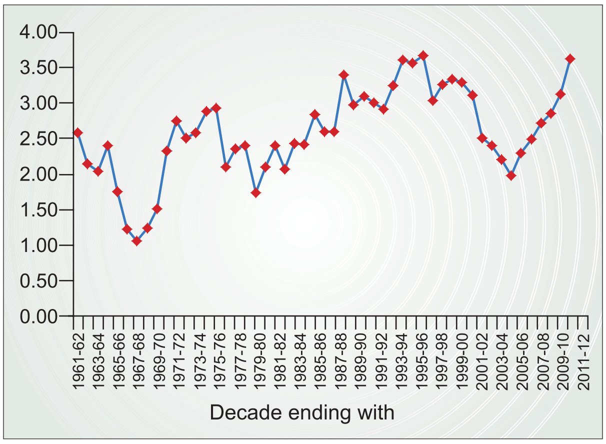
13.

Agricultural Economics, Marketing and Statistics

All India and state level agricultural growth and its determinants: Indian agriculture during the decade of 1995 to 2004-05 faced slowdown but witnessed a turnaround in growth after 2004-05. The growth trajectory is now heading towards target growth rate of 4%. Various measures taken during 11th Plan and progress in technology were instrumental in reversing slowdown in agriculture growth.

State level growth: Performance of agriculture at state level during the last decade was examined based on growth rate in Net State Domestic Product (NSDP)-Agriculture during 2000-01 to 2010-11 at 2004/05 prices. Gujarat, Rajasthan, Chhattisgarh, Madhya Pradesh, Andhra Pradesh and Jharkhand out of 20 major states achieved growth rate higher than the national target. One-fifth states are close to the national target of 4% growth rate in agriculture. States of Kerala, Uttar Pradesh, Uttarakhand and Jammu and Kashmir achieved less than 2% growth in agriculture sector during 2001 to 2011. These results showed that action at state level is important determinant of agricultural growth.



Trend growth in GDP-Agriculture (at 2004-05 prices) based on 10 years period: Decade ending with 1961-62 to decade ending with 2011-12 (%)

Distribution of states according to agricultural growth

State	Growth rate
Kerala	1.11
Uttar Pradesh	1.72
Jammu and Kashmir	1.78
Uttarakhand	1.78
Punjab	1.85
West Bengal	2.18
Bihar	2.52
Tamil Nadu	2.74
Karnataka	2.90
Asom	2.93
Himachal Pradesh	3.41
Haryana	3.41
Odisha	3.61
Maharashtra	3.87
Madhya Pradesh	4.42
Rajasthan	4.76
Andhra Pradesh	4.76
Chhattisgarh	5.58
Jharkhand	6.16
Gujarat	6.85

Food security and undernourishment in India – Assessment of alternative norms and the income effect: Total food production in India increased at a much faster pace than the growth in human population during the last four decades. However, this did not articulate in terms of improvement in food and nutritional security in the country.

Estimates of undernutrition (calorie deficiency) and malnutrition (protein deficiency) were prepared for various income groups. The nutritional status in India was examined using two indicators—one based on ICMR-NIN (Indian Council of Medical Research-National Institute of Nutrition) norm and the second based on FAO norm of 1,800 Kcal. The average intake levels of poor households were at levels even lower than the FAO norm of 1,800 Kcal. Calorie deficiency was higher for rural areas than urban areas. More than half of the income poor population was calorie deficient in both rural and urban areas across all the choices of norms. Incidence of undernutrition and malnutrition was much higher based on ICMR-NIN norm.

Undernutrition was not confined to poor households. Such a population can be termed to be suffering from ‘involuntary hunger’ as they do not have the necessary income resources to take care of the quantity aspect of their intakes. However, more than 50% of middle

Prevalence of under-nutrition and malnutrition based on FAO norm and ICMR-NIN norm in various income groups

Locale and Expenditure class	Undernourishment (%)		Malnourishment (%)
	FAO norm	ICMR-NIN norm	ICMR - NIN norm
Rural			
Poor	56.9	82.6	50
Middle income	21.3	61.3	31.7
High income	7	39	14
All rural	32.3	67	36.7
Urban			
Poor	66.7	78.5	59.9
Middle income	33.7	55.2	40.8
High income	10.1	29.7	22.8
All urban	39.5	58.7	43.8
Rural+Urban	34.2	64.8	38.7

income and more than 30% of upper income households were also found consuming lower than required dietary energy. These individuals can be termed as suffering from 'voluntary hunger' as they have the necessary income resources but still they are not consuming – may be out of choice or due to other non-income factors. The percentage of population with inadequate protein intakes was higher in urban households as compared to their rural counterparts.

Empirical evidence showed that an inverse relationship between food prices and hunger cannot be generalised and recent spikes in food prices did not cause any adverse effect on prevalence of under-nutrition – they have rather improved under-nutrition through positive effect on food production. In terms of brief appraisal of the FAO methodology, it was concluded that such an approach is bound to lead to erroneous conclusions as it deals with food availability rather than food intakes. It was expected, and was found to be the case for India, that the level of hunger will be an underestimate till the use of food commodities for non-food purposes is underestimated. The paradox of hunger amidst plenty prevailing in India suggested that there are historical and cultural factors that make India a different case and need further research. The study clearly brought out that income growth and elimination of poverty is a 'necessary' but not a 'sufficient' condition for reducing undernourishment and malnourishment in India.

Changes in rural labour market and its implications for Indian agriculture: Rural workforce has increased during the last 16 years, mainly on account of the increase in male labour. The number of female workers did not increase despite 25% increase in their population between 1993-94 and 2009-10. This has resulted in decline in WPR of female as well as total workers in rural India. The decline in WPR for rural women is largely explained by withdrawal by female labour from agriculture presumably due to improvement in economic conditions of farm families. There has been a big increase in pursuit for education by rural female. Improved literacy and low preference for farm work require creation of employment opportunities at large scale in rural non-farm sector to attract women to workforce.

Rural labour market is undergoing profound changes with labour moving from agriculture towards non-farm sectors. Changes in rural labour market are influenced by a set of complex factors such as pattern of economic growth, inter-sectoral wage rate and worker productivity differentials, education, MGNREGS and socio-cultural factors. The output growth in non-farm sectors outpaced growth in agriculture sector during the last 16 years. This prompted workers to move towards non-farm sectors to fetch higher income. Similarly, higher wage rate and worker productivity in non-farm sectors were also found to be the driving forces for such changes. The movement of workers from agriculture to non-farm sectors can be accelerated further through improving employment opportunities in the later till wage and worker productivity differences equalize and excess labour in the former vanishes. MGNREGS has a significant influence in labour market by reducing the labour availability for farm operations, increasing wage rate and by influencing work culture and work environment of rural workers. MGNREGS constituted about 7% of the employment of rural labours on a full year basis. On actual employment basis the

Structure of employment and population by gender in rural India

Variable	Male			Female			Persons		
	1993-94	2009-10	CGR	1993-94	2009-10	CGR	1993-94	2009-10	CGR
Agriculture	139.13	145.61	0.29	90.31	83.07	-0.52	229.44	228.68	-0.02
Industry	13.14	16.23	1.33	7.33	7.85	0.42	20.48	24.08	1.02
Construction	6.01	26.20	9.64	0.94	5.44	11.58	6.95	31.64	9.94
Services	27.60	41.50	2.58	5.87	7.95	1.92	33.47	49.46	2.47
Total workforce	187.76	231.87	1.33	104.77	104.62	-0.01	292.52	336.49	0.88
Total population	339.53	423.89	1.40	319.41	400.85	1.43	658.94	824.74	1.41

CGR, Compound growth rate (%).

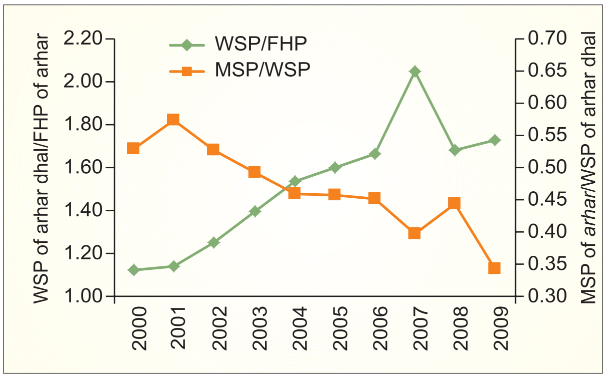
share of MNREGS in total labour supply will be much higher. Though in per cent term MNREGS share in rural labour supply looks small but it corresponds to total employment in industry sector and three-fourths of employment in construction sector in rural India. Therefore reduced labour supply for agriculture due to MGNREGS is obvious.

The consistent increase in real wages has potential for cost push inflation in the country. Changing work culture and emerging contractual arrangement between labours and labour hiring farm households are also affecting rural labour market. Changes in rural labour market are slow due to requirement of skill and education level in non-farm sectors, concentration of industrial unit away from rural habitation and limited capacity of non-farm sector to ensure productive employment to in-coming workers. The improvement in education and skills of the largely uneducated and unskilled rural labours will accelerate these changes.

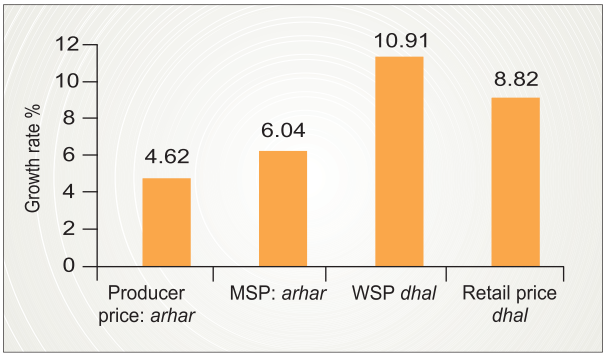
Though the movement of labour out of agriculture is a welcome development from the economic growth and development point of view, there is a strong need to develop effective strategy to face labour scarcity and wage rate increase, which subsequently increases cost of production and prices. This should include the strategy for farm sector in the form of appropriate mechanization, farm practices and custom hiring arrangements. Agricultural R&D has to play a vital role in terms of offering substitute for labour in farm operations and in terms of offsetting cost push inflation resulting from structural shift in labour and rise in wages.

Development policies and agricultural markets: Agricultural marketing suffers from inefficiency, disconnect between prices received by the producers and prices paid by consumers for agricultural products, fragmented and long marketing channels, poor infrastructure and policy distortions. With farm size getting smaller day by day, income from agriculture produce can be improved by enabling the farmers to get a share of value added in marketing by developing and strengthening marketing mechanisms which include producers as partners. Urgent reforms are needed in agricultural marketing to achieve such goals and to address conditions prevailing in agricultural markets.

A very serious consequence of present market system is declining competitiveness in marketing, because of which increase in prices at consumer level, resulting from various factors, is not passed on to farmers. A classic example of this was found in the case of *arhar* (pigeonpea) in Maharashtra where benefit of increase in prices of pulses was captured by middlemen without any benefit to farmers. Price spread between farm harvest price of *arhar* (whole grain) in Maharashtra and wholesale price of arhar *dhal* (split and polished grain) in Mumbai market increased from less than 25% to more than 70% in one decade during 2000 and 2009. Thus, in just 10 years, per cent rate of margin of middlemen recorded a three-times increase within the same state and for same type of product.



Ratio of wholesale price of *arhar dhal* in Mumbai to WSP and FHP of *arhar* in Maharashtra



Annual growth rate in price of *arhar* in Maharashtra and *arhar dhal* in Mumbai

This is a clear evidence of middlemen cornering benefit of increase in price of pulses experienced during the last decade.

During 1999-00 to 2009-10 the farm harvest price (FHP), i.e. price received by producers, for *arhar* in the state increased by less than 5% per year whereas wholesale prices (WSP) and retail prices of *arhar dhal* increased by more than 10% cent per year. Thus, crops like pulses, and farmers producing these crops, have suffered from market failure.

Farm incomes in India: Estimates of farm income are not available in India for country level and at state level. In the absence of such crucial information, all sorts of statements are made about income of the

Real farm income: Per cultivator, per farm and per unit of NSA at 2004-05 prices (Rs)

	Farmers' income per cultivator	Farmers' income per farm	Farmers' income per hectare of NCA
1972-73	14,582	20,972	11,317
1977-78	15,663	21,616	12,690
1983-84	18,331	24,230	15,863
1987-88	18,864	23,163	17,420
1993-94	22,200	27,305	21,470
1997-98	26,353	30,984	25,604
2004-05	31,200	32,143	28,988
2009-10	43,833	35,484	34,466

farmers and their plight. This study fills this gap by preparing a series of farm income. The total farm income in real terms has showed a rising trend during last four decades barring a few dips. More meaningful trend in farm income was obtained by looking at the level of farm income per cultivator, per holding and per unit of net sown area. During the last four decades, per cultivator farm income at 2004-05 prices increased from Rs 14,582 to Rs 43,833 while the farm income per holding increased from Rs 20,972 to Rs 35,484, which is less than two times. This has happened due to higher increase in the number of holdings as compared to the number of cultivators. Farmer income per hectare of net sown area followed almost same increase as farm income per cultivator.

STATISTICS

Advanced super-computing hub for OMICS knowledge in agriculture (ASHOKA): The first supercomputing hub for Indian Agriculture was established at the IASRI. This supercomputing environment is being developed for high performance computing in the field of agricultural bioinformatics and computational biology at Centre for Agricultural Bioinformatics (CABin). The facility is set up in a state-of-art data centre and two super-computers of this hub are listed at rank 11 and 24 in the list of top super-computers of India (http://topsupercomputers india.iisc.ernet.in/jsps/june2013/index.html).

This hub has approximately 1.5 Peta Byte storage divided into three different types of storage architecture i.e. Network Attached Storage (NAS), Parallel File System (PFS) and Archival. This hub also consists of super-computing systems at NBAGR Karnal, NBPGR New Delhi, NBFGR Lucknow, NBAIM Mau and NBAII, Bengaluru which form a National Agricultural Bioinformatics Grid in the country. The aim is to provide seamless access to these biological computing resources to the biological researchers across the country.

Experimental designs balanced for indirect effects of treatments: For easy accessibility and quick reference of Neighbour Balanced Designs and Crossover Designs by the experimenters, a software "Web Generation of Experimental Designs Balanced for Indirect Effects of Treatments" was developed and deployed at www.iasri.res.in/webdbie. The software generates five classes of Neighbour Balanced Block Designs and eight classes of Crossover Designs.

The webpage displays the layout plans along with the randomized layout for given number of treatments. The parameters of the designs so generated are also displayed. The details of the designs are also included. The online catalogue ($v \leq 20$) of Neighbour Balanced Designs and Crossover Designs was developed and is included in the software. Search facility of all designs and designs for some particular value of parameters is provided along with showing the layout of the design. This software provides freely available solution for the researchers and students working in this area.

Small area inference using survey weights: In this era of decentralization, the thrust of planning process has shifted from macro to micro level. Small area estimation (SAE) techniques are used to produce reliable estimates for small areas. Unit level linear mixed models are often used in SAE; and empirical best linear unbiased prediction (EBLUP) also proved to be efficient. However, this approach of SAE does not make use of the unit level survey weights. As a result, small area estimator based on this approach is not design consistent unless the sampling design is self-weighting within areas. The Pseudo empirical best linear unbiased prediction (Pseudo-EBLUP) approach overcomes this limitation by using sample weights and also leads to design consistent small area estimator. A bias-robust method for estimating the mean squared error (MSE) of Pseudo-EBLUP estimator that remain approximately unbiased under failure of assumptions about second order moments was developed. The proposed estimator provides area specific MSE estimates for the Pseudo-EBLUP. In addition, the conditional approach of MSE estimation leads to estimator of MSE that is simpler to implement, and potentially more robust.

Goat microsatellite database (GoSatDb) : A web based relational database was developed consisting of 865,210 microsatellite markers present in the whole genome sequence of goat. GoSatdb allows microsatellite search using multiple parameters like microsatellite type simple and compound, repeat types, viz. mono, di, tri, tetra, penta and hexa nucleotide, copy number, microsatellite length, pattern of the repeat motif itself and the location of the marker on the chromosome. Microsatellites can be retrieved by specifying the chromosome number (or numbers). The database also searches specified number of markers in a provided location range on a particular chromosome. The nucleotide sequences of the particular marker are also provided to facilitate primer designing for PCR amplification of any desired microsatellite. It is available at http://cabindb.iasri.res.in/goat/ for users.

Stochastic volatility (SV) models through particle filtering : The SV model was represented in the state space form. State space form of SV models where the errors are made independent by making some changes in the two equations was formulated. The implementation of particle filtering when disturbances term in transition as well as measurement equations are dependent was also carried out. The general formula for volatility process on the basis of its lag values was developed. Parameter estimation of SV was carried out using Matlab 2007 software package. The program for implementation of particle filtering for parameter estimation of SV was developed. The formulae for two-step ahead forecast as well as the conditional variance were derived. The kernel density estimate of the residuals of SV model revealed that the distribution does not have mode around zero. The modified estimated threshold type SV model with mean encapsulated the innovation was symmetric around zero. Recursive measurement equation with asymmetric analysis was derived for maximizing the quasi-maximum likelihood which gave estimates of parameters of SVT model. SV in mean model was fitted to the All-India data of monthly export of spices through particle filtering technique; and comparison was carried out with GARCH to assess the benefits of using SVM over GARCH.

Econometric study on water markets: An econometric study was undertaken on water markets in canal command area of North-Western Rajasthan where water resources for agricultural purposes are becoming scarcer. Earlier this region (Sri Ganganagar and Hanumangarh districts) witnessed impressive development of canal irrigation and agriculture. The water markets are emerging due to shortage of canal water and saline groundwater in most of the deeper aquifers. This study examined irrigation development in the region, structure and determinants of water markets, to assess equity, efficiency and reliability in water use under different forms of water markets. It was observed that: (i) three-fifths of net sown area and two-thirds of gross sown area were irrigated; (ii) the region is dominated by canal irrigation, but growth in canal irrigated area was poor during 2000-01 to 2008-09; and (iii) the annual growth in groundwater irrigated area was impressive (14%) during the same period. In terms of volume, groundwater development was only 46 and 80% in Sri-Ganganagar and Hanumangarh districts, respectively, in 2009. There is a further scope for regulated and monitored groundwater development as salinity of groundwater in the lower aquifers is a serious problem in here. Out of 60 selected farmers, nearly a half were self-users only, two-fifths self-users plus buyers; and only 13% self-users plus sellers of canal and groundwater in this area. Nearly two-fifths of the total farmers were using both canal and groundwater and one-third of the total farmers were dependent on canal only as source of irrigation on their farms; of the total buyer farmers, nearly a half were purchasing canal water, 29% were purchasing groundwater and 23% were purchasing both canal as well as groundwater. The farm specific technical efficiency was good (80%) in wheat production in the region.

Application of optimization techniques for construction of incomplete block designs: Within blocks incomplete block designs are very useful to maintain homogeneity among the experimental units. An efficient incomplete block design may not be always available for given number of treatments, blocks and block sizes. For this purpose, the linear integer programming was used to obtain highly efficient incomplete block designs. A constraint satisfaction approach to construct incomplete block design with specified concurrence matrix was proposed. A multi-step linear integer programming approach to construct a proper binary incomplete block design with specified parameters and concurrence matrix was developed. Nearly balanced concurrence matrix was also generated through the algorithm. Using the two approaches, construction of different classes of binary incomplete block designs viz. balanced incomplete block designs, regular graph designs, semi-regular graph designs etc. were illustrated with examples. Modification of the algorithm for obtaining incomplete block designs for tests vs control(s) comparisons was also shown and illustrated with examples. All the proposed methods were implemented using R and SAS. An R package called 'ibd' was developed and is available on cran.r-project.org/web/packages/ibd/index.html. SAS macros were prepared. For the benefit of experimenters a catalogue of efficient incomplete block designs in a restricted parametric range was also prepared. The layouts of the designs are available on Design Resources Server at http://iasri.res.in/design/ibd/ibd and http://iasri.res.in/design/btib/btib.

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