Trends in
Agricultural Economics

Estimating Growth Rates and Decomposition Analysis of Agricultural Production in Iran (1970-2000)*

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Abstract: The main objectives of this study are to examine the trends in area, production and yield of Iran's agricultural production especially food grains; the decomposition of output growth of main crops and systematically document the pre and post-revolutionary and pre and post-reform trends in agricultural growth in Iran. Compound growth rates of area, production and yield were estimated by fitting semi-log trend equation using data for 1970/71-1999/2000. Decomposition of output growth of main crops were examined by fitting component analysis model using data for the period 1970/71-1999/2000. The performance of agricultural sector was slightly better during the pre-revolutionary period than that of post-revolutionary period. Production yield per hectare of food grains grew during the 1970-78 at the higher rate than that of during the 1979-2000. During the post-revolutionary period, the total agricultural crops during the pre-economic reforms period grew at the higher rate than that of post-economic period, but the growth in yield during the post-economic reforms period was much better than that of during the 1979-89. The main source of growth of agricultural production during the period 1970-2000 has been the growth in yield per hectare and expansion in irrigated area.

Key words: Agricultural sector, Iran, economic reforms, food grains production, output growth, post-revolutionary period

INTRODUCTION

Agriculture plays an important role in economic development, such as provision of food to the nation, enlarging exports, transfer of manpower to non-agricultural sectors, contribution to capital formation and securing markets for industrialization. Moreover, agriculture has strong, direct forward linkages to agricultural processing and backward linkages to input-supply industries (Johnston and Mellor, 1961). Because of these strong linkage effects, agricultural growth can lead wider economic growth in many countries; even open economies, during their early stages of industrialization (Fan *et al.*, 2005; Barrett *et al.*, 2003; Irz *et al.*, 2001). It is known empirically that a large share of manufacturing in the early stages of development is agriculturally related (Pryor and Holt, 1999; Gemmell *et al.*, 2000). Research by Gollin *et al.* (2002) shows the importance of agriculture in the early stages of development. The researchers find that growth in agricultural productivity is quantitatively important in explaining growth in GDP per worker.

Agriculture makes other important contributions to nutrition, food security and macroeconomic stability beyond the pro-poor growth (Timmer, 2002). Macroeconomic stability is especially sensitive to volatility in the agricultural sector (Timmer, 2005; Perry *et al.*, 2005). In turn, volatility in the agricultural sector tends to be relatively high because of climatic shocks that reduce domestic production and unstable world prices of agricultural commodities. The implication is that these shocks in the agricultural sector, especially food crises, are often the major source of macroeconomic instability

in the early stages of development (Barro and Sala-i-Martin, 1995; Dawe, 1996; Timmer, 1996, 2002). Agricultural growth combined with appropriate policies can mitigate the effects of these shocks, with benefits to the poorest and most vulnerable.

The dominant paradigm of structural transformation since the 1970s has seen agriculture as an engine of growth in countries in the early stages of development because of agriculture's high share of economic activity and strong growth linkages with the rest of economy. This role of agriculture in structural transformation has been demonstrated in many Asian countries through the green revolution, which began in the 1960s and spread rapidly throughout the region in the 1970s and 1980s, especially in densely populated and irrigated areas (Datt and Ravallion, 2002; Ravallion and Chen, 2004).

Growth in agriculture contributes to rapid rises in agro-processing and processed food marketing, which not only provides new engines of growth but an opportunity to substitute for imports. The need for agricultural growth during the early stages of development has been examined in recent neoclassical literature. For example, Yang and Zhu (2004) use growth theory to capture the inter-temporal dynamics of the development process. The researchers demonstrate that, without agricultural productivity, a traditional economy cannot overcome the fixed supply of natural resources and thus, cannot generate sustained economic growth. Regardless of how fast the nonagricultural sector grows, stagnant agricultural production during the early stages of development prevents the structural transformation from a traditional to a modern economy. While early development economists saw agricultural growth as an essential component and even a precondition for growth in the rest of economy, the process by which this growth was generated remained beyond the concern of most development economists (Ruttan, 2002).

Keeping in view the importance of agriculture, quantitative assessment of the contribution of the various factors to growth of agricultural output is helpful in reorienting the programmes and priorities of agricultural development so as to achieve higher growth. There are so many factors, which affect the growth of agricultural output. Among these, area and yield are the major one (Singh, 1981; Cauvey, 1991). These sources of output growth have relevance in deciding programmes of agricultural development and priorities of investment in it (Ranade, 1980; Deosthali and Chandrahekhar, 2004). Thus, it becomes important to find why these growth rates differ from one another, so that the bottlenecks could be removed to achieve the speedy development of agricultural sector (Sikka and Vaidya, 1985).

Decomposition of growth in agricultural output has remained of active interest to researchers and policy makers. A breakdown of growth into various components, area, yield, cropping pattern, etc. facilitates output projection with alternative targets and policies (Jamal and Zaman, 1992). Thus, decomposition of agricultural growth among its constituent forces is of great importance. An analysis of the behaviors of agricultural production in the past and estimation of its growth rates can provide a basis for future projections of agricultural output (Lakshmi and Pal, 1988). Therefore, an attempt is made in the present study to analyze agricultural growth and the contribution of various components to the overall output growth of the Iran for the period from 1970-71 to 1999-2000.

The Iranian economy comprises of several important sectors, which contribute to total national product. But by far, agriculture is the main stay of Iranian economy and prosperity of agriculture can significantly contribute to the general prosperity of the nation. The growth of agricultural production in Iran since the 1970s has been one of the main accomplishments of the nation's development policies. There are at least three causes for worry concerning the future development of the agricultural sector in Iran. First, in the past, the relatively high growth rate of the agricultural sector in Iran was achieved mainly through the expansion of cultivated areas. This pattern of growth can no longer continue due to the lack of adequate water resources. Therefore, a new strategy for agricultural development should be used with emphasis placed on increasing agricultural land productivity. Second, although, the contribution of technology inputs towards sustainable output growth has been recognized, yield in

Iran's agriculture has generally been rather low. Third, Iran's agriculture differs regionally due, primarily, to the differences in geographical area, such as climate and natural resources and thus production characteristics.

MATERIALS AND METHODS

The present study is based on secondary data for the last 30 years i.e., from 1970-71 to 1999-2000. In the present study, compound growth rates of area, production and yield for the selected crops for each period were estimated to study the growth in area, production and yield of these crops. Both linear and Compound Growth Rates (CGR), were estimated. Linear rates of growth are found not very convenient for any comparison of growth between two period and two crops. It seems more appreciable to analyze the movement of agricultural crops in terms of compound rather than linear growth rate (Dandekar, 1980). However compound growth rates were used for the study. The Compound Growth Rate (CGR), are usually estimated by fitting a semi-log trend equation of the form.

$$\ln Y = a + bt$$

where, Y is the time series data of production, area and yield of main crops, t is the trend term and a is the constant coefficient. The slope coefficient b measures the relative change in Y for a given absolute change in the value of the explanatory variable t. If we multiply the relative change in Y by 100, we get the percentage change or growth rate in Y for an absolute change in variable t. The slope coefficient b measures the instantaneous rate of growth. We can calculate the compound growth rate r as fallow.

$$CGR\ (r) = [\text{antilog } b - 1] \times 100$$

The above mentioned equation has estimated by applying OLS method. The t-test was applied to test the significance of b. This equation is generally used on the consideration that change in agricultural output in a given year would depend upon the output in the preceding year (Minhas, 1966; Dandekar, 1980; Singh and Rai, 1997; Deosthali and Chandrahekhar, 2004). Since the performance of agriculture has been affected by widespread drought and climate changes during the period under study, i have calculated the growth rate of area, yield and production based on triennium method.

To measure the relative contribution of area and yield to the total output change for individual crop component analysis model as given below was used. Several research workers used this model and studied growth performance of crops (Bastine and Palanisami, 1994; Bhatnagar and Nandal, 1994; Mundinamani *et al.*, 1995; Gupta and Saraswat, 1997; Singh and Ranjan, 1998; Singh and Asokan, 2000; Siju and Kombairaju, 2001; Kakali and Basu, 2006).

$$\Delta P = Ao\Delta Y + Yo\Delta A + \Delta A\ \Delta Y$$

Change in Production = Yield effect + Area effect + Interaction effect

Thus, the total change in production can be decomposed into three effects viz. yield effect, area effect and the interaction effect due to change in yield and area.

The study was restricted to principal crops with the assumption that the excluded crops do not affect the cropping pattern and in turn would not vitiate the main conclusions of the study. The selection of crops for the study was thus dictated by the availability of data. All the important cereals, pulses, total food grains, oilseeds and commercial crops were selected for the present study. Selected crops accounted for more than 80% of the total cropped area. Minor pulses, sugarcane and other crops were not considered for lack of data on these crops. Thus, the study was restricted to principal crops.

The study has made use of data from secondary sources. The time series data on area, production and productivity of these selected crops and input use i.e., net irrigated area, gross irrigated area and fertilizer consumption were collected from the various Government Publications. The entire study period was split into three sub periods to evaluate the impact of agricultural policies on agricultural performance and assess the changes in relative contribution of different factors to the output growth over the period of time. The sub periods are Period I: 1970-71 to 1978-79; Period II: 1979-80 to 1990-91; Period III: 1990-91 to 1999-2000 and Overall Period: 1970-71 to 1999-2000.

RESULTS AND DISCUSSION

Pre-Revolutionary Period (1970-1978)

Table 1 shows the trend in production of main crops in period of 1970-78. Overall production of food grains has increased by 3.8% per annum during the trigennium beginning 1970 to the triennium ending 1978. Among the food grains, rice has recorded the highest growth rate at 4.02%, followed by wheat at 3.93% per annum during triennium beginning 1970 to triennium ending 1978. Among cash crops, potato has recorded the highest growth rate of 10.45% per annum, followed by oilseeds at the rate of 10.09% per year. Production of cotton, which is the major raw materials in Iranian agricultural crops mix, declined from aronnd 5.1 million tones in the triennium beginning 1970 to 4.9 million tones in the triennium ending 1978 at the annual rate of -0.6%.

Growth in yield is the main source of the growth in production of agricultural crops. Table 2 shows the yield of main crops during 1970 to 1978. According to data reflected in this table the yield of wheat, rice and barely increased from 785, 3002 and 663 kg per hectare in the triennium beginning

Table 1: Production and compound growth rate of main crops (1000 tones)

Year	Wheat	Rice	Barley	Pulses	Food grains	Sugar beet	Potato	Cotton	Oil seeds
TB 1970	4168.7	1103.3	997.3	187.7	6457	3622	331	515.7	52.7
1970	4260	1060	1083	191	6594	3455	416	503	58
1971	3700	1050	900	196	5846	3772	157	444	46
1972	4546	1200	1009	176	6931	3639	420	600	54
1973	4600	1334	923	200	7057	3881	481	615	57
1974	4700	1313	863	210	7086	4075	533	715	79
1975	5500	1500	1438	225	8663	4670	550	470	100
1976	6000	1600	1487	230	9317	5272	570	510	130
1977	5500	1400	1230	187	8317	4187	697	535	105
1978	5526	1531	1217	203	8477	3659	932	427	126
TE 1978	5675.3	1510.3	1311.3	206.7	8703.7	4372.7	733	490.7	120.3
G-Rate[#]	3.93	4.02	3.5	1.2	3.8	2.4	10.45	-0.6	10.09

[#] Annual compound growth rate based on own estimation, Sources: Ebrahim (1992), Central Bank of Iran (1979 to 2000, Various Reports), Government of Iran, Ministry of Agriculture (2000)

Table 2: Yield and compound growth rate of main crops (kg per hectare)

Year	Wheat	Rice	Barley	Pulses	Food grains	Sugar beet	Potato	Cotton	Oil seeds
TB 1970	785.3	3002.0	663.0	726.3	853	23504.3	10561.7	1620.7	678
1970	800	2783	702	751	882	20387	10921	1603	690
1971	725	3040	623	766	796	25219	10256	1495	710
1972	831	3183	664	662	882	24907	10508	1764	635
1973	808	2074	704	747	850	24409	10689	1777	635
1974	798	3011	672	788	844	23286	10660	1938	617
1975	919	3102	938	845	1042	23350	10000	1621	388
1976	1052	3789	1138	768	1194	26234	8444	1777	Na
1977	1012	3465	963	716	1108	25262	11039	1693	913
1978	1040	3954	1034	768	1151	24834	12895	1525	1134
TE 1978	1034.7	3736.0	1045.0	750.7	1151	25443.3	10792.7	1665.0	1024
G-Rate[#]	3.5	2.8	5.9	0.4	3.8	1.0	0.3	0.7	5.3

[#] Annual compound growth rate based on own estimation, Na: Not Available, Sources: Ebrahim (1992), Central Bank of Iran (1979 to 2000, Various Reports), Government of Iran, Ministry of Agriculture (2000), FAO (1998)

Table 3: Area and compound growth rate of main crops (000 hectare)

Year	Wheat	Rice	Barley	Pulses	Food grains	Sugar beet	Potato	Cotton	Oil seeds
TB 1970	5300	368	1502	259	7428	155	31	302	78
1970	5325	381	1543	254	7503	169	38	314	84
1971	5103	345	1445	256	7149	150	15	293	65
1972	5471	377	1520	266	7633	146	40	299	85
1973	5693	643	1311	268	7915	159	45	310	90
1974	5890	439	1284	266	7877	175	50	366	128
1975	5985	484	1533	266	8268	200	55	259	258
1976	5703	422	1307	299	7732	201	68	311	Na
1977	5435	404	1277	261	7377	166	63	280	115
1978	5313	387	1177	264	7142	147	72	227	111
TE 1978	5484	405	1254	275	7417	171	68	272	113
G-Rate[#]	0.4	1.2	-2.24	0.77	0.0	1.26	10.1	-1.27	4.7

[#] Annual compound growth rate based on own estimation, Na: Not Available, Sources: Ebrahim (1992), Central Bank of Iran (1979 to 2000, Various Reports), Government of Iran, Ministry of Agriculture (2000), FAO (1998)

1970 to 1035, 3736 and 1045 kg per hectare in the triennium ending 1978 at the annual rate of 3.5, 2.8 and 5.9%, respectively. It should be noted that wheat, rice and also barley have been selected because of their predominance in terms of the area under cultivation and as representatives of staple food products. Among cash crops, oilseeds have recorded the highest growth rate of 5.3% per annum. It is clear from Table 1 and 2 that the performance of production and yield per hectare for main food crops such as wheat, rice, sugar beet and oilseeds during the period 1970-77 has been notable. In this regards while the main source of growth for food grains has been yield per hectare that of regarding cash crops was expansion of arable land (compare Table 1, 2). This is obvious from Table 1 that the pattern of growth of cash crops and of food grains and even within cash crops is widely uneven. While the annual growth rate of oilseed is 10.09% that of for pulses and cotton is 1.2 and -0.6% per year, respectively.

Given the fact that cash crops cover no more than 25% of the cultivated area and also given the regioual concentration of cash crop and also food grains (like rice) productions, the unevenness of the regioual growth of agricultural incomes due to this one factor alone must have been considerable. An interesting implication of the above detail is that, even within the crops farming sector itself, the pattern of output and productivity changes was uneven. In particular, the output of rice, wheat and barley, which together cover about three-quarters of the cultivated area, grew more steadily and their yields per hectare increased at significantly higher rates than those of pulses, cotton and sugar beet.

Table 3 reports the total area under cultivation of principal crops during the pre-revolutionary period of 1970-1978. Barley and cotton recorded decline in area as evident from negative rate of growth, however, area under food grains was almost constant. The largest decline in area has been recorded by barley at the rate of -2.24% per aunum followed by cotton at the annual rate of -1.27%. A high rate of increase in area for oilseeds could be due to government policy of increasing production through expansion of area under cultivation. Potato recorded highest growth rate at 10.1%, which was evidently contributed by the high profitability from growing potato. While the sugar beet crop recorded significant increase in area, the growth rates of wheat and pulses were too much less. The higher growth in area of cash crops (sugar beet, potato and oilseeds) rather than food grains during this period was due to the fact that Government tried to keep low the prices of staple foods in order to keep low living cost of urban people and industrial workers.

Pre-Economic Reforms Period of 1979-1989

The pattern of growth of annual crops during post-revolutionary period of 1980-2000 is shown in Table 4. During pre-economic reforms period of 1979-89 production of food grains increased from 9.7 million tones in the TB 1980 to 11.9 million tones in the TE 1989 at the annual rate of 2.33%. Among food grains the largest increased has been recorded by barley at the rate of 7.02% per year. Production of cereals (wheat and rice) increased at the annual rate of only 1.04 and 1.57%,

Table 4: Production and compound growth rate of main crops (selected years)

Year	Wheat	Rice	Barley	Pulses	Food grains	Cotton	Oil seeds	Sugar beet	Potato
TB-1980	6338	1470	1623	270.3	9701	284	117.7	3823	1329
1980	5744	1181	1265	225	8415	219	110	3917	1338
1982	6660	1605	1903	296	10464	358	138	4321	1814
1984	6206	1484	2293	303	10286	351	118	3392	1784
1985	6631	1776	2297	343	11047	324	137	3924	1725
1988	7265	1419	3394	299	12377	379	299	3454	1443
1989	6010	1854	2847	264	10975	394	236	3535	2033
TE 1989	6958.3	1692.0	2990.7	301.0	11942.0	371.3	253.7	3815.0	1941.3
G-Rate#	1.04	1.57	7.02	1.2	2.33	3.03	8.9	-0.03	4.3
TB 1989	7604.3	2063.7	3165.3	388.7	13222.0	414.0	172.7	4058.7	2053.7
1990	8010	1980	3548	325	13863	436	145	3641	2516
1991	8793	2357	3101	577	14828	412	137	5000	1612
1995	11228	2301	2952	676	17157	523	234	5521	3074
1996	10015	2685	2736	704	16140	598	210	3687	3140
1999	8673	2348	1999	471	13491	441	271	5548	3433
2000	8088	1971	1686	559	12304	497	329	4332	3658
TE-200	9572	2363.3	2328.7	535.7	14799.7	466	309.7	4955.7	3507
G-Rate#	2.12	1.24	-2.75	2.96	1.03	1.08	5.5	1.83	5.0
G-Rate# 1980-00	2.08	2.4	1.82	3.5	2.13	2.51	5	1.31	5

Compound growth rate based on own estimation, Source: The Agricultural Data Bank of Iran (2000), Ebrahim (1992), Government of Iran, Ministry of Agriculture (2000), FAO (1998)

Table 5: Area and compound growth rate of main crops (selected years)

Year	Wheat	Rice	Barley	Pulses	Food grain	Cotton	Oil seeds	Sugar beet	Potato
TB1980	6180.3	455.0	1876.0	320.7	8832.0	177.3	89.3	169.3	111.7
1980	6081	459	1439	223	8202	136	63	169	92
1981	6268	423	2348	395	9434	198	96	156	127
1984	5960	442	2163	431	8996	212	90	134	116
1985	6195	479	2084	469	9227	186	95	145	112
1988	6552	467	2576	561	10156	192	142	147	105
1989	6257	519	2651	618	10045	228	179	149	121
TE1989	6466.7	504.3	2482.3	562.7	10016.0	204.0	156.3	156.0	125.3
CGR	0.5	1.15	3.16	6.44	1.40	1.55	6.41	-0.90	1.30
TB1989	6243.0	538.7	2512.7	693.3	9987.7	218.0	176.7	157.0	136.7
1990	6279	524	2729	481	10013	221	193	149	149
1991	6193	573	2158	981	9905	205	158	173	140
1994	6781	563	1757	946	10047	185	227	204	149
1995	6567	566	1752	1110	9995	272	198	203	145
1998	6180	615	1825	959	9579	229	259	185	163
1999	4739	587	1403	935	7664	216	237	186	161
2000	5101	534	1376	1016	8027	246	189	162	166
TE2000	5340	578.7	1534.7	970	8423.3	230.3	228.3	177.7	163.3
CGR 89-2000	-1.41	0.65	-4.39	3.10	-1.54	0.48	2.2	1.1	1.65
CGR 80-2000	-0.7	1.21	-1.0	5.69	-0.24	1.32	4.8	0.21	1.9

Aunual compound growth rate based on own estimation, Na: Not Available, Sources: Ebrahim (1992), Central Bank of Iran (1979 to 2000, Various Reports), Government of Iran, Ministry of Agriculture (2000), FAO (1998)

respectively. Among non-food grains largest growth has been recorded by oilseed, which was the highest rate in agricultural crops, at the rate of 8.9% per annum, followed by potato and cotton at the rate of 4.3, 3.03% per annum from TB 1980 to TE 1989. The production of sugar beet declined at the rate of -0.03% per annum, maiuly owing to a fall in area under cultivation from 169 thousand hectare in 1980 to 149 thousand hectare in 1989.

Table 5 reports the total area under cultivation of annual crops, both irrigated and non-irrigated area during the post-revolutionary period of 1980-2000. During the pre-economic reforms period, total area under food grains increased from TB 1979 to TE 1989 at the annual rate of 1.4%. Among food

Table 6: Yield and compound growth rate of main crops (selected years) (kg per hectare)

Year	Wheat	Rice	Barley	Pulses	Food grains	Cotton	Oil seeds	Sugar beet	Potato
TB-1980	1024	3245	878	867	1096	1602	1368	22500	12314
1980	944	2573	879	1009	1026	1610	1746	23177	14543
1981	1054	3839	724	734	1083	1388	1093	20711	6737
1984	1041	3357	1060	703	1143	1655	1311	25313	15575
1985	1070	3707	1102	731	1197	1741	1442	27062	15623
1988	1108	3038	1317	533	1218	1974	2105	23496	13733
1989	960	3572	1073	427	1092	1728	1318	23724	16958
TE 1989	1074	3344	1207	542	1192	1826	1650	24376	15493
G-Rate[#]	0.5	0.32	3.59	-5.08	0.9	1.45	2.1	0.89	2.57
TB 1989	1218	3821	1270	563	1324	1903	978	25687	17610
1990	1275	3778	1300	675	1384	1972	751	24436	17061
1991	1419	4113	1437	588	1497	2009	867	28901	18811
1994	1603	4012	1733	662	1672	2091	1268	25955	21452
1998	1934	4505	1808	601	1942	2008	1270	26956	21528
1999	1830	4000	1424	503	1760	2041	1143	29828	21681
2000	1585	3691	1225	550	1532	2020	1740	26740	22036
TE-2000	1783	4065	1486	551	1745	2023	1384	27841	21748
G-Rate[#]	3.5	0.56	1.4	-0.18	2.5	0.56	3.2	0.7	1.94
G-Rate[#] 1980-00	2.8	1.1	2.65	-2.3	2.3	1.16	0.06	1.06	2.87

[#] Compound growth rate based on own estimation, Sources: Ministry of Agriculture, the Agricultural Data Bank of Iran (2000), Government of Iran, Statistical Center of Iran (2003)

grains, the largest increase in area has been recorded by pulses at the rate of 6.44% per annum followed by barley at the rate of 3.16%. At the same time, area under cash crops, except sugar beet which declined at annual rate of -0.9% and potato, increased at higher rate rather food grains. Among cash crops, the oilseed has recorded the highest growth rate at the rate of 6.41% per year followed by cotton at the rate of 1.55% per year.

Apart from expansion of area which is limited in Iran mainly due to limitation of water resources, another important factor in order to increase the production of agricultural crops is the improvement in yield per hectare. Table 6 shows the trends in yield per hectare in Iranian agriculture during the post-revolutionary period of 1980-2000. According to the data reflected in Table 6 during the pre-economic reform period of 1980-89, yield per hectare of food grains increased from 1096 kg ha^{-1} in the TB 1980 to 1192 kg ha^{-1} in the TE 1989 at the annual rate of only 0.9%. Among food grains while the yield of barley has increased at the annual rate of 3.59%, the yield of wheat and rice increased at very low growth rate of 0.5 and 0.32% per year, respectively. Moreover the yield of pulses has declined from 867 kg ha^{-1} in the TB 1980 to 542 kg ha^{-1} in TE 1989 at the annual rate of -5.08%. The pattern of growth in yield per hectare within commercial crops is much better than that of food grains. The yield per hectare of potato and oilseed increased at the annual rate of 2.57 and 2.1%, respectively during the TB 1980 to TE 1989. During this period the yield of cotton and sugar beet increased at the annual rate of 1.45 and 0.89%, respectively at the same time.

In sum, despite the government's efforts during the pre-economic period in order to increase the yield per hectare, in particular in the case of food grains, by mechanization of production by wide utilization of farm machinery in agriculture at subsidized prices and granted loans, investment in agricultural infrastructure (World Bank, 2004), supplying inputs such as fertilizers, pesticides and seeds and pricing policy for several main crops, the yield per hectare did not increase at a reasonable and acceptable rate, particularly in case of food grains.

Post-Economic Reforms Period of 1989-2000

The economic reforms strongly affected the agricultural price policy in two ways. First, the foreign exchange system reforms resulted in increase in the prices of agricultural inputs such as fertilizers, pesticides and farm machinery. While the cost of inputs was kept more or less constant

during the 1980s, but when the liberalization policy was introduced in the early 1990, their prices rose (Ali, 2001). Second, the economic reforms resulted in the significant increase and wide changes in the minimum guaranteed prices for agricultural crops.

The major characteristic of agricultural programs during this period (1989-2000) was the effort to equalize prices of domestic agricultural products with those of international markets in order to promote production incentives. However, the actual practice since the beginning of these plans was implementation of a guaranteed pricing system based on the cost of production and a 20% profit margin for the farmers (World Bank, 2004).

The pattern of growth of annual crops during post-economic reform period has shown in Table 4. During post-economic reforms period of 1989-2000 production of food grains increased from 13.2 million tones in the TB 1989 to 14.8 million tones in the TE 2000 at the annual rate of 1.03%. Among food grains the largest increased has recorded by pulses at the rate of 2.96% per year, followed by wheat at the rate of 2.12% per year. Production of barley declined from 3165.3 million tones in the TB 1989 to 2328.7 million tones in the TE 2000 at the annual rate of 2.75%. This was mainly due to widespread drought across country during the period of 1998-2000. During the post-economic reforms period the production of commercial crops has increased at a higher rate than that of food grains. Among non-food grains largest growth was recorded from oilseed (same as in pre-economic reforms period), which has the highest rate in agricultural crops, at the rate of 5.5% per annum, followed by potato at the rate of 5% per annum. Production of cotton increased at the annual rate of 1.08%.

In sum, despite the fact that the Islamic government has declared agriculture as the pivot of development and increased the minimum guaranteed price of major crops during the post-economic reforms period, increase in the production of major crops has not been remarkable. While, based on FAO's data, the population growth rate during this period was 1.7% per year, the annual growth rate of food grains, rice, wheat, pulses and potato has been 1.03, 1.24, 2.12, 2.96 and 5%, respectively. It should be noted that the low level of growth rate of production has been mainly due to negative growth rate of net sown area during this period.

Table 5 reports the total area under cultivation of annual crops, both irrigated and non-irrigated area during the post-revolutionary period of 1980-2000. During the post-economic reforms period the area under food grains declined at the rate of -1.54% per annum. Among food grains, the largest decline in area has been recorded by barley at the rate of -4.39% per annum followed by wheat at the annual rate of -1.41%. This is mainly due to widespread drought across country after 1998 which declined the area cultivated under wheat and barley from 6180 and 1825 thousands hectare in 1998 to 5101 and 1376 thousands hectare in 2000. The area under agro-industry crops (cotton, oilseed and sugar beet) has increased at the annual rate of 0.48, 2.2 and 1.1%, respectively. Considering the low level of growth rate in area under cultivation during the post-economic reforms period, it seems that improvement in yield per hectare is the main factor to increase the production of agricultural crops.

Table 6 shows the trends in yield per hectare in Iranian agriculture during the post-revolutionary period of 1980-2000. According to the data reflected in table 6, during the post-economic reform period of 1989-2000, yield per hectare of food grains increased from 1325 kg ha^{-1} in the TB 1989 to 1745.1 kg ha^{-1} in the TE 2000 at the annual rate of only 2.5%, which has been much higher than that of during the pre-economic reforms period. Among food grains the largest increase has been recorded in case of wheat at the annual rate of 3.5% followed by barley at the annual rate of 1.4%. The yield of rice also has increased from 3821.4 kg ha^{-1} in the TB 1989 to 4065.6 kg ha^{-1} in the TE 2000 at the annual rate of 0.56%. The yield per hectare of potato, cotton and sugar beet declined rather than previous period. Yield of potato increased from 17610.4 kg ha^{-1} in the TB 1989 to 21748.8 kg ha^{-1} in the TE 2000 at the annual rate of 1.94%, while that of regarding cotton and sugar beet was only 0.56 and 0.7%, respectively. Among commercial crops the largest growth rate in yield has recorded by oilseeds at the annual rate of 3.2%.

Table 7: Decomposition of growth in production of principal crops (%)

Crop	Effect	Period 1970-1978	1980-1989	1989-2000	1980-2000	1970-2000
Wheat	Area	10.2	48.1	-66.5	-33.6	0.7
	Yield	89.0	48.1	165.1	134.6	98.9
	Interaction	0.8	3.8	1.4	-1.0	0.4
Rice	Area	29.8	73.2	52.4	50.4	56.6
	Yield	69.7	20.4	45.2	45.8	41.5
	Interaction	0.5	6.4	2.4	3.8	1.9
Barley	Area	-64.0	45.1	-159.6	-54.9	2.4
	Yield	168.6	51.1	50.9	145.6	93.1
	Interaction	-4.6	3.8	8.7	9.3	4.5
Pulses	Area	64.2	536.7	104.7	162.6	122.2
	Yield	33.3	-423.3	-6.1	-65.7	-25.0
	Interaction	2.5	-13.4	1.4	3.1	2.8
Food grains	Area	0.0	60.1	-149.5	-11.3	12.9
	Yield	100.0	38.6	242.7	108.0	85.7
	Interaction	0.0	1.3	6.8	3.3	1.4
Cotton	Area	211.7	51.2	44.4	52.6	206.7
	Yield	-116.7	47.8	51.9	46.2	-200.0
	Interaction	5.0	1.0	3.7	1.2	-6.7
Oilseeds	Area	46.6	72.0	40.0	96.0	59.7
	Yield	52.5	23.6	58.2	1.2	39.3
	Interaction	0.9	4.4	1.8	2.8	1.0
Sugar beet	Area	52.5	3000.0	60.1	16.0	30.0
	Yield	41.7	-2966.7	38.3	80.9	60.0
	Interaction	5.8	66.7	1.6	3.1	10.0
Potato	Area	96.6	30.2	33.0	38.0	63.4
	Yield	2.7	59.8	38.8	57.4	29.3
	Interaction	0.5	10.0	28.2	4.6	7.3

Sources: Own estimation

An examination of the performance of the agricultural sector during the post-revolutionary period indicates that the agricultural crops grew relatively at a low rate (Table 4). Moreover, the growth rate of yield has not also been considerable (Table 6).

Decomposition of Output Growth of Individual Crops

The pervious section presented an analysis of growth in area, production and yield of selected crops in Iran. An analysis of growth in area, production and yield of these crops indicated the general pattern of growth and the direction of changes in area and yield. But this does not evaluate the contribution of area and yield to the production growth. For that, it is necessary to examine the sources of output growth. The growth in output of selected crops was therefore apportioned to the various sources by breaking the change in production into three effects i.e., area effect, yield effect and interaction effect. The relative contribution of area, yield and their interaction to change in production of individual crops is presented in Table 7.

The decomposition analysis of growth of principal crops over period under study in Iran revealed that growth in production of wheat, barley, sugar beet and food grains was mainly on account of change in yield. About 60 to 98.9% growth in crop output was due to yield effect. Production of rice, pulses, cotton, oilseeds and potato, however, increased due to expansion of area. About 56.6 (for rice) to 206.7 (for cotton) percent growth in crop was due to area effect.

During pre-revolution period, increase in output was noticed in the case of wheat, rice and barley which was mainly due to increase in yield. The area effect was the major force of output growth of commercial crops (pulses, cotton, sugar beet and potato), mainly due to shift in cropping pattern in favor of cash crops, whereas yield and area had almost equal contribution to total change in oilseeds.

In this period, as evidence from Table 7, the main source of growth in food grains was the yield effect mainly due to supplying modern inputs such as fertilizers, pesticides, farm machinery at subsidized price and granting loans by the government (Ali, 2001; Karshenas and Pesaran, 1995).

During post-revolution period of 1980-2000, while the yield effect was the main source of output growth of food grains, there has been negative contribution of area and yield factors to change in production incase of wheat and barley respectively. Among cash crops, while yield effect turned out to be the most powerful factor for increasing production incase of sugar beet and potato, area expansion was responsible factor to output growth incase of cotton and oilseeds. About 96% growth in oilseeds was due to area effect. During sub-period of pre-economic reforms area effect continued to be the most powerful factor in increasing the production of all the crops except barley and potato in which yield was responsible factor to output growth. The high share of area in increase in production during this period was mainly due to redistribution of land by the Seven-Member Committees which established after Islamic Revolution. It should be noted that area expansion in this period was possible because of implementation of government policy to provide water resources to farmers such as building new dams and expansion of tub wells in area which redistributed by the Seven-Member Committees (Ali, 2001). During sub-period of post-economic reforms while area effect was remarkably negative due to sharp decline in the total area under wheat and barley, yield effect turned out to be the most powerful factor for increasing production of food grains which contributed to 242.7%. This great achievement was due to sharp increase in yield of wheat which in turn was due to implementation of wheat self-sufficiency program. In the case of pulses the yield effect was negative, whereas yield and area had almost equal contribution to total change in rice. In this period growth of productivity was mainly responsible for growth of output of cotton, oilseeds and potato whereas area effect was the main factor of growth incase of sugar beet.

CONCLUSIONS AND POLICY IMPLICATION

From the foregoing discussion, it emerges that the main source of growth in production of main crops, especially total food grains, during the period 1970-2000 has been the growth in yield. It seems that the agricultural price policy, especially after economic reforms, by ensuring the remunerative prices to the farmers and supplying the significant amount of inputs, especially fertilizers at the subsidized prices, has been the most important factor to promote the farmers to increase the production of agricultural crops. Moreover, it is obvious that the performance of agricultural sector was much better during the pre-revolutionary period (1970-1978) than that of post-revolutionary period (1979-2000). Production and yield of total food grains grew during the 1970-78 at the higher rate than that of during the 1979-2000. In this period, the main source of growth in production has been the increase in the yield per hectare. This great achievement has mainly emanated from government support policies by supplying new inputs such as chemical fertilizers and pesticides at subsidized price as well as farm machinery and granting loans. Moreover, among non-food grains, except cotton, production other crops grew at the higher rate during pre-revolutionary period. The main source of growth in this period was area effect. This was mainly due to agricultural policies such as price controls and pricing policy for some staple foods which resulted in shift in cropping pattern in favor of cash crops.

During the post-revolutionary period, the production of total food grains in sub-period of pre-economic reforms (1979-1989) grew at the higher rate than that of post-economic period (1989-2000). Among non-food grains, production of cotton and oilseeds grew at the higher rate during pre-economic reforms period. However, the main source of growth in this period was area effect which was mainly due to expansion of arable land and redistribution of land by the government. Limitation of water

resources, which restricted the expansion of arable land, resulted in low growth rate of production of principal crops during the post-economic reforms period. Despite the sharp decline in area under wheat, barley and total food grains, mainly due to shift in cropping pattern in favor of cash crops, increase in production of food grains was remarkable. Therefore, it is obvious that the main source of growth in production of total food grains, sugar beet and potato was increase in yield per hectare. The positive effects of policy reforms by the government on farm efficiency and productivity in the 1990s might have contributed to this structural change.

The decomposition findings have important policy implication for the simple reason that each of the growth components has a limited potential for expansion. For example, the land potential has already been exhausted due to limitation of water resources in Iran. When this potential is exhausted, assuming that current yield trends continue, the growth in crop production will decline after some years. Coupled with a growing population whereby some arable lands would be reduced to accommodation this population, this will imply a decline in per capita production. There is an urgent need to increase crop production, particularly the food grains production which will become inevitable in view of population growth. As such, efforts have to be directed toward further increasing the productivity of various crops. The future policy of the government will have to be cantered on the developing new high-yielding varieties in Iran. Research efforts therefore need to be intensified further to develop high yielding varieties of the crops suitable to agro-climate conditions of the regions.

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