Article

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Journal of Development Economics and **Management Research Studies (JDMS),**
***A Peer Reviewed Open Access International Journal***
**ISSN: 2582 5119 (Online)**
05(05), 66-82, July-September, 2020
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# Application of Mathematical Models in Agriculture- A Review

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**Abstract**

*Application of mathematical models are for solving problems in agriculture for a scientific understanding, quantitative expression and to take strategic decisions. Mathematical models include mechanistic, empirical, deterministic, and stochastic approaches. It has dynamic models with differential equations, static models with algebraic for a specific set of conditions, deterministic models suggest solutions, stochastic model deals with defined by probability functions, mechanistic model deals with theory or hypothesis, and empirical models uses existing data to explain the relationship between one or two variables. Mathematical models have been developed to investigate specific issues limited to mathematical formulation and the added complexity inherent of integrated models. Mathematical methods of resource utilization optimization have been used in practice and the first mathematical programming approaches include the method of linear programming (simplex method). Linear approach to modeling establishes the relationship between a dependent variable and one or more independent variables. In the linear equation, dependent and independent variables, coefficients, intercept or the bias coefficient and degree of freedom have been used. The application of mathematical models in agriculture portrays the main methods of various mathematical tools like analytical, simulation and empirical. This paper aims at application of Mathematical Models in agriculture.*

Keywords: Mathematical models, mechanistic, empirical, deterministic, stochastic approaches, dependent and independent variables, linear programming, Linear approach, agriculture.

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## Introduction

Mathematical models are used for solving the intricate issues and problems in the agriculture for a number of reasons like developing scientific understanding, quantitative expression of a system for decision making, to take a tactical decision as well as strategic decisions by the agricultural planners. This study aims at application of Mathematical Models in agriculture. It is because farm planning in agriculture is imperative in different size of farm holdings to achieve the desired results. Agriculture and its allied sectors are pervasive in terms of employment and livelihoods for the marginal, small and large farmers, who dominate the agriculture in countries like India. To attain the Sustainable Development Goals (SDGs) in ending poverty and bringing an inclusive growth, activities related to agriculture need to be closely integrated with the SDG targets. As a result, Indian government has taken many initiatives to ensure its long-term development of agriculture. Various government interventions for the growth of allied sectors such as animal husbandry, dairying, and fisheries demonstrate the commitment to maximising the potential of allied sector to enhance farm welfare. Aside from several initiatives aiming at enhancing agricultural productivity and marketing, the government also implements a large food management programme with significant financial implications in terms of food subsidies. Agriculture and its allied sector sectors employ 54.6 percent of the workforce (Census 2011) and account for 17.8 percent of the India's Gross Value Added in 2019-20.

Mathematical models consist of mechanistic and empirical with deterministic and stochastic approaches. The mechanistic model deals with one level in the hierarchy by considering processes of mechanisms through which changes occur at lower levels. The empirical model account for mechanism by which changes occur in the system. In deterministic approach, the empirical model attempts to perform prediction from a regression relationship while mechanistic deals with Newtonian mechanics with different equations. In Stochastic model, for empirical study tools like Analysis of variance is used, while for mechanistic approach Mendelian inheritance is applied with probabilistic equations.

In a comprehensive crop model, yield prediction has depended on statistical regression models, sometimes improved by accounting for the soil moisture balance (Baier & Robertson, 1968) or by calculating crop transpiration with simplified procedures (Zaban, 1981). A tulip bulb model uses intermediate harvests to update the yield prediction (Benschop, 1985) but the model has not been applied in practice.

Reddy, V.R., D.N. Baker, F.D. Whisler and R.E. Fye, (1987) have used a model to examine cotton yields in the U.S.A since 1965 with a threefold increase from 1935 to 1965. The model found damage in root function due to use of herbicide which caused for the decline in yield. The study found that use of herbicide damage to roots and consequent yield reduction experimentally over a period of 20 years.

Baldwin (1995) describes that 'dynamic models are with differential equations; static models have algebraic and solved for a specific set of conditions; deterministic models suggests solutions of an equation or set of equations; stochastic model deals with defined by probability functions that seeks to take account of the variance that is not fully understood; mechanistic model provides equations that is derived from theory or hypothesis about the fundamental nature of the system; mechanistic model refers with a casual relationships within the system related to a broad range of realities; and empirical models uses existing data to explain the relationship between one or two variables (Riggs, 1963).

According to J. H.M. Thornley, (1996) developed "water sub-model is designed for use with plant growth simulators that represent internal plant substrates and variable root partitioning. The model calculates water row from soil to root, root to shoot, and shoot to the atmosphere, for a closed-canopy situation. The model has three state variables: the masses of water in the soil, root and shoot, and represents the processes of evapotranspiration, rainfall interception and evaporation from the canopy, and drainage. The Penman Monteith equation is used for crop transpiration. The fluxes of water from soil to root, and root to shoot, are driven by water potential difference. Tissue water potential and its components are calculated from tissue water content and other plant variables and parameters. The model is able to simulate osmoregulation and describes a variable relationship between tissue water potential, its components and relative water content, depending on growth conditions. The model has elsewhere been integrated with two plant ecosystem models: for grassland and forest".

D. Dourado-Neto, D. A. Teruel, K. Reichardt, D.R. Nielsen, J. A. Frizzone, And O.O.S. Bacchi (1998) have observed that the mathematical models are used for agricultural purposes in order to forecast the results produced by a given system, effects of certain environmental conditions and agricultural practices on crop performance. They have opined that 'modelling represents a better way of synthesizing knowledge about different components of a system, summarizing data, and transferring research results to users.'

R. Bixby, M. Fenelon, Z. Gu, E. Rothber, and R. Wunderling (2000) have observed that due to NP-hardness of supply chain problems and the large sized data widely used in the real world are meta-heuristics like genetic algorithm and particle swarm optimization. In optimization problems, the solution technique of mixed integer programming models, or mixed integer linear programming, are employed in supply chain problems.

J. H. M. Thornley and J. France (2007), are of the view that in agriculture and science simple mathematical models like hierarchy and description have been applied. Hierarchy, description, empirical, mechanistic and teleonomic models are the different model types which requires objectives that are 'critical in a modelling project, models for research are usually different from models for application, and the benefits from a model can be diverse'.

O.D. Sirotenko (2009) has discussed four aspects viz., ecological, energetic, and productive. With these aspects in empirical models is to describe the main objective of mechanistic simulation to explain the described one. In this, the sense of a concept of hierarchy level is explained by an exampletypical of agriculture:

| Level | Description |
|---|---|
| *i*+1 | Totality of organisms (crops, herd) |
| *i* | Organism (animal, plant) |
| *i-1* | Organs |
| ..... | Tissues |
| ..... | Cells |

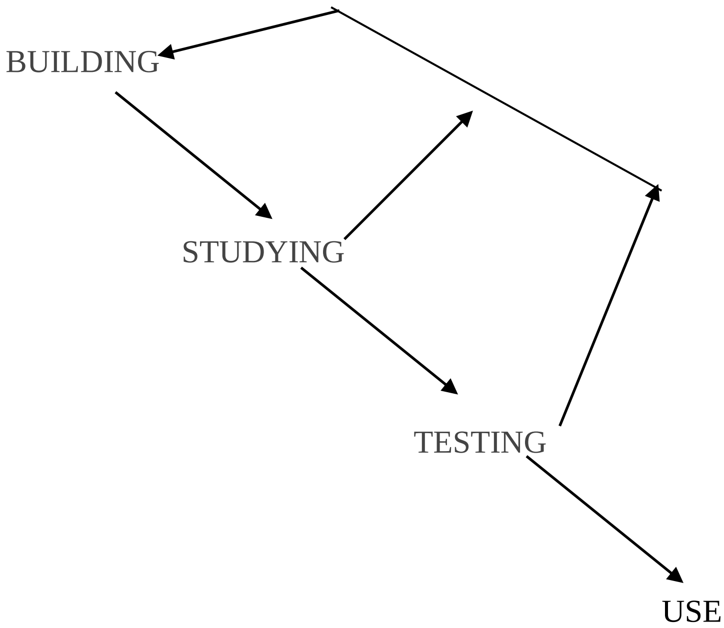
According to him. in the static mathematical model while construction no time variable is involved and the vegetation periodis divided into a large number of time intervals that increases the number of independent variables and, consequently, decreases the accuracy of model coefficient assessment.

M.J. McPhee (2009) mathematical modelling frameworks with key features are required to understand the complexity and diversity in agricultural production and marketing systems. Biology, computer programming, statistics, mathematics, economics, and social science needs such models. Mathematical models have been developed to investigate specific issues such as the effects of climate change, climate variability, and to assist third world countries improve their production at the farm gate.

W. Zhang, W.E. Wilhelm, (2011) mathematical models have remained relatively small and within the reach of commercial solvers as the industry grows and problems become larger, basic research will become increasingly important to ensure solvability. They emphasized to consider mixed integer programming models as solution approach for fresh agri-food supply chain problems.

N.Mason, H. Flores, J.R. Villalobos, and O. Ahumada, (2015) have opined that the technology and tools for increasing the efficiency of agri-food supply chain have been researched with ‘limited mathematical formulation, which contrasts with the intuition of traditional decision-makers, their limitations on capturing the whole system dynamics, and the added complexity inherent of integrated models. Therefore, this work aims to focus on research in fresh agri-food supply chains which employ mixed integer programming models as solution approach to investigate its improving potential especially in the efficiency of the products delivery’.

G.Marion and Lawson (2015) have categorised four broad categories of modelling like building, studying, testing, and use as given in the following sequencing type. Modelling project begins from building through the use. Defects are found at the studying as well as testing stages which are corrected by revolving back to building stage. Such process will keep on going until perfection is reached in the relevant model building.




They have developed a deterministic model which describes such a population in continuous time is the differential equation as given below:

$$\frac{dp}{dt} = ap$$

where p(t) is population size at time t, and a is a constant. Solution of this equation by integration gives

p(t) = p(0)eat

where p(0) is population size at time zero. According to this solution, populations grow in size at an exponential rate.

O.D. Sirotenko and V.A. Romanenkov (2012) paper pronounces an approach for solution to the problems using mathematical modelling and computer technology approaches where the optimization problems are generalized for land, fertilizer, irrigation water, facilities, labour use in plant-growing, the herd structure and feeding rations in livestock. Mathematical methods of resource utilization optimization have been used in practice and the first mathematical programming approaches include the method of linear programming (simplex method). The models of agricultural processes and the optimization methods have been developed quickly based on the specific problem or the specific parameters a wide range of methods from classical analytical studies of the systems of here that all parameters in the economic-mathematical model (resources, technical economic coefficients and coefficients of the objective function) are deterministic, a priori known quantities. Problems considering the risk and uncertainty factors, in which some (and in the general case all) parameters are random values, are known as stochastic problems of resources allocation. Stochastic is the integral attribute of agricultural production connected with the uncertain character of the environment and, primarily, weather conditions. Consider the statement of a general problem of linear programming in a matrix form: find

$F(x) = C*X \rightarrow max$ at $AX<B$, $X>0$.

Where the matrix *A* and the vectors *B* and *C* are deterministic, it is the most frequently encountered statement of a problem. In stochastic problems A, *B* and *C* may be random. Problems of stochastic programming differ considerably in the objective function.

P.Paam, R. Berretta, M. Heydar, R.H. Middleton, R. García-Flores, and P. Juliano (2016) made a comprehensive and structured review on recent studies in the field of agribusiness planning models, aiming to optimize fresh agri-food supply chain, with a focus on loss minimization in the fruits and vegetables. R.D. Kusumastuti, D.P. Donk, and R. Teunter, (2016) discussed the literature on crop related agrichains focusing on the integration, or lack thereof, harvesting and processing planning and related inventory control issues.

Pia Ghoshal and Bhaskar Goswami (2017) study is based to analyze production efficiency of agricultural system in four regions of India. The paper used a stochastic frontier model, employing time series data ranging from 2005-06 to 2013-14. They have used Battese and Coelli (1995) inefficiency frontier model for panel data is as follows:

$Y_{it}=exp(X_{it}\beta + V_{it} - U_{it} \ldots (1)$

where, $Y_{it}$, denotes the production at the t-th observation (t = 1, 2,….., T) for the i-th firm (i = 1, 2,..., *N)*

$X_{it}$, is a (1xk) vector of values of known functions of inputs of production and other explanatory variables associated with the i-th firm at the t-th observation;

β is a (*kx*1) vector of unknown parameters to be estimated;

the $V_{it}$ s are assumed to be iid *N* (0,σ*V*2) random errors, independently distributed of the *Uit*s.

the $U_{it}$ are non-negative random variables, associated with technical inefficiency of production, which are assumed to be independently distributed, such that *Uit* is obtained by truncation (at zero) of the normal distribution with mean, *zit*δ and variance, σ2. *zit* is a (1*xm*) vector of explanatory variables associated with technical inefficiency of production of firms over time; and

δ is an (*mx*1) vector of unknown coefficients.

Equation (1) specifies the stochastic frontier production function in terms of the original production values. The technical inefficiency effect, *Uit*, in the stochastic frontier model (1) could be specified in equation (2),

$U\ z\ W\ \delta = W_{it}$

where, the random variable, *Wit*, is defined by the truncation of the normal distribution with zero mean and variance, σ2, such that the point of truncation is –*zit*δ i.e. *Wit* > – *zit*δ. These assumptions are consistent with $Uit$ being a non-negative truncation of the $N(zit\ \delta, \sigma 2)$-distribution.

They have the production function of the following form:

$$\ln(Y_{i\,t}) = \beta_0+\beta 1\ln(INSCRE_{\ it})+\beta_2\ln(NIA_{it})+\beta_3\ln(CONFER_{it})+\beta_4\ln(CONPES_{it})+V_i t-Uit \quad \ldots(3)$$

where the technical inefficiency effects are assumed to be defined by,

$$Uit=\delta 0+\delta 1\ln(RATELIT_{it})+\delta 2\ln(RATETECHEDU_{it})+\delta 3\ln(LENROAD_{it})+\delta 4\ln(SHARENSDP_{it}).(4)$$

Where ln denotes the natural logarithm (i.e. logarithm to the base e);

*Y* is the total agricultural production of the individual states considered4.

*INSCREit* represents institutional credit which comprises of purpose wise refinance disbursements by NABARD under investment credit provided to each representative states. It shows refinances given for the purpose of minor irrigation, land development and farm mechanization. It is measured in terms of rupees lakh.

*NIAit* is the Net Irrigated Area of each state. It is measured in terms of '000 hectares.

*CONFERit* represents consumption of fertilizers by each representative state. Its principal components include N (nitrogen), P (Phosphate) and K (potassium). It is measured in terms of '000 tonnes7.

*CONPESit* represents consumption of pesticides. It is measured in terms of metric tonnes8.

*RATELITit* represents rate of literacy of the rural areas of the representative states and the rate is calculated in terms of total rural population of the state.

*RATETECHEDUit* represents rate of technical education of the rural areas of the representative states and the rate is calculated in terms of total rural population of the state.

*LENROADit* represents length of roads per square kilometre area of the representative state. Importance of infrastructure in explaining inefficiency is brought into the analysis by considering this variable.

*SHARENSDPit* is share of agricultural Net State Domestic Product to total Net State Domestic Product. We have attempted to consider the significance of agricultural sector in the state's economic scenario by this variable.

$V_{it}$ and $U_{it}$ are as defined in the previous section. The $Vit$ s are assumed to be iid $N\ (0,\sigma V2)$ random errors, independently distributed of the $U_{it}$s. The $U_{it}$ s are non-negative random variables, associated with technical inefficiency of production, which are assumed to be independently distributed, such that $U_{it}$ is obtained by truncation (at zero) of the normal distribution with mean, $zit\delta$ and variance, σ2.

*zit* is a (1*xm*) vector of explanatory variables associated with technical inefficiency of production of firms over time; and δ is an (*mx*1) vector of unknown coefficients.

The study found a positive relationship between agricultural productivity and higher use of fertilizers, and pesticides is seen along with the significance of net irrigated area and institutional credit for these regions of the selected states.

**Linear Regression and its Mathematical implementation**

Linear approach to modeling establishes the relationship between a dependent variable and one or more independent variables viz., simple linear regression and multiple linear regression respectively. In the linear equation, dependent and independent variables, coefficients, intercept or the bias coefficient and degree of freedom have been used. Here, multiple linear regression of the following form is used:

$Y=\beta_0+ \beta_1 X_1+ \beta_2 X_2+ \beta_3 X_3+ \beta_4 X_4+ \beta_5 X_5+ \beta_6 X_6+ \beta_7 X_7+ \mu$

Where ***Y*** is the total food grains per hectare in kg

$X_1$= Net area sown in hectare

$X_2$= Gross Sown Area in hectare

$X_3$= Net Irrigated Area in hectare

$X_4$= Gross Irrigated Area in hectare

$X_5$= Area under high yield varieties in hectare

$X_6$= Consumption of Fertilizer (N+P+K) (lakh tonnes)

$X_7$= Consumption of Pesticides (Technical Grade Materials) ('000 tonnes)

$\beta_0$ = Constant term

$\beta_1$ to $\beta_7$ are predictors that has a corresponding slope coefficient

μ represents all the other variables that have not been included as independent variables

The above model is used for the following data and the results and diagrammes are given after the Table 1.

Table 1: Food grains production (in kg. per hectare), area under cultivation (in hectare), consumption of NPK (in lakh tonnes) and pesticides (in '000 tonnes)

| Year | Total Foodgrains | Net area sown | Gross Sown Area | Net Irrigated Area | Gross Irrigated Area | Area under high yield varieties | Consumption of Fertilizer (N+P+K) (lakh tonnes) | Consumption of Pesticides (Technical Grade Materials) ('000 tonnes) |
|---|---|---|---|---|---|---|---|---|
| 2020-21 | 2386 | 1452 | 2089 | 722 | 1268 | 0 | 321 | 5503 |
| 2019-20 | 2343 | 1436 | 2056 | 702 | 1254 | 0 | 304 | 5498 |
| 2018-19 | 2286 | 1399 | 2014 | 698 | 1021 | 0 | 278 | 5462 |
| 2017-18 | 2235 | 1392 | 2000 | 695 | 1001 | 0 | 262 | 5314 |
| 2016-17 | 2153 | 1394 | 2002 | 686 | 981 | 0 | 259 | 5275 |
| 2015-16 | 2056 | 1395 | 1971 | 673 | 966 | 0 | 268 | 5412 |
| 2014-15 | 2070 | 1401 | 1984 | 684 | 965 | 0 | 256 | 5612 |
| 2013-14 | 2101 | 1414 | 2010 | 681 | 958 | 0 | 245 | 6028 |
| 2012-13 | 2129 | 1399 | 1942 | 663 | 922 | 0 | 255 | 4562 |
| 2011-12 | 2078 | 1410 | 1958 | 657 | 918 | 0 | 278 | 5298 |
| 2010-11 | 1930 | 1416 | 1977 | 637 | 889 | 0 | 281 | 5554 |
| 2009-10 | 1798 | 1392 | 1892 | 619 | 851 | 0 | 265 | 4182 |
| 2008-09 | 1909 | 1419 | 1953 | 636 | 889 | 0 | 249 | 4386 |
| 2007-08 | 1860 | 1410 | 1952 | 632 | 881 | 0 | 226 | 4477 |
| 2006-07 | 1756 | 1398 | 1924 | 627 | 868 | 0 | 217 | 4151 |
| 2005-06 | 1715 | 1412 | 1927 | 608 | 843 | 0 | 203 | 3977 |
| 2004-05 | 1652 | 1406 | 1911 | 592 | 811 | 0 | 184 | 4067 |
| 2003-04 | 1727 | 1407 | 1897 | 571 | 780 | 0 | 168 | 4100 |
| 2002-03 | 1535 | 1319 | 1739 | 539 | 731 | 0 | 161 | 4830 |
| 2001-02 | 1734 | 1407 | 1880 | 569 | 784 | 0 | 174 | 4702 |
| 2000-01 | 1626 | 1413 | 1853 | 552 | 762 | 0 | 167 | 4358 |
| 1999-00 | 1704 | 1411 | 1884 | 575 | 792 | 0 | 181 | 4620 |
| 1998-99 | 1627 | 1428 | 1917 | 574 | 787 | 784 | 168 | 4916 |
| 1997-98 | 1552 | 1420 | 1900 | 552 | 757 | 760 | 162 | 5224 |
| 1996-97 | 1614 | 1429 | 1895 | 551 | 760 | 764 | 143 | 5611 |
| 1995-96 | 1491 | 1422 | 1875 | 534 | 714 | 721 | 139 | 6126 |
| 1994-95 | 1546 | 1430 | 1881 | 530 | 707 | 709 | 136 | 6136 |
| 1993-94 | 1501 | 1423 | 1866 | 513 | 683 | 670 | 124 | 6365 |
| 1992-93 | 1457 | 1427 | 1857 | 503 | 668 | 654 | 122 | 7079 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1991-92 | 1382 | 1416 | 1822 | 499 | 657 | 647 | 127 | 7213 |

Source: RBI data on Indian economy.

Table 2: Coefficients[a]

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Correlations | | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Zero-order | Partial | Part | Tolerance | VIF |
| $\beta_0$ | -990.408 | 1112.225 | | -.890 | .383 | | | | | |
| $\beta_1$ | .510 | 1.542 | .039 | .331 | .744 | .042 | .070 | .013 | .108 | 9.254 |
| $B_2$ | -.326 | 1.134 | -.082 | -.288 | .776 | .896 | -.061 | -.011 | .019 | 53.133 |
| $\beta_3$ | 3.504 | 1.481 | .812 | 2.366 | .027 | .972 | .450 | .092 | .013 | 77.609 |
| $\beta_4$ | .525 | .232 | .271 | 2.258 | .034 | .944 | .434 | .088 | .105 | 9.521 |
| $\beta_5$ | -.077 | .073 | -.086 | -1.063 | .299 | -.647 | -.221 | -.041 | .232 | 4.304 |
| $\beta_6$ | -.243 | .737 | -.050 | -.330 | .745 | .936 | -.070 | -.013 | .065 | 15.354 |
| $\beta_7$ | .040 | .018 | .120 | 2.255 | .034 | -.135 | .433 | .088 | .534 | 1.872 |

a. Dependent Variable: Y

Table 2 provides the results of the linear regression and the regression coefficient of Net Irrigated Area in hectare is 3.504 indicating one hectare increase in this input the food grains output increases by 3.5 kg per hectare, while the other regression coefficients give different situation as found from the table.

Table 3: **Coefficients**[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -723.706 | 116.853 | | -6.193 | .000 |
| | Net Irrigated Area | 4.195 | .191 | .972 | 21.997 | .000 |
| 2 | (Constant) | -487.781 | 130.784 | | -3.730 | .001 |
| | Net Irrigated Area | 2.969 | .449 | .688 | 6.617 | .000 |
| | Gross Irrigated Area | .593 | .201 | .307 | 2.950 | .006 |

a. Dependent Variable: Total Foodgrains

Table 4: **Excluded Variables**[a]

| Model | | Beta In | t | Sig. | Partial Correlation | Collinearity Statistics |
|---|---|---|---|---|---|---|
| | | | | | | Tolerance |
| 1 | Net area sown | .054[b] | 1.243 | .225 | .233 | 1.000 |
| | Gross Sown Area | .128[b] | 1.307 | .202 | .244 | .198 |
| | Gross Irrigated Area | .307[b] | 2.950 | .006 | .494 | .142 |
| | Area under high yield varieties | .043[b] | .704 | .487 | .134 | .526 |
| | Consumption of Fertilizer (N+P+K) (lakh tonnes) | .064[b] | .417 | .680 | .080 | .084 |
| | Consumption of Pesticides (Technical Grade Materials) ('000 tonnes) | .103[b] | 2.456 | .021 | .427 | .943 |
| 2 | Net area sown | .004[c] | .087 | .931 | .017 | .803 |
| | Gross Sown Area | .023[c] | .230 | .820 | .045 | .163 |
| | Area under high yield varieties | .012[c] | .207 | .838 | .040 | .504 |
| | Consumption of Fertilizer (N+P+K) (lakh tonnes) | -.015[c] | -.108 | .915 | -.021 | .081 |
| | Consumption of Pesticides (Technical Grade Materials) ('000 tonnes) | .080[c] | 2.039 | .052 | .371 | .894 |

a. Dependent Variable: Total Foodgrains

b. Predictors in the Model: (Constant), Net Irrigated Area

c. Predictors in the Model: (Constant), Net Irrigated Area, Gross Irrigated Area

Table 5: **Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1383.13 | 2407.34 | 1831.77 | 283.024 | 30 |
| Residual | -132.210 | 101.902 | .000 | 58.794 | 30 |
| Std. Predicted Value | -1.585 | 2.034 | .000 | 1.000 | 30 |
| Std. Residual | -2.170 | 1.672 | .000 | .965 | 30 |

a. Dependent Variable: Total Foodgrains

Tables 3 to 5 provides the results of stepwise regression and also endorses the results given in Table 2.

Chart 1: Distribution of total food grains and inputs

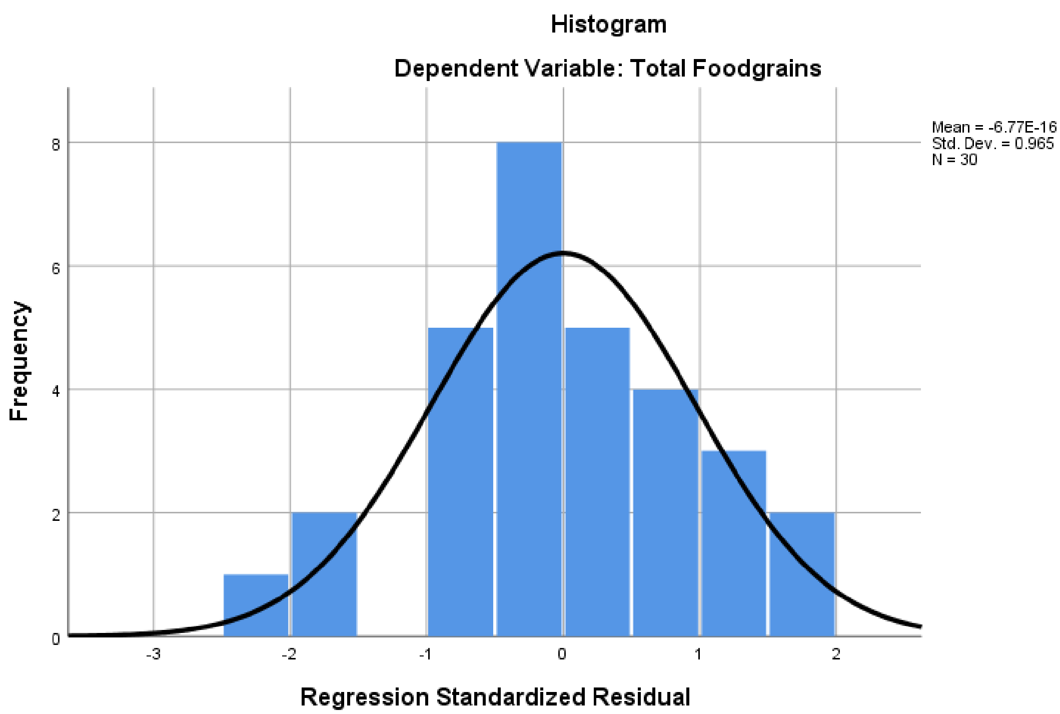


Chart 2: Normal P-P Plot of Regression Standardised Residual

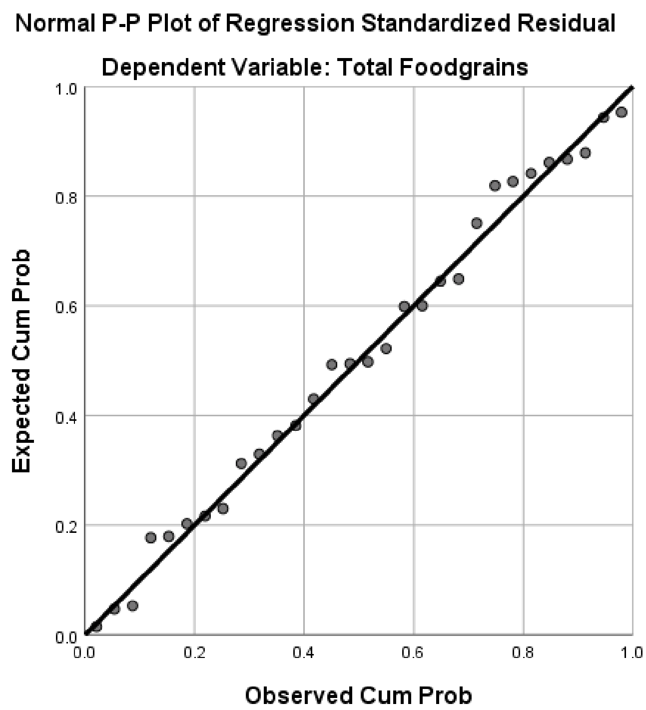



Chart 3: Partial Regression Plot of NIA

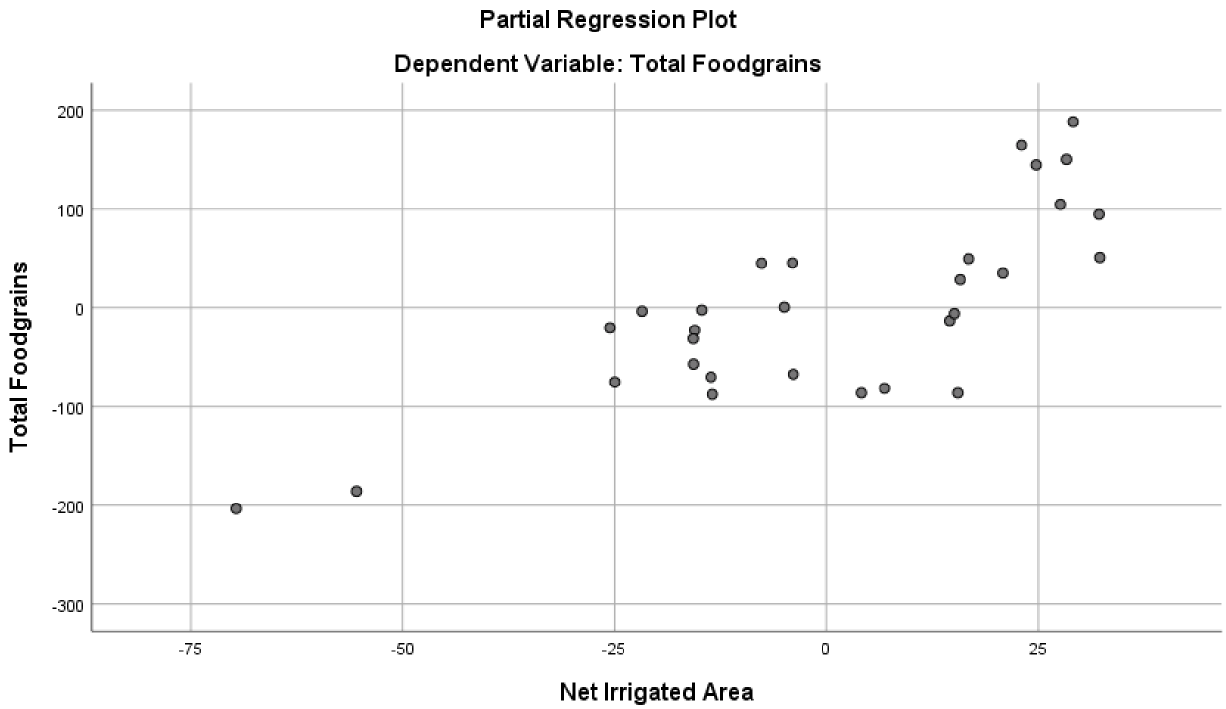
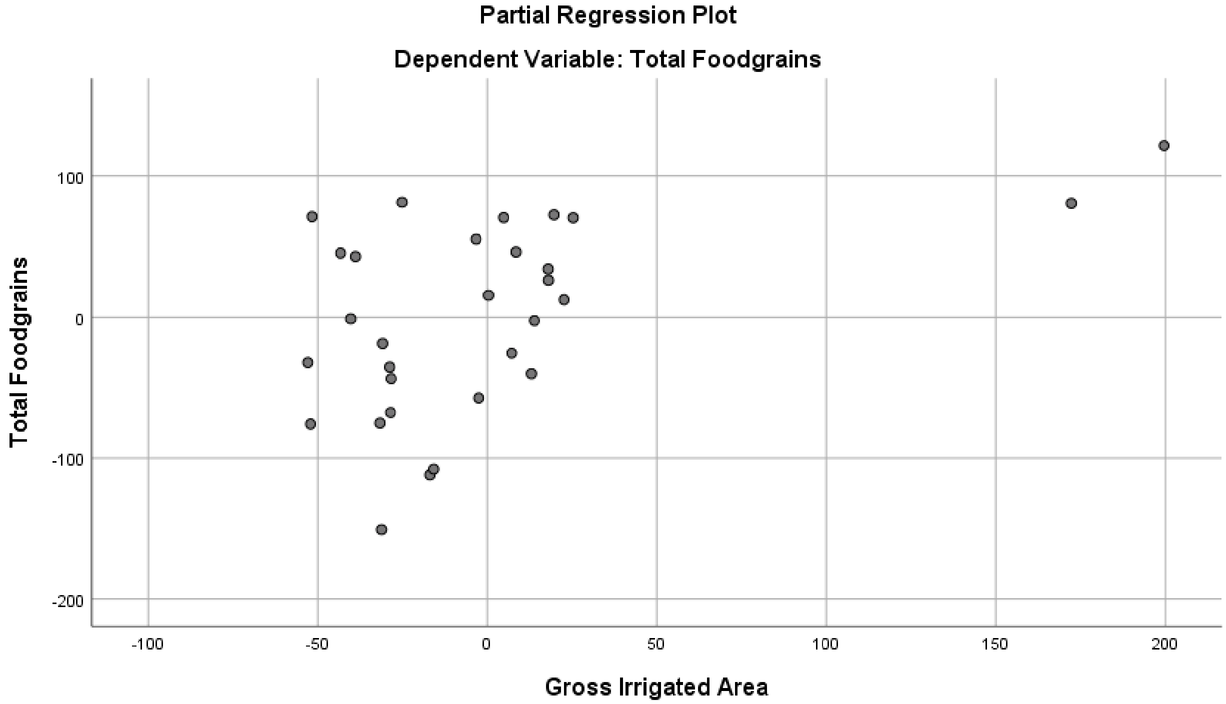


Chart 4: Partial Regression Plot of GIA




Charts 1 to 4 shows the Distribution of total food grains and inputs, Normal P-P Plot of Regression Standardised Residual, Partial Regression Plot of NIA, and Partial Regression Plot of GIA which describes the distribution of data of dependant and independent variables over the periods.

## Conclusion

The application of mathematical models in agriculture discussed portrays that the main types of methods of various mathematical means and tools like analytical, simulation and empirical. The mathematical modelling incorporates five stages encompassing formulation, solution, interpretation and validation. Any mathematical model has various components that varies according to its construction and they include variables or decision parameters, constants and calibration parameters, input parameters, data, phase parameters, output parameters, and noise and random parameters. The mathematical model combines equations, charts, formulas etc., and it is formulated on the basis of theory, literature and logical manner. These mathematical models have applications of manifold which provides precision and strategy to provide solution to a problem. Regression models are under mathematical modelling which is widely used in the present-day research.

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