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Hectareage Prediction Models for Paddy Crop of Middle Gujarat

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SUMMARY

The present investigation was undertaken with a view to identify the models for predicting the hectareage of paddy crop of the middle Gujarat region. The investigation was carried out on the basis of secondary data covering the period of nineteen years, (1998-99 to 2016-17). The District level data relating to hectareage, production, productivity and farm harvest prices of paddy were obtained from the published and compiled information by Directorate of Agriculture, Gujarat State, Gandhinagar. The linear multiple regression technique (basically Nerlovian type) was employed. The eight single equation and four simultaneous equation (SE) models were tried for paddy crop, the following models were selected on the basis of the values of adjusted coefficient of multiple determination. SE model-III for paddy is given below.

HEPD = 40960.532**** - 10.414*** HEBJ + 0.784 HEMZ - 1.187**** HEPDL + 3.720*** HEBJL + 5.588**** EYPD + 0.866 EYBJ - 6.205*** EYMZ - 6.833**** EPPD + 1.502 EPBJ (R^2= 0.946)

HEBJ = 3261.298 - 0.061 HEPD + 0.108 HEMZ - 0.093 HEPDL + 0.337 HEBJL + 0.441 EYPD + 0.220 EYBJ - 0.619 EYMZ - 0.594 EPPD + 0.227 EPBJ (R^2= 0.960)

HEMZ = 1816.343 + 0.028 HEPD + 0.147 HEBJ + 0.220 HEBJL + 0.649 HEMZL - 0.120 EYPD - 0.176 EYBJ - 0.092 EYMZ - 0.226 EPMZ - 0.106 EPBJ (R^2= 0.850)

*, **, ***, **** Significant at the 20, 10, 5, 1 percent level of significance, respectively

For the selected crops, SE model was recommended for prediction of the current hectareage on the basis of the adjusted coefficient of multiple determination ($\bar{R}^2$). For Paddy hectareage the main affecting factors viz., bajra hectareage, lagged hectareage of paddy, expected yield of maize and expected price of paddy. Expected yield and expected price of paddy were determining factors of bajra hectareage.

Keywords: Hectareage; Prediction; Paddy; Production; Price; R Square.

1. INTRODUCTION

The importance of timely and reliable forecast of area, production and productivity of principal crops need not be over-emphasized for the country like India, where the economy is mainly based on agricultural production. Price and non-price variables both are expected to influence allocation of land to different crops. The present investigation was undertaken with the following objectives.

1. To identify the models for predicting the hectareage of paddy crop of the middle Gujarat region
2. To suggest the models for prediction of hectareage for paddy crop
3. To assess the impact of various factors influencing the paddy hectareage

2. MATERIALS AND METHODS

The linear multiple regression technique (basically Nerlovian type) was employed. The eight single equation and four simultaneous equation models were tried for paddy crop, the best fitted models were selected on the basis of the values of adjusted coefficient of multiple determination. The competing crops were determined for the paddy crop on the basis of time of sowing and/ or magnitude and direction of the correlation between hectareage of these crops. The crops, their percentage share of area and competing crop viz., bajra and maize were selected. The District level data relating

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to hectareage, production, productivity and farm harvest prices of paddy crop was obtained from the published and compiled information by Directorate of Agriculture, Gujarat State, Gandhinagar for the period starting from 1998-99 to 2016-17(19 years).

2.1 Nerlovian Adjustment Lagged Model (Nerlove, Marc. 1958)

The dynamic nature of model is attained through the inclusion of distributed lag in output response to price. The response to any change in an economic variable is not immediate or with a uniform lag, but it is generally distributed lag.

The long run supply, A_t^*, is assumed in Nerlovian frame work to be related to the price (P_t^e) in the simple 1inear manner:

$$A_t^* = a + b\,P_t^e + U_t \qquad \text{(I)}$$

The variation in A_t^* is connected by variations in observed supply with the assumption of the following relationship between actual and the Long run desired levels of supply.

$$A_t - A_{t-1} = \gamma(A_t^* - A_{t-1}) \qquad 0 \le \gamma \le 1 \qquad \text{(II)}$$

where,

γ is the coefficient of adjustment, by substituting value of A_t^* in equation (II).

$$A_t = A_{t-1} + \gamma\,(a + b\ P_t^e + U_t - A_{t-1}) \qquad \text{(III)}$$

$$= X + B_1 A_{t-1} + B_2 P_t^e + V_t \qquad \text{(IV)}$$

where,

$X = a\,\gamma \qquad V_t = \gamma U_t$

$B_1 = 1 - \gamma \quad B_2 = b\gamma$

This conceptual model-IV acted as a basis for the single equation and simultaneous equation model (SE model) for paddy crop. The parameters of this model are estimated by the ordinary least square (OLS) method. The reduced form would remain basically the same, even if one includes more explanatory variables.

2.2 Selection of Variables

Correlation coefficients of 27 explanatory variables with the hectareage under paddy crop (having two competing crops) were worked out. On the basis of these, 16 explanatory variables for paddy were selected for inclusion in different single equation models. Total number of variables 15 including dependent variable were selected for the simultaneous equation models.

2.3 Specification of the Variables

Specification of the variables was included in the present investigation are given below.

Code of variables	Name of variables
X	Crop
PD	Paddy
MZ	Maize
BJ	Bajra
HEPD	Current hectareage under Paddy crop in 00' ha
HEBJ	Current hectareage under Bajra crop in 00' ha
HEMZ	Current hectareage under Maize crop in 00' ha
HEPDL	Lagged hectareage of Paddy crop in 00' ha.
HEMZL	Lagged hectareage of Maize crop in 00' ha.
HEBJL	Lagged hectareage of Bajra crop in 00' ha.
EYPD	Expected yield of Paddy crop was calculated as average of the last three year's yield in kg/ha.
EYBJ	Expected yield of Bajra crop was calculated as average of the last three year's yield in kg/ha.
EYMZ	Expected yield of Maize crop was calculated as average of the last three year's yield in kg/ha.
EPPD	Expected price of Paddy crop calculated as the average of the last three year's price
EPBJ	Expected price of Bajra crop calculated as the average of the last three year's price
EPMZ	Expected price of Maize crop calculated as the average of the last three year's price

2.3.1 Hectareage variables

HEX : Current hectareage under 'X' crop in 00' ha.

HEXL : Lagged hectareage of 'X' crop in 00' ha.

2.3.2 Price variables

PXL : Lagged price of 'X' crop in rupees per quintal

RPXL : Lagged relative price of 'X' crop calculated as:

For two competing crops,

$$\text{RPXL} = \frac{PXL}{\dfrac{PC_1LH_1 + PC_2LH_2}{H_1 + H_2}} \qquad \text{(V)}$$

where,

PC_1L and PC_2L: Lagged price of competing crops first and second, respectively

H_1 and H_2: Lagged hectareage of first and second competing crops, respectively

EPX : Expected price of 'X' crop calculated as the average of the last three year's price

REPX: Relative expected price of 'X' crop was calculated as: For two competing crop,

$$REPX = \frac{EPX\left(H_1C_1 + H_2C_1 + H_3C_1 + H_1C_2 + H_2C_2 + H_3C_2\right)}{EPC_1\left(H_1C_1 + H_2C_1 + H_3C_1\right) + EPC_2\left(H_1C_2 + H_2C_2 + H_3C_2\right)} \quad \text{(VI)}$$

where,

EPC_1 and EPC_2: Expected price of first and second competing crop.

H_1C_1, H_2C_1, H_3C_1 : Last three years hectareage of first competing crop.

H_1C_2, H_2C_2, H_3C_2 : Last three years hectareage of second competing crop.

2.3.3 Yield variables

EYX : Expected yield of 'X' crop was calculated as average of the last three year's yield in kg/ha.

2.3.4 Return variables

GRXL : Lagged gross return of 'X' crop in rupees

RGRXL: Lagged relative gross return of 'X' crop was calculated as:

For two competing crops,

$$RGRXL = \frac{GRXL}{\dfrac{GRC_1H_1 + GRC_2H_2}{H_1 + H_2}} \quad \text{(VII)}$$

where,

GRC_1 and GRC_2: Lagged gross return of first and second competing crops

H_1 and H_2 : Lagged hectareage of first and second competing crops

EGRX : Expected gross return of 'X' crop as average of last three year's gross return

REGRX: Relative expected gross return of 'X' crop was calculated as:

For two competing crops,

$$REGRX = \frac{EGRX\left(H_1C_1 + H_2C_1 + H_3C_1 + H_1C_2 + H_2C_2 + H_3C_2\right)}{EGRC_1\left(H_1C_1 + H_2C_1 + H_3C_1\right) + EGRC_2\left(H_1C_2 + H_2C_2 + H_3C_2\right)} \quad \text{(VIII)}$$

where,

$EGRC_1$ and $EGRC_2$: Expected gross return of first and second competing crop

2.3.5 Risk variables

PRSK, YRSK, RRSK: Risk due to price, yield and return, respectively, calculated as standard deviation of the last three year's price, yield and gross return.

2.4 Formation of Different Single Equation Models

On the basis of the correlation coefficients of selected explanatory variables with current hectareage under different crops, 8 single equations, linear as well as loglinear models were formed. Care was taken that the explanatory variables included in a model form a logical set and also the absence of multicolinearity between the pairs of explanatory variables was ascertained using the following criterion. Multicolinearity was considered to be not serious when the condition that $R \geq |r|$ is fulfilled (Klein, 1962).

Where,

r :Simple correlation coefficient between the two explanatory variables included in the model

R: Multiple correlation coefficients corresponding to the model

2.4.1 Specification of the Single Equation Models

Eight single equation models were tried, which are as under: Paddy

I	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ+ B_3 HEMZ + B_4 EYPD + B_5 PPDL + B_6 PRSK + B_7 YRSK + B_8 RRSK + U
II	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 EYPD+ B_5 RPPDL + B_6 PRSK + B_7 YRSK + B_8 RRSK + U
III	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 EYPD + B_5 EPPD + B_6 PRSK + B_7 YRSK + B_8 RRSK + U
IV	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 EYPD+ B_5 REPPD + B_6 PRSK + B_7 YRSK + B_8 RRSK + U
V	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 GRPDL+ B_5 PRSK + B_6 YRSK + B_7 RRSK + U
VI	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 RGRPDL+ B_5 PRSK + B_6 YRSK + B_7 RRSK + U
VII	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 EGRPD+ B_5 PRSK + B_6 YRSK + B_7 RRSK + U
VIII	HEPD	$B_0 + B_1$ HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 REGRPD + B_5 PRSK + B_6 YRSK + B_7 RRSK + U

2.5 Formation of Simultaneous Equation Models

Different simultaneous equation models were formed. In order to solve the simultaneous equation model, identification of the model is a must. Hence, the equations of model were identified on the basis of order condition. As per this condition an equation in the model is said to be exactly identified, if the total number of variables (endogenous and exogenous) excluded from it but included in other equations of the model is equal to the number of endogenous variables in the model less one. All the equations included in the simultaneous equation models were exactly identified. The model was then fitted employing two stage least square method (Acharya and Madanani, 1988).

2.5.1 Specification of Simultaneous Equation Models

From the selected variables different simultaneous equation models (SE Models) formed for paddy crop is as under:

SE Model – I		
1	HEPD	$a_0 + a_1$ HEBJ + a_2 HEMZ + a_3 HEPDL + a_4 HEBJL + a_5 EYPD+ a_6 EYBJ + a_7 EYMZ + a_8 PPDL + a_9 PBJL + U
2	HEBJ	$a'_0 . + a'_1$ HEPD + a'_2 HEMZ + $a'_3 .$ HEPDL + a'_4 HEBJL + a'_5 EYPD+ a'_6 EYBJ + a'_7 EYMZ + a'_8 PBJL + a'_9 PPDL + U’
3	HEMZ	$a''_0 + a''_1$ HEPD + a''_2 HEBJ + a''_3 HEBJL + a''_4 HEMZL + a''_5 EYPD+ a''_6 EYBJ + a''_7 EYMZ + a''_8 PMZL + a''_9 PBJL + U”
SE Model – II		
1	HEPD	$a_0 + a_1$ HEBJ + a_2 HEMZ + a_3 HEPDL + a_4 HEBJL + a_5 EYPD+ a_6 EYBJ + a_7 EYMZ + a_8 EGRPD + U
2	HEBJ	$a'_0 + a'_1$ HEPD + a'_2 HEMZ + a'_3 HEPDL + a'_4 HEBJL + a'_5 EYPD+ a'_6 EYBJ + a'_7 EYMZ + a'_8 EGRPD + U’
3	HEMZ	$a''_0 + a''_1$ HEPD + a''_2 HEBJ + a''_3 HEBJL + a''_4 HEMZL + a''_5 EYPD + a''_6 EYBJ + a''_7 EYMZ + a''_8 EGRPD + U”
SE Model – III		
1	HEPD	$a_0 + a_1$ HEBJ + a_2 HEMZ + a_3 HEPDL + a_4 HEBJL + a_5 EYPD+ a_6 EYBJ + a_7 EYMZ + a_8 EPPD + a_9 EPBJ + U
2	HEBJ	$a'_0 + a'_1$ HEPD + a'_2 HEMZ + a'_3 HEPDL + a'_4 HEBJL + a'_5 EYPD+ a'_6 EYBJ + a'_7 EYMZ + a'_8 EPPD + a'_9 EPBJ + U’
3	HEMZ	$a''_0 + a''_1$ HEPD + a''_2 HEBJ + a''_3 HEBJL + a''_4 HEMZL + a''_5 EYPD+ a''_6 EYBJ + a''_7 EYMZ + a''_8 EPMZ + a''_9 EPBJ + U”
SE Model – IV		
1	HEPD	$a_0 + a_1$ HEBJ + a_2 HEMZ + a_3 HEPDL + a_4 EYPD + a_5 EYBJ+ a_6 EYMZ + a_7 GRPDL + a_8 YRSK + U
2	HEBJ	$a'_0 + a'_1$ HEPD + a'_2 HEMZ + a'_3 HEPDL + a'_4 HEBJL + a'_5 EYPD+ a'_6 EYBJ + a'_7 EYMZ + a'_8 GRPDL + U’
3	HEMZ	$a''_0 + a''_1$ HEPD + a''_2 HEBJ + a''_3 HEBJL + a''_4 HEMZL + a''_5 EYPD + a''_6 EYBJ + a''_7 EYMZ + a''_8 GRPDL + U”

3. RESULTS AND DISCUSSION

The farmers take decisions regarding what to grow and how much to grow. These decisions depend upon certain monetary and non-monetary considerations like, lagged price, relative price, expected price, price risk, gross income, expected yield, yield risk, lagged hectareage *etc*. It is very likely that prediction models for crop hectareage would differ from state to state due to the changes in climatic factors, alternate crops or enterprises and socio-economic factors. Little research work has been reported on comparison of the single equation models for crop hectareage prediction (Kaul and Sidhu, 1971 in Punjab, Acharya and Bhatia, 1974 in Rajasthan). No investigation on comparison of different models for prediction of hectareage has however, been reported for *kharif* crops of middle Gujarat. Thus a maiden attempt has been made to study different models and to identify the best prediction model for crop hectareage of paddy crop of middle Gujarat.

Multiple regression analysis was employed to fit different single equation models for prediction of crop hectareage. In addition to this, different sets of simultaneous equation models were fitted to compare their predictability with the single equation models. Simultaneous equation models take care of the interdependence of the competing crops hectareage.

3.1 Correlation

For paddy crop, bajra and maize were selected as the competing crops. Correlation coefficients between different variables for paddy crop was presented in Table 1. Perusal of the results revealed that lagged explanatory variables of the crop were significantly and positively correlated (0.339), while there was a significant and negative correlation between the paddy and competitive crops' [bajra (-0.597) and maize (-0.443)] hectareage. Lagged price and expected price of the crop had positive and significant correlation (0.572, 0.499, respectively), while lagged relative price of paddy had negative and significant correlation with the current paddy hectareage (-0.477). This suggested that most of the price variables were important factors affecting paddy hectareage. The current hectareage had positive and highly significant correlation with expected yield of the crop (0.688), thereby indicating that it was an important determinant of paddy hectareage. All the gross return variables *viz*., lagged gross return, lagged relative gross return, expected gross return and relative expected gross return had positive and significant correlation with the current hectareage of cotton crop (0.592, 0.426, 0.597, 0.475, respectively). This suggested that the gross return variables were important factors affecting the current hectareage of the paddy crop. Price risk had a positive and significant correlation (0.494), while yield risk had negative and significant correlation with the paddy hectareage (-0.614), suggesting that these are important determinants of paddy hectareage.

3.2 Single Equation Models

Eight independent single equation multiple regression models were fitted using the selected variables including dependent variable. The selection of the set of explanatory variables for each of the models, following two points were considered:

i. The set of explanatory variables in the model are logical.
ii. Absence of multicollinearity between the explanatory variables included in the model.

Each of the linear as well as log linear equations were tried and the coefficients of multiple determinations (R^2) were computed with a view to compares their predictability. On this basis, linear form was found to be better fitted as compared to the log linear form. Thus, the linear form of the equation was selected for the present investigation. The results in Table 2 indicated that R^2 was the highest for model-II (0.891) and the lowest for model-V (0.649), However, $\bar{R}^2$ was the highest for model-II (0.766), and the lowest for model-V (0.342). The partial regression coefficient of lagged hectareage was negative in all of the models but significant in the models I (-1.203), II (-0.949), III (-0.900) and IV (-0.976) at different levels of significance. The coefficient of current hectareage of the competing crop (Bajra) was negative in all the models, but was significant only in the models VI (-1.967) and VIII (-1.903), while for the second competing crop (Maize), it was non-significant in all the models. Coefficient of expected yield was positive and significant in all the models which included it. Among the price variables, coefficients of lagged price, expected price and relative expected price were negative but non-significant. Comparison of the coefficient of determination (R^2) and the adjusted coefficient of determination ($\bar{R}^2$) indicated that model-II (0.766) was the best suited for prediction of paddy hectareage among the single equation models tried.

3.3 Simultaneous Equation Models

The results of four main equations corresponding to different SE models for paddy was given in Table 3. Calculated hectareage of bajra and maize and lagged hectareage of paddy and expected yields of paddy, bajra and maize appeared in all the equations. Lagged hectareage of bajra was incorporated in equations of SE models I, II and III. As far as the price variables are concerned, lagged price of paddy and bajra were incorporated in the equation of the first model, whereas expected prices of these crops were included in the equation corresponding to SE model-III. Expected gross return found the place in equation of SE model-II. The SE model-IV included lagged gross return of paddy and the yield risk variable. The coefficients of multiple determination (R^2) for different models were high (0.812 to 0.946), suggesting that in general a large amount of variation could be explained through the fitted SE models. SE model-III ranked first, both in the case of R^2 (0.946) and $\bar{R}^2$ (0.865). It could be inferred therefore that among the SE models tried, SE model-III had the best fit for predicting the paddy hectareage.

Singh and Kumar (1976) in Haryana, found that there was no significant impact of lagged relative price, price risk and yield risk on current acreage of paddy, while lagged yield and lagged acreage had positive impact on current acreage. In the study of supply response function of paddy in Punjab, Chinchole (1986) reported that the lagged acreage and relative price had no impact on current acreage of paddy. Price risk had negative impact while yield risk had positive impact on acreage under paddy. Similar type of study was taken by Parmar (1991) in paddy as well as cotton and bajra crops.

4. CONCLUSION

The eight single equation and four simultaneous equation models were tried for paddy crop, the following models were selected on the basis of the values of adjusted coefficient of multiple determination. Single equation form for the adjusted coefficient of multiple determination was the highest (0.766) for model-II among the single equation models. The functional form of the recommended model is as under:

HEPD = B_0 + B_1 HEPDL + B_2 HEBJ + B_3 HEMZ + B_4 EYPD+ B_5 RPPDL + B_6 PRSK + B_7 YRSK + B_8 RRSK + U

SE model-III :

HEPD = 40960.532^{****} - 10.414^{***} HEBJ + 0.784 HEMZ - 1.187^{****} HEPDL + 3.720^{***} HEBJL + 5.588^{****} EYPD + 0.866 EYBJ - 6.205^{***} EYMZ - 6.833^{****} EPPD + 1.502 EPBJ (R^2= 0.946)

HEBJ = 3261.298 - 0.061 HEPD + 0.108 HEMZ - 0.093 HEPDL + 0.337 HEBJL + 0.441 EYPD + 0.220 EYBJ - 0.619 EYMZ - 0.594 EPPD + 0.227 EPBJ (R^2= 0.960)

HEMZ = 1816.343 + 0.028 HEPD + 0.147 HEBJ + 0.220 HEBJL + 0.649 HEMZL - 0.120 EYPD - 0.176 EYBJ - 0.092 EYMZ - 0.226 EPMZ - 0.106 EPBJ (R^2= 0.850)

*, **, ***, **** Significant at the 20, 10, 5, 1 percent level of significance, respectively

The area prediction of paddy crop was SE-III model was recommended for prediction of the current hectareage on the basis of the adjusted coefficient of multiple determination. Main factors affecting for paddy hectareage are bajra hectareage, lagged hectareage of paddy, expected yield of maize and expected price of paddy.

REFERENCES

Acharya, S.S., and Bhatia, S. (1974). Acreage response to price, yield and rainfall change in Rajasthan. *Agricultural Situation in India*, 29 (4), 209-217.

Acharya, S.S. and Madanani, M.K.G. (1988). Applied ecenometrics for agricultural economists .*Himanshu Publications*, ISBN: 8185167109, 183-197.

*Chinchole, P.T. (1986). Supply response of paddy in Bhandra district. Unpublished thesis, 12 (1), 11-12.

Parmar, D.J. (1991). Hectareage prediction models for major *kharif* crops of Gujarat State - An empirical investigation. M.Sc. (Agri.) Unpublished thesis submitted to Gujarat Agricultural University, Sardar Krushinagar.

Nerlove, Marc. (1958). Dynamic of supply estimation of farmers response to price. *John Hopkins Press,* Baltimore.

Kaul, J.L. and Sidhu, D.S. (1971). Acreage response to prices for major crops in Punjab: An Econometric study. *Indian Journal of Agricultural Economics*, 26 (4), 427-434.

*Klein, L.R. (1962). *An Introduction to Econometrics Englewood Cliffs: Prentice Hal1*, p. 110.

Singh, I.J. and Kumar, P. (1976). Impact of price and price variability on acreage allocation in Haryana. *Indian Journal of Agricultural Economics,* 31 (2), 31-37.

* Original not seen

Table 1. Correlation coefficients between different variables for paddy crop

Sr. No.	Variable	HEPD	HEBJ	HEMZ	HEPDL	PPDL	RPPDL	EPPD	REPPD	EYPD	GRPDL	RGRPDL	EGRPD	REGRPD	PRSK	YRSK	RRSK
1	HEPD	1															
2	HEBJ	-0.597***	1														
3	HEMZ	-0.443**	0.809	1													
4	HEPDL	0.339*	-0.712	-0.476	1												
5	PPDL	0.572***	-0.932	-0.909	0.561	1											
6	RPPDL	-0.477**	0.279	0.047	-0.203	-0.188	1										
7	EPPD	0.499***	-0.839	-0.656	0.783	0.798	-0.299	1									
8	REPPD	0.309	-0.778	-0.815	0.555	0.839	-0.009	0.820	1								
9	EYPD	0.688****	-0.900	-0.688	0.816	0.836	-0.408	0.924	0.713	1							
10	GRPDL	0.592***	-0.960	-0.855	0.668	0.973	-0.250	0.815	0.789	0.894	1						
11	RGRPDL	0.426*	-0.269	-0.161	0.471	0.224	-0.004	0.417	0.178	0.476	0.287	1					
12	EGRPD	0.597***	-0.957	-0.889	0.636	0.974	-0.270	0.826	0.866	0.883	0.976	0.263	1				
13	REGRPD	0.475**	-0.512	-0.312	0.656	0.440	-0.186	0.830	0.575	0.721	0.466	0.713	0.497	1			
14	PRSK	0.494**	-0.454	-0.382	0.280	0.513	-0.203	0.422	0.152	0.456	0.495	0.118	0.373	0.196	1		
15	YRSK	-0.614***	0.795	0.565	-0.633	-0.750	0.560	-0.910	-0.647	-0.913	-0.791	-0.348	-0.782	-0.718	-0.490	1	
16	RRSK	-0.018	-0.097	-0.254	-0.132	0.210	0.268	-0.144	-0.067	-0.124	0.133	-0.407	0.040	-0.468	0.641	0.196	1

*, **, ***, **** Significant at the 20, 10, 5, 1 percent level of significance, respectively

Table 2. Partial regression coefficients for different single equation models for paddy crop

Variable/Models	I	II	III	IV	V	VI	VII	VIII
Constant	7029.108*	4482.080*	4054.548	3775.158	9191.736**	9240.828***	3581.394	9031.474***
HEPDL	-1.203****	-0.949****	-0.900***	-0.976***	-0.399	-0.384	-0.337	-0.390
HEBJ	-1.411	-0.617	-0.597	-0.643	-1.978	-1.967*	-0.689	-1.903*
HEMZ	-0.471	0.106	0.252	0.140	-0.325	-0.365	0.603	-0.305
EYPD	3.915****	3.443****	3.404***	3.383***	-	-	-	-
PPDL	-1.521	-	-	-	-	-	-	-
RPPDL	-	-1698.461*	-	-	-	-	-	-
EPPD	-	-	-0.384	-	-	-	-	-
REPPD	-	-	-	-407.469	-	-	-	-
GRPDL	-	-	-	-	-0.000004	-	-	-
RGRPDL	-	-	-	-	-	-55.743	-	-
EGRPD	-	-	-	-	-	-	0.00007	-
REGRPD	-	-	-	-	-	-	-	-44.753
PRSK	7.909**	7.997***	7.496**	7.078*	11.058**	12.076*	11.662***	11.197***
YRSK	4.740***	5.624	4.088**	4.461***	2.659	3.036	3.111*	2.683
RRSK	0.000*	0.000**	0.000*	0.000*	-0.001**	-0.001	0.000**	-0.001*
R^2	0.875	0.891	0.848	0.845	0.6491	0.650	0.679	0.6492
$\bar{R}^2$	0.732	0.766	0.673	0.668	0.3422	0.344	0.398	0.3423

*, **, ***, **** Correlation is significant at the 20, 10, 5, 1 percent level of significance

Table 3. Partial regression coefficients for main equations corresponding to different simultaneous equation models for paddy crop

Variable	Models			
	I	II	III	IV
Constant	-7550.551	-12863.279*	40960.532****	2896.966
HEBJ	6.775	11.074****	-10.414***	1.747
HEMZ	1.011	1.302	0.784	-0.506
HEPDL	0.049	0.064	-1.187****	-1.113***
HEBJL	-2.784	-1.375*	3.720***	-
EYPD	1.707	0.656	5.588****	4.381***
EYBJ	-5.131**	-8.197****	0.866	-2.561*
EYMZ	3.300	4.273****	-6.205***	1.008*
PPDL	5.350	-	-	-
PBJL	-1.095	-	-	-
EPPD	-	-	-6.833****	-
EPBJ	-	-	1.502	-
EGRPD	-	0.000454***	-	-
GRPDL	-	-	-	0.000031
YRSK	-	-	-	2.869*
R^2	0.812	0.919	0.946	0.840
$\bar{R}^2$	0.529	0.825	0.865	0.657

*, **, ***, **** Significant at the 20, 10, 5, 1 percent level of significance, respectively