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**Analysis of Index Numbers Applied to
Agricultural Output in Syria**

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1. Background

The process of concentration, specialization and coordination of agricultural production, technological changes and the increased openness of Syrian economy are factors which require the use of advanced scientific methods in the fields of economic & policy analysis especially in agriculture to deal with the complexity of agricultural phenomena. An example of such methods we mention the methodology of index numbers, which is used in short term analysis to assure the planned objectives and to be sure that the operations of agricultural production and their coordination are going in the right direction.

2. Objectives

This paper aims to analyze and quantify the impact of various policies on the value of agricultural production comprising the policies of horizontal and vertical expansion as well as price policies. The focus is to assess to what extent the goals of the Syrian Agricultural Strategy (SAT) are met and how the level of the productivity per hectare (ha) is affected. The change in the area reflects the impact of extensive (horizontal) policies, while the yield variations express the effect of intensive (vertical) policies. In turn, the alteration of prices is the result of price policies.

3. Some quantitative and qualitative aspects of agricultural policies

This section gives an idea of some proposed aims of the SAT (2001-2010) to be used as benchmark for the forthcoming assessment.

Some quantitative prospects of policies

- Increase the cultivated area 0.8% annually due to the limited possibility of horizontal expansion. While the afforested land can be expanded by 2.1% annually.
- Improve the yield 3-5% annually for some irrigated crops and 1-2% annually for some rain-fed ones.
- Enhance the production by 2.6% for wheat, 0.49% for cotton and 1.6% for sugar beet.
- Augment the annual growth rate of the production of some fruit trees from 3.5% to more than 11% as a result of both entering new trees in the production cycle and adding new areas.

Some qualitative benchmarks

- Reduce the share of wheat and barley in the crop rotation.
- Increase the share of food legumes, feed grain and green fodder in the agricultural cycle.

4. Methodology of index numbers

The **methodology** refers to the index of the value change in agricultural production and uses a combination of Laspyres and Paasche indexes for the interpretation of its components. Given the quantity and price composition of agricultural crops at, let's assume, current time 1 and at base time 0, the index of the value change in agricultural production expressed as, I_V :

$$I_V = \sum q_1 p_1 / \sum q_0 p_0$$

Where:

q and p are the quantity and price of a given crop;

$\sum q_1 p_1$ is the value of a given agricultural production mix in current time;

$\sum q_0 p_0$ is the value of a given agricultural production mix at base time.

Multiplying and dividing I_V by the same factor $\sum q_1 p_0$ and algebraically rearranging, I_V can be rewritten as follows:

$$I_V = \sum q_1 p_0 / \sum q_0 p_0 \cdot \sum q_1 p_1 / \sum q_1 p_0$$

$\sum q_1 p_0 / \sum q_0 p_0$ is a Laspeyres index applied to quantities, while $\sum q_1 p_1 / \sum q_1 p_0$ is a Paasche index applied to prices. The former measures the effect of just the quantity change over the change in agricultural value between the current and base time, the latter instead measures just the effect of price change.

Calling

$$I_Q = \sum q_1 p_0 / \sum q_0 p_0$$

$$I_P = \sum q_1 p_1 / \sum q_1 p_0$$

I_V can be expressed as follows:

$$I_V = I_Q \cdot I_P$$

Given that the quantity produced of a certain crop results from the multiplication of the area under that crop by its yield, I_Q can also be expressed as follows:

$$I_Q = \sum a_1 y_1 p_0 / \sum a_0 y_0 p_0$$

Where

a and y are the area and yield of a given crop.

Multiplying and dividing I_Q by the same factor $\sum a_1 y_0 p_0$ and algebraically rearranging I_V can be written as follows:

$$I_V = \sum a_1 y_0 p_0 / \sum a_0 y_0 p_0 \cdot \sum a_1 y_1 p_0 / \sum a_1 y_0 p_0 \cdot \sum a_1 y_1 p_1 / \sum a_1 y_1 p_0$$

Calling:

$$I_A = \sum a_1 y_0 p_0 / \sum a_0 y_0 p_0$$

$$I_Y = \sum a_1 y_1 p_0 / \sum a_1 y_0 p_0$$

$$I_P = \sum a_1 y_1 p_1 / \sum a_1 y_1 p_0$$

The value change in agricultural production can be written as:

$$I_V = I_A \cdot I_Y \cdot I_P$$

Where:

$$I_i > 0 \quad i = V, A, Y, P$$

I_A measures the effect of just the area change over the change in agricultural value, between the current and base time, keeping constant the yield and the price; I_Y measures the effect of just the yield change, keeping constant the area and the price; I_P measures the effect of just the price change, keeping constant the area and the yield.

The effect can also be expressed in percentage share equal to $(I_i - 1) * 100$.

If:

$0 < I_i < 1$ the effect of factor i on the change of agricultural production is negative;

$I_i = 1$ factor i has no effect on the change of agricultural production;

$I_i > 1$ the effect of factor i on the change of agricultural production is positive.

5. Analysis of index numbers of agricultural production

The analysis is focusing on agricultural production and its both sub-sectors namely: crop and animal production.

5.1. Analysis of agricultural production

To assess the real growth of agricultural production, it has to be evaluated at current and constant prices (Table 1). Table 1 indicates a reasonable growth as shown by the annual growth rate (AGR) and index number, which is the result of the improvement in both the quantity of production and prices of agricultural products, but the augmentation in quantities occurred at a higher pace than that of prices, which points out to a good performance. The produced quantity of agricultural production increased by an AGR of 5.7% during 2000-2006, from 13890 thousand tons in 2000 to 16321 thousand tons in 2006, while the unit value of agricultural production enhanced by an AGR of 1.30% during the same period, from 24 SP/kg to 26 SP/kg.

Table 1. Evolution of the value of agricultural production at current prices and at constant prices of 2000, 2000-2006 (billion SP)

Item	2000	2001	2002	2003	2004	2005	2006	AGR %	Index %
Value 1	337	374	389	397	419	452	507	7.04	150
Value 2	337	357	361	343	374	398	433	4.27	128

Source: Elaborated from Central Bureau of Statistics (CBS). *The Annual Statistical Abstract (ASA) 2007*.

AGR: Annual growth rate calculated for the period 2000-2006 (base 2000).

Index: Calculated between 2000 and 2006.

Value 1: Value of agricultural production at current prices.

Value 2: Value of agricultural production at constant prices of 2000.

5.2. Analysis of crop production

Table 2 illustrates the evolution of the value of crop production at current and constant prices from 2000 to 2006. The table shows acceptable growth rates and reasonable changes as a result of the increase in both quantity produced and prices, but the amplification of the quantity is higher than that of the prices indicating a good performance. The quantity of crop production increased by an AGR of 5.5% during 2000-2006, from 11689 thousand tons in 2000 to 16084 thousand tons in 2006, whereas the unit value of this production enhanced by an AGR of 1.8%, from 18.4 SP/kg in 2000 to 20.5 SP/kg in 2006.

Table 2. Evolution of the value of crop production at current prices and at constant prices of 2000, 2000-2006 (billion SP)

Item	2000	2001	2002	2003	2004	2005	2006	AGR % 00-06	Index % 06/00
Value 1	215	249	258	260	273	288	330	7.4	153
Value 2	215	234	244	227	233	249	272	4.0	127

Source: Elaborated from CBS. *The ASA 2007*.

Value 1: Value of crop production at current prices.

Value 2: Value of crop production at constant prices of 2000.

Table 3 gives an idea about the impact of the area, yield and price on the value of crop production expressed by index numbers and disaggregated by the individual groups of crop production during 2000-2006. The table indicates that the combined effect of these measures was positive (value increase) on both aggregate level and individual groups reaching its highest by legume crops and its lowest by industrial crops.

Table 3. Impact of the area, yield and price on the value of crop production, 2000 and 2006

Item	Index number of area	Index number of yield	Index number of unit value	Index number of total value
Crop production	1.04²	1.32³	1.11⁴	1.53¹
Cereals	1.03	1.74	1.05	1.88
Legumes	0.99	1.79	1.43	2.54
Grazing crops	0.71	1.55	1.40	1.53
Industrial crops	0.95 ⁵	1.00	1.07	1.01
Vegetables	1.36	1.09	1.32	1.96
Fruits	1.12	1.06	1.46	1.74

Source: Elaborated from CBS. *The ASA 2007*.

1 The value of crop production increased by 53% $((1.53-1)*100)$ from 2000 to 2006 as a result of the changes in the area, yield and price.

2 The value of crop production enhanced by 4% $((1.04-1)*100)$ from 2000 to 2006 following the increase in the area.

3 The value of crop production augmented by 32% $((1.32-1)*100)$ from 2000 to 2006 due to the yield improvement.

4 The value of crop production improved by 11% $((1.11-1)*100)$ from 2000 to 2006 because of the amplification in the price.

5 The value of industrial crops decreased by 5% $((0.95-1)*100)$ from 2000 to 2006 as a result of the area decline.

The value of crop production increased by 47% from 2000 to 2005 because of the boost in the average yield per hectare (ha), price and cultivated area. Consequently, the land productivity enlarged from 46 thousand SP/ha in 2000 to 64 thousand SP/ha in 2005.

5.2.1. Cereals

Table 4 shows the impact of the changes in the area, yield and price on the value of cereals production during 2000-2005. The combined effect of these measures was positive except for the corn crop. Also the area's effect was positive on the whole crops excluding corn. The same impact was of yield without any exception. The effect of the price was negative because of the corn and maize prices. The value of cereals production augmented by 54% from 2000 to 2005. This increase refers to the increase in the area, which led to an increase in the value by 12% and the improvement of the yield, which induced the value by 41%. On the other hand, the price decline caused a value reduction by 3%. As a result, the land productivity increased from 15 thousand SP/ha in 2000 to 21 thousand SP/ha in 2005. The same interpretation applies to the individual groups considering if the indices are greater or less than one. It is noteworthy that the enhancement in the area and yield exceeds the projected growth rates of the Syrian Agricultural Strategy (SAS) and that the policies of vertical expansion dominate.

Table 4. Impact of the area, yield and price on the value of cereals production, 2000-2005

Item	Index number				Productivity (000 SP/ha)	
	Area	Yield	Price	Total impact	2000	2005
Total cereals	1.12	1.41	0.97	1.54	15	21
Wheat	1.13	1.33	1.03	1.55	21	29
Irrigated	1.23	1.18	1.04	1.51	39	48
Rain-fed	1.06	1.59	1.03	1.74	8	13
Barley	1.01	3.59	1.06	3.84	1	6
Maize	0.92	1.07	0.89	0.88	31	29
Sorghum	1.22	1.38	0.88	1.48	15	19

Source: Elaborated from MAAR. *The Annual Agricultural Statistical Abstract 2005*.

5.2.2. Legumes

Table 5 refers to the effect of the variations in the area, yield and price on the value of legumes production during 2000-2005. The combined influence of these measures was positive excluding bitter vetch. Also the area's effect was positive on the whole crops except for chick peas and bitter vetch. The same impact was of yield apart from bitter vetch. The effect of the price was also positive with the exception of dry haricot beans, bitter vetch, flowering sern and rampling vetch. The value of legume crops improved by 83% from 2000 to 2005. This increase is related to the expansion in the area (+13%) and the boost in both the yield (+44%) and the price (+13%). Hence, the land productivity improved from 18 thousand SP/ha in 2000 to 32 thousand SP/ha in 2005. The same interpretation applies to the individual crops taking into consideration if the indices greater or less than one. It is worthy to note that the enhancement in the area and yield exceeds the projected growth rates of the Syrian Agricultural Strategy (SAS) and that the influence of the policies of vertical expansion have the principal impact.

Table 5. Effect of the area, yield and price on the value of legume production, 2000-2005 (%)

Item	Index number				Productivity (Thousand SP/ha)	
	Area	Yield	Price	Total impact	2000	2005
Total legumes	1.13	1.44	1.13	1.83	18	32
Lentils	1.16	1.81	1.25	2.64	15	35
Chick peas	0.85	1.19	1.05	1.06	21	27
Dry broad beans	2.36	1.12	1.11	2.94	47	58
Dry haricot beans	1.12	1.20	0.82	1.10	96	94
Bitter vetch	0.72	0.83	0.62	0.37	12	6
Flowering sern	1.06	1.30	0.97	1.33	14	18
Rampling vetch	1.03	1.63	0.75	1.26	11	13

Source: Elaborated from MAAR. *The Annual Agricultural Statistical Abstract 2005*.

5.2.3. Green fodders

Table 6 illustrates the consequences of the fluctuations in the area, yield and price on the value of green fodder during 2000-2005. The interaction of these aggregates to increase the value of green fodder production was positive excluding alf-alfa. On average, the area's effect was negative on the whole crops except for maize and clover. Whereas, the impact of the yield was positive excluding maize and alf-alfa. The influence of the price was positive for all crops. As a consequence, the value of grazing crops increased by 10% from 2000 to 2005. This enhancement refers to the improvement in both the yield (+24%) and the price (+6%). The decline in the area however led to a value decrease by 16%. Consequently, the land productivity increased from 18 thousand SP/ha in 2000 to 29 thousand SP/ha in 2005. The same interpretation applies to the individual crops taking into consideration if the indices greater or less than one. This growth violates the goals of the SAS.

Table 6. Impact of the area, yield and price on the value of green fodders, 2000-2005

Item	Index number				Productivity (Thousand SP/ha)	
	Area	Yield	Price	Total impact	2000	2005
Total grazing crops	0.84	1.24	1.06	1.10	18	29
Grazing barley	0.55	1.84	1.06	1.07	14	27
Grazing flowering sern	0.70	1.69	1.06	1.26	24	42
Grazing maize	3.31	0.43	1.06	1.49	47	21
Grazing alf-alfa	0.68	0.99	1.06	0.72	42	44
Grazing clover	1.31	1.08	1.06	1.51	29	33

Source: Elaborated from MAAR. *The Annual Agricultural Statistical Abstract 2005*.

5.2.4. Industrial crops

Table 7 gives an idea about both the estimated index numbers and the land productivity related to the industrial crops during 2000-2005. The indices included in this table imply the impact of the area, yield and price on the value of industrial crops. These measures together impacted the value of industrial crops positively. The effect of the area was negative on aggregate level and on most of the crops, but the impact of it was positively exceptional on oily sunflower, sunflower, aniseeds, cumin and black cumin. The influence of the yield however was almost positive with the exception of sunflower. The price effect was positive on average comprising indices both greater and less than one. Hence, the value of industrial crops increased by 4% from 2000 to 2005 because of the improvement in the yield (+8%) and the fair prices (+4%). But, the reduction in the area affected the value of these crops negatively (-7%). This decrease of the area doesn't comply with the overall goal of the SAT regarding area expansion. Furthermore, these changes led to a productivity increase from 110 thousand SP/ha in 2000 to 116 thousand SP/ha in 2005.

Table 7. Effect of the area, yield and price on the value of industrial crops, 2000-2005

Item	Index number				Productivity (Thousand SP/ha)	
	Area	Yield	Price	Total impact	2000	2005
Total industrial crops	0.93	1.08	1.04	1.04	110	116
Sugar beet	0.95	0.99	1.00	0.93	96	95
Cotton	0.88	1.07	1.00	0.94	123	132
Soy beans	0.83	1.21	0.96	0.96	23	26
Oily sunflower	1.92	1.97	0.99	3.74	17	34
Sunflower	2.74	0.79	2.24	4.84	36	63
Tobacco	0.97	1.14	1.17	1.29	108	144
Peanut	0.77	1.14	1.00	0.87	88	100
Sesame	0.98	1.19	0.93	1.08	47	51
Aniseeds	1.26	1.60	1.35	2.73	89	193
Cumin	2.07	1.16	1.35	3.25	46	73
Black cumin	1.33	1.55	1.00	2.06	97	150

Source: Elaborated from MAAR. *The Annual Agricultural Statistical Abstract 2005*.

5.2.5. Vegetables

Table 8 indicates the index numbers, which show explicitly the impact of several measures (area, yield and price) on the value of vegetables. These measures combined together led to a substantial increase in the value of this group on both aggregate level and for all items. The effect of each indicator separately was positive for almost all items of the group. The value of vegetables increased by 79% from 2000 to 2005 due to the increase in the area (+22%), the yield (+17%) and the price (+25%). Hence, the value of production per hectare improved from 202 thousand SP in 2000 to 273 thousand SP in 2005. These rates of growth are superior compared to the benchmarks of the SAT. It is implied also that the horizontal expansion (area increase) dominates the vertical one (yield improvement).

Table 8. Impact of the area, yield and price on the value of vegetables, 2000-2005

Item	Index number				Productivity (Thousand SP/ha)	
	Area	Yield	Price	Total impact	2000	2005
Vegetables	1.22	1.17	1.25	1.79	202	273
Green peas	1.06	1.47	1.01	1.58	98	146
Green broad bean	1.29	1.12	1.24	1.79	151	209
Green beans	1.88	0.93	1.21	2.13	172	195
Cucumber & snake	1.52	1.06	1.20	1.94	201	256
Eggplant	1.24	1.00	1.17	1.46	285	336
Pumpkin	1.27	1.06	1.10	1.47	54	62
Lettuce	1.12	1.00	1.64	1.83	170	277
Cauliflower	1.51	1.01	1.51	2.31	178	270
Cabbage	1.20	0.77	1.73	1.60	157	210
Potato	1.29	0.97	1.12	1.40	234	255
Tomato	0.79	1.60	1.35	1.72	386	837
Dry onion	1.56	1.11	0.75	1.30	163	136
Green pepper	1.42	0.99	1.09	1.52	334	360
Okra	1.25	1.12	1.23	1.72	86	119
Squash	2.17	0.85	1.18	2.19	241	243
Dry garlic	2.17	1.09	2.05	4.87	147	330
Melon	1.64	1.78	1.33	3.89	71	169

Source: Elaborated from MAAR. *The Annual Agricultural Statistical Abstract 2005*.

5.2.6. Fruit trees

Table 9 presents the index numbers related to the area, yield, price and value of fruit trees production and the productivity as well calculated for the period 2000-2005. The value index indicates on average a positive impact of the combined effect of the area, yield and price on the value of fruit trees production. The aggregate indices of these indicators imply also a positive influence. Disaggregating these indices by items shows different impacts of policies on the individual fruit crops varying between positive and negative. Hence, the value of fruit trees production increased by 53% during the period 2000-2005 as a result of the improvement in the area (+11%), yield (+28%) and price (+7%), which led to a productivity boost from 128 thousand SP/ha in 2000 to 180 thousand SP/ha in 2005.

In brief, Figure 1 compares among the various impacts of policies, comprising horizontal expansion, vertical expansion and price policies, and traces the total impact of these policies using the index numbers. Consequently, it can be concluded the following:

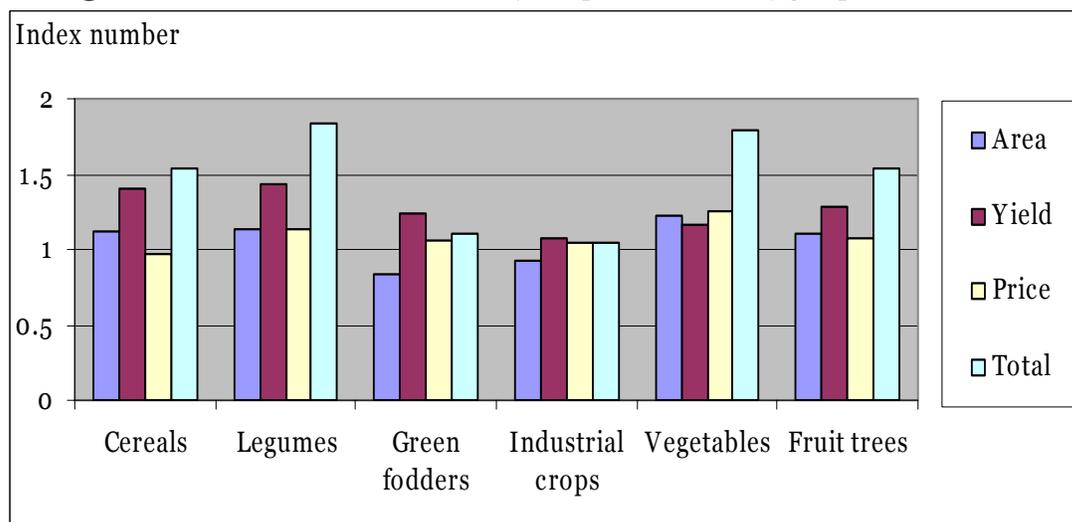
- The highest impact of the area was by legume and vegetable crops complying with the openness and alternative crops policies.
- The greatest effect of yield was by cereals and legumes crops because of the fair climatic conditions and the switch to irrigated agriculture.
- The biggest influence of the price was by legume and vegetable crops.
- The total impact of policies was highest by legume and vegetable crops.

Table 9. Effect of the area, yield and price on the value of fruit trees production, 2000-2005

Item	Index number	Productivity		Price	Total impact	2000	2005
		(Thousand SP/ha)					
	Area	Yield					
Fruits	1.11	1.28	1.07	1.53	128	180	
Olives	1.14	0.62	0.93	0.66	69	40	
Grapes	0.78	0.96	0.97	0.73	132	124	
Apples	0.92	1.13	1.04	1.08	164	193	
Pistachio	0.97	1.16	1.22	1.36	212	298	
Citrus	1.16	0.84	1.02	0.99	286	245	
Pomegranate	0.67	1.17	1.26	0.99	203	299	
Apricot	1.07	0.77	1.29	1.08	114	115	
Cherry	1.15	0.82	1.01	0.96	97	80	
Almond	1.47	2.49	1.12	4.10	492	1368	
Green plums	1.00	0.94	1.33	1.25	129	161	
Plums	1.11	0.78	2.99	2.59	76	176	
Pears	0.69	0.94	1.03	0.66	162	156	
Peaches	1.22	1.00	0.95	1.17	234	223	
Quince	0.58	1.01	1.09	0.64	181	199	
Nuts	0.69	1.21	0.66	0.55	526	418	
Fig	0.94	1.21	0.86	0.97	99	103	
Indian apricot	0.66	3.21	1.04	2.18	361	1202	
Plums	0.35	4.07	0.99	1.42	106	431	

Source: Elaborated from MAAR. *The Annual Agricultural Statistical Abstract 2005*.

Figure1. The index numbers of the area, yield, price and value by groups, 2000 - 2005



Source: Elaborated from MAAR. *The Annual Agricultural Statistical Abstract 2005*.

5.4. Analysis of animal production

Table 10 shows the evolution of the value of animal production at current and constant prices from 2000 to 2006. The table indicates acceptable growth rates and reasonable changes as a result of the increase in quantity produced and prices pointing out to a good performance. The quantity of animal production increased by an AGR of 6.6% during 2000-2006, from 2200 thousand tons in 2000 to 3237 thousand tons in 2006.

Table 10. Evolution of the value of animal production at current prices and at constant prices of 2000, 2000-2006 (billion SP)

Item	2000	2001	2002	2003	2004	2005	2006	AGR % 00-06	Index % 06/00
Value 1	122	125	131	137	147	164	177	6.4	145
Value 2	122	123	116	116	141	149	161	4.7	132

Source: Elaborated from CBS. *The ASA 2007*.

Value 1: Value of animal production at current prices.

Value 2: Value of animal production at constant prices of 2000.

Table 11 indicates the impact of the quantity and price on the value of some sub-sectors of animal production. The table implies a positive impact both on aggregate level and for the quantity & unit value

Table 11. Impact of quantity and price on the value of animal production, 2000 and 2006

Item	Index of quantity	Index of unit value	Total impact
Dairies	1.51	1.08	1.64
Meat	1.26	1.03	1.29
Eggs	1.49	1.20	1.78

Source: Elaborated from CBS. *The ASA 2007* and MAAR. *The AASA 2006*.

6. Concluding remarks

The data indicates a good performance for both total agricultural production and its both sub-sectors crop and animal production because of the improvements in the area, yield, prices and produced quantities. Hence, price and vertical - horizontal growth policies are considered the main driving forces of both agricultural production and the sustainable agricultural development.

Regarding the horizontal growth policy, it had a positive impact on cereal crops (+12 %), legumes (+13 %), vegetables (+22 %) and fruits (+11 %), while its effect was negative on the green fodder crops (-16 %) and industrial crops (-7 %). This improvement in cereals, legumes, vegetables and fruits crops is corresponding with the actual objectives of the development plans, unlike the other crops. In general, a good progress was achieved as a result of this policy. There is also an improvement in the field of animal production.

Concerning the vertical growth policy, it had a positive impact on cereal crops (+41 %), legumes (+44 %), green fodder crops (+24 %), industrial crops (+8 %), vegetables (+17 %) and fruits (+28 %). This means that its effect was positively substantial on these groups complying with the actual objectives of the development plans.

Finally, the price policy had a positive impact on legumes (+13 %), green fodder crops (+6 %), industrial crops (+4 %), vegetables (+25 %), and fruits (+7 %), while its effect was negative on cereals crops (-3%). An improvement in the prices of animal products is also to observe. In general, the price policy had a positive inducement corresponding with both the actual objectives of the development plans and the social market economy.

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