

DETERMINATION OF AGRICULTURAL PRODUCTIVITY IN EGYPT : MULTIPLE REGRESSION ANALYSIS

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Agriculture in recent days, as other types of business, needs capital to increase its productivity to secure sufficient returns to rural people. Moreover, in developing countries, such as Egypt, agricultural output should be increased to supply economic surplus which can be used in consumption, further production in agriculture, or to provide capital needed for investments in non-agricultural sectors for the economic growth of the country.

This research has been undertaken to show how multiple regression analysis can be used to determine productivity within the agricultural sector of the economy, and to clarify the role of capital in this respect. Therefore, the need for capital in agriculture is cited, the situation of capital and credit in the Egyptian agricultural sector is reviewed, and then the effect of capital on agricultural production and thus productivity is tested with the use of a multiple regression analysis.

The Need for Capital and Credit in Agriculture :

Increase in agricultural output comes from two main sources :

1. The horizontal expansion by increasing the area under cultivation, which does not hold great promise because of the limitation of the cultivable land available for a country.

2. The vertical expansion by increasing agricultural productivity in two ways :—

- a) the use of additional inputs other than land.
- b) the use of improved technology.

This is the most hopeful to increase agricultural production to support the economic growth of any nation. Thus, agriculture should be changed from the traditional system, as it is in almost all the underdeveloped countries, to the commercial business.

In changing from a self-sufficient or traditional system of farming to a commercial business of farming requires the use of money... We cannot improve productivity very far without substituting capital for labor. This capital is in the form of fertilizer, machinery, and other material... The changing of the proportion or mix of these factors [land, labor, capital, and management] may make a great change in production and productivity per man... A frighly developed agriculture will require the efficient use of a large amount of capital and credit.⁽¹⁾

The best source to acquire capital is savings. But for farmers with small holdings, low productivity, and high uncertainty, income is insufficient to allow savings. Therefore, some agricultural credit system should be organized to provide loans for agricultural needs in suitable terms and reasonable rates of interest. A specialized system is preferred in this situation because of uncertainty involved in agriculture and seasonality of the product which requires a flow of relatively small amounts of capital over a relatively long period of time throughout the production processes without any returns until the maturity of the products which are influenced by uncontrolled factors.

These certain characters necessitate a governmental participation to provide farmers with the loanable funds to start any agricultural development in developing countries. Such system should aim to create more agricultural efficiency which can support its ends.

The situation in Egypt.

In Egypt the cultivated land is limited, to a great extent, to irrigation water available from the River Nile. So, cultivable land is limited. In the same time population increases constantly.

1) Marvin G. Smith, «Agricultural Economic Development in the World (Agricultural Credit and Capital, 1959), p. 1, 2. (Mimeographed).

Therefore, increase in agricultural productivity is the only way to provide food and fiber needed for inhabitants, savings to be invested in non-agricultural sectors, and to yield sufficient returns for people having agriculture as a way of livelihood.

Capital needed for agricultural development was and, for some extent, still facing problems. Saving⁽¹⁾ is insufficient because of low income level, and credit faces many problems in lending and borrowing. On the lending side :

- 1) Lack of lending sources.
- 2) Lack of loanable funds available for agriculture.
- 3) High rate of interest on the available funds.
- 4) The granted loans are insufficient to finance borrower's purposes.

On the borrowing side :

1. Lack of education and managerial ability which avoid the best use of borrowed capital to the borrower's advantage. This reduces farmer's returns.

2. Small farmers, the majority in the country, lack the suitable collateral which deprived them of loans for a long time.

3. Low repayment and risk bearing ability, especially for small farmers, results from uncertainty in agricultural production and its effect upon small farmers.

These problems have given rise to extensive government participation in the farm credit field.

1) No data are available concerning savings in agriculture. However, Ministry of Planning has reported that total domestic savings to total national products was 14% in 1964/65, 13% in 1965/66, and 13.7% in 1966/67 with an average of 13.3% for the three years period. It is worth noticed that the same ratio in 1964 was 38% in Japan, 36% in Yugoslavia, 29% in Western Germany, 28% in the USSR, 26% in Poland, and 19% in Eastern Germany, (Ministry of Planning, **Following up and Evaluation of Economic growth in the U.A.R., 1966/67**, Cairo, August 1968, P. 132 - 155). Arabic.

Agricultural Credit in Egypt.

The agricultural finance and credit system was organized recently in Egypt passing through five stages.

The First Stage : Before the Establishment of the Co-operative Movement in 1923 : — There were neither farmer's organizations nor any specialized agent for agricultural finance. Farmers had very limited and highly excessive sources to get their needs. Those sources were relatives, big landowners under the feudalism system, usurers and merchants who used to lend with an exorbitant interest rate, and foreign controlled commercial banks.

These insufficient ways of borrowing raised farm mortgage from L.E. 50,000 in 1876 to about L.E. 7 millions in 1883. As a result of that, one bank, throughout five years, expropriated about 54,000 feddan in the settlement of about L.E. 1.5 million debts, about L.E. 28 per feddan.

The Second Stage : Formation of Cooperatives : — In 1923 the first cooperative law in Egypt was enacted organizing agricultural cooperatives with the main purpose of lending to their members. The government deposited to their account the sum of L.E. 100,000 at Bank Misr, and allowed them to draw from this credit at five per cent interest the advances which they have granted to their members.

Because of the small number of farmers involved in cooperative societies along with the inadequate funds allocated for loans and the complication of remittance, this program failed to help farmers solving their financial problems.

The Third Stage : The Establishment of the Agricultural Credit Bank. The agricultural economic depression in 1930 necessitated the existence of a specialized bank for agricultural credit. In November 1930 the Decree No. 50 was enacted authorizing the government to participate in the establishment of an agricultural bank which was created by another decree on July 25, 1931 with the name of Agricultural Credit Bank.

The Bank was organized as a joint stock company with initial share capital of L.E. one million, one half of which was owned

by the government to keep the bank under its supervision for the farmers' benefit.

The Fourth Stage : The Conversion to Cooperative Bank.

To overcome the weaknesses which have appeared in the co-operative movement, the bank was converted to a cooperative bank, instead of the idea that was raised for the establishment of a new bank. In 1948, its capital was increased by L.E. 500,000 half of which was subscribed by the government, and the other half by cooperative societies. In March 1949, its name was changed to the Agricultural and Cooperative Credit Bank.

In spite of these efforts, agricultural credit system was greatly handicapped and did not help too much in solving the financial problem because of :⁽¹⁾

1) The weaknesses of cooperative understanding between farmers and managers of cooperative societies which did not permit them to seek advantages from cooperative privileges.

2) Loans were granted to cooperatives without any supervision even without making sure that such loans were actually granted to the members or used in the purposes for which the loans were granted.

3) Most loans were requested in cash and only for a limit extent in kind. Without supervision, those loans were used improperly. Thus, they failed to help borrowers to improve their benefits.

4) Collateral security needed, the endorsement of landowners for tenants and land mortgage for small farmers, has deprived small farmers, who constitute the majority, of loans.

5) The bank served small portion of the farmers, most of them were big landowners.

6) The granted loans were insufficient for the purposes for which they were granted.

1) National Development Council, **Agricultural Short and Medium term Financial Policy Improvement in Egypt**, A report prepared by Mahmoud El Shafie and Zaki Shearh, No. 1 (Cairo : 1956). Arabic.

The Fifth Stage : Supervised Agricultural Credit System.

Supervised credit involves more detailed individual loan analysis and follow-up supervision... This type of credit shows promise of expanding the use of credit and of stimulating agricultural development. It is necessary for the government to subsidize this kind of program or to pay at least for the educational phase of the work... Most of the problem seem to be lack of trained personnel, insufficient capital, and high cost of planning and supervision of loans.⁽¹⁾

Supervised credit was started in Egypt in 1952 after the promulgation of the Agrarian Reform Law and the redistribution of the confiscated land among landless farmers. The law required new proprietors to participate in the formation of cooperative societies. The Higher (National) Committee for Land Reform Organization, then the administration authority for the confiscated land, allocated sufficient funds and appointed a special supervisor for every cooperative, whose job was to participate with the board of directors in the control and administrative responsibilities. Loans were granted to cover the needs of farm operation. Loans in kind were encouraged. A technical staff provided farmers with high quality seeds, fertilizers, determined crop rotations, etc. Care is taken of marketing the products and advances, equal to eighty per cent of the crop value, were granted as soon as the product was delivered to Agrarian Reform warehouses. Savings were encouraged between the new small landowners.

Table 1 shows the development of loans, in cash and in kind, as well as the services, included irrigation, ploughing, mechanical threshing, pest control, and cost of guarding, rendered to Agrarian Reform Cooperatives throughout the 1953-1958, period.

1) Smith, *op. cit.*, p. 5.

TABLE 1. — *Loans and Services Granted to Agrarian Reform Cooperatives*

Year	Loans in Cash & Kind L.E.	Services L.E.	Total L.E.
1953	1,144,000	350,000	1,494,000
1954	1,678,787	456,000	2,134,787
1955	2,142,865	752,427	2,895,292
1956	2,680,788	955,620	3,636,408
1957	2,890,556	1,230,650	4,121,206
1958	3,150,787	1,635,120	4,785,907

Source : National Bank of Egypt, *Economic Bulletin*, Vol. XIII, No. 1 (Cairo 1960), p. 38.

The Agricultural Credit Facilities Available for Farmers and Cooperatives in Egypt.

Although some farmers could borrow from other commercial banks, this study is confined to the credit available from the Agricultural Credit Bank which was converted to the Agricultural and Cooperative Credit Bank since 1948, and then the Egyptian Public Organization for Agricultural and Cooperative Credit since 1964.

The loans granted by this bank represent the great bulk of the credit available for agriculture in Egypt.

Table 2 shows the development of agricultural loans granted by the Agricultural and Cooperative Credit Bank in selected years since its first year of operation and their distribution according to redemption and beneficiaries.

The changes in advances structure, according to beneficiaries, individuals and cooperatives, reflect the policy adopted by the country to achieve closer specialization in cooperative finance up to the time it was completely confined to cooperatives in 1962.

The rise in the advances and increasing services rendered to cooperatives reflect the growing importance of the Bank over the time and especially in recent years.

It is clear that even the Agricultural and Cooperative Credit Bank is not confined to agriculture, its services granted for agriculture represent the main portion of its activities.

Table 3 shows the distribution of the advances granted by the Agricultural and Cooperative Credit Bank throughout the 1952 - 62 period according to uses and the percentage increase in the total from year to year.

It is clear that loans granted to finance seasonal needs of agriculture in short-term loans, in cash and in kind, constitute the most important part.

The advances granted for livestock breeding started late in 1956 on small scale but it was growing very fast.

Figure 1 shows the development of agricultural loans granted by the Agricultural and Cooperative Bank up to 1960 and their proportions in cash and in kind. Figure 2 shows the same development extended to 1962 and the structure of the loans according to beneficiaries individuals and cooperatives.

TABLE 2.—The development of the loans granted by the agricultural and co-operative credit bank for agriculture

Year	Agr. Advances According to Redemption (1)				Total	Total Agr. As % of Total Loans Granted (2)	Total Agr. loans as % according to Beneficiaries (3)		
	Short-term	Medium	Long	Total			Co-ops	Inds.	Total
	1931	N.A.	N.A.	N.A.	2,200,000	100	—	100	100
1942	N.A.	N.A.	N.A.	4,000,000	100	19	81	100	
1952	15,606,325	73,121	6,572	15,686,018	98.5	21	79	100	
1953	16,013,215	42,573	11,962	16,067,750	98.3	23	77	100	
1954	16,862,707	61,828	9,235	16,933,770	97.4	26	74	100	
1955	18,231,830	87,742	11,020	18,330,592	94.5	30	70	100	
1956	16,269,040	182,432	27,782	16,479,254	92.9	38	62	100	
1957	18,317,686	135,879	9,651	18,463,216	91.4	42	58	100	
1958	21,774,382	201,541	5,533	21,981,456	89.8	50	50	100	
1959	25,221,214	572,210	8,805	25,802,229	90.0	70	30	100	
1960	30,735,761	1,095,638	94,975	31,926,374	89.9	84	16	100	
1961*	34,257,425	1,205,387	229,000	35,691,812	90.4	96	4	100	
1962*	56,600,000	770,000	20,000	57,390,000	94.1	100	—	100	

Sources : (1) *Egyptian Economic and Political Review*, Vol. 7, No. 5, May, 1961, p. xv.

(2) Calculated by the writer from (1).

(3) *Agricultural and Co-operative Credit Bank Publication*, No. 1, 1964, pp. 148, 149, Arabic.

* Table 3.

TABLE 3.—*The development of the agricultural loans granted by the Agricultural and Cooperative Credit Bank According to uses (L.E. 000's)*

Year	Advances For				Total	Increase in Total As % of Preceding year *
	Production Expenses	Against Agr. Product	Livestock Breeding	Machinery Purchases		
1952	13,822	1,785	—	73	15,686	—
1953	15,386	627	—	43	16,068	2.4
1954	15,228	1,635	—	62	16,934	5.4
1955	17,047	1,185	—	88	18,331	8.2
1956	14,663	1,597	9	178	16,479	-10.1
1957	16,796	1,478	25	164	18,463	12.0
1958	19,661	2,056	58	159	21,981	19.1
1959	23,101	1,955	165	497	25,802	17.4
1960	27,395	3,151	384	891	31,926	23.7
1961	32,574	1,683	445	751	35,692	11.8
1962	49,087	7,531	205	545	57,390	60.8

Source : Egypt, Ministry of Agriculture, *Ministry of Agriculture in Fifty Years, November 1913-1963* (Cairo : November 20, 1963), p. 476. Arabic.

* Calculated by the writer.

Fig. 1. — The Development of agricultural loans extended by the Agricultural and Cooperative Credit Bank in cash and in kind.

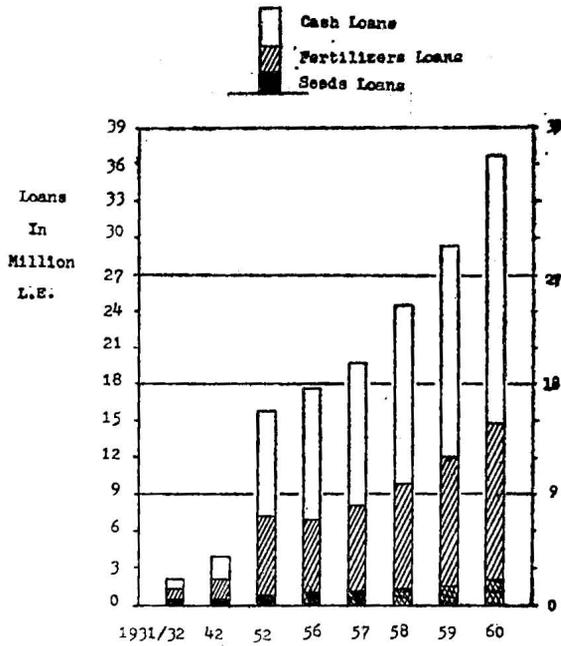
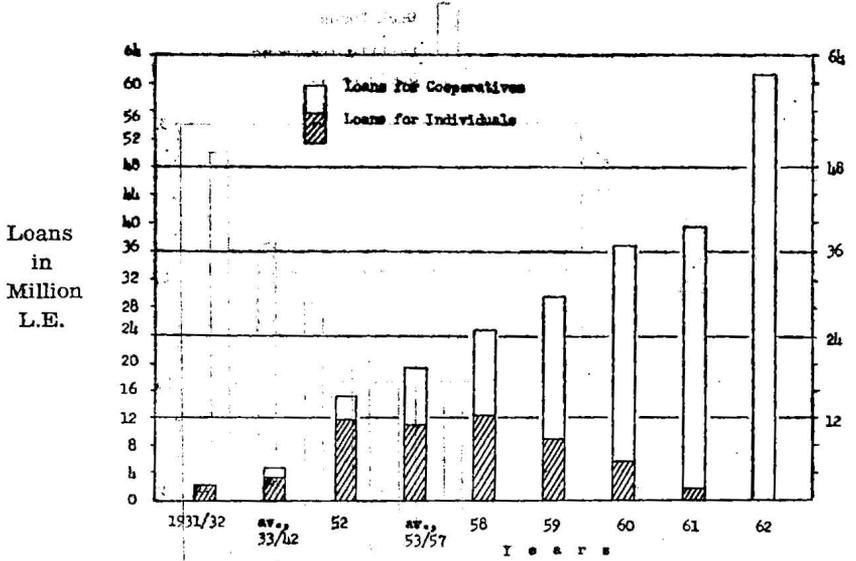


Fig. 2. — The Development of agricultural loans extended by the Agricultural & Cooperative Credit Bank according to beneficiaries (individuals and cooperatives).



The Effect of Agricultural Finance and Cooperatives on Agricultural Production in Egypt during the 1952 — 1960 Period.

The limitation of cultivable land area in Egypt necessitates the improvement of agricultural productivity to support the economic development of the country.

In such a situation, abundant labour needs to be used to improve natural resources. Investment must be made to improve technical skills and managerial talents of rural people. Scarce supply of capital inputs from outside agriculture need to be used sparingly and where marginal returns are largest in order to increase crop yields and the overall productivity in agriculture, which is defined as the ratio between total output and total input with annual outputs and inputs valued at constant prices so that real changes in the overall productivity ratio can be observed over time.⁽¹⁾

Over the 1952 - 1960 period, great amount of capital has been made available for farmers in Egypt for agricultural production, which has been increased. Moreover, this period had experienced a great deal of stability in the relations affecting production factors in the agricultural sector with a good response from farmers to the changes that took place at that period. Those were the main reasons for choosing the 1952 - 1960 period for this analysis under the assumption that the growth in agricultural productivity could be related to the increase in the amount of capital forwarded toward agriculture.

Recent research has proved that both capital, presented by loans granted by Agricultural and Cooperative Credit Bank, and agricultural production have been significantly increased over the period under consideration.⁽²⁾

1) Raymond P. Christensen and Harold T. Yee, «The Role of Agricultural Productivity in economic Development.» *Journal of Farm Economic*, Vol. 45, No. 5 (December, 1964), p. 1051.

2) Abdallah Abu-Hammad, «An Analysis of Factors Inhibiting Performance of Agricultural Credit Programs in Developing Countries» (Unpublished Master's thesis, Department of Agricultural Economics, the Ohio State University, 1965).

Table 4 shows the compound annual growth rates for agricultural output and population in Egypt during the 1952-1960 period. Total agricultural production and total food production were increasing at compound annual rate of 2.9 per cent and 3.4 per cent respectively while total population was increasing at 2.4 per cent. This clarifies that agricultural production was increasing at higher rate than increase in population which is required to obtain economic growth in the country. This means that the increase in agricultural production has supported the increase occurring in population and realized excess or surplus which could be used to support the economic growth of the country.

TABLE 4.—*Percentage Compound Annual Growth Rates and Agriculture's Share of Gross National Product and Total Employment In Egypt during the 1952 — 1962 Period*

Total pop.	% Compound Annual Growth Rate				Agr's Share %	
	Gross National Product	Agr. Sector Output	Total Agr. Production	Total Food Pro.	Gross National Product	Total Employment
2.4	4.9	2.4	2.9	3.4	36.2	64

Source : Christensen and Yee. *Journal of Farm Economics*, Vol. 46 No. 5 (December, 1964) p. 1054 .

Multiple Regression Analysis for Agricultural Productivity.

Table 5 shows total value of agricultural output and the components of inputs used in agricultural production during the 1952-1960 period in Egypt. These data have been used statistically by the writer to determine whether the increase in agricultural production, during that period, was due to inputs or agricultural productivity.

Multiple regression with different multiple hypothesis was run, for the nine years period, between the dependent variable, agricultural output (0), and the following independent variables :

- | | | |
|--------------------------------|-------------------|--|
| 1) Cultivable land area | (A ₁) | } Input components |
| 2) Quantity of fertilizer used | (F) | |
| 3) Value of other inputs used | (I) | |
| 4) Amount of credit available | (C) | |
| 5) Cropped land area | (A ₂) | } Indicators for changes in agricultural productivity. |
| 6) Time | (T) | |

Time and cropped area were chosen as indicators for changes in agricultural productivity on the following basis : (a) Time measure the changes occurred as a result of improvement in technology over time and was represented by an automatic linear trend 0, 1, 2, 3. (b) Cropped area, which is the total number of feddans cultivated by different crops the year around — multiple cropping, measure the improvement in land productivity because on limited cultivatable land area, it is possible to cultivate two or three crops a year only by increasing its productivity through the use of highly intensive irrigation and drainage system, high quality seeds and fertilizers, machinery, and other improved technology tools.

To overcome the curvilinear characters of the production function, logarithmic form was used to transform the function into linear function.

The variable model used in this analysis was the technical equation $O = f(A, F, I, C, T)$.

Various multiple hypotheses were used in the forms :

1. $O = f(A_1, F, I, C, T)$
2. $O = f(A_2, F, I, C, T)$
3. $O = f(A_2, F, I, C)$
4. $O = f(A_1, F, I, C)$
5. $O = f(A_2, T)$

The results obtained are summarized in the followings :

1) Correlation between cropped area and output + 93.85 per cent.

Correlation between time and output + 83.39 per cent.

Correlation between cultivatable area and output + 78.62 per cent.

TABLE 5.—*Agricultural Output and Inputs Components in Egypt During the Period 1952—1960*

Year	Credit Available (L.E.000's)	Cultivable Area (Feddan 000's)	Cropped Area (Feddan 000's)	Quantity of Fert. Used (Ton 000's)	Value of Inputs other than fert. (L.E. 000's)	Value of total Agr. output (L.E.000's)
	(1)	(2)	(3)	(4)	(5)	(6)
1952	15,686	5,672	9,310	769	109,000	369,000
1953	16,068	5,715	9,380	740	99,000	382,000
1954	16,934	5,744	9,910	784	101,000	433,000
1955	18,331	5,745	9,966	758	98,000	432,000
1956	16,479	5,771	9,962	788	88,000	445,000
1957	18,463	5,831	10,100	879	87,000	425,000
1958	21,981	5,843	10,089	873	87,000	421,000
1959	25,802	5,865	10,269	995	94,000	449,000
1960	31,926	5,879	10,370	934	98,000	474,000

Sources : (1) Table 2.

(2) National Bank of Egypt, *Economic Bulletin*, Vol. XVII, No. 2 (Cairo : 1964), p. 245.

(3) *Ibid.*, Vol. XIII, No. 1 (Cairo : 1960), pp. 68, 94.

(4) Egypt, Central Committee for Statistics, *Fundamental Statistical Data* (Cairo : 1962), p. 93.

(5 & 6) Egypt, Ministry of Agriculture, *Agriculture Economics*, Vol. XII, No. 1 (Cairo : January, 1962), p. 17. Arabic. The values are deflated by the writer on the constant basis of 1953 prices, obtained from U.N.'s *Statistical Yearbook*, 1961, p. 479.

Correlation between credit available and output + 70.78 per cent.

Correlation between fertilizer used and output + 62.35 per cent.

Correlation between value of other inputs and output — 45.55 per cent.

This indicates that the variables used as indicators for changes in agricultural productivity, cropped land area and time, were the highest correlated factors with output, while other inputs had negative correlation with output.

2) When five factors, cultivatable area, credit, fertilizers, and other inputs as input factors and time as indicator for changes in productivity, were regressed on output, $R^2 = 96.9960$ per cent (F test indicates significant correlation at five per cent level of significance).

Regression co-efficients were significant at five per cent for all the factors except cultivatable area which indicates that the correlation was significant.

The same result was obtained when cropped area was used instead of cultivable area.

3) When cropped area was used with other input factors only excluding the effect of time, $R^2 = 93.2663$ per cent (F test was significant).

4) When input factors including cultivatable area were regressed excluding the effect of time $R^2 = 72.5230$ per cent (F test was insignificant).

In the same time, the test for the contribution due to time in explaining the variation beyond that explained by input factors showed significant effect of time on output.

5) When productivity indicators, time and cropped area, were used excluding input factors effect, $R^2 = 39.5601$ (F test was highly significant at 1%).

In the same time, the test for the contribution due to input factors showed great insignificance which means that changes in output during the period under investigation were mainly due to changes in agricultural productivity and that changes in input factors in the same period had no significant statistical effect on output.

Table 6 summarizes the results mentioned above.

On the basis of these results, given the available data, the increase occurred in agricultural production during the period under investigation was mostly due to increasing agricultural productivity.

Table 7 shows the increase occurring in agricultural statistics in 1960 compared with the situation in 1952.

As the amount of agricultural loans was doubled at the end of the period, it provided more capital for agricultural production which was increased as a result of increases in its productivity. This provides a sound ground for the writer to conclude that credit and loans granted through the 1952 - 1960 period under investigation have significantly affected agricultural production in Egypt through increasing agricultural productivity.

Also, the writer concludes, as the great bulk of these loans have been made available through cooperatives which have supervised their members to a great extent, that the cooperative system in Egypt has facilitated the performance of the agricultural finance system and has avoided the obstacle which had hindered its operation before.

Moreover, the suitability of multiple regression analysis in determining productivity is very clear and useful even without a large amount of data.

TABLE 6.—*Summary for the Regression Results*

No. of observation 9 (Years). Independent Variables Regressed on Output	R ²	sign. of (F. 95)	Effects of other Variables (F. 95)
A ₁ ,C,F,I,T	96.9960	Sing.	—
A ₂ ,C,F,I,T	96.6201	Sign.	—
A ₂ ,C,F,I	93.2663	Sin.	T has insign. effect
A ₁ ,C,F,I	72.5230	Insign.	T has sign. effect
T,A ₂	89.5601	highly sign.	Input factors have insign. effect.

A₁ = cultivatable land area.

A₂ = cropped land area.

F = fertilizer.

I = other inputs.

T = time.

C = Credit available.

TABLE 7.—*Important Agricultural Statistics
In 1952 and 1960*

Item	1952	1960	Change%
Agricultural Loans (L.E. 000's)	15,686	31,926	+103.5
Cropped Area (Feddan 000's)	9,310	10,370	+ 11.4
Credit Available (L.E.-fedd)	1.7	3.1	+ 82.4
Quantity of fertilizers (Ton 000's)	769	934	+ 21.5
Quantity fertilizer-fedd. (Ton)	0.083	0.090	+ 8.4
Other Inputs used (L.E. 000's)	109.00	98.000	— 10.1
Other Inputs L.E.-feddan	11.7	9.5	— 23.2
Net Agr. Income (L.E. 000's)	240.000	349.000	+ 45.4

Source : Table 5.