated wheat will change by 0.08% in the short run and by 0.17% in the long run if the actual value of the wholesale price of wheat changes by 1%. Similarly, the change in the irrigated land will be 0.06% in the short run and 0.15% in the long run if the actual CGO price changes by 1% . The area under cultivation of non-irrigated wheat was not signigicantly responsive to either wholesale or CGO prices.

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پاسخ سطح زیر کشت گندم نسبت به قیمت در ایران، ۴۰-۱۳۳۹ تا ۷۱-۱۳۷۰

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چکیده

هدف از این مطالعه بر آورد کشش های قیمتی سطح زیر کشت گندم آبی و نیز گندم دیم بود. برای برآورد از مدل تعدیل جزئی نرلاو استفاده شد. کشش های سطح زیرکشت گندم آبی نسبت به قیمت عمده فروشی گندم در کوتاه مدت و در دراز مدت به ترتیب ۰/۰۸ و ۰/۱۷ درصد برآورد شد. همین کشش ها نسبت به قیمت های سازمان غله کشور به ترتیب ۰/۰۶ و ۰/۱۵ درصد بود. بر اساس این کشش ها، اگر قیمت عمده فروشی گندم یک درصد تغییر کند، سطح زیر کشت گندم آبی در کوتاه مدت ۰/۰۸ درصد و دردراز مدت ۰/۱۷ درصد تغییر خواهد کرد. اگر قیمت گندم توسط سازمان غله کشور یک درصد تغییر کند، درصد تغییر در سطح زیر کشت گندم آبی در کوتاه مدت ودر دراز مدت، به ترتیب، ۰/۰۶ و ۰/۱۵ درصد خواهد بود. سطح زیر کشت گندم دیم نسبت به تغییر در قیمت عمده فروشی و یا قیمت سازمان غله کشور از نظر آماری عکس العمل معنی داری نداشت.

INTRODUCTION

Wheat is an economically strategic commodity in Iran. There has been an overall increase in the amount of land under wheat cultivation (Fig. 1).

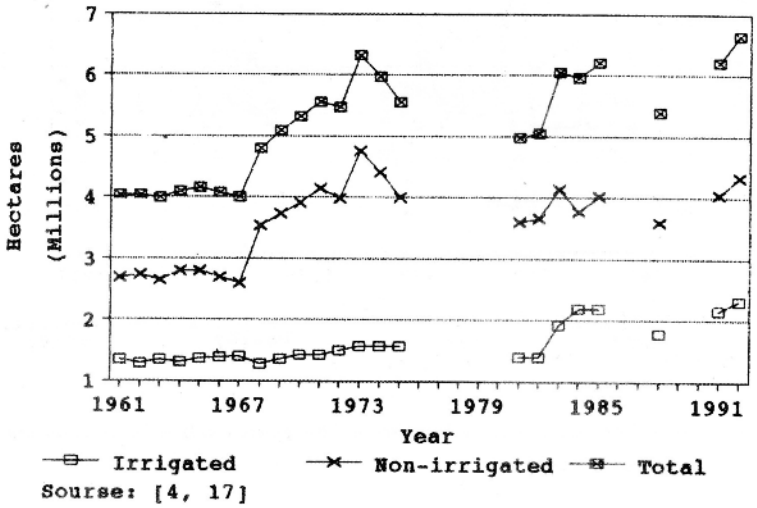

Fig. 1. Irrigated and non-irrigated wheat area in Iran for selected years from 1961 to 1992.

During the period of 1960-61 to 1991-92, the area under cultivation of irrigated and non-irrigated wheat has increased from 1, 344, 148 and 2, 685, 072 to 2, 317, 678 and 4, 321, 891 hectares, respectively. In terms of percentage of the total cultivated land of the country, however, wheat and especially irrigated wheat have lost their share over time. The irrigated wheat land comprised 58 and 40% of the total irrigated land of the country, excluding fallow, in 1960-61 and 1991-92, respectively. The corresponding figures for non-irrigated wheat land were 69 and 61%. Fig. 1 also shows that there have been some fluctuations in both irrigated and non-irrigated wheat land over time. For further explanation of these fluctuations the annual percentage change in the cultivated area of irrigated and non-irrigated wheat and barley are shown in Fig. 2 which shows that, within the period of 1962 to 1968, irrigated and non-irrigated wheat have substituted each other . That

is, in any of these years the area of irrigated and non-irrigated wheat covaried. The same trend was observed for barley between 1962 to 1967.

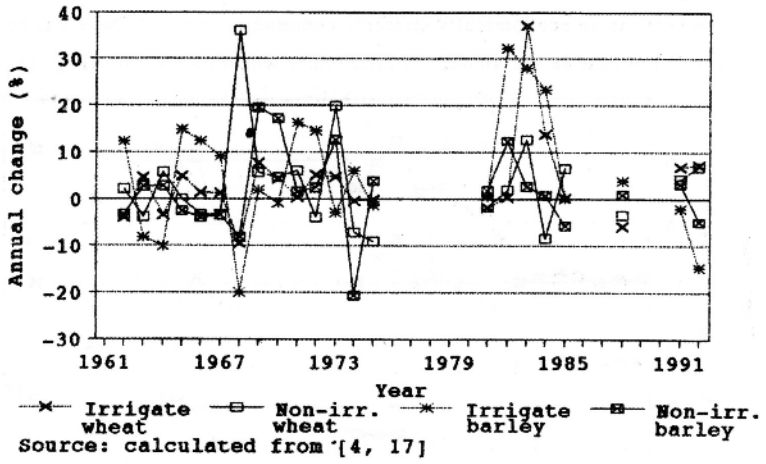

Fig. 2. Annual percentage change in wheat and barley area in Iran for selected years from 1962 to 1992.

Table 1 shows the distribution of field crop cultivations for selected years in Iran. It shows that there have been diversified field crops in Iranian agriculture and the percentage of the cultivated land under these crops has changed over time.

The quantity of imported wheat has fluctuated and generally increased over time to cope with the rapidly increasing demand. Imports increased from 138,312 tons (4.6% of consumption) in 1961 to 3,636,563 tons (32% of consumption) in 1991 and dropped to 1, 856, 788 tons (15% of consumption) in 1992 (4, 16).

Iranian farmers have had the choice of selling their wheat surpluses to either the Country Grain Organization (CGO) for its offered prices or to other buyers in the domestic free market. The wheat price offered by CGO has generally been slightly lower than the free market price (22). CGO was one of the main buyers of wheat especially for harvesting season. Its purchase amounted, for example, to 18, 30, 42, and 40 percent of domestic wheat production for years 1987, 1990, 1991, and 1992, respectively (21).

The imports and CGO purchases of wheat have comprised the government inventory of this product. This inventory has been supplied at a subsidized price to the bread industry of the country.

Table 1. Distribution of field crop cultivation, aggregate irrigated and non-irrigated, for selected years in Iran.

Crops	1960	1965	1975	1985	1991	1992
			(%)			
Wheat	61.3	59.9	60.2	57.0	49.4	51.5
Barley	18.2	17.5	15.6	19.1	18.1	16.2
Paddy	5.0	5.2	4.3	4.4	4.6	4.5
Pulses	2.0	2.1	3.5	4.3	7.8	9.3
Potato	0.3	0.4	†	1.0	1.1	1.2
Cotton	4.8	5.1	3.1	1.7	1.6	1.3
Sugarbeets	0.7	1.2	1.0	1.3	1.4	1.3
Oil seeds	0.8	0.8	†	0.9	1.3	1.9
Tobacco	0.4	0.4	†	0.2	0.1	0.1
Other crops§	6.5	7.4	11.4	10.1	14.7	12.7
Total (1,000 ha)	6,541	6,934	9,254	10,900	12,580	12,905

Source: Data were taken or calculated from references (4) and (10).

† Included in the other crops category.

§ Include other cereals, fiber crops, vegetables and vine crops, herbs, onion, and some other summer crops.

Iranian wheat growers have always faced a lower price than the international price for their marketed wheat. This is because government subsidized wheat has supplied for a considerable amount of the market demand. The wheat price has been allowed to rise over time, especially since 1972, when rapid inflation started in the whole economy. The price rise was implemented by devices such as increasing the price that CGO offered for its wheat purchase. This price rise, however, had been insufficient to catch up with the general inflation rate. That is, within the period under study, with the exception of a couple of years, the real wholesale price indices for wheat have been less than one. One of the reasons for the government to allow the price of wheat to rise has been to increase the domestic supply of wheat in

order to reduce imports. Information on the supply response of wheat in Iran is thus helpful for policy makers deciding what price level to impose.

The literature shows that farmers are responsive to change in prices of agricultural commodities in developing as well as in developed countries. Krishna (12) reviewed acreage and price response studies. His results revealed that in less developed countries the acreage-price elasticities for staple food crops ranged from zero to 0.4 and that the acreage-price elasticities for two commercial fiber crops, cotton and jute, were higher, 0.4 to 0.7. Comparing these results with studies of acreage response to price in more developed nations, he concluded that the responses of traditional and commercial farmers to price are of similar magnitude. Long-run price elasticities of about 0.93 were indicated for developed countries. Nouri-Naini and Pedram (21) used the ratio of the wholesale price index of wheat to wholesale price index of barley as the independent price variable in their partial adjustment regression price response model. Their results show that the responsiveness of aggregate irrigated and non-irrigated area of wheat to this price ratio in Iran were 0.56 and 1.17 in the short and long run, respectively.

The purpose of this study was to investigate the responsiveness of country level wheat area to price in Iran and more specifically to estimate the wheat area- price elasticities. Studies on wheat area-price response in Iran, (e.g., 21) have used the aggregate irrigated and non-irrigated land under wheat cultivations. This study, however, estimated the responsiveness of irrigated and non-irrigated wheat area to price, separately.

METHODOLOGY AND DATA

Methodology

Different models and variable specifications especially with regard to price variables, have been used in estimating price elasticities in previous price response studies. Nerlove (18), in the study of three different crops including wheat, was the first to use the partial adjustment model. In his

model, while the cultivation area of crop was used as the dependent variable of the regression, the lagged area was also included as one of the independent variables. Besides the theoretical reasons, justification for using this model by Nerlove was that the magnitude of the estimated price elasticities were closer to reality than those estimated by the traditional model. As it will be explained later, in the traditional model only the short-run elasticities can be estimated, but in the partial adjustment model both short-run and long-run elasticities can be estimated. Furthermore, the possible existence of autocorrelation in the traditional model is often eliminated when the partial adjustment model is used. Considering these points, the partial adjustment model was used in this study.

Different price specifications have been used in the previous price response studies. Duloy and Watson (5) used actual prices deflated by actual prices of competing crops. Tomek (24), in a study on cotton, and Saylor (23), in a study on coffee, also used deflated prices in their models. Fisher (6), in a study on wheat, used different types of prices including actual wheat price. Nerlove and Adison (20) used actual price of the commodity. Krishna (11) used price indices deflated by prices of competing crops. Askari and Cumming (1) categorized the different types of prices that have been used in the previous price response studies. The actual price of the crop received by the farmers was one of the four price categories. The other three categories they summarized were: the ratio of the price of the crop received by farmers to some consumer price index; the ratio of the price of the crop received by farmers to some index of the prices of the farmers' inputs; and the ratio of the price of the crop received by farmers to some price indices of the competitive crops (or the price of the most competitive crop). In the present study many different price specifications were examined. However, only the results of the estimated regressions that used lagged actual price of wheat, and that gave statistically better estimates than the other price measurements, are presented. Other price specifications whose estimated coefficients are not shown here, due to statistically less significant results, were: the ratio of the wheat wholesale price to the barley wholesale price or to the commodity wholesale price index and; the ratio of CGO wheat price to CGO barley price or to the commodity wholesale price index.

In other price response studies (6, 11, 13) besides the price variable, various other explanatory variables have been used in regression models. In this study too, such variables as lagged dependent variable, the amount of previous year's rainfall, the previous year's ratio of the yield of wheat to yield of barley, price of chemical fertilizers, time trend, and dummy variables for different lengths of time were used as explanatory variables. However, among all of the estimated regressions only those that used the independent variables of lagged actual wheat price and lagged wheat area provided more statistically significant results. The regressions, were also estimated in the log-log form. The log-log form results, however, were not as significant as those of the simple form.

In this study the Nerlovian partial adjustment model, as equation [1] below (9, 19, 20) was used to estimate the long-run supply function:

$$A^*_t = ß_0 + ß_1 P_{it-1} + U_t \qquad [1]$$

where

A^*_t = Expected wheat area cultivated at country level in year t in hectares.

P_{it-1} = Wheat price in year t-1 in Rials (1 $U.S.=3000 Rls in 1955) per kg, i=1 for actual wholesale price and =2 for actual CGO price.

U_t = Disturbance term for year t.

$ß_0$ = Intercept.

$ß_1$ = Estimated partial regression coefficient.

Since the expected wheat cultivation area is not directly observable, let us assume the wheat cultivation area adjustment hypothesis, namely:

$$A_t - A_{t-1} = \delta (A^*_t - A_{t-1}) \;\&\; 0 < \delta < 1 \qquad [2]$$

where A_t and A_{t-1} in hectares are the actual country wheat-cultivated area in year t and t-1, respectively, and δ is called the elasticity or the coefficient of adjustment (12, 13, 20). Note that if δ equals one, then the actual and expected wheat areas would equal (1, 11, 13, 18, 19).

Equation [2] states that a constant percentage of discrepancy between the actual and the expected wheat cultivation area is eliminated within a single period (year).

Substituting A^*_t from equation [1] into equation [2] and rearranging, then we obtain:

$$A_t = \delta \beta_0 + \delta \beta_1 p_{it-1} + (1-\delta) A_{t-1} + \delta U_t \quad [3]$$

which may be called the short-run supply function for wheat. To get back to the long-run supply function [1] all that needs to be done is to divide the whole short-run supply function by δ and drop A_{t-1} term. δ is calculated as one minus the estimated coefficient of the lagged variable, A_{t-1}. Equation [3] is used in separate regressions to estimate the irrigated and the non-irrigated wheat price response.

The short-run wheat area price elasticity is calculated as the ratio of the mean of the previous year price, P_{it-1} to the mean of wheat area, A_t, multiplied by $\delta \beta_1$, the estimated price coefficient in equation [3] and the long-run area price elasticity, β_1 in equation [1], is calculated by dividing the estimated price coefficient (i.e., $\delta \beta_1$) in equation [3] by δ. Furthermore, δ is equal to one minus the estimated coefficient of the lagged area, A_{t-1}, in equation [3] (18).

The estimated regressions were compared based on their R^2 (coefficients of multiple determination), F-ratios, and the Durbin-Watson statistics. The Durbin-*h* test was not employed here due to the smallness of sample size. In the case of small samples, the Durbin-Watson test would give satisfactory results (7). The regressions were also compared on the basis of the theoretically justifiable signs and significance level of the estimated partial regression coefficients.

Data

The data included the country area of land under cultivation of irrigated and non-irrigated wheat, different wheat prices, and the amounts of rainfall for 23 selected years between 1960-61 to 1991-92. The selected years were those for which more dependable data were available. These years were 1960-61 to 1974-75, 1980-81 to 1984-85, 1987-88, 1990-91 and 1991-92. Each agronomic year started on 23rd of September. The data for wheat cultivated land were taken from different publications of Center for Iranian Statistics (4) for all the years under investigation with the exception of 1991-92 that was taken from Ministry of Agriculture (17). Wholesale prices of wheat were taken from unpublished data of the Central Bank of Iran used

also by Foroohideh (8). These prices were checked against the price data from two wheat wholesalers in the cities of Isfahan and Shiraz. The wholesale price of wheat for the last three years under study were from Center for Iranian Statistics (3). Wheat prices of CGO, with the exception of those for 1988, 1991, and 1992, were taken from unpublished data of CGO that was also used by Foroohideh (8). Country Grain Organization price of wheat for 1988 was estimated using a first-order regression method (14). That is, the wheat prices announced by the CGO versus the wholesale prices of wheat for the years when both prices were available were regressed. Then, the estimated coefficients of this regression were used to calculate the missing price.

The prices for 1991 and 1992 were taken from Agricultural Data Bank (16). The indices of commodity wholesale price were taken from Central Bank publications and Center for Iranian Statistics (4). The rainfall data were taken from Center for Iranian Statistics (2, 4).

RESULTS AND DISCUSSION

Equation [3] is used to estimate the response of irrigated as well as non-irrigated wheat area to price. The results are shown under regressions 2 and 4 in Tables 2 and 3 for the irrigated and non-irrigated wheat. In both tables, the first two regressions used the wholesale price of wheat and the last two regressions used the CGO price. In regressions 1 and 3 in both tables, the price of wheat is used as the independent variable. The estimated results of these regressions are compared with the other regressions in which the Nerlovian partial adjustment mode was used. All of the estimated partial adjustment regressions, that is, regressions 2 and 4 in the two tables, have high R^2 and statistically significant F ratios. They show no positive autocorrelation on the basis of their Durbin-Watson statistics. As mentioned above, many other regressions were estimated in which different measures of price and other different independent variables were included. However, the

estimated results of only those regressions that were statistically significant are presented here.

Table 2. Estimated coefficients of wheat wholesale and the CGO prices, in year t-1, $\delta\beta_1$, for irrigated wheat using equation [3]. The dependent variable is the irrigated wheat area in year t for Iran, for selected years from 1960-61 to 1991-92.

Regression number	1	2	3	4
Explanatory Variables:				
Wheat, wholesale price				
P_{1t-1}	8816.9***†	5057.8***		
	(7.11)§	(3.02)		
Wheat, CGO price				
P_{2t-1}			9037.3***	4700.4**
			(6.28)	(2.70)
Lagged irrigated wheat area				
A_{t-1}		0.52459***		0.5944***
		(2.90)		(3.40)
R^2	0.72	0.80	0.66	0.79
R^2 (adj.)	0.70	0.78	0.65	0.77
F ratio	50.54***	38.87***	39.42***	35.88***
n_1, n_2	1,20	2,19	1,20	2,19
D-W	1.02	1.78***	0.92	1.79***
k, n	1,22	2,22	1,22	2,22
SEE	1183379	156588	199813	161664
Intercept	1380459***	658225**	1408772***	574523**
	(27.85)	(2.61)	(20.04)	(2.31)

† **, *** represent statistically significant at 5% and 1% level, respectively.

§ The figures in parentheses are the calculated t values.

Irrigated Wheat

On the basis of the results of regression 2 in Table 2, the short-run and the long-run area elasticities with respect to wheat wholesale price were estimated to be 0.08 and 0.17%, respectively. As explained above, the short-

run elasticity was calculated as the ratio of the mean of the price to the mean of the area multiplied by the estimated coefficient of the price in this case, (24.56/1, 587, 608) *5057.8=0.08. The long-run elasticity was calculated as the short-run elasticity divided by δ (δ was calculated as one minus the estimated coefficient of the lagged variable; in this case δ equaled 0.47541).

Table 3. Estimated coefficients of wheat wholesale and the CGO prices in year t-1, δβ1, for non-irrigated wheat using equation [3]. The dependent variable is the non-irrigated wheat area in year t for Iran, for selected years from 1960-61 to 1991-92.

Regression number	1	2	3	4
Explantory variables:				
Wheat wholesale price				
P_{1t-1}	7199.2*†	2668.2		
	(1.73)§	(1.05)		
Wheat CGO.price				
P_{2t-1}			7675.6*	2983.9
			(1.73)	(1.11)
Lagged irrigated wheat area,				
A_{t-1}		0.78537***		0.78457***
		(6.26)		(6.28)
R^2	0.13	0.72	0.13	0.72
R^2 (adj.)	0.09	0.69	0.09	0.69
F ratio	3.00*	23.93	3.00	24.14***
n_1, n_2	1,20	2,19	1,20	2.19
D-W	0.38	2.16***	0.37	2.16***
k,n	1,22	2,22	1,22	2.22
SEE	614795	360583	614713	359460
Intercept	3,451,118***	771,546*	3,468,060***	777,800*
	(20.77)	(1.76)	(21,64)	(1,77)

† *, **, *** represent statistically significant at 10%, 5% and 1% level, respectively.

§ The figures in parentheses are the calculated values.

on the basis of the results of regression 4 in Table 2, the short-run and long-run area elasticities with respect to CGO price were estimated to be 0.06 and 0.15%, respectively. They were calculated by using the same

procedure already mentioned, namely (20.832/1, 587,608)* 4700.4 = 0.06 for the short run and 0.06/0.4056 = 0.15 for the long run.

Comparing the area elasticities of wheat with respect to wholesale price with those elasticities with respect to CGO price, the short-run as well as the long-run wholesale price elasticities were larger than the corresponding CGO price elasticities. The estimated elasticity values imply that the amount of land under cultivation of irrigated wheat will change by 0.08% in the short run and by 0.17% in the long run if the actual value of the wholesale price of wheat changes by 1%. Similarly, the change in the irrigated land will be 0.06% in the short run and 0.15% in the long run, if the actual value of CGO price changes by 1% .

The estimated elasticities of the present study are within the range of the similar estimated elasticities of previous studies that ranged from 0.08 to 0.93 (12). The present estimated elasticities, however, are smaller than 0.556 and 1.17 for the short run and the long run, respectively (21). In a study by Nouri-Naini and Pedram (21), however, the aggregate irrigated and non-irrigated wheat areas and the ratio of wholesale price index of wheat to wholesale price index of barley differed from the variable specifications used in this study. The estimated elasticities of wheat area response to wheat price in the short run and in the long run have been found to vary due in part to different definitions of wheat prices employed in the analysis (15).

Non-irrigated Wheat

The estimated regressions 2 and 4 in Table 3 are for non-irrigated wheat. They show satisfactory R^2, F ratios, and Durbin-Watson statistics. The estimated coefficients of the lagged dependent variables, A_{t-1}, are statistically significant but the estimated coefficients for the wheat prices (either wholesale or CGO) are not significant. This might imply that the output price policy approach to increase the non-irrigated wheat area is not statistically reliable.

The statistical results of this study can, to a great extent, be observed by looking into the information shown in Figs. 3 and 4. Fig. 3 plots the

annual percentage changes of irrigated and non-irrigated wheat areas versus the lagged annual percentage changes in their respective wholesale prices. Fig. 4 is similar to Fig. 3 except for the fact that it uses the CGO wheat prices. As shown in Fig. 3, in 14 of the 21 years under study the percentage changes in irrigated wheat area are in the same direction as the lagged annual percentage changes in the wheat wholesale price. For non-irrigated wheat, however, this has happened in only two years. This implies that the irrigated wheat area has been more responsive to wholesale price than non-irrigated area. As shown in Fig. 4, only in six years the annual percentage changes in either irrigated or non-irrigated wheat areas have been in the same direction as the lagged annual percentage changes in their respective CGO price.

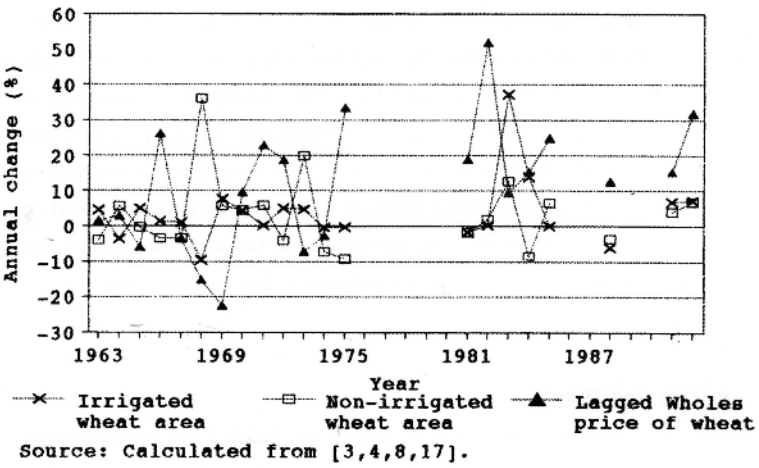

Fig. 3. Annual precent change in irrigated and non-irrigated wheat area and in its lagged wholesale price in Iran, for selected years from 1963 to 1992.

CONCLUSIONS

In this study the responsiveness of irrigated and non-irrigated wheat area to wheat price were analyzed in separate regressions. The results show that whereas the irrigated wheat area is significantly responsive to wheat wholesale and CGO prices, the non-irrigated area is not. In addition, the

irrigated wheat area has been more responsive to wholesale price than to the CGO price of wheat. The irrigated wheat area elasticity with respect to wheat wholesale price is 0.08% in the short run and 0.17% in the long run. The corresponding elasticities with respect to CGO price is 0.06 and 0.15%, respectively. These estimated elasticities imply that the amount of land under cultivation of irrigated wheat will change by 0.08% in the short run and by 0.17% in the long run if the actual value of the wholesale price of wheat changes by 1%. The changes of the irrigated land will be 0.06% in the short run and 0.15% in the long run if the actual CGO price changes by 1%.

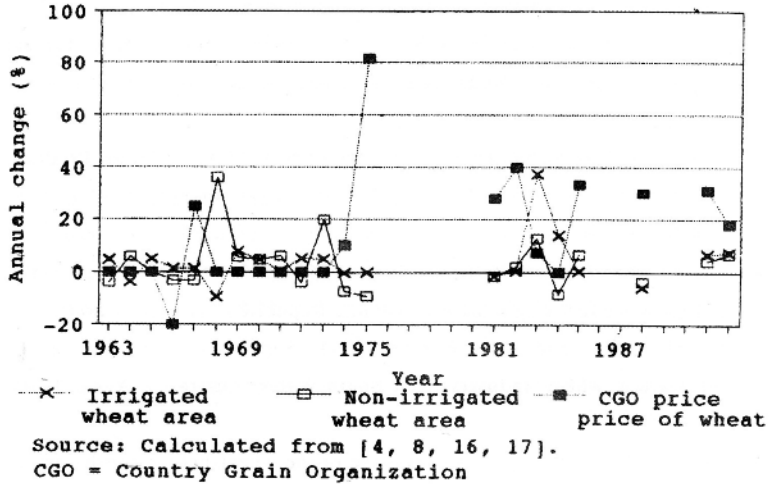

Fig. 4. Annual percent change in irrigated and non-irrigated wheat aera and in its lagged CGO price in Iran, for selected years from 1963 to 1992.

The area under cultivation of non-irrigated wheat has not been significantly responsive to either wholesale or CGO prices. This might imply that the output price policy approach to increase the non-irrigated wheat area is not statistically reliable.

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