Evolution of Agricultural Total Factor Productivity in Egypt

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Abstract

This paper was conducted for providing an up to date calculation of Agricultural Total Factor Productivity (TFP) in Egypt during the period 1961-2014 using the TornqVist Thiel approach. The included agricultural inputs were: agricultural labor, machinery, seeds, pesticides, capital stock, animal feed including green and concentrated fodder, fertilizers, and natural resources. The main result is that the agricultural TFP in Egypt took an up warding pattern during the whole studied time period. The slight decreases in the TFP curve was due to a higher increase in inputs than the increase in outputs.

Key words: TFP, Tornqvist-Thiel index.

Summary

This paper was conducted for providing an up to date estimate of Agricultural Total Factor Productivity (TFP) in Egypt during the period 1961-2014 using the TornqVist Thiel approach. The included agricultural inputs were: agricultural labor, machinery, seeds, pesticides, capital stock, animal feed including green and concentrated fodder, fertilizers, and natural resources. Main results of the study were:

1. The annual growth rates of the studied inputs and outputs variables are quite varying. As for the quantities, machinery had the highest growth rate by 4.1%; followed by capital stock 3.7%; pesticides 3.6%; fertilizers 3.5%; seeds and animal feed were each equal to 1.7%;Labor 1.2% and the lowest gross rate was for the natural resources 0.7%. On the other hand input values had higher growth rates than quantities; as they are all more than 10%. Natural resources had the highest growth rate amounting to 15.2%, followed by machinery 13.7%; labor 13.5%; capital stock 12.7%; seeds10.7%; pesticides 10.6%; fertilizers 10.5%; and animal feed 10.3%.
2. The crops revenue shares in the agricultural revenue fluctuated during 1961 – 2014. Results clarify the increasingly strategic importance of crops in the agricultural revenue. In 1961 it was 0.7 compared to 0.3 for Livestock. However the lowest share of crops was in 1984 when it reached 0.56 while the livestock was 0.44. In 2012, 2013, 2014 the crops share was almost constant reaching 0.81 each year which was the highest share during the whole time period while livestock share was 0.19 which was apparently the lowest share for a Livestock during the whole studied time period.
3. The Tornqvist-Thiel Indexes for agriculture, crops and livestock gradually increased during 1962 – 2014. The Agriculture Index increased from 113.5 in 1962 to 538.9 in 2014. The crops Index increased from 118.6 in 1962 to 501 in 2014. The livestock Index increased from 102.9 in 1962 to 567.4 in 2014.

4. Agricultural TFP started with 11.6 in 1962 and slightly fluctuated in an upwarding pattern during the whole period. However it reaches its highest value 308.9 in 2013. And decreased to be 306 in 2014. It is noticeable that all the slight decreases in the TFP curve were due to a higher increase in inputs than the increase in outputs.

Introduction

Agricultural growth is vital for overall economic development and poverty alleviation, especially when it comes to developing countries (Johnston and Mellor 1961). Several features of the modern world point to the increased long-term importance of agricultural productivity. They include rapid population growth, diminishing returns to traditional factor inputs, high fuel and fertilizer prices, environmental degradation, the possibility of output-reducing climate change, and declining availability of arable land, fresh water supplies and other natural resources. Furthermore, the productivity growth in the agricultural sector is both a necessary and sufficient condition for the advancement of the sector and consequently the economy. As a necessary condition; it allows agriculture to skip the Ricardo's diminishing returns law. Besides, the sufficient condition comes out of the production increase with a reduction in unit cost and prices. (Saikia, D., 2009).

There are two concepts of productivity: partial productivity and total factor productivity (TFP). Partial productivity measures single factor contribution (i.e. labor) to the growth of output and the other factors remain constant. Therefore, it doesn't clarify whether the productivity growth is due to an increase of input-use, an efficiency improvement or technological advancement. In addition, partial productivity ignores time factor, inputs other than land, labor and capital, and secondary products while all this should be included. (Saikia, D., 2009).This proves the need to the TFP; it measures the net growth of output per unit of total inputs. This way, the TFP level is determined by the efficiency and intensity of inputs utilization in production. Thus, the TFP illustrates the efficiency change as well as the technical change inclusively.

The research problem is that there has been little research on the area of the agricultural TFP in Egypt. Besides, the animal feed input was represented by only the green fodder (barseem).Moreover; the previous work highlighted the need for more investigation on the TFP determinants; as the investigated explicative variables could only explain 20% of TFP growth.

Objectives were to provide an up to date estimation and demonstrating the historical trend of the agricultural TFP in Egypt during the period from 1961-2014. As well as including the concentrated fodder to the animal feed input.

Methodology data sources

In this paper,theTornqvist-Theil Index was applied tocalculate the Agricultural TFP in Egypt during the period 1961-2014**.**Tornqvist-Theil Index is an approximation to DivisiaIndex,constructing the aggregate output index and aggregate input index. Explanation on theoretical properties and issues in measurement of the productivity through the Tornqvist Index can be found in Diewert (1978, 1980); Christensen

(1975); Capalbo and Antle (1988) and Coelli et al., (2005). The Tornqvist output, input and TFP index in logarithm form can be expressed as follows:

Output index:

$$Ln\left(\frac{Q_t}{Q_{t-1}}\right) = {}^{1}/_{2}\sum_{j}\left(R_{j,t} + R_{j,t-1}\right) Ln\left(\frac{Q_{j,t}}{Q_{j,t-1}}\right)$$

Input index:

$$Ln\left(\frac{X_t}{X_{t-1}}\right) = {}^{1}/_{2}\sum_{i}\left(S_{i,t} + S_{i,t-1}\right) Ln\left(\frac{X_{i,t}}{X_{i,t-1}}\right)$$

TFP index:

$$Ln\left(\frac{TFP_t}{TFP_{t-1}}\right) = Ln\left(\frac{Q_t}{Q_{t-1}}\right) - Ln\left(\frac{X_t}{X_{t-1}}\right)$$

Where;

$R_{j,t}$ is the share of output (j) in total revenue in time (t),
$Q_{j,t}$ is the output (j) in time (t),
$S_{i,t}$ is the share of input (i) in total input cost, and
$X_{i,t}$ is the input (i) in time (t),

The TFP index (last equation) measures TFP changes by calculating the weighted differences in the growth rates of outputs and inputs. The growth rates are in log ratio form, and the weights are revenue and cost shares for outputs and inputs, respectively.

The TFP index as defined in the last equation can be used as an approximation of technological progress, assuming that producers behave competitively, that the production technology is input-output separable, and that there is no technical inefficiency (Antle and Capalbo, 1988).

To calculate the agricultural output value ,considerable calculations have been done using the available information about different agricultural commodities production and prices. Multiplying produced quantities of each commodity by its unit price provide the overall annual value of that commodity. By summing up crops commodities and livestock commodities, the annual agricultural output values have been obtained.

As for the agricultural inputs, relevant inputs have been introduced into the index .These are labor, machinery, pesticides, animal feed. Capital stock , and natural resources. Specific calculations have been made with respect to each input to reach, as much as possible, the right estimate or a proxy for that input to considered in the index. These calculations are as follows:

Labor: the weekly agricultural wage rate was collected from CAPMAS then multiplied by 52 to get the annual wage rate. Then the agricultural labor value = the annual wage rate*agricultural labor number.

Pesticides: The quantities were not possible to find. The number of cropped hectares treated by different types of pesticides was used instead as a proxy.

Animal feed:It consisted of two main components; the green fodder and concentrated fodder. The green fodder was mainly barseem(clover, alfaalfa) and the

concentrated fodder is divided into livestock fodder and poultry fodder. The main ores of livestock and poultry feed stuff were collected from 1997-2009. The average of each ore during this period was calculated then multiplied by its share in the total amount in order to apply the Total Digestible Nutrients TDN for the concentrated feed for livestock. (See appendices, table3) The TDN of the green fodder (alfaalfa and clover) was applied as well therefore the Total quantity of animal feed could be calculated by summing the green fodder to the concentrated fodder.

Machinery: the agricultural machinery was presented by the annual number and value of tractors; the other types of agricultural machinery were not included.The unit prices of tractors (in current local currency) were calculated based on the annual machinery import value drawn from the FAO database. From this annual unit value, an annual cost of machinery services was derived by amortizing the price of machine over 15 years and assuming a fixed marketing margin.

Capital Stock:The components of the land development, livestock fixed assets, Plant crops, and structures for livestock are taken in calculation. Each of these values was amortized based on the following rates, successively: 99 years, 10 years, 20 years, and 25 years. These depreciation rates are in line with the accounting system in the respective countries. The final capital stock formula is then: CS (year t) =sum ((land development/99) + (Livestock fixed assets/10) + (plant crops/20) + (structure for livestock/25)). The capital stock values are reported in the FAO data as '2005 Constant USD'. We first changed the values to current USD (based on the US inflation rates) and then we applied the exchange rates to obtain the current Egyptian values.

Natural resources: include land, rangelands, and water used for irrigation. The annual land area was available in the FAO dataset while the value of natural resources was calculated by the residual imputation method. It is in fact considered as being the residual difference between the overall agricultural output and the sum of all inputs values. This value reflects the opportunity cost of using the natural resources, mainly agricultural land an irrigation water, as an agricultural input.

With respect to data sources, all crops, livestock productions, land areas, labor, machinery, animal capital, and fertilizer consumption are collected from Food and Agricultural Organization (FAO) annual time series during 1961 to 2014 period.All inputs and output values used in the study were collected from the Central Agency for Public Mobilization and Statistics (CAPMAS) and the Ministry of Agriculture and land reclamation(MALR), agricultural economics issues; Livestock and poultry issues; machinery issues.

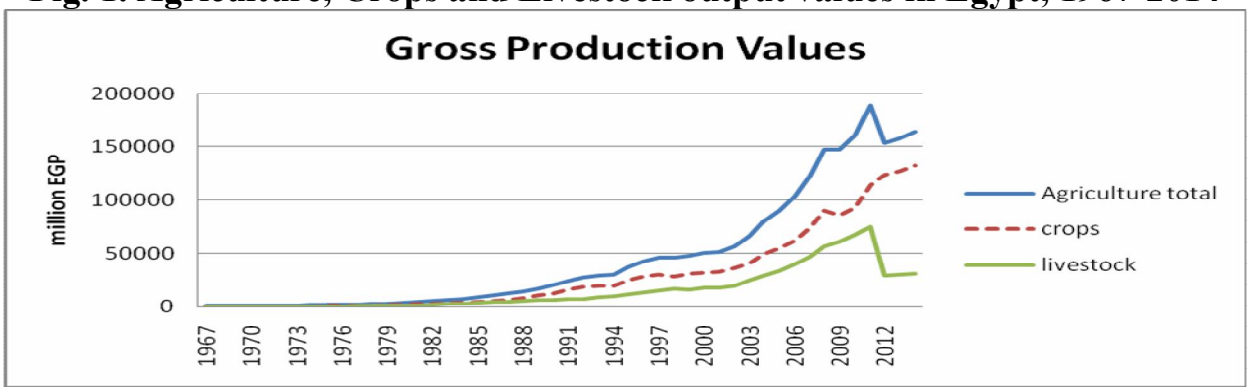
Results

This section displays the results of the historical calculation of the agricultural TFP in Egypt. First it shows the output calculation and trend. Second, it shows the detailed agricultural inputs quantities and values. In some specific inputs, such as animal feed; are shown in more depth as it consists of two major components, the green fodder and the concentrated fodder. Third, the major steps that lead to the calculation of the Tornqvist Thiel index and therefore the agricultural TFP.

1. Total Agricultural outputs:

Figure 1 shows the trend of agriculture, crops, and livestock Output values. As for the livestock there was an upwarding trend and it peaked at 2011 with EGP 47.6 billion. However in 2012 it plunged from 74 to EGP 29.7 billion, with a two-thirds decline. This mainly resulted from the price fall of some livestock commodities. Such as cattle meet indigenous, buffalo meat indigenous, milk whole fresh sheep meet, duck meat, geese meat, turkey meat, and rabbits.Accordingly the agriculture output value followed a similar pattern. On the other hand the Crops value decreased considerably in 2010following the decline in The Crops production for some main crops; such as wheat, rice, barely, maize, sorghum, dry bean, dry peas, olives, nuts, sunflower seeds, green peas, Leguminous vegetables, okra and strawberries. Crops values peaked at 2014 with EGP 132.7 billion.

Fig. 1. Agriculture, Crops and Livestock output values in Egypt, 1967-2014



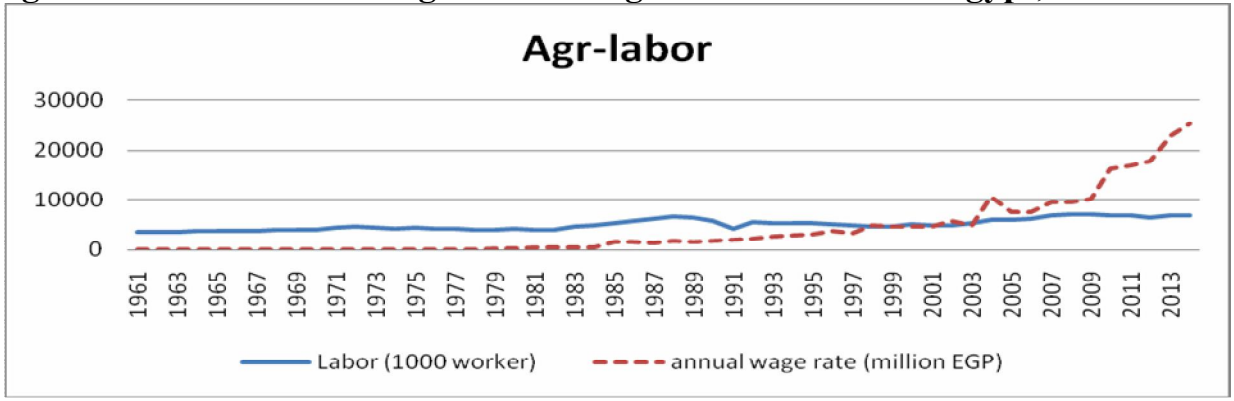
Source: Author's own calculation based on FAOSTAT data.

2. Total Agricultural inputs:

2.1. Labor

Figure 2 presents the agricultural labor force [1000 workers] and their annual wage rate [million EGP].The total agri–labor number slightly fluctuated during the studied time period. Although 2014 has the highest labor number with 6.7 million workers. According to the World Bank (WB), the share of agriculture labor among total labor force in Egypt is decreasing. It recorded 31%, 30%, 28% in 1991, 2000 and2014 respectively. According to Richard et.al. (1981), this could be put down to the internal migration from rural to urban areas and the rising number of temporary migration to abroad.

Fig. 2. The number and wage value of Agricultural labor in Egypt, 1961 - 2014.



Source: Author's own calculation based on FAOSTAT and CAPMAS data.

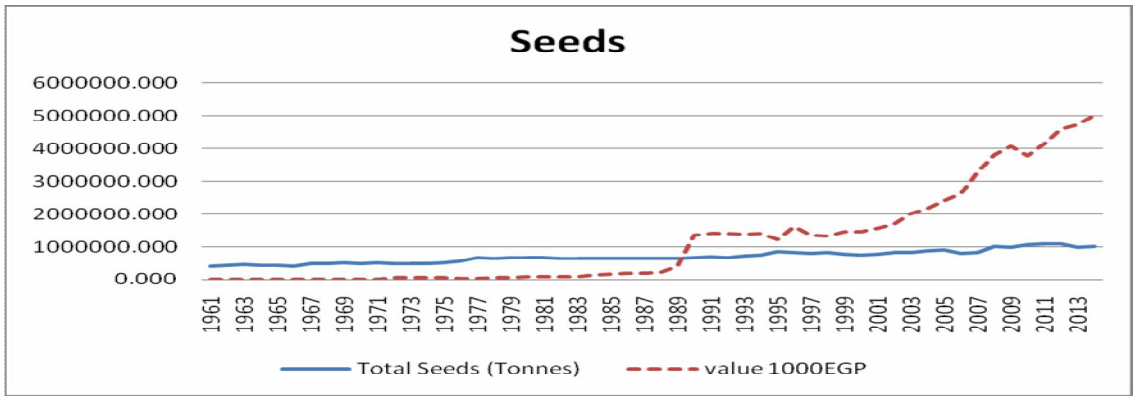
As for the annual wage rate,it increased gradually, starting by EGP 27.5 million in 1961 then rising notably to 1560 million EGB in 1985. Reached a slight decrease in 2003 to be EGP 4784 million then growing significantly in 2004 to be EGP 10712 million reaching EGP 2537 6 million in 2014.

2.2. Seeds

Figure 3 illustrates the quantities and values of seeds. Quantities moderately fluctuated from 40,000 tons in 1961 to 1079768.8 tons in 2012 in which it reached its maximum point. However it declined to 989197.5 tons in 2014. As stated in FAO's Egypt country report in 1996; several agencies are involved in the production and regulatory aspects of seed production. First, MALR is responsible for the multiplication, conditioning and distribution of seeds as well as the regulations. In addition it is involved in the breeding of improved hybrid varieties including the production of breeder and foundation of seeds as well as the testing of new varieties. Second, the agricultural research center as well as The central administration of seeds (CAS) responsible for maintaining supervisory functions to ensure varietal purity. Third, the Egyptian agricultural organization imports foreign seeds also owns seed cleaning and conditioning facilities which it makes it available to the private sector. Fourth, the organization for improvement of Egyptian cotton. Fifth, there are six private sector seed companies which are involved in Corn vegetable and forage crops seed production.

Seeds values faced several significant rises. In 1961 the value was EGP 20.4 million then it fluctuated in an upwarding pattern till 1990 reaching EGP 1369.8 million in which the value more than tripled; as it was EGP 413.9 million in 1986. It considerably fluctuated till 1997; afterwards it increased steadily till 2009 to reach EGP 4067 Million. And in 2010 to be EGP 3772 million then grew gradually to reach EGP 5017 million in 2014.

Fig. 3.Seeds quantities (tons) and values (thousands LE) during the period 1961-2014.



Source: Author's own calculation based on FAOSTAT data.

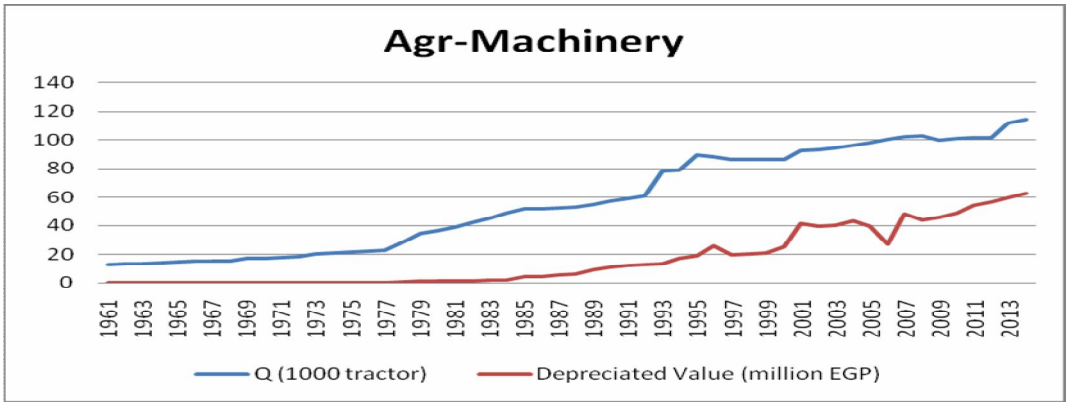
2.3. Machinery

Figure 4 exhibits the agricultural machinery quantities (reflected by tractors numbers in thousands) and the depreciated value is in (million EGP).Tractors number was 12837 tractors in 1961 and it grew slowly to 61000 tractors in 1992 then increased to 78099 tractors in 1993 by a 27%.There was a significant increase in 1995 when the number rose from 78846 to 89080 tractors with a 12% increase. In

2013 it rose from 101620 to 112460 tractors with a 9% increase, reaching to 114623 tractors in 2014.

As for the depreciated value, started from EGP 60,000 in 1961 with gradual increases till it more than doubled to be EGP 4.17 million in 1985, as a result of the high prices not quantities. The second significant increase was in 1996 it reached EGP 26.25 million with a 36% increase despite their decrease in the tractors number in the same year; hence the increase in the value could be put down to the rise in prices. In 2001 it increased by 64% to be EGP 41.25 million. On the other hand there was a significant drop in 2006 reaching EGP 27.1 million with a 44% decrease. Afterwards, there was a gradual increase till it reached EGP 63.15 million in 2014.

Fig. 4.The numbers of machinery and values (thousands) during the period 1961-2014.



Source: Author's own calculation based on FAOSTAT data.

2.4. Pesticides

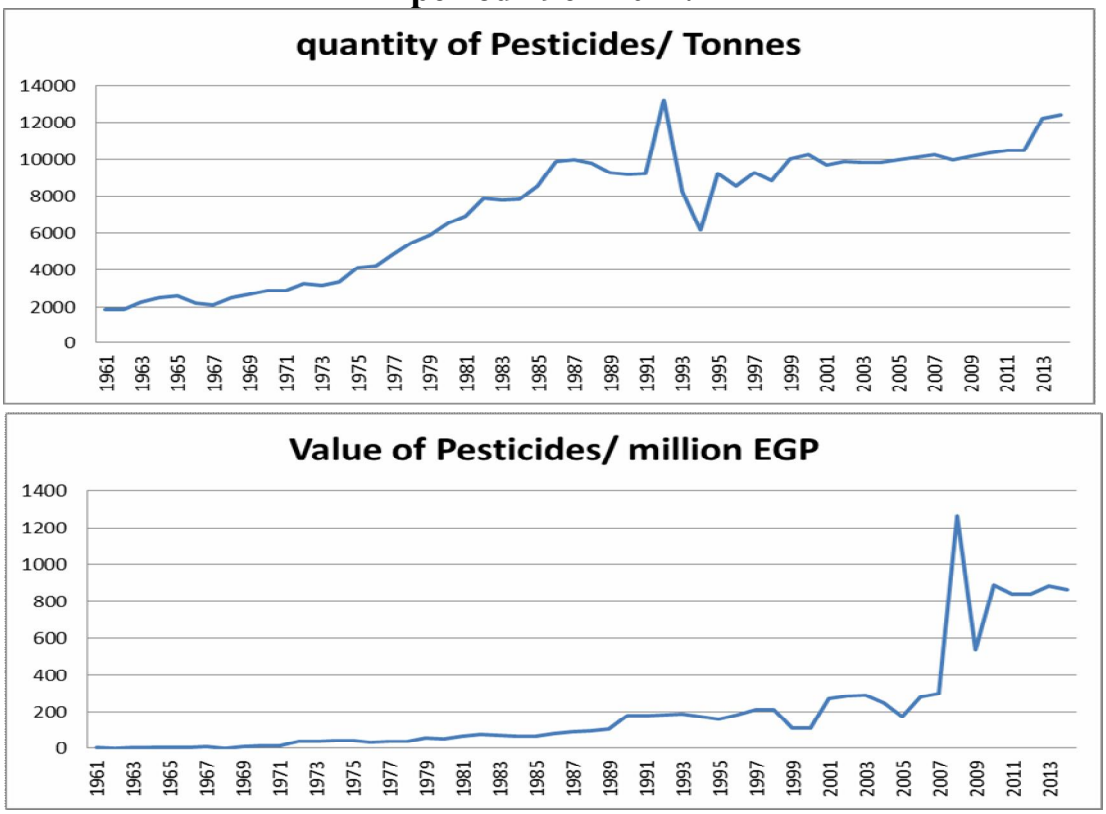
Figure 5 shows Pesticides quantities in tons and values in million EGP. Quantities of pesticides started at 1859.3 tons in 1961. It fluctuated in an up warding trend until 1991 reaching 9207.6 tons. In 1992 it jumped to 13213 tons with a 44% increase. However, it dropped again to 8254 tons in 1994. In 2014 it reached its peak with 12414.4 tons.

Values of Pesticides reached EGP 3.7 million in 1961 with a notable increase by 68% in 1990 to be EGP 175.5 million. In 1999 it plunged to almost half; from 210.7 to EGP 109.3 million. In 2008 it rocketed to be EGP 1264 million after 302.6 in 2007, with a four time increase. However in 2009 it plunged again to EGP 534 million reaching to 862 in 2014.

2.5. Fertilizers:

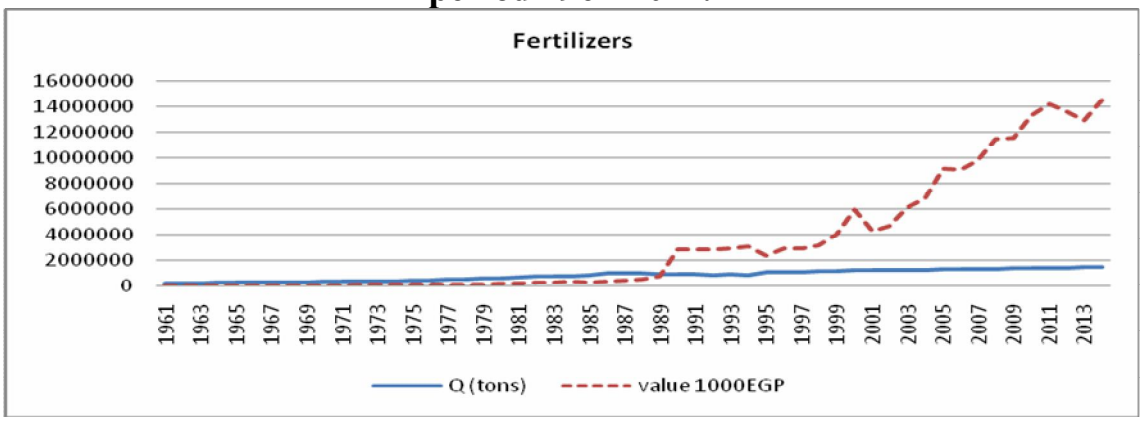
Figure 6 shows the fertilizers quantities in tons and values (1000 EGP). Fertilizers quantities in 1961 was 242279 tons then grew gradually till 1986 when it rose to 100920 tons with a 16% increase. Also there was a considerable increase in 1995 to 112640 tons with a 33% then it followed an upwarding trend till it reached 151704 tons in 2014. Fertilizers values started with EGP 66.2 million in 1961.Taking an upwarding trend, till 1989 when it tremendously rose from EGP 777.2 million to EGP 2824.6 million in 1990 with a 3.6 times increase. This resulted from a shortage in quantity supplied by a 7%. (See appendix). In 2000 values increased significantly by 47% to be EGP 5955.9 million, then it fluctuated till 2014 to be EGP 14502 million.

Fig. 5.The pesticides quantities (in tons) and values (in million EGP)) during the period 1961-2014.



Source: Author's own calculation based on FAOSTAT and MALR data.

Fig. 6.Fertilizers quantities (in tons) and values (in Thousands EGP)) during the period 1961-2014.

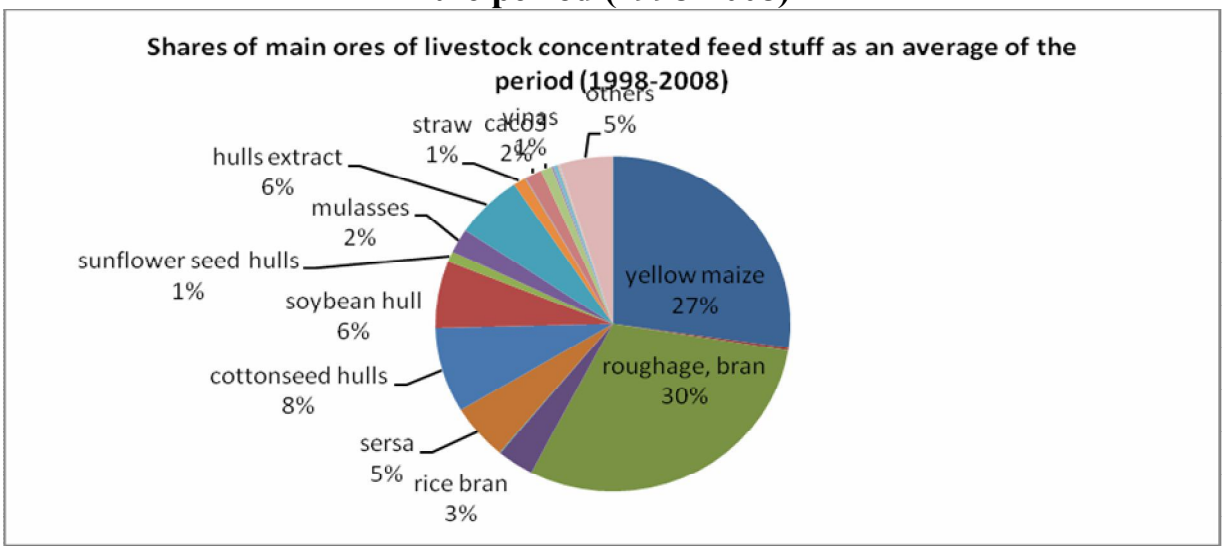


Source: Author's own calculation based on FAOSTAT data.

2.6. Animal feed

Animal feed consisted of two main components; the green fodder and concentrated fodder. The green fodder was mainly bar seem (clover, alfalfa) and the concentrated fodder is divided into livestock fodder and poultry fodder. Figure 7 shows the main components of livestock concentrated feed stuff in average for the period of 1998–2008. Roughage bran had the highest contribution with a 30% followed by yellow maize which accounted for 27%. the remaining 43% is notably scattered among the other components; 8% cotton seed hulls, 6% hulls extract and soyabean hulls each,5% sersa, 3% rice bran, 2% for molasses and CaCo3 each, and 1 % for each of vinas, straw, sunflower seed hulls, and lastly 5% for others.

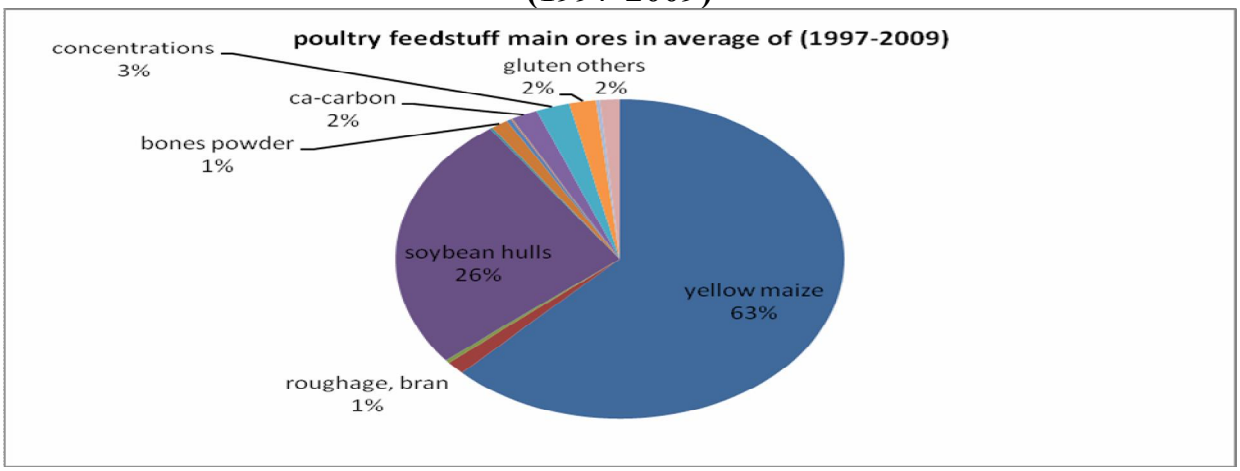
Fig. 7.Shares of main ores of livestock concentrated feed stuff as an average of the period (1998-2008)



Source: MALR, statistics of livestock, poultry, fish production and beehives

Figure 8 shows the main components of poultry feedstuff. The dominant component was the yellow maize that accounted for 63%, followed by soybean hulls 26%.The remaining 12% 11% is highly scattered among other components: 3% concentrations, 2% for each of CaCo3 and gluten, 1% for each of bones powder and roughage bran, and lastly, 2% for others.

Fig. 8.Shares of main ores of poultry feed stuff as an average of the period (1997-2009)



Source: MALR, statistics of livestock, poultry, fish production and beehives.

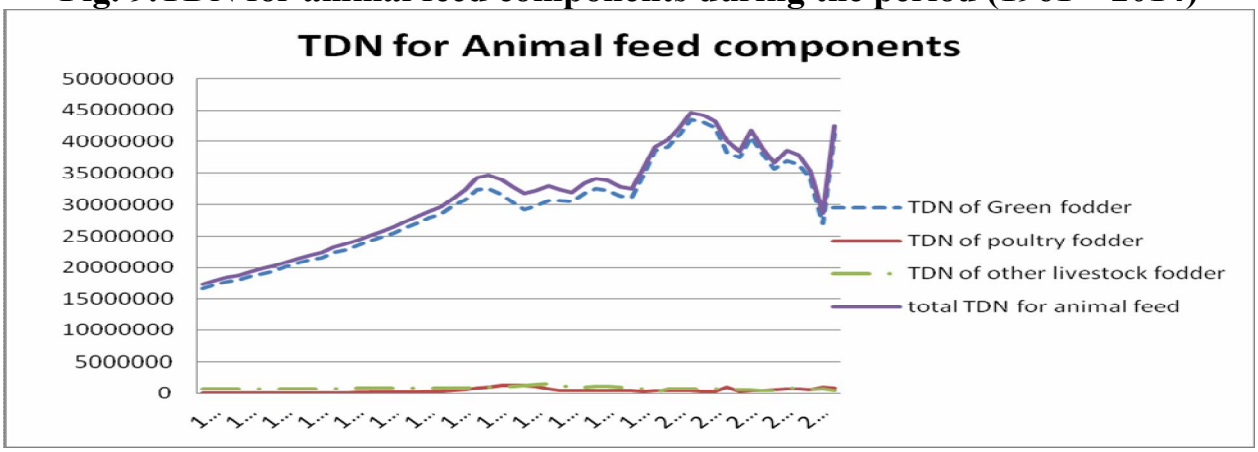
Figure 9 shows the total TDN of animal feed as whole, it also compares the TDN of the principle components of animal feed (green fodder, livestock concentrated fodder , poultry concentrated fodder).

As shown, the total TDN for animal feed took the highest values curve as it is the product of the summing of its three components. It is noticeable that it took the same pattern of the green fodder; as the latter has the highest TDN values. In addition bar seem represents more than 60% of whole animal feed. The fluctuations among the curve are due to the variation of the green fodder production.

Poultry and livestock TDNs are basically representations of the fodder production quantities of both. As a result, the fluctuations in poultry TDN are due to

the fluctuations in production quantities. Poultry fodder quantities took an upwarding trend till 1990 when it plunged by 61.8%. Then it fluctuated till 2005 in which it tripled then fluctuated again. Similarly for livestock TDN, it's followed the variation of livestock fodder production quantities, as it reached its maximum value in 1990 then fluctuated till 2014.

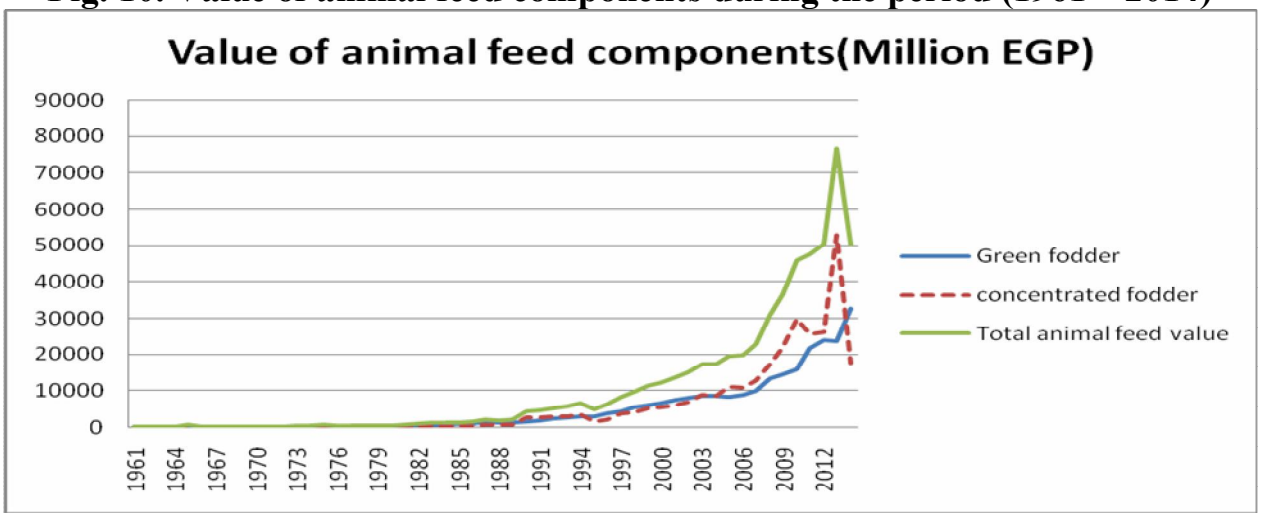
Fig. 9.TDN for animal feed components during the period (1961 – 2014)



Source: Researcher's calculation.

Figure 10 presents the value of animal feed in million EGP. The curves of green fodder Values and concentrated fodder values almost took the same pattern with slight differences between each other. In 2003 the concentrated fodder curve began to be higher than the green fodder, despite that there was no significant increase in quantities in the same year. Moreover, Shata, M.A. et. al. (2014) stated that the green fodder quantity accounts for 70.7% of total animal fodder, and the concentrated fodder accounts for 29.3%.Despite that, it is apparent that concentrated fodder had higher values especially when the production gab of it in Egypt is 36.3%.According to Shata, M.A. et. al. (2014). Not surprisingly, the rise in 2003 might well be due to the currency flotation. Since, the concentrated fodder values sometimes took approximately similar values to green fodder, then in the 2000s it took higher values; the total animal feed values took almost the same pattern of concentrated fodder.

Fig. 10. Value of animal feed components during the period (1961 – 2014)



Source: MALR, statistics of Agricultural Income.

Despite that the green fodder curve fluctuated in an up warding trend till the end of the studied time period; other curves acted differently. Concentrated fodder curve sharply peaked EGP 52791 million in 2013, which was double the amount in 2012; as quantities increased by 44%. Then quantities fell again in 2014; accordingly the concentrated fodder curve fell as well to reach EGP 17629.12 million.

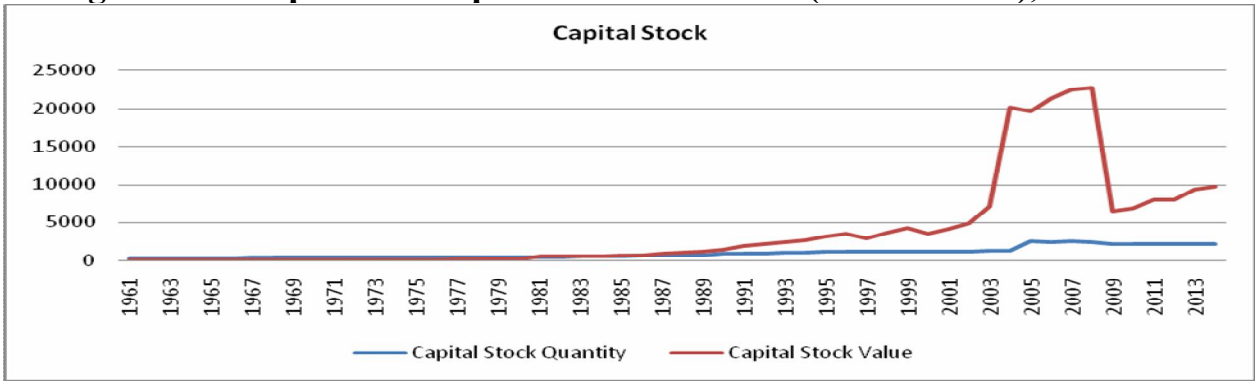
Almost similarly, the total animal feed curve slightly fluctuated in an up warding trend from EGP 249.5 million in 1961 to a significant increase in 2013 reaching EGP 766633.6 million; As a result of concentrated fodder increase. There was a rapid decrease in 2014 to EGP 50455.1 million also as a result of concentrated fodder.

2.7. Capital stock

Finger 11 shows the Capital stock quantities and values. Capital stock quantities curve started by 300 units in 1961, then it increased gradually till 1974 reaching 436.3units. In 1975 it started to fluctuate from 436.3 units in 1975 to 537.3 units in 1985. In 1986 there was a significant increase by 20% reaching 643.1 units as a result of the significant increase in both plant crops (permanent crop production) and land development (total area equipped for irrigation). After 1986 the curve increased gradually till 2005 when the quantity mounted 2471.7 units by a 93% increase. This was according to the increase of all Capital stock components including the most significant increase of permanent crops by 87% in the same year. In 2014 capital stock quantities reached 2162 units with 3.7% to growth rate (tabe 1).

Capital stock values curve started by EGP 15.3 million in 1961 then slightly fluctuated in and up warding trend. However, there were some points at which the curve sharply changed. Reaching 7133.6, 20199.6, EGP 226660.7 million in 2003, 2004 and 2008 respectively. Besides there was a significant drop in 2009 reaching EGP 6424.6 million. In 2004 capital stock values increased by 47% than in the previous year. This was not only as a result of quantity increase, as it increased slightly, but also could be put down to higher prices. This could be confirmed by the successive significant rise in 2004 as the values almost tripled while quantities increased moderately. In 2008 the values topped the highest value due to the previous gradual increase. In 2009 values fell to be almost the fifth of the previous year. As quantities of capital stock decreased mainly as a result of the decrease in total animal units and permanent Crops. After that the curve took and up warding trend till 2014 reaching EGP 9750 million.

Fig. 11. The capital stock quantities and values (million EGP), 1961 – 2014



Source: Author's own calculations based on FAO data.

Table (1): Descriptive statistical indicators of the inputs and outputs variables.

inputs and outputs		Count	Minimum	Maximum	Mean	Standard Deviation	annual growth rate
quantity of Labor	thousand worker	54	3600	6965	5011.9	1028.6	1.2%
Labor Value	Million EGP	54	27.5	25376	4001.4	5999.3	13.5%
Fertilizers quantities	Tons	54	238962	1517003.92	868626.9	415335.47	3.5%
Fertilizers values	Million EGP	54	66.18	14502	3399.689	4553.603	10.5%
Total Seeds quantities	Tons	54	4028062	1079769	687591	186861	1.7%
Seeds value	Million EGP	54	19.4	5017	1184.3	1473.7	10.7%
Tractors Number		54	12837	114623	517312	34632.7	4.1%
Depreciated Tract Value	Million EGP	54	0.06	63.2	16.6	19.9	13.7%
pesticides quantities	Tons	54	1859.3	13213	7269.3	3338.1	3.6%
pesticides values	Million EGP	54	1.3	1264	204.1	283.8	10.6%
Total Animal Feed quantities	Tons	54	17354691	44626361.5	31060663	7706488	1.7%
Total Animal Feed Value	Million EGP	54	249.5	76633.6	10517.2	16634.7	10.3%
Capital Stock Quantity		54	300	2517.5	969.3	701.7	3.7%
Capital Stock Value	Million LE	54	15.3	22660.7	3887.3	6208.5	12.7%
Natural resources quantity	1000 ha	54	2445	3761	2983.4	440.3	0.7%
Natural resources value	Million LE	54	42.2	176957	33761.3	44231.1	15.2%
Total agricultural output	Million LE	54	469.2	282982	56971.9	76337.8	12.6%

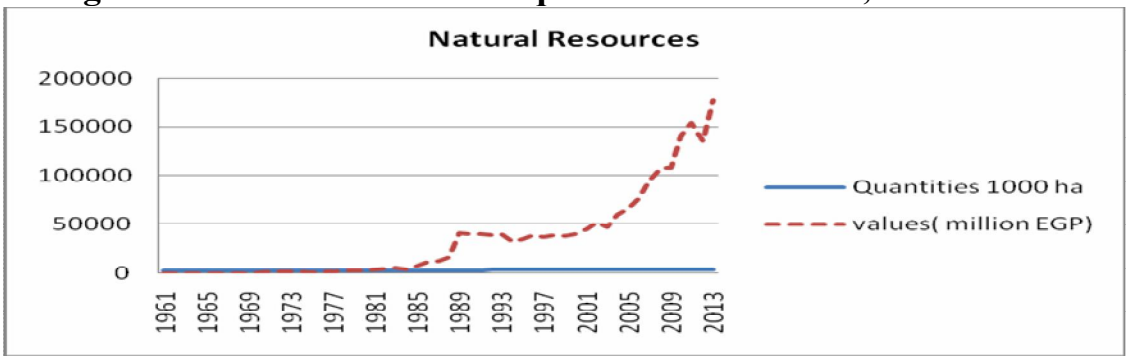
Source: Researcher's calculations using MS Excel.

2.8. Natural resources

Figure 12 represents the natural resources quantities and values. The natural resources quantities were quite steady during the studied time period. Started with 2568 in 1961 then slightly fluctuated or remained steady till 1992 it reached 2900 and then increased moderately till it reached 3745 in 2014. According to USDA, GAIN report, these gradual increases could be put down to the land reclamation programs to face Egypt's increasingly limited supply of arable land. It stated that In the 85 years from 1930 to 2015 land reclamation efforts in Egypt yielded an additional 2.6 million feddans of agricultural land, however the most significant obstacle when it comes to natural resources productivity is the fact that around 95.5% of land owners have less than five feddans according to FAO's country report (table 1). Ownership fragmentation is the main concern when applying new technologies especially the large scale technologies; Discouraging farmers from adopting Agricultural innovations, causing heterogeneous land quality, according to Niroula. S. G et. al. (2005). Moreover, farmers who consolidated their land were more productive according to Sundqvist and Anderson(2006).

Natural resources value started by EGP 86.7 million in 1961and increased gradually till it shifted to EGP 41 billion in 1990. It then fluctuated till it reached EGP 177 billion in 2014.

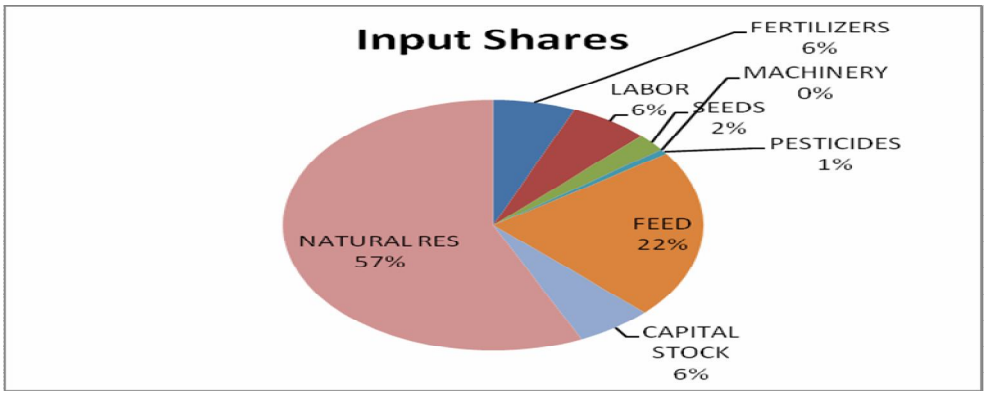
Fig. 12.The natural resources quantities and values, 1961 – 2014.



Source: Researcher's calculations based on FAO data.

Figure 13 shows the Agricultural input shares. The dominant input was natural resources that accounted for 57% followed by animal feed 22%; 6% for each of fertilizers, labor, capital stock; 2% for seeds; Pesticides 1%; machinery less than 1%.

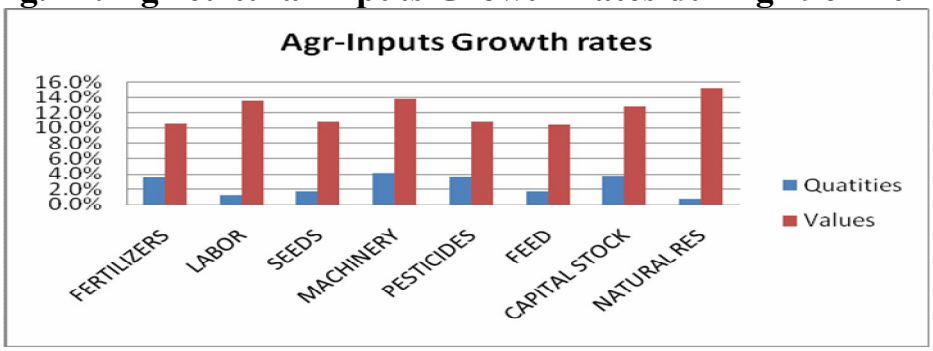
Fig. 13.Averaged agricultural input value shares of total agri-inputs during 1961-2014



Source: Author's own calculations.

Figure 14 shows the Agricultural inputs quantities and values growth rates during the studied time period. As for the quantities, machinery had the highest growth rate by 4.1%; followed by capital stock 3.7%; pesticides 3.6%; fertilizers 3.5%; seeds and animal feed were equal by 1.7%; Labor 1.2% and the lowest growth rate was for the natural resources 0.7%. It is disappointingly noticeable that inputs which depend highly on imports such as machinery, Pesticides, fertilizers have the highest of growth rates. While Labor and natural resources which are genuinely domestic have the lowest the growth rates. On the other hand input values had higher growth rates than quantities; as they are all more than 10%. Natural resources had the highest growth rate by 15.2%, followed by machinery 13.7%; labor 13.5%; Capital stock 12.7%; seeds10.7%; pesticides 10.6%; fertilizers 10.5%; animal feed 10.3%.

Fig. 14. Agricultural Inputs Growth Rates during 1961-2014

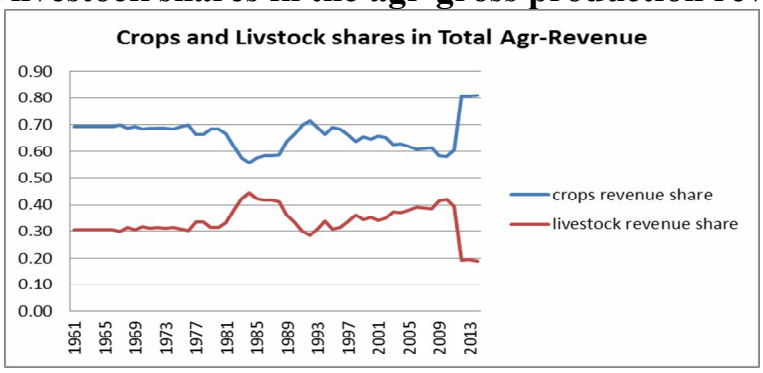


Source: Researcher's calculations.

Figure 15 exhibits the crops and livestock shares in total agricultural revenue: It clarifies the increasingly strategic importance of crops in the agricultural revenue. In 1961 it was 0.7 compared to 0.3 for Livestock. However the lowest share of crops was in 1984 when it reached 0.56 while the livestock was 0.44. In 2012, 2013, 2014 the crops share was almost constant reaching 0.81 each year which was the highest share during the whole time period while livestock share was 0.19 which was apparently the lowest share for a Livestock during the whole studied time period. This was mainly as a result of the decreasing prices of some major livestock commodities, such as: meat indigenous for each of the following (cattle, Buffalo,

sheep, goats, pink, duck, keys, chicken, rabbits) in the Specified years (2012, 2013, and 2014).

Fig.15. crops and livestock shares in the agr-gross production revenue, 1961– 2014.



Source: Researcher's calculation based on MALR data.

3. Tornqvist-Theil Output Indexes for Egyptian Agriculture.

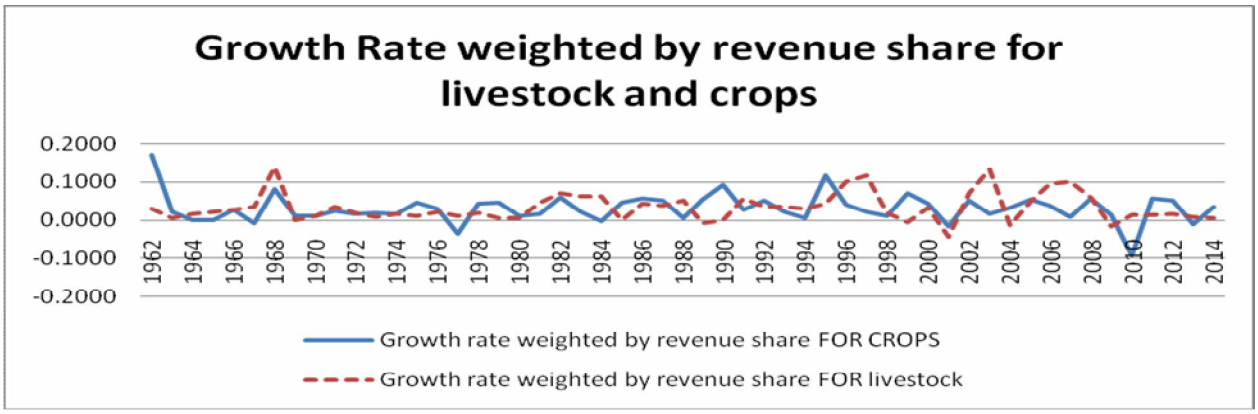
Figure 16.a demonstrates the growth rate weighted by revenue shares for livestock and crops.

As for Crops, it started by 0.17 in 1962 as maximum value during the whole time period. As shown in the graph, it reached negative growth rates in 1964, 1965, 1967, 1977, 1984, 2001, 2010, 2013. In 2014 it reached 0.035. As for livestock, it started by 0.028 in 1962. There were negative growth rate in 1985, 1989, 1999, 2001, 2004, 2009. On the other hand, the livestock topped the highest growth rate in 2003 reaching 0.134. In 2014 it reached 0.005 (table 2).

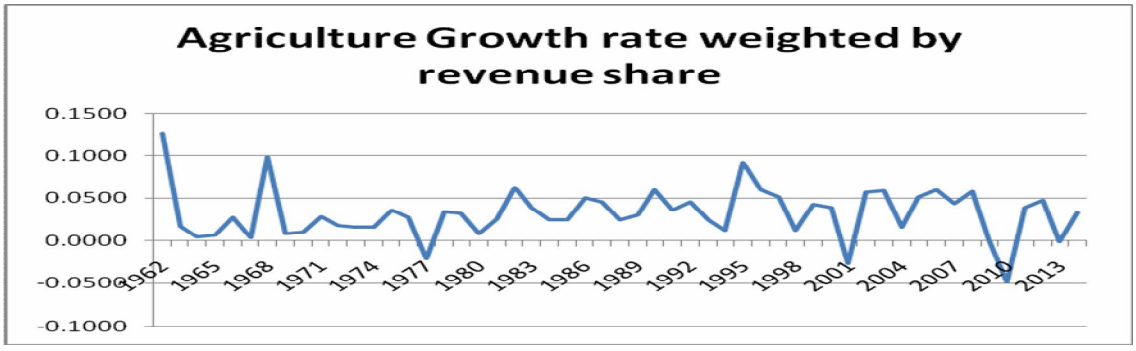
Figure 16.b. shows the total agriculture growth rate, the curve typically followed the same pattern of crops curve; as crops have the dominant share in agricultural revenue.

Fig. 16.Growth rates weighted by revenue share for Livestock, Crops and Total Agriculture.

A.

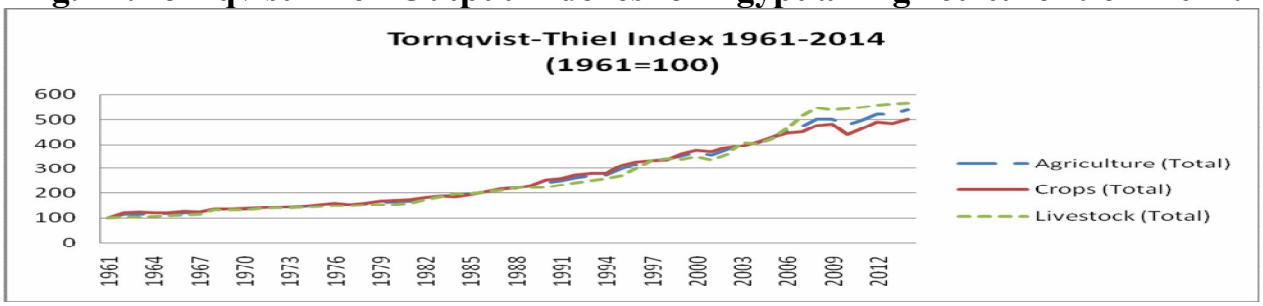


B.



Source: Author's own calculation.

Fig. 17.Tornqvist-Theil Output Indexes for Egyptian Agriculture 1961 -2014.



Source: Researcher's calculation.

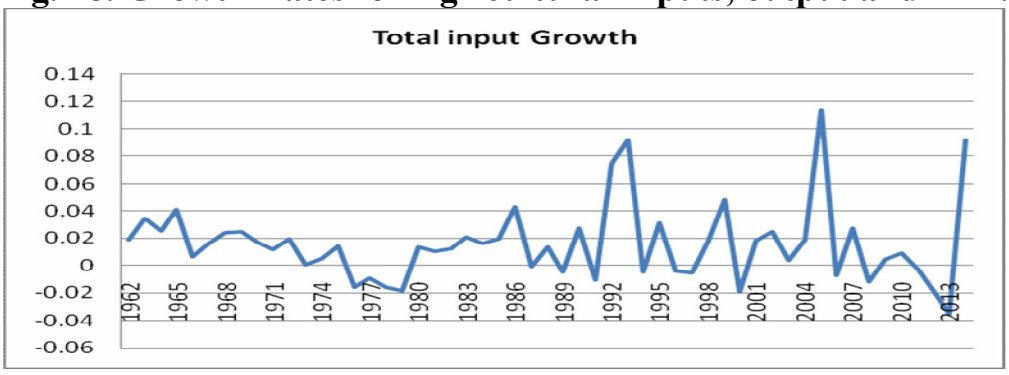
Figure 18.a. shows the total Agricultural input growth, started with 0.019 in 1962. In 2005 it reached the highest point of growth by 0.11; however the largest negative growth rate was -0.03 in 2013. In 2014 it reached 0.09 (table 2).

Figure 18.b. shows the total output growth that started in 1962 by 0.13 and this was the highest point of growth. The curve fluctuated sharply and the largest negative growth point was -0.05 in 2010. It reached 0.03 in 2014 (table 2).

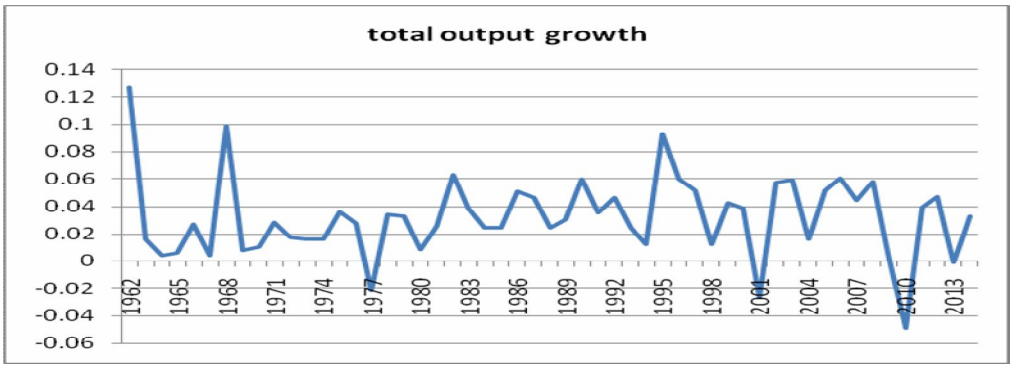
Figure 18.c. shows the TFP Growth as it is the result of deducting their input growth from the output growth. It takes positive values when the output growth is higher than the input growth and vice versa. That is why it takes a negative sign (-0.06) in 2014 despite that both inputs growth and Output growth were positive. However the input growth outweighed the output growth (table 2).

Fig. 18. Growth Rates for Agricultural Inputs, output and TFP.

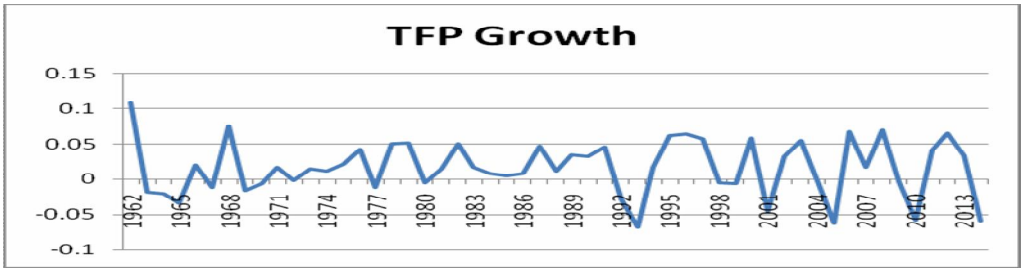
A.



B.



C.



Source: Author's own calculation.

Table (2): Growth rate weighted by revenue for agriculture, crops, livestock, and agricultural, crops and livestock Tornqvist-Thiel Index, 1961 – 2011

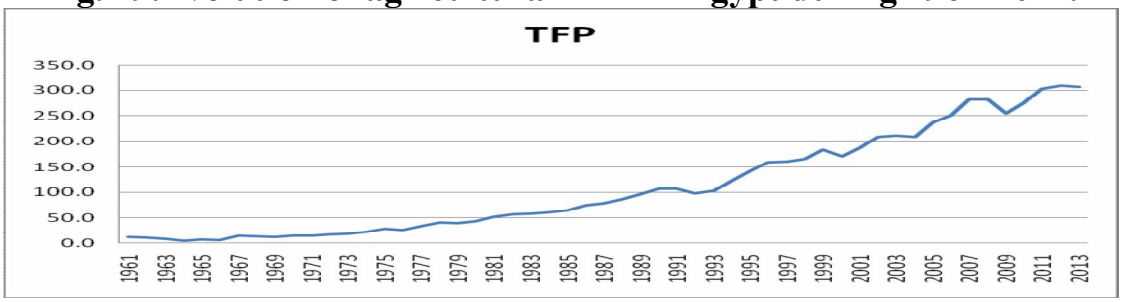
year	Agriculture Growth rate weighted by revenue share	Growth rate weighted by revenue share FOR CROPS	Growth rate weighted by revenue share FOR livestock	Tornqvist-Thiel Index (1961=100)-Agriculture	Tornqvist-Thiel Index (1961=100)-crops	Tornqvist-Thiel Index (1961=100)-livestock
1961				100	100	100
1962	0.1269	0.1705	0.0283	113.5296	118.5887	102.866
1963	0.0164	0.0219	0.0039	115.4052	121.2162	103.2657
1964	0.0042	-0.0009	0.0158	115.8915	121.1064	104.9071
1965	0.0062	-0.0006	0.0214	116.6066	121.0349	107.1765
1966	0.0271	0.0277	0.0256	119.8073	124.4399	109.9528
1967	0.0037	-0.0094	0.0337	120.2465	123.2718	113.7209
1968	0.0990	0.0813	0.1386	132.7549	133.7176	130.6291
1969	0.0078	0.0112	0.0001	133.7937	135.2293	130.6369
1970	0.0102	0.0105	0.0096	135.1607	136.652	131.8949
1971	0.0283	0.0251	0.0354	139.0456	140.1272	136.6417
1972	0.0174	0.0166	0.0190	141.4827	142.4777	139.2677
1973	0.0160	0.0194	0.0086	143.765	145.2653	140.4673
1974	0.0163	0.0165	0.0159	146.1299	147.683	142.7206
1975	0.0357	0.0467	0.0114	151.4423	154.7452	144.3533
1976	0.0273	0.0302	0.0207	155.6333	159.4874	147.3707
1977	-0.0215	-0.0368	0.0113	152.3194	153.7209	149.0505
1978	0.0341	0.0415	0.0194	157.6038	160.2424	151.968
1979	0.0326	0.0456	0.0055	162.8239	167.7203	152.8034
1980	0.0085	0.0101	0.0050	164.214	169.4212	153.5764
1981	0.0254	0.0155	0.0462	168.4451	172.0629	160.8421
1982	0.0626	0.0587	0.0700	179.3298	182.4681	172.5028
1983	0.0386	0.0223	0.0626	186.3801	186.5863	183.6475
1984	0.0243	-0.0040	0.0615	190.9739	185.8328	195.2997
1985	0.0246	0.0445	-0.0013	195.7397	194.2805	195.0556
1986	0.0505	0.0565	0.0422	205.8849	205.5767	203.4729
1987	0.0460	0.0512	0.0387	215.5738	216.3708	211.508
1988	0.0244	0.0054	0.0512	220.8978	217.5344	222.6304
1989	0.0302	0.0546	-0.0091	227.6751	229.7534	220.6236
1990	0.0596	0.0909	0.0005	241.6477	251.6132	220.7391
1991	0.0356	0.0254	0.0578	250.403	258.0852	233.872
1992	0.0460	0.0507	0.0341	262.1884	271.5093	241.9816
1993	0.0243	0.0204	0.0338	268.6346	277.1037	250.2935
1994	0.0122	0.0044	0.0283	271.9201	278.339	257.4874
1995	0.0927	0.1158	0.0435	298.3279	312.5198	268.9405
1996	0.0594	0.0410	0.1000	316.593	325.6111	297.2181
1997	0.0514	0.0206	0.1157	333.3053	332.3781	333.6766
1998	0.0124	0.0093	0.0185	337.4701	335.4801	339.916
1999	0.0425	0.0689	-0.0061	352.1215	359.4181	337.8342
2000	0.0386	0.0421	0.0321	365.982	374.8808	348.8394
2001	-0.0270	-0.0177	-0.0442	356.2463	368.3142	333.7543
2002	0.0570	0.0499	0.0705	377.1511	387.1683	358.1301
2003	0.0587	0.0160	0.1343	399.9593	393.3996	409.5963
2004	0.0158	0.0332	-0.0134	406.3413	406.685	404.1548
2005	0.0513	0.0532	0.0481	427.7292	428.9104	424.0719
2006	0.0601	0.0384	0.0947	454.2357	445.7161	466.1955
2007	0.0440	0.0080	0.1002	474.6718	449.3092	515.3361
2008	0.0576	0.0562	0.0597	502.7995	475.2945	547.0309
2009	0.0009	0.0124	-0.0163	503.2396	481.2178	538.1604
2010	-0.0492	-0.0930	0.0118	479.0605	438.4989	544.5485
2011	0.0391	0.0577	0.0119	498.1686	464.5399	551.0645
2012	0.0470	0.0504	0.0153	522.1474	488.5453	559.5659
2013	-0.0014	-0.0105	0.0088	521.4122	483.4435	564.4857
2014	0.0330	0.0357	0.0052	538.9272	501.025	567.4183

Source: Researcher's own calculation.

Figure 19 shows the evolution of TFP over the whole time period of the study. It started with 11.6 in 1962 and slightly fluctuated in an upwarding pattern during the whole period. However it reached its highest value 308.9 in 2013. And decreased to be 306 in 2014 (tabel 3).

It is noticeable that all the slight decreases in the TFP curve was due to a higher increase in inputs than the increase in outputs as clarified in table 3.

Fig. 19.Evolution of agricultural TFP in Egypt during 1961-2014.



Source: Author's own calculation.

Table. 3. Total inputs, total output and TFP 1961-2014.

year	Index Total input	total output	TFP	year	Index Total input	total output	TFP
1961	100	100		**1991**	144.7	250.4	105.7
1962	101.9	113.5	11.6	**1992**	155.9	262.2	106.2
1963	105.5	115.4	9.9	**1993**	171.0	268.6	97.6
1964	108.2	115.9	7.7	**1994**	170.3	271.9	101.7
1965	112.8	116.6	3.8	**1995**	175.7	298.3	122.6
1966	113.5	119.8	6.3	**1996**	175.1	316.6	141.5
1967	115.4	120.2	4.8	**1997**	174.2	333.3	159.1
1968	118.3	132.8	14.5	**1998**	177.4	337.5	160.0
1969	121.3	133.8	12.5	**1999**	186.4	352.1	165.8
1970	123.4	135.2	11.8	**2000**	182.9	366.0	183.1
1971	124.9	139.0	14.1	**2001**	186.4	356.2	169.9
1972	127.4	141.5	14.1	**2002**	191.1	377.2	186.0
1973	127.5	143.8	16.3	**2003**	191.9	400.0	208.0
1974	128.2	146.1	17.9	**2004**	195.6	406.3	210.7
1975	130.1	151.4	21.3	**2005**	219.3	427.7	208.4
1976	128.1	155.6	27.5	**2006**	217.8	454.2	236.5
1977	127.0	152.3	25.3	**2007**	223.9	474.7	250.8
1978	125.0	157.6	32.6	**2008**	221.3	502.8	281.5
1979	122.8	162.8	40.1	**2009**	222.4	503.2	280.9
1980	124.5	164.2	39.7	**2010**	224.4	479.1	254.7
1981	125.8	168.4	42.6	**2011**	223.9	498.2	274.3
1982	127.4	179.3	51.9	**2012**	220.0	522.1	302.2
1983	130.2	186.4	56.2	**2013**	212.5	521.4	308.9
1984	132.4	191.0	58.6	**2014**	232.9	538.9	306.0
1985	135.0	195.7	60.7				
1986	141.0	205.9	64.9				
1987	140.9	215.6	74.6				
1988	142.9	220.9	78.0				
1989	142.3	227.7	85.4				
1990	146.2	241.6	95.4				

Source: Author'sown calculation.

Conclusion

This paper summarized the data collection and calculation procedures for the estimation of the TFP of the Egyptian agricultural sector for the period 1961-2014. Data was collected from different sources and some missing values were estimated and/or approximated through some proxy variables and assumptions. The list of assumptions has been discussed in the above sections.

The main results can be summarized as follows:

- The trends of agricultural, crop and livestock output values increased speedily since 1999-2000. the trends of labor, fertilizers, capital stock and seeds values increased dramatically since 1990
- The annual growth rates of the studied inputs and outputs variables are quite varying. As for the quantities, machinery had the highest growth rate by 4.1%; followed by capital stock 3.7%; pesticides 3.6%; fertilizers 3.5%; seeds and animal feed were equal by 1.7%;Labor 1.2% and the lowest gross rate was for the natural resources 0.7%. On the other hand input values had higher growth rates then quantities; as they are all more than 10%. Natural resources had the highest growth rate by 15.2%, followed by machinery 13.7%; labor 13.5%; Capital stock 12.7%; seeds10.7%; pesticides 10.6%; fertilizers 10.5%; animal feed 10.3%.
- The crops revenue shares in the agricultural revenue fluctuated during 1961 – 2014. Results clarify the increasingly strategic importance of crops in the agricultural revenue. In 1961 it was 0.7 compared to 0.3 for Livestock. However the lowest share of crops was in 1984 when it reached 0.56 while the livestock was 0.44. In 2012, 2013, 2014 the crops share was almost constant reaching 0.81 each year which was the highest share during the whole time period while livestock share was 0.19 which was the lowest share for a Livestock during the whole studied time period.
- The Tornqvist-Thiel Indexes for agriculture, crops and livestock gradually increased during 1962 – 2014. The Tornqvist-Thiel Indexes for agriculture increased from 113.5 in 1962 to 538.9 in 2014. The Tornqvist-Thiel Index for crops increased from 118.6 in 1962 to 501 in 2014. The Tornqvist-Thiel Index for livestock increased from 102.9 in 1962 to 567.4 in 2014.
- Agricultural TFP started with 11.6 in 1962 and slightly fluctuated in an upwarding pattern during the whole period. However it reaches its highest value 308.9 in 2013. And decreased to be 306 in 2014. It is noticeable that all the slight decreases in the TFP curve was due to a higher increase in inputs than the increase in outputs

However, further analyses are needed in order to:

- Relate the observed growth of TFP to the set of explicative variables.
- Relate the observed trend of TFP growth to different agricultural policy contexts which Egypt experienced during the studied period 1961-2014.

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- Ministry of planning: http:// mop.gov.eg/
- World Bank data: http://data.worldbank.org/

الملخص

هذه الورقة البحثية هدفت بالأساس لإجراء تقدير حديث للإنتاجية الكلية الزراعية (TFP) في مصر خلال الفترة ١٩٦١-٢٠١٤ باستخدام منهجيةTornqVist Thiel. وكانت المدخلات الزراعية المشمولة في الدراسه هي: العمالة الزراعية ،الآلات ، البذور ، مبيدات الآفات ، رأس المال التراكمي، والأعلاف الحيوانية بما في ذلك الأعلاف الخضراء والمركّزة ، الأسمدة والموارد الطبيعية. وكانت النتائج الرئيسية لهذه الدراسة هي:

معدلات النمو السنوية للمدخلات والمخرجات المدروسة متفاوتة إلى حد كبير. بالنسبة للمدخلات (كميات) ، فقد حققت الآلات أعلى معدل نمو بنسبة ٤,١ ٪. يليها رأس المال التراكمي بنسبة ٣,٧٪. المبيدات الحشرية ٣,٦ ٪. الأسمدة ٣,٥ ٪. وكانت البذور وأعلاف الحيوانات متساوية بنسبة ١,٧٪ ؛ وكان العمل ١,٢٪ وأدنى معدل نمو كان للموارد الطبيعية ٠,٧٪. ومن ناحية أخرى ، كانت معدلات النمو في (قيم) المدخلات أعلى من معدلات النمو في الكميات. حيث زادت جميع القيم عن ١٠ ٪. حققت الموارد

الطبيعية أعلى معدل نمو بنسبة ١٥,٢ ٪ ، تليها الآلات ١٣,٧ ٪. العمالة ١٣,٥ ٪. رأس المال التراكمي ١٢,٧ ٪. البذور ١٠,٧٪، المبيدات الحشرية ١٠,٦ ٪. الأسمدة ١٠,٥ ٪. علف الحيوان ١٠,٣ ٪.

تذبذبت إيرادات المحاصيل الزراعية في الدخل الزراعي خلال عام ١٩٦١ – ٢٠١٤. وتوضح النتائج الأهمية الإستراتيجية المتزايدة للمحاصيل في الدخل الزراعي. ففي عام ١٩٦١ كان ٠,٧ مقابل ٠,٣ بالنسبة للثروة الحيوانية. ومع ذلك ، كانت أدنى حصة من المحاصيل في عام ١٩٨٤ عندما وصلت إلى ٠,٥٦ بينما كانت الثروة الحيوانية ٠,٤٤. أما في عام ٢٠١٢ ، ٢٠١٣ ، كانت حصة المحاصيل ثابتة تقريبًا وبلغت ٠,٨١ سنويًا والتي كانت أعلى حصة خلال فترة الدراسة بأكملها ، في حين كانت حصة الثروة الحيوانية ٠,١٩ والتي كانت أقل حصة للثروة الحيوانية خلال فترة الدراسة بالكامل.

ازداد مؤشر Tornqvist-Thiel لكل من الزراعة ،المحاصيل والثروة الحيوانية تدريجياً خلال ١٩٦٢ – ٢٠١٤. ارتفع مؤشر Tornqvist-Thiel للزراعة من ١١٣,٥ في عام ١٩٦٢ إلى ٥٣٨,٩ في عام ٢٠١٤. ارتفع مؤشر Tornqvist-Thiel للمحاصيل من ١١٨,٦ في عام ١٩٦٢ إلى ٥٠١ في ٢٠١٤. ارتفع مؤشر Tornqvist-Thiel للثروة الحيوانية من ١٠٢,٩ في عام ١٩٦٢ إلى ٥٦٧,٤ في عام ٢٠١٤.

بدأت مؤشر الانتاجية الكلية لعناصر الانتاج الزراعي (TFP) بـ ١١,٦ في عام ١٩٦٢ وتذبذبت قليلاً في نمط تصاعدي خلال الفترة بأكملها. ومع ذلك ، فإنها تصل إلى أعلى قيمة لها ٣٠٨,٩ في عام ٢٠١٣. وانخفضت إلى ٣٠٦ في عام ٢٠١٤. ومن الملاحظ أن جميع الانخفاضات الطفيفة في منحنى TFP كان نتيجة لأن الزيادة في المدخلات الزراعية كانت أعلي من الزيادة في الناتج الزراعي.