13. Agricultural Economics, Marketing and Statistics

Challenges to ensuring global food security through wheat: Technological breakthrough in wheat, popularly known as green revolution technology, and policy support had led to much faster increase in wheat production as compared to the increase in population. The slowdown in global wheat production is caused both by slowdown in productivity growth and decline in area under wheat since 1986. Wheat productivity after 1995 witnessed less than 1% annual growth as against 1.2% growth rate in population. A very significant source of growth in wheat production is large gap between actual and maximum obtainable yield in most of the countries, which shows that wheat production can be put on higher growth trajectory even if no more new technologies become available. However, this has to be done in a production environment that throws formidable challenges like global warming, threat of pests and diseases, declining relative production and profitability, and stress on land and water. All such challenges require development of appropriate technologies and strong R&D support.

Dealing with effects of monsoon aberrations on agriculture: Monsoon failure is experienced in some parts of the country almost every year. Long-term trend shows that drought is experienced at least once in five years in all the states except the North East. Periodicity of drought is as high as once in three years in states like Rajasthan, Andhra Pradesh, Haryana, Tamil Nadu, Gujarat, Jammu and Kashmir and West Uttar Pradesh. Further, besides amount of rainfall its distribution is also important in affecting level of farm production. In a few years crop output turned out to be higher than normal even if rainfall was deficit and in a few years crop output turned out to be lower than normal even with higher than average rainfall.

Periodicity of occurrence of drought in various parts of the country

Frequency of deficient rainfall	Meteorological sub-division
Once in 2½ years	West Rajasthan, Rayalaseema, Telangana, Haryana, Chandigarh and Delhi
Once in 3 years	East Rajasthan, Gujarat Region, Jammu and Kashmir, Tamil Nadu and Puducherry, West Uttar Pradesh
Once in 4 years	North Interior Karnataka, Uttarakhand, Vidarbha
Once in 5 years	Bihar, Coastal Andhra Pradesh, East Uttar Pradesh, Gangetic West Bengal, Jharkhand, Kerala, Odisha, South Interior Karnataka, Madhya Maharashtra, West Madhya Pradesh
Once in 15 years	Arunachal Pradesh, Asom and Meghalaya, Nagaland, Manipur, Mizoram and Tripura

Due to rising stress on water resources effect of monsoon failure is now felt more strongly than before. Thus, besides relief measures, more attention need to be paid to maintain production activity during monsoon failure. This requires short term and long term strategy. Agricultural scientists have developed varieties of rice, coarse grain, pulses and oilseeds that are of much shorter duration and which are drought tolerant. They also have alternative crop plans for different rainfall regimes in different agro-ecological settings. Such options can be effectively implemented if reliable information is available on rainfall and its distributions in different periods at disaggregate geographic regions. Indian Meteorological Department (IMD) forecasts on monsoon rains are too general and aggregate for using in planning for alternative production strategies in the event of monsoon failure in a particular area like a district. We need to improve the capacity of IMD to provide credible, usable and specific forecast on monsoon rainfall at disaggregate level like a large district and also put in place early warning system for events like drought. Implementing alternative production plan also require prompt action in terms of supply of seed of alternative crops and institutional credit. Agriculture being a state subject, the initiative to implement a strategy to face monsoon failure has to come from the concerned state.

Regional variations in agricultural productivity—A district level study: There is a large variation in agricultural productivity in different regions of the country. This clearly calls for a regionally differentiated strategy for future growth and development of agriculture sector in the country. This study prepared estimates of crop productivity at district level based on data for all major crops including horticultural crops. The productivity is low in 161 districts and very low in 120 districts. In general very low and low productivity districts were characterized by low rainfall, low irrigated area which also results in lesser amount of fertilizer use. Area under fruits and vegetables in these districts is also generally low. Moreover total livestock density and total bovine density in these districts was also lower.

Fertilizer use, irrigation and rainfall caused significant variation in productivity across districts. The highest coefficient was for fertilizer, which shows 1% increase in fertilizer between districts results in 0.32% increase in agriculture productivity. Diversification in favour of fruits and vegetables comes next with elasticity coefficient of 0.189. Elasticity of

Distribution of districts in broad productivity categories

Productivity category	Range (Rs/ha NSA)	No. of districts	Share in NSA%	Share in VCO%
Very low	< 18,199	120	31.46	13.00
Low	18,199–27,955	161	28.38	22.86
Average	27,955–37,712	102	15.86	17.71
High	37,712–57,225	105	15.06	24.28
Very high	> 57,225	63	9.24	22.15
Overall	32,834	551	100.00	100.00

productivity with respect to irrigation across districts was 0.07. These results indicate the importance and need to manage rainfall water to raise productivity particularly in low productivity districts.

Another very interesting result from the cross section data of districts is that agricultural productivity is very powerful in reducing rural poverty. A 1% increase in land productivity reduces poverty by as much as 0.65%. The effect of dependence of workers on agriculture was reverse. A 1% reduction in labour force in agriculture resulted in 0.57% decline in rural poverty. This highlights the need for reducing pressure on land by shifting labour force from agriculture to non-farm activities.

Rural urban linkages—A new perspective: The linkage effect of agriculture on rural non-farm sectors and total non-agriculture sector in India diluted considerably after early 1990s with sharp drop in agriculture share in GDP. This needs to be seen in the light of sharp acceleration in growth of non-agriculture sector and equally impressive growth in urban consumption. It looks as if these changes in Indian economy have reversed the linkages between agriculture and other sectors during last 15 years. However, little empirical literature exists on role of urban consumption in promoting agricultural output and income and non-farm employment. Similarly, while there is lot of concern in India to shift workforce from agriculture sector, linkage effect of growth in RNFE (rural non-farm employment) on income of agriculture workers has not received much attention of researchers. This study makes a simple attempt to explore how growth in urban consumption in India affects agriculture income and rural non-farm employment, and, how growth in RNFE affects per worker agriculture income. The other variable included in the model were per hectare fertiliser use in a state (FERTPH), infrastructure level in a state (INFRA), land–labour ratio and dummy for the second period. The model used state as unit of observation at two points of time, i.e. 1993–94 and 2004–05.

Growth in urban consumption (PCCUS) is an important determinant of growth in agriculture income and non-farm rural income measured by employment—10% growth in urban consumption was associated with 4.6% growth in agriculture income and 4.9% growth in rural non-farm employment (RNFE). Further, a 10%

Estimates of econometric model on agriculture income and RNFE

Included observations: 34
Total system (balanced) observations 68

	Coefficient	Std. Error	t-Statistic	Prob.
Equation 1: Dep. variable: Agriculture income per agriculture worker				
C(1) Constant	1.847	2.016	0.916	0.364
C(2) PCCUS	0.463	0.250	1.853	0.069
C(3) RNFE	0.830	0.160	5.183	0.000
C(4) LANDPERWRKR	0.493	0.079	6.220	0.000
C(5) FERTPH	0.251	0.064	3.911	0.000
C(6) DUMMY	–0.197	0.086	–2.289	0.026
Equation 2: Dep. variable: Share of rural non farm workers in rural workers				
C(11) Constant	–2.127	2.767	–0.769	0.445
C(12) PCCUS	0.638	0.318	2.005	0.050
C(13) INFRA	0.174	0.089	1.951	0.056
C(16) DUMMY	0.193	0.109	1.769	0.082
Determinant residual covariance		0.005064		
Equation 1: R-squared	0.833		Mean dependent var	9.482
Adjusted R-squared	0.803		S.D. dependent var	0.531
S.E. of regression	0.236		Sum squared resid	1.555
Equation 2:				
R-squared	0.340		Mean dependent var	3.324
Adjusted R-squared	0.274		S.D. dependent var	0.373
S.E. of regression	0.318		Sum squared resid	3.027

increase in RNFE resulted in 8.3% increase in income of an agriculture worker. The study emphasized the need for understanding impact of urban growth on rural agriculture and rural non-farm sectors and impact of growth in rural non farm sector on farm sector.

Total factor productivity for major crops in India: Among cereals, wheat recorded highest total factor productivity (TFP) growth (1.9%) during 1975–2005, followed by maize and barley (1.4% each), *bajra* (1%), rice (0.7%), and *jowar* (0.6%). The decadal performance (data not reported here) revealed that TFP growth weakened in the two decades over base period 1975–85, with a few exceptions. The productivity growth of *bajra* accelerated after base period, mainly due to adoption of hybrid varieties.

Annual TFP growth for oilseeds crop ranged between 0.7 and 0.8% during 1975–2005. The growth declined in the recent years (1996–2005) as compared to growth achieved during 1986–95. With the existing trend in domestic production, it will be quite challenging to meet domestic demand of edible oils for the country. TFP growth in pulse crops was low for moong and gram and negative for *arhar* and *urad* during 1975–2005. TFP of cotton increased annually by 1.4%, and of jute 1.3%. TFP growth for sugarcane was negative. The negative trend of TFP is affecting adversely the regular and sufficient supply of these crops and leading to fluctuating and rising prices of these commodities.

The declining and low growth in TFP of major crops over years indicate that challenges to research in agriculture sector are increasing, and high growth experienced in the past years may not sustain in future if technological improvements do not occur.

Annual TFP growth, its share in total output, and growth in real cost of production for major crops in India, 1975–2005

Crops	TFP growth (%)	Share of TFP in output growth (%)
Cereals		
Rice	0.67	24.6
Wheat	1.92	58.9
Maize	1.39	16.5
Jowar	0.63	23.7
Bajra	1.04	27.6
Barley	1.38	29.4
Pulses		
Gram	0.16	26.1
Moong	0.53	10.0
Arhar	-0.69	(-)
Urad	-0.47	(-)
Oilseeds		
Soybean	0.71	5.5
Groundnut	0.77	27.1
Rapeseed & mustard	0.79	10.1
Commercial crops		
Sugarcane	–0.41	(–)
Cotton	1.41	31.6
Jute	1.28	74.1

The share of TFP growth in total output growth ranged from 24 to 59% in cereals, 10 to 26% in pulses, 6 to 27% in oilseeds, and 32 to 74% in fibre crops during 1975–2005. The share of TFP growth in output growth was higher for wheat among cereals, gram among pulses, groundnut among oilseeds, and jute among fibre crops.

Sectoral impact of investments in agricultural research and education: In order to have an idea about the rate of return to public investments in agricultural research and education (R&E) macro level data from CSO on value of output and input was used to estimate growth in output, input and TFP for two periods, viz. 1985–86 to 2006–07 and 1990–91 to 2006–07.

Total factor productivity and internal rate of return to investment in public sector investments in research and education in agriculture (crop and livestock) sector

Particulars	Period	
	1985–86 to 2006–07	1990–91 to 2006–07
Growth in agricultural output, %	2.92	2.80
Growth in inputs used in crop and livestock sectors, %	2.39	2.38
Growth in TFP, %	0.52	0.42
Share of TFP in output growth, %	17.80	14.70
Elasticity of TFP with respect to R&E investment	0.296	0.296
Internal rate of return to investments in agricultural R&E, %	46	42

The growth in agricultural output for the period 1985–2006 was estimated to be 2.92% against the input growth of 2.39% resulting in 0.52% growth in TFP. The TFP share in output growth is estimated to be 17.8%. The IRR to public R&E investment in agriculture has been estimated quite high, 46%. Though, there is a small decline in output growth and TFP growth as well as in IRR to R&E since early 1990s, the impact continues to be quite high, IRR being 42% even in the recent period.

Impact of agriculture research on self-sufficiency: An important contribution of output growth achieved through agriculture research is reduction in import dependence to meet our food requirement and thus improvement in food self-sufficiency. Estimates of contribution of research to output growth prepared in the study were used to quantify exact contribution of research to food self-sufficiency of various crops.

The incremental production between TE 1975 and TE 2005 was 46 mt for rice, 44 mt for wheat, and 8.3 Mt for maize. It was estimated that without contribution of research wheat production in the country during

Contribution of research to production and self-sufficiency in major food commodities

	Rice	Wheat	Maize	Bajra	Gram	Groundnut	R&M
Incremental production between TE 1975 and TE 2005 (million tonnes)	46.00	44.00	8.30	3.10	0.70	0.80	5.80
Share of research in production growth%	13.60	23.60	13.10	20.60	11.00	9.80	8.90
Self sufficiency%							
(a) Actual 2005–06	105.14	98.08	103.95	100.0	88.02	66.29	66.19
(b) Without research contribution	97.97	83.40	96.27	91.68	86.81	65.64	61.99
(c) Research role in self-sufficiency	7.17	14.69	7.68	8.32	1.21	0.65	4.20
Dependence on import without research contribution (mt)	1.77	9.80	0.55	0.28	0.66	5.55	5.08

2005-06 would be lower by 10.4 mt and rice production would be lower by 6.3 mt. Contribution of research in production of maize and *bajra* is estimated to be 1.09 and 0.64 mt. Cumulative effect of agriculture research on output of gram is estimated 80 thousand tonnes. In oil seeds groundnut production would have been lower by 80 thousand tonnes and rapeseed and mustard production turns 5.2 lakh tonnes lower without contribution of research. Thus, in the absence of research output of rice and wheat would be 85.53 mt and 60.9 mt instead of current production of 91.79 mt and 69.35 mt during the year 2005–06.

In all the commodities, domestic demand during the year 2005–06 was much higher than what would have been the production in the country without contribution of research and India would have been far away from self-sufficiency. Comparing domestic demand with domestic production adjusted for trade and change in stock showed that domestic production of wheat during 2005–06 was enough to meet 98% of countries demand. Without contribution of research, self-sufficiency in wheat declines to 83.4%. This implies that India would have been forced to import 9.8 mt of wheat in the absence of research contribution during the last three decades. In rice, India export about 5% of domestic production and ratio of production to demand is 105.14%. This ratio declines to 97.9% when incremental output due to research is not counted. Thus, without contribution of research to rice production India is forced to import 1.77 million tonnes of rice after wiping out export of 4 million tonnes. Contribution of research in self-sufficiency in maize and *bajra* is about 8%.

STATISTICS

Outliers in multi-response experiments: A general expression of Cook-statistic was obtained for detecting any t-observations from each of any k responses as outliers for multi-response experiments. Then appropriate expressions for some particular cases are also obtained. Further, outlier(s) may exist in more than one observation vectors. Therefore, a general expression of Cook-statistic under mean shift model for detecting any t outlier observation vectors has been obtained. Two upper bounds of Cook-statistic were also obtained. These upper bounds help to reduce the computation of all possible sets of t outlier observation vectors. If these upper bounds are not statistically significant, then there is no need to compute all possible set of vectors. Developed statistics are applied to real experimental data.

Partially balanced incomplete block designs: Two three-class association schemes called tetrahedral association scheme and cubical association scheme were defined along with methods of constructing partially balanced incomplete block designs based on these schemes. Designs based on cubical association scheme are resolvable. These designs are more efficient than the circular lattice [PBIB(3) designs] with the same number of experimental units for the estimation of elementary treatment contrasts.

Fertilizer response ratio: Eight fertilizer response ratios for different fertilizer combinations such as N, NP, NK, NPK over control, P over N and NK, K over N and NP were worked out for different crops when the recommended doses of these fertilizers were applied. The fertilizer response ratios vary widely from region to region and crop to crop. Fertilizer response ratios for *kharif* rice of N over control vary from 1.97 kg/kg (North Telengana) to 25.57 kg/kg (Eastern Dry Zone of Karnataka) at NARP zone level and that of NPK over control varied from 4.34 kg/kg (North Telengana) to 26.35 kg/kg (Upper Brahmputra Valley of Asom). At national level the fertilizer response ratio of all nutrient combinations were high and varied from 11.96 kg/kg of N over control to 17.73 kg/kg of P over NK for rice crop, whereas these values were low ranged 2.93kg/ kg to 7.07 kg/kg for *jowar* crop. The response ratios of various nutrients for maize and wheat crop were of moderate and high order at national level. Among the pulse crops, red gram showed lower response ratios of 2.51 kg/kg to 4.16 kg/kg for various nutrient combinations. The response ratios of cotton were 4.16 kg/kg of N over control and 9.49 kg/kg of K over NP. The study revealed that for the cereal group of crops the respective response ratios at all India level for all nutrient combinations are higher than those of oilseed and pulse group. The fertilizer response ratios of N over control are 9.20, 7.73 and

8.51 kg/kg for cereals, oilseeds and pulse group, whereas these value of NPK over control are 10.80, 5.60 and 6.70 kg/kg respectively. The pooled response ratio for all foodgrain crops put together at national level lies between 8.79 kg/kg (NP over control) and 10.98 kg/kg (K over NP). The fertilizer response ratio for all foodgrain crops for NPK over control was 9.27 kg/kg, which is more than response observed for N, NP, NK over control. This indicated that use of recommended dose of NPK enhances productivity.

Neighbour balanced designs: The concept of Neighbour Balanced Block (NBB) designs was defined for the experimental situation where the treatments are the combinations of levels of two factors, and only one of the factors exhibits neighbour effect. Some methods of constructing complete NBB designs for two factors in a plot strongly neighbour balanced for one factor, were obtained. These designs are variance balanced for estimating the direct effects of contrasts pertaining to combinations of levels of both the factors. An incomplete NBB design for two factors was also obtained, which is partially variance balanced with three associate classes. Conditions were derived for the estimation of coefficients of second-order response surface model for the experimental situation in which the experimental units, i.e., plots experience the neighbour effects from immediate left and right neighbouring plots assuming the plots to be placed adjacent linearly with no gaps. A method of constructing rotatable designs for fitting second-order response surface in the presence of neighbour effects was also developed.

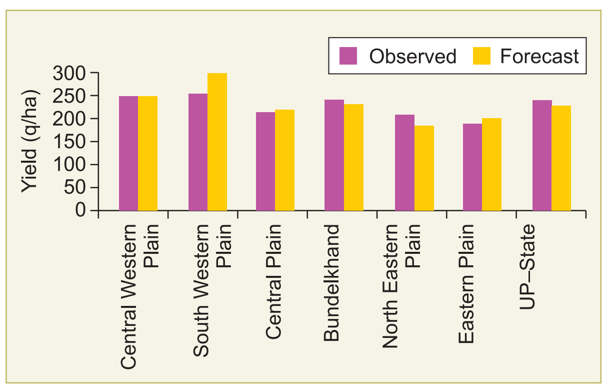
Inclusion probability inversely proportional to size sampling scheme: Inclusion probability proportional to size sampling schemes (IPPS) are the sampling schemes in which the first order inclusion probabilities are proportional to size measures. The method of IPIPS scheme was obtained by using Sampfords' inclusion probability proportional to size sampling scheme (IPPS sampling scheme). As an alternative, probability proportional to aggregate inverse of sizes sampling plan (PPAIS sampling plan) was introduced and its properties were studied. A unit by unit sampling was also suggested to achieve the above proposed sampling plan. An analogue form of ratio estimator was also introduced, which is shown to be unbiased under the PPAIS scheme. The expressions for the second order inclusion probabilities of the PPAIS were also obtained. Performance of the proposed estimator under PPAIS plan and IPIPS sampling scheme was compared with alternative plans, and their superiority over other unequal probability sampling schemes was established through a simulation study on bivariate normal populations for different correlations between Y and X.

Multiple objective functions for minimization of sampling variance: The concept of multiple objective functions was proposed for minimization of sampling variance of the Yates-Grundy form of the Horvitz-Thompson estimator in an optimal controlled nearest proportional to size sampling scheme. It was shown empirically that the true sample variance of the proposed procedure compared favorably with that of the existing optimal controlled and uncontrolled high entropy selection procedures.

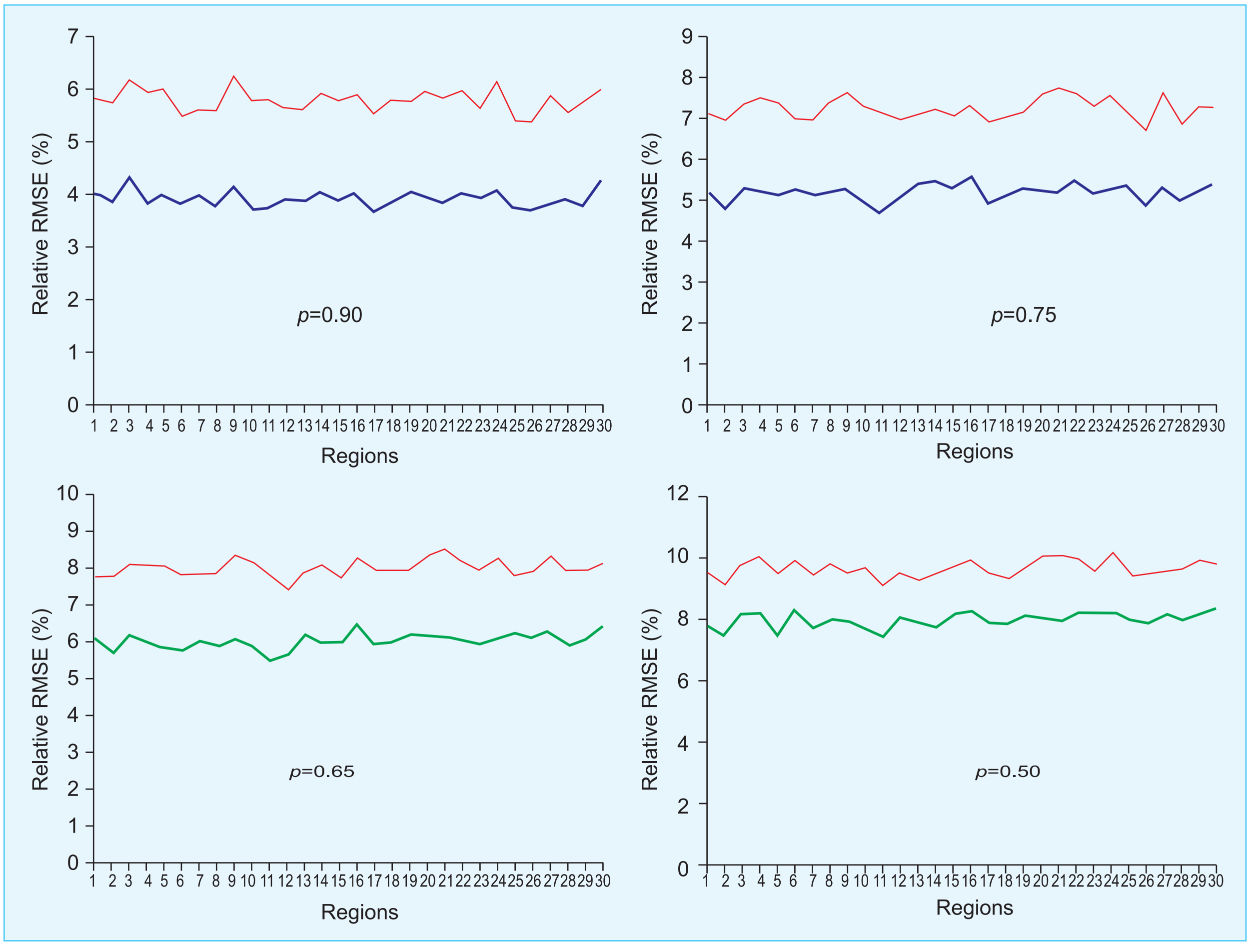
Weather-based models for forecasting potato yield: Weather-based models for forecasting potato yield in Uttar Pradesh were developed by using weather data on maximum and minimum temperature and morning and evening relative humidity during the period 1971–2002. The models were developed at district as well as zone levels. The data for the year 2002–03 was used for validation of models. Using these models, the forecasts were computed at district-level. The district-level forecasts were combined by taking the area under the districts as weights to obtain forecasts at agroclimatic zone/state level. The salient findings are:

- District level models provide better forecast than zone level models in most of the cases indicating that development of district-level models may be preferred only when adequate data are available.
- At state level, the deviations of forecasts from the observed ones are less than 5 per cent.
- It is feasible to obtain reliable forecasts about three/four weeks before harvest.

Small area estimation for zero-inflated data: The thrust of planning process in recent years has shifted from macro to micro level. In view of the demands of modern time, the thrust of research efforts has shifted to development of precise estimators for small areas. An offshoot of this development is that various small area estimation (SAE) techniques are being proposed by the researchers for implementation. In our country large number of surveys/censuses are being carried out. These SAE techniques can be used to provide reliable estimates of various parameters of interest to administrators and policy planners. A method was developed for SAE in the study on "Small Area Estimation for Zero Inflated Data". The performance of the proposed method was evaluated through simulation studies using both data generated under the model and the real survey data of 59^{th} round of the National Sample Survey Organization on Debt-Investment Survey 2002–03 for rural areas of the State of Uttar Pradesh. The variable of interest is amount



Forecast of Potato Yield in Agro Climatic Zones of Uttar Pradesh



of loan outstanding per household with an aim to predict the district level average value of amount of loan outstanding per household.

Region-specific relative RMSE of the EBLUP (thin line) and proposed estimator (solid line) under model based simulations for different proportion (p) of zeros are presented above.

The above graphs clearly indicate that values of the Relative RMSE% for the proposed estimator, which have been depicted by thick lines, are always lower than the values from already available SAE based method (depicted by thin line). This indicates that the proposed method performs always better for different values of correlation across all the regions.

Decision support system for manpower planning-II (PERMISnet-II): Personnel Management Information System Network-II (PERMISnet-II) for ICAR is higher version of PERMISnet, which has been redesigned and developed using .NET technology. Information coverage in PERMISnet-II system is vast and contains personal, professional and referential attributes of ICAR personnel along with information on plan wise cadre strength and institutional parameters for different categories of ICAR institutions. System provides exhaustive report modules and different access rights to different type of users which include Research Manager Personnel, Nodal Officers, Individual users and General users. PERMISnet-II system has been implemented in ICAR from IASRI server at the address http://permisnet.iasri.res.in/. For implementation, data from earlier PERMISnet system was incorporated into PERMISnet-II system.

System has been designed in modular approach with different access rights to different users.

Nodal officer module: Nodal officers of the authentication can update and manage the data and generate reports related to their institutes.

RMP module: Research managers at the Council have the privilege to view information at different levels which ranges from single institute to compiled reports of all ICAR institutions and subject matter divisions.

Selective/ customized report: This module is part of nodal officer as well as RMP modules. This module provides the flexibility to generate report based on different combinations of parameters such as Service Type, Designation, Discipline/ Functional Group, Sex, Qualification, Caste Category, Religion, Abroad Visits, Age, Retiring Age etc. Report can be generated for single institute or all institutions in the category of Subject Matter Divisions, Zone and State.

Individual users: Individual users after authentication have the privilege to view the biodata covering all the parameters, print the biodata, change the Password, and download complete biodata in MS word format.

General users: General users can view general information about ICAR, viz. institute list, subject matter division wise list of regional stations; zone-wise list of institutes; list of institutes in difficult area; list of the directors of institutes; list of nodal officers; and institutional organizational structure report.

Graphical reports: Module for graphical reports has been added for RMPs. This will facilitate pictorial representation of compiled information.

Multi-dimensional cubes: Access to this module will be provided to RMPs. This will facilitate the policy makers to view the data on multi-dimensional parameters.

Design resources server: Design resources server (www.iasri.res.in/design), developed to popularize and disseminate research in design of experiments among experimenters and research statisticians has been strengthened by adding:

- **Statistical genomics:** A new link on statistical genomics was initiated essentially as an e-learning platform, which can be useful to the researchers particularly the geneticists, the biologists, the statisticians and the computational biology experts. These are hosted at http:// iasri. res. in/ design/ Statistical_Genomics/default.htm.

To popularize the server among agricultural scientists, a Bulletin on the Design Resources Server was published and Workshops were organized at several NARS institutions. During the year, the server has been accessed by the users in 448 cities across six countries.

Bioprospecting of genes and allele mining for abiotic stress tolerance: A centralized statistical and computational genomics lab facility for the analysis of genomic data was developed. Genomic sequence information on abiotic stress related genes of different traits and species was collected from public domain and a library was developed. Phylogenetic analysis of the genes responsible for abiotic stress tolerance traits across species was studied and further compared for conserved regions through structural visualization. An algorithm was developed to determine and identify optimum number and combination of molecular markers required for explaining the maximum diversity present in the data. A database on core collection of germplasm for rice was designed and data is being populated (http://bioinformatics.iasri.res.in).

Project information and management system of ICAR (PIMS-ICAR): PIMS-ICAR system was developed to check duplication in research projects both at divisional as well as at inter-divisional level. It is hosted at http://pimsicar.iasri.res.in. The system will act as a decision support system and would be quite useful to academicians, planners, policy makers, scientists/ technologists and other stakeholders in the field of agricultural sciences and technology. Keyword and ontology based approaches are considered to check duplication of research projects. The system can extract keywords from the title, objectives and activities of the project to match across all the ongoing projects.

National agricultural bioinformatics grid (NABG): A project on “Establishment of National Agricultural Bioinformatics Grid (NABG)” under NAIP component-I has been initiated at the IASRI to keep pace with the research and developments in agricultural bioinformatics/ biotechnology and related fields at global level. Under the project, supercomputing facilities involving five different domain organizations, namely NBPGR New Delhi, NBAGR Karnal, NBFGR Lucknow, NBAIM Mau, and NBAII Bengaluru, will be developed. This national facility will have computational framework to support biotechnological research in the country and will facilitate in providing platform for inter-disciplinary research in cross-species genomics. The first priority of the project is to develop databases, data warehouse, software and tools, algorithms, genome browsers and high-end computational facilities through systematic and integrated approach in agricultural bioinformatics. This will be followed by capacity building for research and development in agricultural bioinformatics and in turn agricultural biotechnology.

Strengthening statistical computing for NARS: A general purpose high-end statistical package SAS has been procured with 151 licenses for perpetual use with three years updates and upgrades to provide enabling statistical computing facilities to the researchers of NARS. The efforts would not merely be focused on an interface of statistics, computer science and numerical analysis, but would also involve designing of intelligent algorithms for implementing statistical techniques particularly for analyzing massive data sets, simulation, bootstrap, etc. The package can be installed on multiple official machines both in stand-alone as well as intranet mode. The availability of SAS package would enable the researchers to undertake probing, in-depth, appropriate, intractable analysis of data generated from agricultural research including those in advanced research areas like biotechnology, genomics, microarrays, forecasting, agricultural field experiments, surveys, microarrays, and massive data sets such as climate change, biodiversity, market intelligence. It would also facilitate data sharing over web and creation of analytics for All-India Co-ordinated Research Projects and other Network Projects of NARS.

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