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An Analytical Study Of The Most Important Economic Variables Affecting Agricultural Income

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Abstract:
Agriculture is a fundamental sector of the Egyptian economy, providing food security, employment, and raw materials for industry, while contributing significantly to the national GDP and income. The research addresses the declining growth rate of agricultural income in Egypt, which negatively impacts the living standards of rural populations and hinders economic prosperity. The study aims to identify key economic variables influencing agricultural income, enabling policymakers to focus on these factors to enhance real agricultural income, improve per capita income, and raise living standards in rural areas. Specific objectives include analyzing trends in agricultural income and its components from 2005 to 2022, estimating the contributions of various agricultural activities, and identifying significant economic variables affecting agricultural income. A combination of descriptive and quantitative methods, including regression analysis and structural equation modeling (AMOS), was used for this study. Secondary data from the Ministry of Agriculture, the Central Agency for Public Mobilization and Statistics, the Ministry of Planning, and the Central Bank of Egypt were analyzed. Key findings reveal that agricultural income and its components (crop, livestock, and fisheries) showed significant annual growth, with crop income growing faster than livestock income, and fisheries income surpassing both. Crop production accounted for the largest share of agricultural income, suggesting that investment should prioritize crop production activities.

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I. Introduction

The agricultural sector forms the backbone of the Egyptian economy and stands as one of the most critical real sectors upon which the national economy heavily relies. It plays a significant role in ensuring food security and generating extensive employment opportunities. Moreover, it serves as a vital source of raw materials essential for manufacturing industries and contributes substantially to the Gross Domestic Product (GDP) as well as to the Gross National Income (GNI).

In this context, the net agricultural income reached approximately 364.6 billion EGP in 2020, compared to 346.8 billion EGP in 2019, reflecting an increase of about 5.1%. This accounted for approximately 5.4% of the GDP, which totaled 6772.8 billion EGP. Agricultural income is derived from three main activities: plant production, livestock production, and fish production.

Research Problem

The research problem lies in the low growth rate of Egyptian agricultural income, which adversely affects the living standards of rural populations and impedes their economic welfare. Evidence indicates that the growth rate of net agricultural income is insufficient when compared to the growth rate of the rural population, thereby hindering the achievement of economic prosperity for these communities.

Research Objective

The primary objective of this research is to identify the key economic variables that determine agricultural income, enabling agricultural policymakers to focus on these factors to maximize real agricultural income. Consequently, this would lead to an increase in per capita agricultural income, thereby improving the living standards of rural populations. This goal will be achieved through the following sub-objectives:

- Analyzing the development of agricultural income and its main components at current prices during the period (2005–2022).

- Estimating the contribution of agricultural activities generating agricultural income and assessing the relative contribution of each activity's components during the study period, which serves as a basis for investment allocation decisions targeting these activities.
- Identifying the most significant economic variables influencing agricultural income throughout the study period.

II. Research Methodology And Data Sources

The study employed both descriptive and quantitative analytical methods. Regression analysis in its various forms was utilized to examine the trends of selected variables and determine the contributions of plant, livestock, and fish incomes to overall agricultural income. Among the available models, the most appropriate was selected. Additionally, the study used the AMOS model for confirmatory factor analysis (CFA).

The research relied on both published and unpublished secondary data relevant to the study's focus, sourced from the Ministry of Agriculture and Land Reclamation, the Central Agency for Public Mobilization and Statistics (CAPMAS), the Ministry of Planning, Economic Development, and International Cooperation, and the Central Bank of Egypt.

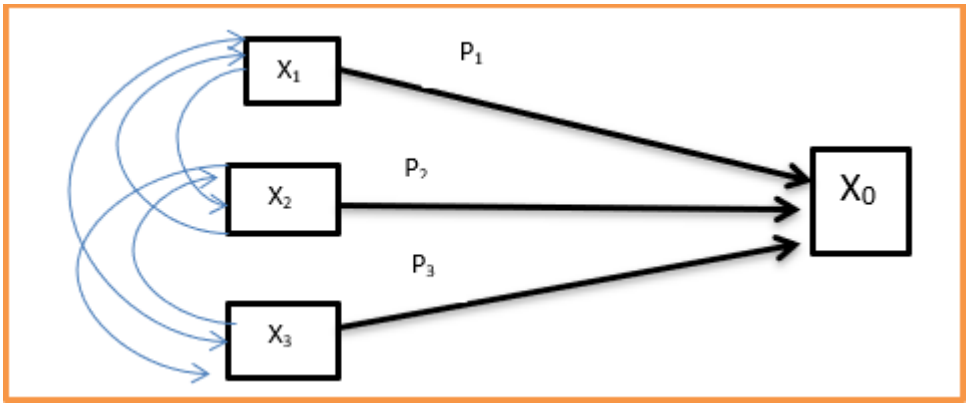
III. Study Results And Discussion

First: Model Description

The model employed is known as Confirmatory Factor Analysis (CFA), one of the most significant applications of structural equation modeling (SEM). It is used to analyze the reciprocal relationships among a set of **Exogenous variables** (external variables) and **Independent variables** affecting agricultural income as the **Endogenous variable** (dependent variable).

The model estimates regression coefficients and correlations among variables, calculating path coefficients that represent the regression coefficients between independent and dependent variables. These coefficients should always be less than one (positive or negative). Furthermore, the model computes the correlation coefficients among independent variables, reflecting their mutual effects. It is designed to account for multiple independent variables influencing the dependent variable.

The following diagram illustrates the model's structure. The arrows show the relationships among independent variables and their direct impact on the dependent variable, as well as the interconnections among independent variables. Bidirectional arrows represent the correlation coefficients.



Model Explanation

In this model:

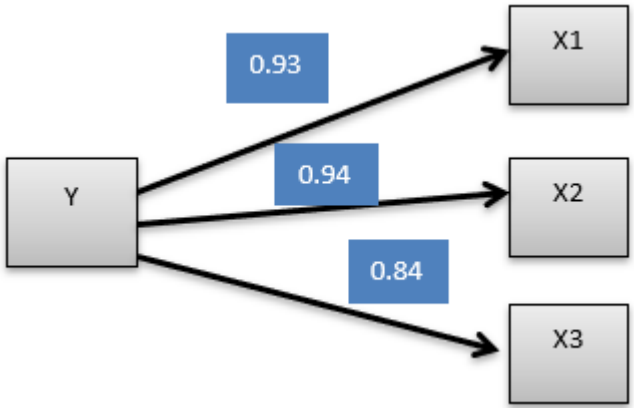
- **X_0** represents the dependent variable (agricultural income).
- **X_1, X_2, and X_3** represent the independent variables (net plant income, net livestock income, and net fish income, respectively).
- **P** denotes the path coefficient, which measures the direct relationship between the dependent variable and the independent variables.

Figure (1) illustrates the results of the analysis, including the direct path coefficients between the independent variables and the dependent variable. The findings indicate the following:

1. **Path coefficient between net plant income (X_1) and agricultural income (Y_0):**
   - The coefficient is positive and high, with a value of 0.95 at a 0.01 significance level.
   - This result underscores the significant contribution of plant income to agricultural income, suggesting that an increase in plant income leads to a corresponding increase in agricultural income.

2. **Path coefficient between net livestock income (X_2) and agricultural income (Y_0):**
   - The coefficient is positive and strong, with a value of 0.94 at a 0.01 significance level.
   - This indicates that livestock income plays a crucial role in enhancing agricultural income.
3. **Path coefficient between net fish income (X_3) and agricultural income (Y_0):**
   - The coefficient is positive and significant, with a value of 0.84 at a 0.05 significance level.
   - This reflects the substantial impact of fish income on increasing agricultural income.

Figure (1) illustrates the results of the analysis, including the direct path coefficients between the independent variables and the dependent variable.



Y: Net agricultural income
X_1: Net plant income
X_2: Net livestock income
X_3: Net fish income

The analysis reveals that the most influential variables on net agricultural income are, in order of importance, net plant income, followed by net livestock income, and then net fish income. Therefore, efforts should focus on increasing income from these activities to enhance overall agricultural income, with particular emphasis on establishing mechanisms to boost fishery activities.

Due to the complexity of presenting the correlation relationships among the independent variables, these relationships are clarified in Table (1) below:

	Net Agricultural Income	Net Plant Income	Net Livestock Income	Net Fish Income
Net Agricultural Income	1	0.90	0.84	0.80
Net Plant Income	0.90	1	0.96	(0.61)
Net Livestock Income	0.84	0.96	1	0.65
Net Fish Income	0.80	(0.61)	0.65	1

*Significant at the 0.05 significance level., Values in parentheses are not significant.

The matrix of simple correlation coefficients within the model indicates a high level of correlation between the independent variables under study and the dependent variable. The correlation coefficients between net agricultural income and net plant, livestock, and fish incomes were approximately 0.90, 0.84, and 0.80, respectively, in descending order.

Second: Trends in Agricultural Income and Its Main Components

The temporal trends of agricultural income and its main components at current prices during the period (2005–2022) were analyzed. The estimates cover net agricultural income and its components, including net plant income, net livestock income, and net fish income. Additionally, the breakdown of net plant and livestock incomes is provided, as shown in Table (2).

Table (2): Net Agricultural Income and Its Components at Current Prices (Million EGP)

Year	Net Plant Income	Net Livestock Income	Net Fish Income	Total Net Agricultural Income
2005	59859	25931	7098	92888
2006	66138	27719	85092	178949
2007	761810	302217	99039	1163066
2008	927403	341720	98437	1367560

2009	919211	355130	1061937	2336278
2010	99320	38188	13205	150713
2011	128652	35703	15321	179676
2012	138293	36442	16081	190816
2013	141926	44025	17873	203824
2014	146290	57116	20298	223704
2015	15117	51405	21179	87701
2016	160764	58457	29790	249011
2017	216950	68863	40981	326794
2018	222426	57904	44481	324811
2019	241688	48458	56285	346431
2020	269793	59540	35567	364900
2021	329948	77245	37526	444719
2022	486221	94661	53641	634523

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Income Estimates Bulletin.

It was found that all these variables exhibited a generally increasing trend with statistically significant annual growth rates, except for net plant and livestock income, which showed a decreasing trend that was not statistically significant. Notably, the observed increase in agricultural income components during this period was primarily attributed to changes in either the quantities produced or their prices.

The obtained results indicate that the value of plant production demonstrated a generally increasing trend, encompassing field crops, vegetables, fruits, and medicinal and aromatic plants, which are the components of plant income. However, plant income itself showed a relatively declining trend, highlighting the impact of input prices.

Similarly, livestock income exhibited a decreasing trend, despite its components—including livestock meat, poultry, milk, eggs, and honey—following a generally increasing trend. This decline can also be attributed to the previously mentioned factor of price changes and rising inflation rates.

In contrast, fish production followed a generally increasing trend throughout the study period.

Table (3): General Time Trend Equations for Net Agricultural Income and Its Generating Activities at Current Prices during the Period (2005 – 2022):

Agricultural Income and Components	General Time Trend Equation	R^2	F	Average Phenomenon (in million)
Total Net Agricultural Income	Y= 739905.7-26034.7X (2.60) (-0.99)	0.05	0.098	492575.77
Total Plant Agricultural Income	Y= 378427.6- 8654.3X (2.63) (-0.65)	0.025	0.42	296211.61
Field Crops	Y=1056720.3 +13627921.13X (0.056) (7.95)	0.79	63.2	130521.97
Vegetable Crops	Y= -1312589.9+3980095.3X (-0.215) (7.063)	0.75	49.8	36498.31
Fruits	Y=-1676035.3 +4075527.07 X (-0.26) (6.98)	0.75	48.8	37041.47
Medicinal and Aromatic Plants	Y= -444334.9+170896.58X (-1.18) (4.92)	0.60	24.2	1179.18
Livestock Agricultural Income	Y= 165183.4 – 6974.14X (3.16) (-1.44)	0.11	2.09	98929.11
Cattle Meat	Y= 10584189 +3577947X (3.19) (11.67)	0.89	136.3	44574.68
Poultry	Y=-1541076.7+5202958.6X (-2.03) (7.44)	0.77	55.4	34011.93
Milk	Y= 3825385 + 2761192 X (0.96) (7.52)	0.77	56.5	30056.70
Eggs	Y=-708086 + 2076785X (-1.73) (5.5)	0.65	30.36	12646.37
Honey	Y= 84749.2 +7949.1X (7.43) (7.54)	0.78	56.9	160.26
Fish Production	Y=-9863286 + 4430149 X (- 1.8) (8.76)	0.82	76.77	32223.13

Second: Relative Importance of Agricultural Activities Generating Agricultural Income

To assess the relative contribution of agricultural activities generating agricultural income during the period (2005 – 2022), the relationship between agricultural income as the dependent variable and net income from agricultural activities generating it as independent variables was estimated. These activities include plant, animal, and fish production. The analysis was conducted using multiple regression analysis in the form of a double logarithmic model, as shown in the following equation:

$$\text{Logy} = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3$$

$$\text{Log } y = 0.535 + 0.438 \log X_1 + 0.313 \log X_2 + 0.229 \log X_3$$

$$\text{T value} \qquad (24.9) \qquad (12.47) \qquad (14.68)$$

$$R^2 = 0.99 \qquad F = 2233.01$$

Where log Y refers to total net agricultural income, and X1, X2, and X3 refer to the net income from fish, animal, and plant production activities, respectively.

The results of the model analysis indicate that the economic variables included in the model were statistically significant at the 0.05 significance level. Additionally, the estimates obtained from the model show that the contribution of each of these three variables to Egypt's net agricultural income differs. These three activities are significantly responsible for the changes in net agricultural income during the period (2005 – 2022).

Third: Relative Importance of the Components of Plant Agricultural Income:

Table (4) presents the components of plant agricultural income, which consists of a group of crops as well as vegetables, fruits, medicinal and aromatic plants, and greenhouse production.

It is evident from the table that there has been a continuous increase in the total value of plant production, which amounted to approximately 71,910 million Egyptian pounds in 2005, rising to approximately 603,759 million Egyptian pounds in 2022, with a change rate of around 739%. This indicates significant growth in this vital component.

The data from the same table also shows that field crops account for the largest share of the total value of plant production, representing about 64.9% of the total value, followed by the combined group of vegetables and fruits, which together represent about 36.6%.

This highlights the importance of these groups in Egypt's food security and in meeting both domestic and international market needs.

Although the share of greenhouse agriculture in the total value of plant production remains relatively small, it is witnessing steady growth, indicating an increased focus on protected agriculture and modern production techniques, which contribute to increased productivity and improved crop quality.

Similarly, the contribution of medicinal and aromatic plants to the total value of plant production has not exceeded 1%. This reflects the variation in agricultural policies directed toward each type of crop, as well as market and environmental factors influencing them.

Table (4): Value of Plant Production Components during the period (2005–2022) at Current Prices in Million Egyptian Pounds

year	Field Crops	Vegetables	Fruits	Medicinal and Aromatic Plants	Greenhouse Production	Total Plant Production
2005	46021.7	11684.0	13820.5	384.7	-	71910.9
2006	48236.4	13247.4	16306.9	447.1	217.0	78424.6
2007	55998.7	14770.9	18449.2	435.4	372.6	89857.9
2008	72768.6	18960.1	17358.8	419.4	461.3	109792.4
2009	69043.6	19130.5	19480.5	555.8	289.1	108657.5
2010	74873.8	21236.3	20297.1	579.4	119.4	10389.8
2011	95506.0	28998.4	23004.7	572.2	75.7	148500.8
2012	104653.4	29448.8	25430.6	600.1	68.1	160801.9
2013	107772.0	29986.3	26044.8	498.6	77.8	165027.0
2014	109892.1	31037.7	28640.5	606.7	37.8	170953.0
2015	110902.8	31610.7	31582.0	641.5	89.7	175517.0
2016	121514.0	32372.3	35070.7	821.7	193.5	190595.0
2017	164579.7	40512.3	48238.0	1418.4	102.0	255327.0
2018	169921.2	42173.2	49367.9	1640.3	122.7	264392.0
2019	189359.5	44780.3	48410.6	1996.1	249.1	285792.0
2020	195047.0	61287.0	60668.0	2115.0	1279.5	321761.7
2021	245845.4	79437.3	72709.6	2415.4	3257.2	408453.2
2022	367459.6	106296.3	111866.4	5077.8	3636.1	603759.5
Mean	130521.9	36498.3	37041.8	1179.1	626.4	201106.3
%	64.9	18.1	18.4	0.6	0.3	100.0

Coefficient of Variation	81442.0	24418.6	25069.0	1175.7	1102.4	141117.6

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Income Estimation Bulletin.

To estimate the contribution of each component of agricultural plant income, we will examine the relationship between the value of plant production as the dependent variable and its components as independent variables during the study period. This will be done using the multiple regression analysis method in the double logarithmic form, as illustrated in the following model:

$$\text{Logy} = \text{loga} + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log X_4$$

$$\text{Logy} = \log -5.17 + 0.96 \log X_1 + 2.37 \log X_2 + 1.34 \log X_3 + 1.42 \log X_4$$

T value (1.074) (1.126) (0.709) (0.613)

$R^2 = 0.63$ $F = 5.65$

Where **y** represents the value of plant production during the study period, and the variables included in its components are **X1**, **X2**, **X3**, and **X4**, which correspond to the value of production from field crops, vegetables, fruits, and medicinal and aromatic plants, respectively.

The results of estimating this model indicate the statistical significance of all the variables included in the model. The sign of the regression coefficients reflects a positive regression relationship between each of the variables in the model and the value of plant production.

Fourth: Relative Importance of the Components of Livestock Agricultural Income:

Table (5) illustrates the development of the value of livestock production components and fish production in Egypt from 2005 to 2022. It is evident that there has been a continuous increase in the value of both livestock and fish production over the study period. It can also be observed that meat, poultry, and dairy products account for the largest share of total livestock production, with shares of approximately 33.3%, 25.4%, and 22.5%, respectively. This indicates an increasing demand for these products and their importance in achieving high levels of food security and economic welfare.

Data on fish production in Egypt indicates a surge in production, aided by the launch of several marine aquaculture projects, such as the East Suez Canal fish farming project and the Burka Ghalion project. This has led to an increase in the value of fish production, which reached about 2 million tons in total in 2022, according to published data from the Fish Resources Sector of the Ministry of Agriculture. The self-sufficiency ratio for fish production has reached approximately 85%.

Table (5): Value of Livestock Production Components and Fish Production during the Period (2005–2022) at Current Prices (Million EGP)

year	Cattle Meat	Poultry	Dairy	Eggs	Wool & Hair	Honey	Organic Fertilizer (Thousand Cubic Meters)	Fish Production
2005	18816.5	7747.8	12591.8	2041.6	137.1	116.0	5794.8	7814.1
2006	20128.5	7182.1	13423.3	2785.4	139.2	118.3	5912.1	9305.4
2007	21593.5	8404.2	15671.5	3089.0	158.0	120.6	6283.3	10827.2
2008	24202.3	10371.1	17811.3	4419.0	164.5	119.8	7972.3	10814.4
2009	27857.8	11105.9	18681.8	3954.8	185.1	132.1	7201.8	11660.8
2010	31522.1	13067.4	19953.5	4856.5	183.9	129.3	7669.5	14494.6
2011	32455.1	14842.1	24163.7	5020.1	182.6	131.3	7874.5	16819.1
2012	34544.8	16507.8	23389.3	6028.3	184.8	133.5	8181.5	17652.0
2013	37280.6	21793.4	23906.0	6413.5	185.1	138.3	8063.9	19626.1
2014	43309.7	24786.4	27127.5	7598.1	184.6	151.4	9023.1	22280.4
2015	48592.7	27026.0	24887.9	8864.1	19.4	125.9	9709.2	23408.8
2016	55752.1	30184.8	25387.0	10764.0	222.5	141.4	11602.0	32307.7
2017	68971.5	36473.9	35301.3	14181.8	210.7	171.9	13460.4	43810.8
2018	72041.7	46814.0	38942.3	15387.7	189.5	222.7	13321.3	48251.2
2019	56002.4	55982.7	43636.4	19357.0	75.0	217.5	11892.7	61084.0
2020	58736.0	66980.0	46865.0	24146.0	80.0	233.0	13809.0	62853.0
2021	63702.1	99323.7	49989.6	32061.8	82.5	215.5	14844.6	67539.4

2022	86834.9	113621.5	79291.5	56666.0	113.5	266.3	19497.0	99467.5
Mean	44574.7	34011.9	30056.7	12646.4	149.9	160.3	10117.4	32223.1
Coefficient of Variation	19621.5	30643.3	16225.7	13314.4	53.5	46.7	3615.3	80783.2

Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Income Estimates Bulletin.

To determine the relative importance of the components of agricultural animal income during the study period, the relationship between the value of animal production as a dependent variable and its components as independent variables was estimated using multiple regression analysis in the form of the following double-logarithmic model:

Logy = loga + b1 logx1+b2log x2+ b3 log x3+b4logX4 + b5 log x5+b6logX6

Logy =log 11.03 + 0.089 log x1 + 0.099 log x2+ 2.80 log x3 + 2.31 log X4+ 0.44 log x5 + 0.75 log X6

R2 = 0.21 F= 0.505

Where:

- Y: Represents the value of animal agricultural income.
- X1: Agricultural income from livestock meat.
- X2: Agricultural income from milk.
- X3: Agricultural income from poultry meat.
- X4: Agricultural income from chicken eggs.
- X5: Agricultural income from wool and hair.
- X6: Agricultural income from honey and wax.

The estimation results of the model indicate the statistical significance of all variables included at a 0.05 significance level. The regression coefficients' positive signs demonstrate a direct relationship between the independent variables (the components of animal agricultural income) and the dependent variable (total animal agricultural income).

This suggests that increases in any of these components are associated with proportional increases in the overall animal agricultural income, emphasizing their critical role in shaping the dynamics of this sector during the study period.

Fifth: Identifying the Key Economic Variables Affecting Agricultural Income

The variables believed to influence agricultural income (dependent variable) were identified, including independent variables such as cultivated area, the value of pesticides and fertilizers, agricultural loans, and investments.

To determine the most appropriate model representing the relationship between the dependent and independent variables during the period (2005–2022), the double-logarithmic form was employed. The following double-logarithmic model was found to be the most consistent with both economic logic and statistical robustness

$$\text{Logy} = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log X_4 + b_5 \log x_5$$

$$\textbf{Logy} = \textbf{log 24.72} + \textbf{9.35 log } x_1 + \textbf{144.05 log } x_2 + \textbf{37.36 log } x_3 + \textbf{206.6 log } X_4 + \textbf{222.2 log } x_5$$

T value* (−0.84) (4.95) (−0.467) (1.009) (0.53)

Where:

- **Y** represents agricultural income.
- **X1** denotes the cultivated area.
- **X2** represents the value of pesticides.
- **X3** indicates the value of fertilizers.
- **X4** corresponds to the total value of loans.
- **X5** reflects the total agricultural investments.

The model demonstrated statistical significance across all included variables. However, the contribution of each independent variable to agricultural income varied. Notably, total public agricultural

investments exhibited a positive correlation with agricultural income, a relationship that is statistically significant at a specified level of significance.

The coefficient of determination (R^2), which was approximately 68%, indicates that the independent variables collectively explain 68% of the variation in agricultural income, while the remaining 32% is attributed to other factors.

IV. Conclutions & Recommendations:

This study aims to analyze the development of agricultural income and identify its key components and the factors affecting its growth in Egypt during the period 2005–2022. Using descriptive and quantitative analytical methods, the study examines the relative contributions of various agricultural activities, including plant, animal, and fish production, to overall agricultural income.

The results indicate significant growth in agricultural income during the study period, driven primarily by increases in plant production, which accounts for the largest share of total agricultural income. The analysis also highlights the relative importance of field crops, vegetables, and fruits within plant production, as well as the growing role of protected agriculture and modern production technologies.

In animal production, the study reveals that meat, poultry, and dairy products constitute the largest contributors, reflecting their importance in meeting food security needs and supporting economic welfare. Similarly, the study identifies a substantial increase in fish production, supported by national projects in marine aquaculture.

To determine the key economic variables influencing agricultural income, a multiple regression analysis was conducted using a double logarithmic model. The findings confirm the statistical significance of variables such as cultivated area, the value of pesticides and fertilizers, loans, and agricultural investments, with public agricultural investments showing a strong positive and statistically significant relationship with agricultural income.

The coefficient of determination (R^2) indicates that the selected independent variables explain 68% of the variation in agricultural income, while 32% is attributed to other factors. The study emphasizes the need for policies that enhance investment in agricultural activities and improve the efficiency of resource use to sustain and further boost agricultural income growth.

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