13. Agricultural Economics, Marketing and Statistics

India has moved from an era of chronic food shortages during 1960s to food self-sufficiency and even food exports from 1990s. The agriculture sector grew at an average rate of 3.3% during the XI Five Year Plan and the targeted growth rate is 4 % in the XII Five Year Plan. Demand for food and agriculture commodities in India is rising at a much higher rate than the growth in population of the country. Rising per caput income and urbanization are leading to dietary transition primarily from food with low price calorie food like cereals towards high price calorie food like livestock products and towards processed and ready-to-eat products. The adoption of new technologies by farmers in the country has resulted in manifold increase in the farm productivity and production. In spite of high growth in demand due to increase in population and per caput income, and shrinking natural resources, public agricultural research enabled production of food to grow faster than demand. This is mainly attributable to improvements in agricultural productivity achieved through technological change enabled by investments in agricultural R&D.

To attain close to 4% growth in agriculture, favourable interplay of policies and technologies is required. These include unambiguous assessment of resources, assurance of stable and remunerative prices to producers, hike in 'investment in agriculture' and 'investments for agriculture', greater involvement of private business in agriculture, supply of quality seed and planting material at reasonable prices, timely and adequate availability of various inputs, push to diversification, strong support to R&D and technology dissemination, providing means (resources as well as policies) to mitigate the climatic challenges, increase in power supply to agriculture, and competitive market environment.

Market integration and price transmission: The case of rice and wheat in India

The analyses focused on impact of world food crisis of 2007–08 on consumers and transmission of world food prices to the retail level. Price transmission to the farmers or farm gate level is important, because only through this transmission, a possible supply response to increase the supply of these cereals can be expected. The long-run elasticity of price transmission from international to wholesale and retail prices of wheat is higher than that to the farm gate prices. The farm gate prices responded differently during rising and falling phases of international prices. Interestingly, the short-run shocks in international prices did not significantly influence domestic prices at any level of wheat supply chain. There is lack of congruence between international and domestic prices of rice and wheat. The rise in domestic prices during the crisis period was observed but was considerably lower than that in global prices.

During 2007–09, the movements in global prices and domestic prices of rice and wheat were almost in contrast to each other. During the five-year period ending 2008–09 or 2009–10, the coefficient of variation in international price was two-to-three times the domestic prices of rice and wheat. On the contrary, the coefficient of correlation between monthly international and domestic prices of rice and wheat have been found, generally, quite low and insignificant, both during pre-crisis (1996–2007) and crisis (2007–2011) periods. The main factors that impeded the transmission of abnormal increase in global prices to Indian markets were timely and effective government intervention in rice and wheat markets, and almost complete insulation of domestic fertilizer prices from increase in international crude oils and fertilizer prices. The paddy and wheat growers in India received considerably higher prices during 2006–08 and it continued during 2008-09, owing to the mix of domestic policies, including hike in MSPs. The farm harvest prices of wheat registered an annual increase of 14 to 22% and that of rice increased by 7 to 20% continuously during 2006–07 to 2008–09. There was a considerable hike in MSPs during 2007 and 2008 as part of food security package of the Government. The crux of findings is that high global prices have impacted farm gate prices in India, not directly but through their influence on the decision of the government related to the levels of fixation of guaranteed support prices.

Commodity outlook models for major grains and oilseeds

The Indian economy is undergoing a rapid transformation due to greater integration with the global economy hence a comprehensive agricultural policy has an important role to play. Timely and reliable information on the likely demand, production, trade and prices of important agricultural commodities in the country is required. Commodity outlook models help generating advance information on medium- and long-term projections on the above-mentioned economic variables. Apart from generating outlook, these models are capable of undertaking sensitivity analysis and simulations under alternative policy and technological scenarios.

Grain outlook model: A grain outlook model was developed that incorporates a system of simultaneous equations for effectively depicting the linkages between various economic variables corresponding to the food balance sheet of major foodgrains in India. This model specifically focuses on rice, wheat and maize, along with their interrelations with other complementary and substitute crops. Technically, the model utilises the time series information for undertaking projections, but simultaneously derives equilibrium values of the

Baseline equilibrium projections for wheat, rice and maize at all-India level (base year 2010–11)

Variable	Wheat			Rice			Maize		
	2015–16	2020–21	2025–26	2015–16	2020–21	2025–26	2015–16	2020–21	2025–26
Area ('000 ha)	29,365	29,755	30,187	42,774	42,945	43,156	9,103	9,078	9,010
Yield (tonnes/ha)	3.07	3.23	3.40	2.33	2.46	2.60	2.50	2.65	2.79
Production ('000 tonnes)	90,136	96,042	102,586	99,820	105,762	112,267	22,758	24,025	25,093
Food and other use ('000 tonnes)	87,483	93,476	100,085	95,911	102,007	108,350	10,389	11,122	11,662
Feed use ('000 tonnes)	2,579	2,495	2,425	0	0	0	9,530	10,283	10,688
Total use ('000 tonnes)	90,063	95,971	102,510	95,911	102,007	108,350	19,918	21,405	22,350
Ending stocks ('000 tonnes)	18,911	18,911	18,911	18,452	18,037	17,990	640	631	634
Net trade ('000 tonnes)	73	71	76	3,917	3,905	3,917	2,823	2620	2,745

variables based on the linkages established through a set of equations that cut across commodity as well as spatial dimensions. The projections on major variables for the three primary crops are presented in tabular form.

Oilseeds outlook model: It was developed for rapeseed/mustard, groundnut and soybean, as the primary commodities. Presently, the oilseeds outlook model has the year 2010 as the base-year for projections and can generate outlooks till the year 2025. As in grains outlook model, provisions were made to regularly update base-year and also to extend the period of forecasting.

In future, it is targeted to integrate both grains and oilseeds models dynamically so that each model takes inputs from the other model and gets converged simultaneously.

Historical and spatial trends in Indian agriculture: Growth analysis at national and state levels

Indian agriculture has witnessed wide variations in growth performance during last six decades after Independence. To find the effects of major changes in technologies and policies on the sector and to understand the broad trends in growth, a comprehensive growth analysis was undertaken by dividing the overall period into six phases, viz. pre-green revolution period (1960–61 to 1968–69); early green revolution period (1968–69 to 1975–76); period of wider technology dissemination (1975–76 to 1988–89); period of diversification (1988–89 to 1995–96); post-reform period (1995–96 to 2004–05); and period of recovery (2004–05 to 2010–11).

The green revolution period was the golden period for Indian agriculture that witnessed tremendous growth in both agricultural output and input use. During the period of wider dissemination of technology the spread of green revolution technologies across regions aided in maintaining the growth tempo realised during the previous period. The subsequent period witnessed the growth becoming broad-based with faster diversification of production towards horticultural and cash crops. However, the post-reforms period experienced a visible deceleration of growth as both public and private investments suffered a setback during this period, and the result was sluggish performance of the sector as a whole. Moreover, the use of primary inputs in the sector also slowed down due to which the yield levels of most of the crops suffered a deceleration. The retardation of growth continued up to the year 2004–05 after which a sharp recovery was realized that can be attributed to a conscious hike in public and private investments and substantial improvement in trade in favour of agricultural sector.

The study has concluded that, more than a matter of chance or as a brief spell of improvement, the recovery can be considered as the result of a significant alteration in strategy that put considerable focus on the agriculture sector, be it a rapid expansion of agricultural credit, reinvigorated growth in the distribution of quality seeds or substantial outlay of public and private investments in the sector. However, the future growth in the sector depends a lot on the manner in which the resources are

Growth rates of GDP (2004-05 prices) of various sub-sectors in India during different phases of growth (%/year)

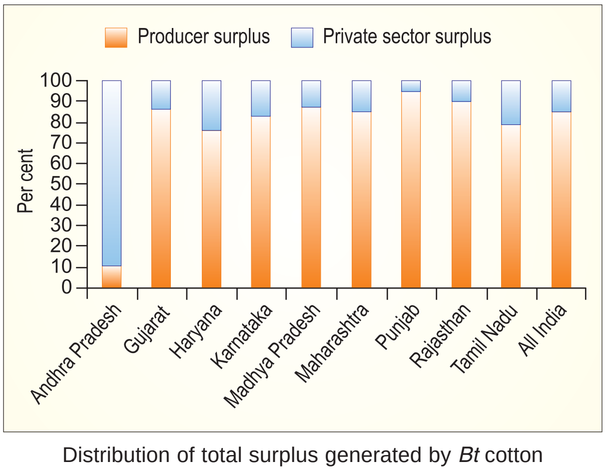
Sector	1960–61 to 1968–69	1968–69 to 1975–76	1975–76 to 1988–89	1988–89 to 1995–96	1995–96 to 2004–05	2004–05 to 2010–11
Agriculture and allied	1.03	1.98	2.42	3.24	2.35	3.31
Agriculture*	0.70	1.93	2.71	3.21	2.30	3.37
Forestry and logging	3.70	2.01	–1.77	0.74	2.05	2.25
Fishery	3.91	4.19	3.45	7.37	3.28	4.42
Non-agriculture	4.90	3.67	5.23	5.91	7.05	9.68
All sectors	3.19	2.99	4.25	5.14	5.95	8.57

*GDP agriculture includes crops and livestock.

put into productive use and the degree to which farmers are incentivised to continue with the farming profession.

Impact of technology and policy on cotton production in India

An empirical quantification of the impact of Bt cotton in India revealed an approximate welfare generation of Rs 220 billion, 85 % of it accruing to producers and the rest to the private sector seed companies and marketing firms. The distribution of the surpluses across the states varied widely depending upon the penetration of Bt technology, its agronomic performance and variations in pre-*Bt* cotton performance. The highest total surplus was recorded in Maharashtra followed by Gujarat. Andhra Pradesh and Punjab depicted contrasting performance in benefits accrual which may be attributed to differences in agronomic performances and the exogenous technology growth. While the lower reduction in insecticide usage combined with positive exogenous technology growth yielded a reduced producer benefit (in absolute terms and in comparison with the acreage) in Andhra Pradesh, the significant reduction in insecticide usage and lower exogenous production growth resulted in higher and more than proportionate benefit in Punjab.



Distribution of total surplus generated by *Bt* cotton across states

Agricultural growth and reduction in poverty

Study based on penal data of states at three points of time, viz 1983, 1993-94 and 2004-05, revealed significant depressing effect of all the three variables on rural poverty, the highest effect being exerted by per capita agriculture NSDP (net state domestic product). The significant negative coefficient of per capita AgNSDP suggested that the improvement in agricultural performance is associated with substantial reduction in rural poverty, indicating that benefits of growth in agriculture have trickled down to rural poor and the growth is inclusive. However, agricultural growth alone will not be sufficient to substantially reduce the incidence of rural poverty. Wages are the major source of rural households and improvement in wages would significantly reduce poverty of rural households. Therefore, the rural development programmes that have direct or indirect influence on living conditions of farming and landless labour households should be accorded a considerable importance to ensure inclusive growth. A significant negative relationship between poverty and literacy suggested that the education plays an instrumental role in rural poverty reduction, calling for greater investment on human resource development in the rural areas for inclusive growth.

Determinants for reduction in poverty of farming and agricultural labourers households

Exploratory variable	Dependent variable: Farmers' poverty (%)	
	Coefficient	Standard error
Agriculture NSDP per person (₹)	–0.976*	0.148
Rural literacy (%)	–0.315**	0.158
Rural wages (₹)	–0.198*	0.069
Constant	12.90	1.29
R^2	0.72	

*Significant at 1% level, **significant at 5% level. *Source:* Estimates based on data from NSSO and CSO, GoI.

Progress of Kisan Credit Cards

An analysis was undertaken to develop a clear picture on progress of Kisan Credit Cards (KCC). It was noted that once the distributional distortions are negated, the

State-wise revised estimates of progress in KCC Scheme, 2009

State	No. of KCCs (in millions)	Estimated actual cards (in millions)	% of household covered by KCCs
Andhra Pradesh	14.7	7.6	63
Asom	0.5	0.4	14
Bihar	3.3	2.9	20
Chhattisgarh	1.6	1.3	39
Gujarat	2.9	2.1	46
Haryana	2.4	1.2	72
Himachal Pradesh	0.4	0.3	35
Jammu and Kashmir	0.1	0.1	6
Jharkhand	1.1	1.0	–
Karnataka	5.3	4.7	63
Kerala	3.3	3.1	45
Madhya Pradesh	5.4	4.5	57
Maharashtra	8.2	7.4	54
Odisha	5.3	2.7	61
Punjab	2.3	0.8	79
Rajasthan	4.9	3.9	63
Tamil Nadu	5.9	5.3	64
Uttar Pradesh	15.9	7.9	35
Uttarakhand	0.6	0.3	32
West Bengal	3.2	2.8	40
India	93.7	61.7	48

coverage of KCCs reduced by one-third. Based on the estimated number of actual KCCs issued, the coverage of operational holdings gets reduced to 48% at the national level as against an absolute number of around 94 million reported at national level, with wide variation across states. On contrasting this poor coverage with the deadline to attain the full coverage by 2007–08, it calls for concerted efforts.

Female participation in agriculture in Eastern India during 1983–84 to 2009–10

The pattern of female participation in agriculture and allied sectors in different agro-ecological zones of India and its temporal variation in Eastern India were examined. Based on the information compiled from the employment schedule of NSSO data from 1983–84 to 2009–10, it was observed that female participation in agriculture is declining at the national level over the period of time; however, the rate of decline in Bihar, Jharkhand and Odisha was more than that noticed at national level. The same trend was observed in livestock and other allied activities as well.

Strengthening statistical computing for NARS: Indian NARS Statistical Computing portal for providing service oriented computing for the users of NARS by adding the modules of Completely Randomized Designs; Resolvable Block Designs; Augmented Block Designs; Row-Column Designs; Nested Block Designs; Split-Split Plot Designs; Split Factorial (Main A, Sub B´C) Designs, Strip Plot Designs; Response Surface Designs; Univariate Distribution Fitting; Tests of Significance; Correlation and Regression Analysis, was strengthened. The data can be analysed by uploading *.xls, *.xlsx, *.csv and *.txt files.

Experimental designs in presence of neighbour effects: In agricultural field experiments the treatments are assessed using small adjacent plots. Under such situations, the treatment applied to one experimental plot may affect the response on neighbouring plots besides the response of the experimental plot to which it is applied. This may be due to spread of treatments to adjacent plots causing neighbour effects, leading to substantial losses in efficiency. For precise comparison of treatment effects in presence of neighbour effects, neighbour balanced designs are useful. These designs ensure that no treatment is unduly disadvantaged by its neighbour(s). During experimentation, there may be possibility that some of the observations could become unavailable for analysis. The robustness of neighbour balanced complete block designs has been examined when specific observations are missing. The information matrix for direct treatment effects of the resultant design (one-sided neighbour effects) after missing of an observation from a block is derived and the efficiency of resulting design is investigated. The efficiencies are quite high indicating the designs are fairly robust against missing observations.

The methodology for estimating the direct and neighbour effects of treatments was derived. Series of row-column designs balanced for neighbour(s) were obtained and are found to be variance balanced for estimating direct and neighbour effects.

Analysis of experimental designs with *t*-family of error distributions: The analytical procedures were developed for the analysis of data generated from designs for one-way and two-way elimination of heterogeneity when the errors follow the *t*-family of symmetric distribution. For 2k factorial experiments when the errors follow the *t*-family of symmetric distribution, contrasts and sum of squares of contrasts for main effects and two

Trend in female participation in agriculture in Eastern India and at national level, 1983–84 to 2009–10

States	Female workers participation				Percentage points reduction during		
	1983–84	1994–95	2004–05	2009–10	1983 to 1994	1994 to 2005	2004–05 to 2009
Bihar	26.43	22.38	22.20	12.44	–4.05	–0.18	–9.76
Jharkhand	47.18	34.94	43.78	28.97	–12.25	8.84	–14.81
Odisha	34.84	36.41	38.29	32.07	1.57	1.88	–6.22
India	37.72	37.53	38.85	33.76	–0.19	1.33	–5.09

STATISTICS

Pigeon pea microsatellite database: *Pigeonpea microsatellite database* (*PipemicroDB*), based on chromosome as well as location-wise search of primers, is available at http://cabindb.iasri.res.in/pigeonpea.

It has an automated primer designing tool for pigeonpea genome. This is first database of pigeonpea marker in world with 123387 STRs extracted *in silico* from pigeonpea genome. It will help in selection of desirable traits, such as high yield, resistance to a particular disease and other traits, that will benefit the crop in long term. This tool enables researchers to select STRs at desired interval over selected chromosome. Further, one can use individual STRs of a targeted region over a chromosome to narrow down location of gene of interest or linked QTL. These markers will be of immense use in marker assisted selection which would help to overcome approximately 50% loss in pigeonpea productivity due to biotic and abiotic stress in India as well as many parts of the world. This will further pave way towards food security in terms of per capita protein requirement/availability to Indian population. This will also have a positive impact on Indian economy by decreasing import of pulses.

factor interactions have been worked out. For testing hypothesis of the main effects and two factor interaction effects, test statistics have been developed.

Robust block designs against missing data: Robustness of incomplete block designs against the non availability of data has been investigated in the literature in terms of average variance of all possible pairwise treatment comparisons in the design. A design that is robust on the basis of overall efficiency may not be robust when the efficiency is worked out on the basis of individual pair-wise treatment comparisons. Therefore, all the estimates of individual pair-wise treatment contrasts for the loss of any number of observation(s) in a block for balanced incomplete block design and variance balanced block designs were investigated. Designs that are robust on the basis of average variance but not on the basis of pair-wise treatment contrasts were also identified.

Efficient designs for drug testing in veterinary trials: In veterinary trials, neither a specific intervention treatment (treatment that has not been tested earlier) can be given continuously to animals, nor can these treatments be withdrawn after any period, for ethical reasons. Owing to treatment surrounding rule, only a limited number of intervention treatments and baseline can be compared at a time. A general method for constructing variance balanced alternating treatments design (ATD), suitable for making comparisons of two or more experimental conditions with each other or baseline was developed. Two series of row-column designs for comparing investigational products with an active control/placebo in veterinary trials were obtained. Further, designs for making comparisons of investigational products with more than one active control were also obtained. Two series of partially variance balanced symmetric factorial row-column designs were obtained.

Stochastic process modeling and forecasting: Threshold autoregressive (TAR) model is an important parametric family, which is capable of describing cyclical data. Self-exciting threshold autoregressive moving average model (SETARMA) was fitted. Real-coded genetic algorithm (RCGA) was employed to estimate the parameters of this model. As an illustration, Annual Mackerel catch data of Karnataka, India during the period 1961–2008 was considered. The SETARMA model generally performed better. Optimal out-of-sample forecasts up to three-steps ahead along with their forecast error variances were derived theoretically for fitted SETARMA model. The observed values were quite close to forecast values and estimated variances were near to theoretical values.

Software for survey data analysis (SSDA) 2.0: A web based software SSDA 2.0 was developed for survey data analysis for stratified multistage sampling design. Some of the important features of the software are: New user registration and editing user profile, individual data storage folder for imputation and analysis under name My Folder, Feedback, Help Manual, Extraction of NSSO Data, Calculation of Summary Statistics, Scrutiny and Editing of Outlier Data, Sample Selection, Imputation of Missing Data using mean zero and mean of neighboring unit methods, Sampling Weight Calculations and Estimates of Parameter. It has links such as contact us, upload file, download file, delete file, and download test data. The extraction program module takes the required text file as well as the meta-data defining the positions of relevant input variables.

Half-yearly progress monitoring system of the scientists in ICAR: A web based software was designed and developed to ensure more objective evaluation of the half-yearly performance of scientists for Half-Yearly Progress Monitoring (HYPM) of the Scientists in ICAR. The HYPM system was implemented from 1 April 2012 for online submission of proposed targets by the scientists for the first half year period (1 April to 30 September 2012). It is launched from IASRI server and made available at http://hypm.iasri.res.in. Various reports are generated for the proposed targets as submitted by the scientists and their achievements along with the comments of the Reporting/Reviewing Officers. These reports include target submission status reports with facility to view individual level proposed targets of the scientist and other options like manpower status, research projects, and salient research achievements of the institutes through the options under Report Module.

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