12. Social Science

Resilience of Indian agriculture to droughts

Impact of droughts on rice production was examined using district level data and the role of adaptation strategies, such as irrigation and crop varieties in mitigating the harmful effects of droughts was assessed.

On average, about one-third of the rice area was affected by drought. The effects of droughts on rice yield had weakened. The yield loss declined, in absolute as well as relative terms, under both moderate and severe drought conditions indicating rice production is becoming resilient to droughts. Econometric estimates validated these results. Improvements in irrigation systems and release of number of rice varieties for rainfed uplands and shallow lands, played important role in enhancing resilience of rice against droughts. Water is becoming increasingly a scarce resource. Improving efficiency of existing irrigation systems and conserving water through innovative measures, such as water harvesting, sprinkler irrigation, alternate wet and dry system, conservation tillage, laser land levelling, etc. need promotion. Further, greater investments in drought-tolerance research and development of extension systems capable of providing farmers timely weather forecasts and seeds of varieties differentiated by their tolerance level to droughts are the pre-requisites for tackling the drought in a holistic manner.

Trends in farm income, and agrarian distress

This study examined income status of farmers in relation to income of other sections of the society. In 1983-84, a farmer-cultivator with agriculture as primary source of income earned three-times more than the earnings of an agricultural labourer but one-third of the income of a non-agricultural worker. Over the next five years, the income of a cultivator increased but at a slower rate compared to others causing a marginal decline in the disparity between farm income and wage earnings. During 1987-88 to 2004-05 a cultivator continued to earn two-and-half times the income of a labourer. The income disparity reduced marginally in 2011-12. The disparity between a cultivator and non-agricultural worker increased from 1:3 in 1983-84 to 1:4 in 2004-05, but declined afterwards due to acceleration in agricultural growth and decline in the number of cultivators. During this period, there was also a small decline in the disparity between agricultural labourer and non-agricultural workers.

After 2004, income per cultivator grew at a rate of 7.3%. These findings indicated that low growth rate in farm income was associated with increase in farmers' distress and vice-versa.

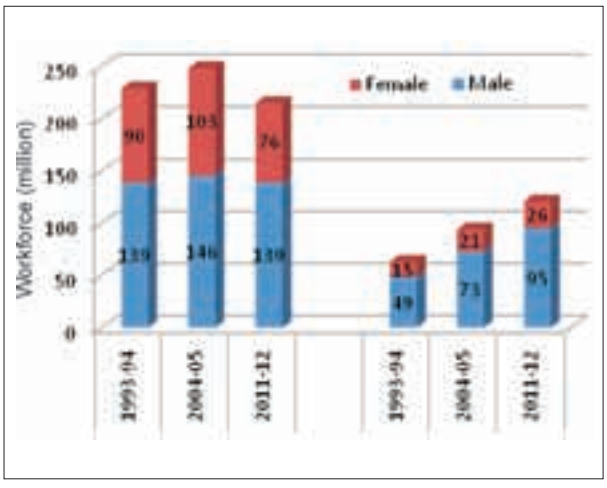
Disparities in agriculture and non-agriculture income at current prices

Year	Farm income per cultivator (₹/annum)	Wage earnings per agricultural labour (₹/annum)	Income per non-agriculture worker (₹/annum')
1983-84	4,286	1,467	12,786
1987-88	5,653	2,201	18,036
1993-94	12,365	4,784	37,763
1999-00	24,188	8,938	78,565
2004-05	26,146	10,043	10,6688
2011-12	78,264	32,311	24,6514

Emerging trends in rural employment and their implications

The rural labour market has undergone some notable changes in the past two decades. Between 1993-94 and 2004-05 rural workforce increased by 50 million, but declined by 7 million afterwards. The decline in rural workforce was primarily due to exit of female workers from the agricultural works, which could not be accompanied by a similar increase in female employment in non-farm sectors; labourers as well as cultivators left agriculture.

The changes in employment pattern are driven by a complex set of pull and push factors, such as differences in inter-sectoral growth rates and wage rates, employment guarantee programmes (e.g. MGNREGS), education levels, etc. Labour absorption capacity of agriculture has almost reached its plateau; and relatively faster growth in non-farm sectors, higher non-farm wages and



improvements in literacy level of cultivators and agricultural labourers are some important factors responsible for the recent changes in employment.

The decline in share of agriculture in workforce though is consistent with the theory of economic development, it may create imbalance in demand and supply of labour in the short-run. A significant rise in agricultural wage rate may increase cost of food production which in turn (if not compensated by improvement in agricultural productivity) may cause rise in food prices.

Crop planning for resource use efficiency and sustainability

An optimum crop plan is essential to improve resource use efficiency and sustainability of agricultural production systems. Using plot-level data from cost of cultivation scheme the net income for major crops was estimated under three situations viz. (i) at market prices, (ii) at social cost and prices (net of subsidies), and (iii) natural resource valuation (NRV) and environmental cost for Punjab.

Net income from different crops in Punjab, TE 2010-11

(₹/ha)

Crop	Market prices	Economic prices	NRV
Paddy—non-Basmati	46,198	33,191	31,353
Paddy—Basmati	53,377	41789	39,951
Wheat	36,244	25,747	25,564
Maize	13,792	5,394	5,235
Sugarcane (Planted)	98,384	85,153	81,355
Sugarcane (Ratoon)	118,676	108,077	104,279
Rapeseed and mustard	14,450	7,556	7,441
Cotton	42,187	30,530	30,479
Potato	27,138	8,209	7,974
Peas	44,549	33,354	34,646
Vegetables	36,497	26,543	26,308

Paddy, especially Basmati, remains the most rewarding crops during *kharif* under market price situation, and also even after adding subsidies to cost and internalizing environmental costs and benefits (nitrogen fixation) perhaps due to assured prices and higher yields. In *rabi* season, pea cultivation becomes more profitable than wheat.

Trend in labour productivity in agriculture

Technological change has made significant impacts on labour absorption and labour productivity in India. There has been a significant improvement in labour absorption during 1975-1995. Labour productivity also improved during this period. After mid-1990s per hectare labour use declined in general. But, there was a notable improvement in labour productivity after the mid-1990s. The net impact of this is an increase in labour earnings in crop production. Nevertheless, there are considerable disparities in labour use and labour productivity across states.

Crop wise labour use and productivity in India

Crop	Use (h/ha)			Productivity (kg/ha)		
	1973-1976	1993-1996	2007-2010	1973-1976	1993-1996	2007-2010
Paddy	861.2	959.6	859.5	2.3	3.8	5.1
Wheat	686.1	452.9	392.9	2.8	6.8	9.8
Cotton	592.5	744.6	833.5	0.8	1.4	2.3
Sugarcane	1,609.9	1,690.8	1,602.5	24.2	39.2	41.8

Harvest and post-harvest losses of major agricultural crops and allied commodities

A survey on harvest and postharvest losses of major 45 crops and livestock produce in 14 agro-climatic regions of the country revealed that in cereals, the losses ranged from 4.6% (maize) to 5.9% (sorghum) and in pulses from 6.6% (green gram) to 8.4% (chick pea). Use of improper threshers and storage practices and delayed harvesting were the main reasons of these losses in pulses. Estimated losses of oilseeds ranged from 3.1% (cottonseed) to 9.9% (soybean). The losses in fruits ranged from 6.7% (papaya) to 15.8% (guava), whereas, in vegetables from 4.5% (tapioca) to 12.4% (tomato). In plantation crops and spices, the losses ranged from 1.1% (black pepper) to 7.8% (sugarcane). The losses were 7.1% in egg and 5.2% and 10.5% in inland fish and marine fish, respectively. The loss in sheep and goat meat was 2.7% whereas the loss in poultry meat was 6.7%. The loss of milk was observed to be 0.9%. In comparison to losses during 2005-07, the losses during 2013-14 have been reduced significantly for wheat, mustard, groundnut, mango, guava, mushroom, tapioca, arecanut, black pepper and coriander, whereas, for maize, sorghum, chickpea, soybean, sunflower, citrus, sapota, cauliflower, cashew, marine fish, meat and poultry meat were significantly increased. Overall losses for food grains, oilseeds and fruits and vegetables were 4.6% to 15.8%, which were 2% lower compared to previous study in 2005-07 in spite of tremendous increase of production in last 10 years. The estimated annual value of the losses, based on average wholesale prices of 2014, was about ₹ 92,651 crore.

Fluctuations in onion prices: An analysis

Consumption of onion is growing steadily with increase in income levels, changing life-style, dietary pattern and urbanization. Post 2002-03 period witnessed exponential growth in onion production enhancing per capita availability, consumption and exports. Clustering of production and perishable nature of onion has resulted in a mismatch in demand-supply. The onion wholesale price indices (WPI) has witnessed severe volatility vis-à-vis food and non-food articles. During the last 10 years, three onion price shocks were experienced indicating the extent of onion price sensitivity to small variations in supply.

The onion prices in and arrival of the leading state, Maharashtra indicated fewer peaks in arrivals and

steeper spikes in prices. It may either due to increased storage capacity of producers enabling them to realize price advantages in lean season or increased stocks by buyers and big traders. The analysis of year 2013 onion availability revealed that traders quickly captured the signals of the impending shortage and its implications and had clear strategy to harness the situation. To encounter such a strategy, an effective mechanism is required with emphasis on the ways of stabilizing supply and prices through stock, trade, de-clustering cultivation and effective state interventions - market intelligence, crop insurance, cold chains, warehousing (particularly in Indo-Gangetic Plans and North-East), grading, sorting, processing, etc.

EMPOWERING WOMEN IN AGRICULTURE

Agriculture is the backbone of the Indian economy and women play a key role in agricultural development and have multi dimension roles in various agricultural activities which is vital for agriculture growth and food security. The Central Institute for Women in Agriculture (CIWA), Bhubaneshwar, is functioning for development methodologies, identification of gender implications in farming systems approach and to develop women specific technologies under different production systems.

Nutrition and livelihood enhancement of tribal families

Demographic profile including socio-economic status, daily routine, resource availabilities and role performance of tribal farm women were assessed. Nutritional status of children (1 to 10 age group) of tribal farm families at village Tarajodi, Mayurbhanj district, revealed that 65.12% had normal nutritional status, 9.30% moderately undernourished, and 9.30% severely undernourished. Gender difference was observed as 13.04% of girls were severely malnourished and 8.70% moderately undernourished in comparison to boys. Awareness creation-cum-skill upgradation programmes on improved methods of homestead gardening, cultivation of potato, sunflower and groundnut, scientific and hygienic storage of food grains to prevent losses during storage were conducted and interventions were made at the selected tribal villages.

Resource efficient horticultural model

A resource efficient horticulture model was developed in 2,000 m^2 area with different components like high density planting of banana, meadow orcharding of guava, high density planting of papaya, pineapple, lime, different green leafy vegetables, roots and tuber crops and other vegetables. An effort was made to standardize suitable intercrops in coconut based multi-storey cropping model with banana, papaya and guava as second storey crops. Different ground storey intercrops like cowpea, turmeric, elephant foot yam and pineapple were cultivated in the interspaces of the main crop. An income of ₹ 60,000/ year and ₹ 1,60,000/year/ha was obtained from coconut and mango as single crop at the age of six years with

Resource efficient horticultural model

average nut yield of 20 nuts/plant and fruit yield 20 kg/ plant, respectively while income of ₹ 4,76,000/year/ha was estimated from mango + turmeric cropping model.

Enhancing livelihood of rural women through livestock

Five lines of sweet potato (Keonjhar, ST-13, ST-14, Shree Kanak and Kamla Sundari) and the two highest foliage producing germplasm (Keonjhar and Kamla Sundari) were evaluated under different harvesting intensity for making available quality fodder to improve the productivity of livestock and increasing income of farm women. Three harvesting treatments were applied viz. no harvest during growth period, 100% and 50% harvest of foliage at 110 days after planting (DAP). Observations on total forage yield and tuber yield for Kamla Sundari revealed that the effect of treatment was

Clothing to combat occupational health hazards of farm workers

Functional clothing trials in cotton field

For combating occupational health hazards, protective clothing namely *kurta pyjamas*, aprons, mask, ear muff and head gear cum scarf with functional features were developed for the workers engaged in different activities in agriculture, agriculture allied sectors, and textile sectors, and assessed for its suitability and acceptability among workers through wear trials. During wear trial of *kurta pyjamas,* KP-2 with 70GSM made from non-woven fabric (cotton fabric with 126 GSM and 51 x 38 fabric count used as lining material) was found to be best (aggregate weighted mean score 2.3) with regard to suitability for plucking *ber* fruit. Similarly, for the workers engaged in okra picking, during wear trials, knitted gloves were found to be suitable, comfortable and durable with highest WMS of 4.0 than hand gloves of woven and latex coated fabric.

not significant for the tuber yield but the forage yield differed significantly among treatments. In Keonjahr germplasm, tuber yield declined significantly when foliage was completely harvested during the growth phase of the crop as compared to the control.

Aqua and poultry feed from fish and shellfish wastes

Effect of dietary inclusion of fish silage prepared from fish waste was studied in Japanese quails, poultry vanraja and rohu (*Labeo rohita*) fingerlings. In Japanese quail layers, egg production significantly increased with silage based diet. Use of fish silage with replacement of fish meal, reduced feed cost/kg egg mass up to 4.25%. The weight of vanraja birds increased significantly when the fish silage replaced fish meal and soybean meal in the diets. The feed cost/kg weight reduced by 14.03%.

Gender related indices in agriculture

Women Empowerment in Agriculture Index (WEAI) was computed as 0.66. Three new domains for indices related to gender in agriculture such as women's empowerment in agricultural activities, gender based tagging of crops/farming systems and gender friendly technologies were identified and various indicators for construction of the indices were also conceptualized.

Gender issues in IPM and suitable interventions

Data from 10 different agro-climatic zones of Odisha, collected for identification of gender issues in IPM and suitable interventions with women's perspective, revealed that women were using ITK related to pest management. Lack of access to technical information on IPM and non availability of women friendly sprayers were the constraints in every agroclimatic zones of Odisha. *Krishi Rakshaks* of two agroclimatic zones were trained for scouting and monitoring of insect pests.

AICRP on Home Science

The All India Co-ordinated Research Project (AICRP) on Home Science is in operation at 10 centres under nine State Agricultural Universities. Three new centres viz. Central Agricultural University, Tura; Tamil Nadu Agricultural University, Madurai; and Sardarkrishinagar Dantewada Agricultural University, Dantewada were included in the XII Five-Year-Plan and became operational from the financial year 2015-16. The main thrust of the project is to empower the women in agriculture for their improved nutrition and livelihood security, and drudgery reduction for better quality living.

Characterization of drudgery

To characterize drudgery of women, five operational villages were selected by each centre following the criteria of accessibility, diversification in production systems and women participation. The predominant production systems of the operational villages were selected for the survey. Six variables were selected for characterizing drudgery of women in production system viz. physical load, posture, repetitive strain, physiological load, duration/time, body pain and disorders. During the period under report, four production systems, viz. wheat, maize, vegetable (spinach, tomato) and sugarcane of the operational villages were identified to characterize drudgery. Technologies (23) were developed/refined/tested by different centres for mitigating drudgery of farm women. Eight technologies were ergonomically evaluated after field interventions, viz. hand wear for vegetables and soybean harvesting, cotton picking, cotton stalk pulling, groundnut striping, potato picking, *bhindi* picking, harvest bags (back and front model) and weeding and interculturing of strawberry production. Technologies scaled up for introduction among SHG were harvest bags (basket), seed-cum-fertilizer bag, seed placement tube, head load managers, revolving milking stool and stand, tailoring table, *gopal khore*, *trishul* weeder and cotton picking apron.

Farm activities by women

Characterization of nutritional diversity in selected cropping systems

Households (810; 90 from each centre) were selected for assessment of gaps related to food and nutritional security. Based on the socio-economic factors, families were categorized into low income group (LIG), middle income group (MIG) and high income group (HIG). In LIG category, complete immunization was recorded in Telangana (43.3%), Haryana (63.3%) and Maharashtra (46.6%) whereas in MIG category, Telangana (30%) had the lowest percentage of complete immunization. Similarly among pregnant women, food restrictions were common in Asom, Telangana and Karnataka, whereas these were not practiced in Haryana.

Empowering youth for quality living

A total of 1,350 school children from 9 centres (i.e. 100-150 children from each centre) studying in VII – X standards in the age group of 11-17 years were selected for empowering youth engaged in agriculture and allied activities with technology and life skills for quality living. In 2015, they were assessed on three aspects viz. reasons for academic backwardness, vocational interest and socio-emotional problems along with their socio-economic status and facilities available. The reasons reported for academic backwardness were academic (39.21%), health (30.56%) and familial (24.36%) reasons.

Commercialization of women-friendly technology DRWA-hand-operated maize dehusker cum sheller

The Institute has commercialized the technology 'DRWA-hand-operated maize dehusker cum sheller with Private manufacturer of agricultural implements, Cuttack on 20th Feb, 2015. The ICAR-CIWA has developed a farm machinery viz. 'DRWA- hand-operated maize dehusker cum sheller', which is a women-friendly hand operated equipment for shelling and de-husking of maize with an output of 60 kg/h. The technology has received appreciation from different stakeholders in widely tested field trials during 2012-14. Considering the necessity of the technology for large scale adoption, the technology has been commercialized for promoting localized production/manufacture to ensure the availability of this technology to the farming community, mitigate the drudgery of farm women, and promote the micro and small enterprises dealing with farm implements.

Contingency plan to tackle aberrant weather situation in Odisha

Districts viz. Mayurbhanj, Angul, Jajpur and Sambalpur of Odisha have been selected for contingency plan, based on their vulnerability to floods during monsoon season. Scientists from ICAR-CIWA are regularly visiting the villages in the districts for weather-based advisory services, and to bridge the technological gaps.

Gender in agriculture partnership (GAP)-India

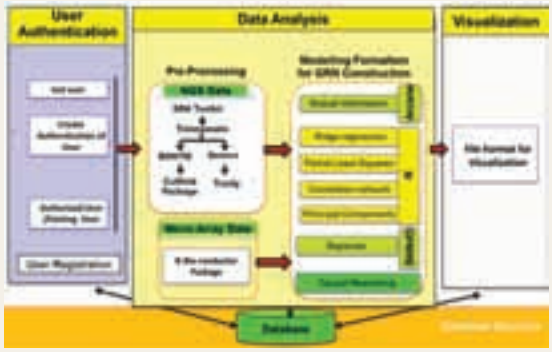
Gender in Agriculture Partnership is for transforming agriculture to empower women and deliver food, nutrition and income security. The GAP-India will work towards to catalyzing the GAP activities in South Asia and link with partners in other countries to benefit and support gender equity actions in the region.

STATISTICS

Web generation of polycross designs (webPD): Polycross nursery is a specific type of field design to ensure random mating among the genotypes and is commonly used in the breeding of wind-pollinated species. For easy accessibility and quick reference of polycross trials by the experimenters, online software was developed. This software provides freely available solution for the researchers and students working in this area and is available at http://design.iasri.res.in/webpd. The software generates five different series of polycross designs and two series of Octa Neighbour Balanced Polycross Designs balanced for eight directions. It displays the layout plans by entering the value of v (number of genotypes) and also displays the parameters of the designs. Along with the designs, the software also displays a complete description about the methods of construction along with example for all the five different series of designs. The online catalogue ($v \leq 20$) of all the five series of polycross designs was also prepared and included in the software, giving the parameters from where design can also be generated.

Web based tool for modeling gene regulatory network (GRN)

This online tool facilitates pre-processing next generation sequencing (NGS)/microarray data, constructing GRN via different modeling formalisms and visualization of network. The program computes gene expression from microarray and NGS data, which can be used further for reconstruction of regulatory networks and thereby subjected for visualization.



SBMDb: First whole genome putative microsatellite DNA marker database of sugar beet for bioenergy and industrial applications (http://webapp.cabgrid.res.in/sbmdb)

The sugar beet whole genome marker discovery and database, SBMDb was developed with 145K markers unified in a common platform. The database presents a wide source for developing and implementing new approaches for molecular breeding, which are required to accelerate industrious use of this crop, especially for sugar, health care products, medicines, and colour dye. Identified markers will help in improvement of bioenergy trait of bioethanol and biogas production along with reaping the advantage of crop efficiency in terms of low water and carbon footprint especially in the era of climate change.

Management Information System (MIS) and Financial Management System (FMS) in ICAR (http://icarerp.iasri.res.in): The system was implemented in 108 ICAR institutions. Data digitization work was carried out in all ICAR institutions; more than 20,000 users were created in the system. More than 10,000 personnel were trained on system.

Unified messaging solution (email with chat features) was implemented (https://mail.icar.gov.in)

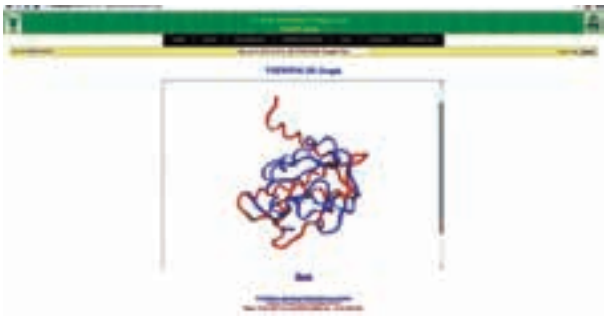
It can be accessed through webmail, outlook and mobile. Microsoft Lync provides instant messaging. E-mail ids were issued for all Directors and key

officials of ICAR-HQ. Email ids are being created for ICAR employees after verification of data from institutes. Accounts were created for more than 70 institutions. KRISHI Portal, Agroweb, NAIP and other applications running from IASRI server (HYPM, NISAGENET) were migrated into Data center environment.

Bioinformatics

Antimicrobial prediction server and algorithm/tool for protein structure comparison were developed for

cattle. Antimicrobial peptides (AMPs), the defence molecules of the host, are being natural alternative to



chemical antibiotics resistance to which is a major challenge in animal health. As cow genome sequence is already available, a computational tool was developed to predict potential peptides having properties of AMP. Ninety-nine well reported natural existing AMPs related to cattle were collected. Statistical analysis to develop model through application of artificial neuron network (ANN) and support vector machine (SVM) can predict putative genes coding for peptides having properties similar to natural existing AMP. Such predictive tool and server can be of immense use in future discovery of "organic" natural existing AMP from cattle genome without having problem of antibiotic resistance. Further, this will reduce the time and cost required in bioassay of potential AMP molecule. The species specific approach is novel and reported for the first time.

Protein structure comparison play important role in *in-silico* functional prediction of a novel proteins. This will help in understanding related coding genes and their use in development of superior varieties/ breeds /commodities in agriculture. To develop algorithm and tool for protein structure comparison, an efficient technique was developed using elastic shape analysis (ESA). The performance of the developed algorithm/tool was more efficient than the existing methods. Also, user friendly web-based application called ProtSComp was developed using above algorithm that can be accessed freely by the users.