सत्यमेव जयते

AGRICULTURAL SITUATION IN INDIA

Since 1948

OCTOBER,2021

AGRICULTURAL SITUATION IN INDIA

VOL. LXXVIII October, 2021 No. 7

Publication Division

Directorate of Economics
and Statistics
Department of Agriculture & Farmers Welfare
Ministry of Agriculture & Farmers Welfare
Government of India
103, F-Wing, Shastri Bhawan,
New Delhi-110 001
Phone: 23380074
(Email: publication.des-agri@gov.in)

Soft copy of the journal is also available at:
eands.dacnet.nic.in/publication.htm

Subscription

		Inland	Foreign
Single Copy	:	₹ 40.00	£ 2.9 or $ 4.5
Annual	:	₹ 400.00	£ 29 or $ 45

Available from
The Controller of Publications,
Ministry of Urban Development,
Deptt. of Publications,
Publications Complex (Behind Old Secretariat),
Civil Lines, Delhi-110 054.
Phone : 23813761, 23813762, 23813764, 23813765
(Email: acop-dep@nic.in)

For article submission see last page.

Contents

From Editor's Desk

This issue of Agricultural Situation in India brings out for its readers the recent farm sector news, inflation rates and price indices of food and non-food items among other statistical information. This edition also covers two research articles titled "Economics of Rice Production and Productivity in Punjab: Some Recent Trends" and "Water Management and Cropping Pattern: A Case Study of Mahabubnagar District", and a brief summary of an Agro-Economic Research on "Improving Water Use Efficiency in India's Agriculture: The Impact, Benefits and Challenges of Micro Irrigation (MI) under the PMKSY-PDMC in Uttar Pradesh" conducted by Agro-Economic Research Centre of University of Allahabad under the AER scheme of DES.

The major farm sector news of October month shared in this edition are: Business Summit on National Mission on Edible Oils-Oil Palm in NE states held; hybrid seed minikits to be distributed; webinar on "Women in Agri-Startups: Creating Value with Supply Chain Management" held; Union Agriculture Minister inaugurates Apple Festival in Kashmir; Third Advance Estimates of Area and Production of Horticultural Crops of 2020-21 released; Union Agriculture Minister addresses National Conference on 'International Year of Fruits and Vegetables.'

For the month of October, 2021 food inflation stood at 12.54 percent. The Wholesale Price Index (WPI) of pulses, fruits, cereals and wheat increased by 5.36 percent, 8.22 percent, 3.22 percent and 8.14 percent, respectively, whereas for vegetables and paddy, it decreased by 18.49 percent and 0.55 percent, respectively, in October, 2021 as compared to corresponding period of last year. The cumulative post-monsoon season rainfall in the country during the period 1st October, 2021 to 27th October, 2021 has been 38 percent higher than the long period average (LPA). Current live storage in 133 major water reservoirs in the country was 141.72 BCM as against 130.10 BCM of normal storage based on the average storage of last 10 years.

The article on Economics of Rice Production and Productivity in Punjab discusses the trends in production and productivity in the post-Green Revolution era. The study finds that rice production is robust and growth is driven predominantly by an increase in yield and to some extent by a shift in the area from other crops. Rice production has brought an assured income to the growers and has resulted in a massive shift in the growing pattern. But, this has come at a cost of depletion in groundwater resources of the state, reduced soil fertility and air pollution because of stubble burning. As rice is a major part of Indian diet, its production needs to be enhanced but not at the cost of environmental degradation. New varieties like organic paddy may be encouraged as it has higher yield, less water guzzling, higher price returns and more environment friendly. The study is of the opinion that Punjab may emerge as a breadbasket of the entire country in the future depending on income and population growth, posing compliance to India's rising food stocks and hovering food security target of the Government.

The second article examines the water management and cropping pattern with three commodities *viz.*, paddy, vegetables and jowar with focus on Mahabubnagar district of Telangana. According to the study, water scarcity is a major factor influencing a change in cropping pattern which in turn affects the income level of farmers. Further, the study suggest that watershed programmes need to be introduced for ground water management as this is the major source of irrigation for the crops. To overcome water shortage, micro irrigation practices may be employed to reduce water wastage, provide adequate water to the crops and to reduce monetary losses due to low yield on account of water scarcity.

The Agro-Economic Research study on "Improving Water Use Efficiency in India's Agriculture: The Impact, Benefits and Challenges of Micro Irrigation (MI) under the PMKSY-PDMC in Uttar Pradesh" evaluates the Per Drop More Crop (PDMC) component of Pradhan Mantri Krishi Sinchayee Yojna (PMKSY) and the impact, benefits and challenges of MI system for the farming community in particular and the overall agriculture sector in general. The study mainly analyzes the various benefits of MI to farmers including input use, cost and returns, also its impact on quality and productivity on major crops and its contribution in employment generation. The findings show that area under micro irrigation is steadily increasing with majority of area covered by horticultural crops like potato, tomato, etc. and agricultural crops like wheat, sugarcane, maize, etc. The overall effect of MI is seen in increased yield, better crop prices and reduction in expenditures on fertilisers, pesticides, diesel, etc. The study recommends that there is still a wide scope for development of this scheme with more support in form of subsidies, better marketing arrangements, impartment of more knowledge and training to farmers and by bringing more and more area under its coverage.

Promodita Sathish

Farm Sector News

Meetings and Events

Business Summit on National Mission on Edible Oils-Oil Palm in NE states held

The Hon'ble Union Minister of Agriculture & Farmers' Welfare, Shri Narendra Singh Tomar, on the occasion of National Mission on Edible Oils-Oil Palm Business Summit for North Eastern States held at Guwahati on 5th October, 2021 asserted that the Government's decision for making major intervention in North Eastern states for oil palm promotion will turn NE states into oil palm hub of the country. Shri Tomar emphasized on playing an equal role for the development of the crop and assured to make major investments for seed nursery, drip irrigation, technical back up, setting of mills, purchase centers and training of farmers. He added that a special package and assistance for NE states will change the socio-economic status of the farmers and will open employment opportunities in the established oil palm mills along with infrastructure development.

The Hon'ble Union Minister informed that the business summit has been aimed to explore the target of area expansion, seedling requirement fixed for different states through processors, details of viability gap payment, interventions and assistance under the mission which with a total outlay of Rs. 11040 crores will bring additional area of 6.5 lakh hectares under oil palm plantation with 3.28 lakh hectares in North Eastern states and 3.22 in Rest of India in next 5 years.

Certificates for FPOs formed by NABARD were distributed and an MOU was signed with ABPRL and Numaligarh Refinery to establish the first of its kind bio refinery in India to produce renewable green fuel bioethanol. In the Summit, books titled "Glimpses of NMEO-Oil Palm in NE States" by Oilseeds Division, DA&FW and "Improved Management Practices of the Oil Palm Cultivation in NE States" by ICAR-IIOPR and Assessment Report were released.

Webinar on "Women in Agri-Startups: Creating Value with Supply Chain Management"

The Department of Agriculture & Farmers' Welfare on 22nd October, 2021 organized a webinar on "Women in Agri-Startups: Creating Value with Supply Chain Management" in the series of events for celebrating Mahila Kisan Diwas, 2021. The webinar was organized under the guidance of Hon'ble Union Agriculture Minister, Shri Narendra Singh Tomar, and in the presence of Hon'ble Minister of State for Agriculture & Farmers' Welfare, Shri Kailash Choudhary. During the webinar, Shri Choudhry also released an e-book depicting "Success Stories of 75 progressive women farmers and women entrepreneurs" to commemorate 75 years of 'Azadi Ka Amrit Mahotsav.'

Inaugurating the webinar, Shri Kailash Choudhary stated that women's contribution to the development of agriculture has increased manifold. Women play a decisive role in ensuring food security and preserving local agro-biodiversity and the Government of India is committed to give priority to women for bringing them into the mainstream of agriculture development.

The webinar on Women in Agri-Startups focused on enabling women entrepreneurship in agribusiness; strategy and schemes to support agri-startups in India; technology transfer to startups for commercialization; value chain management and challenges faced by agri-startups agripreneures. Agriculture sector employs 80% of all economically active women; they comprise 33% of the agricultural labour force and 48% of self-employed farmers. With women predominant at all levels of production - pre-harvest, post-harvest processing, packaging, marketing- of the agricultural value chain, it is imperative to adopt gender-specific interventions to increase productivity in agriculture. The Government has tried to push the agenda of 'Gender Mainstreaming in Agriculture' by way of earmarking funds for women under various schemes/ programmes and development interventions; introducing 'pro-women initiatives' to help women derive the benefits of all beneficiary-oriented components of different programmes. The focus is on the formation of women Self Help Groups (SHGs), Women Federations and Women Farmer Producer Organisations; capacity building interventions; linking them to microcredit; enhancing their access to information and ensuring their representation in decision making bodies at various levels.

Union Agriculture Minister virtually inaugurates Apple Festival in Kashmir

Hon'ble Union Minister for Agriculture and Farmers' Welfare, Shri Narendra Singh Tomar, and the Lieutenant Governor, Shri Manoj Sinha, on 28th October, 2021, virtually inaugurated the Apple Festival, organized for the first time in Srinagar, Jammu and Kashmir. Appreciating the Jammu and Kashmir Government's efforts, Shri Tomar said that Government is doing good and speedy work for the development of agriculture in the UT with the funds provided under various schemes by the Central Government.

Shri Tomar said that this event will provide a better platform to apple growers and other stakeholders. With an annual production of more than 2.2 million metric tonnes, the apple from J&K contributes to 87 percent of the national production and is linked to the livelihood of about 30 percent of the population of Jammu and Kashmir. Shri Tomar expressed happiness that high density plantation has been done in 2300 hectare area under a special scheme in the UT and the largest quarantine center for high density planting material is also being opened.

Union Agriculture Minister addresses National Conference on 'International Year of Fruits and Vegetables'

Hon'ble Union Minister for Agriculture & Farmers' Welfare, Shri Narendra Singh Tomar, on 29th October, 2021 addressed a National Conference on "International Year of Fruits and Vegetables" organized by the Ministry of Agriculture and Farmers' Welfare in collaboration with the Food and Agriculture Organization of the United Nations. The Minister also released operational guidelines for the Horticulture Cluster Development Programme and QR code of the guidelines. The conference was organized as part of the celebration of the "International Year of Fruits and Vegetables, 2021" declared by United Nations Organization. The theme for this year is "Awareness about the nutritional benefits of fruits and vegetables for balanced and healthy diet and lifestyle."

In his keynote address, Shri Narendra Singh Tomar said that this conference is a unique opportunity to raise awareness about the important role of fruits and vegetables in human nutrition, health, food security and also in achieving Sustainable Development Goals of the United Nations. To promote globally popular exotic and important indigenous fruit crops in the country, the Ministry has identified 10 globally popular exotic fruit crops of commercial importance and 10 important indigenous fruit crops with high nutritional and nutraceutical properties. The State Horticulture Departments have also been given targets for the year 2021-22 regarding area expansion for these crops. During the current year, 8951 hectares area for exotic fruits and 7154 hectares area for indigenous fruits will be brought under cultivation.

Shri Tomar said, "India is the second-largest producer of horticulture, producing about 12% of the global fruit and vegetable production. During the year 2019-20, we recorded the highest ever production of 320.77 million metric tonnes in horticulture, while the horticulture production for 2020-21 is estimated to be 329.86 million metric tonnes, which is also higher than the previous year."

Shri Sanjay Agarwal, Secretary, Department of Agriculture & Farmers' Welfare, Government of India said that horticulture has become the growth engine of Indian agriculture. He further stated "International Year of Fruits and Vegetables", is an attempt of the UN to raise awareness on the importance of fruits and vegetables in our daily lives as well as in doubling of farmers' income. He said no one should be deprived of nutritional fulfilment.

Shri Tomio Shichiri, FAO Representative in India, informed that the FAO Regional Office for Asia and the Pacific (FAO-RAP) and the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT) have also organised a webinar with the theme of "Mainstreaming Indigenous Fruits and Vegetables for a Food and Nutrition Secure Future" for celebrating the Year of Fruits and Vegetables. He further said that it is a great opportunity to listen and share the national and international priorities from the decision makers on the promotion of fruits and vegetables.

General Agricultural Sector News

Seed minikits distribution

Under a special programme by the Union Ministry of Agriculture and Farmers' Welfare, 8,20,600 seed minikits will be distributed free of cost in 343 identified districts of 15 major producing states of

the country. This program will increase production and productivity by increasing the seed replacement rate, which will help in increasing the income of the farmers. Hon'ble Union Minister for Agriculture and Farmers' Welfare, Shri Narendra Singh Tomar, launched the programme on 11th October, 2021 by distributing mustard seed minikits worth about Rs. 2 crores in Morena and Sheopur districts of Madhya Pradesh.

The programme has been started under the National Food Security Mission (NFSM) - Oil Seed and Oil Palm scheme. Shri Tomar informed that after micro-level plan for the major mustard producing states of the country, approval has been given to implement minikit distribution of rapeseed and mustard seeds this year. The Ministry has approved 8,20,600 seed minikits consisting of seeds of high yielding varieties with productivity of more than 20 quintals per hectare for distribution in 343 identified districts of 15 states. The programme covers various districts of all the major producing states like Madhya Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Jammu & Kashmir, Jharkhand, Odisha, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand, Assam, Arunachal Pradesh and Tripura. Rs. 1066.78 lakh have been allotted for this programme.

Shri Tomar said that Morena and Sheopur of Madhya Pradesh, Banaskantha in Gujarat, Hisar in Haryana, Bharatpur in Rajasthan, and Etah and Varanasi districts of Uttar Pradesh have been selected for distribution of hybrid seed minikits under pilot project during this year. In these 7 districts of 5 states, 1,20,000 seed minikits from a total of 1615 quintals of seeds will be prepared and distributed. Each district will be given 15 to 20 thousand seed minikits. In addition to the regular programme, three TL hybrid high yielding varieties of mustard have been selected for seed minikit distribution. The selected varieties are JK-6502, Champion and Dawn.

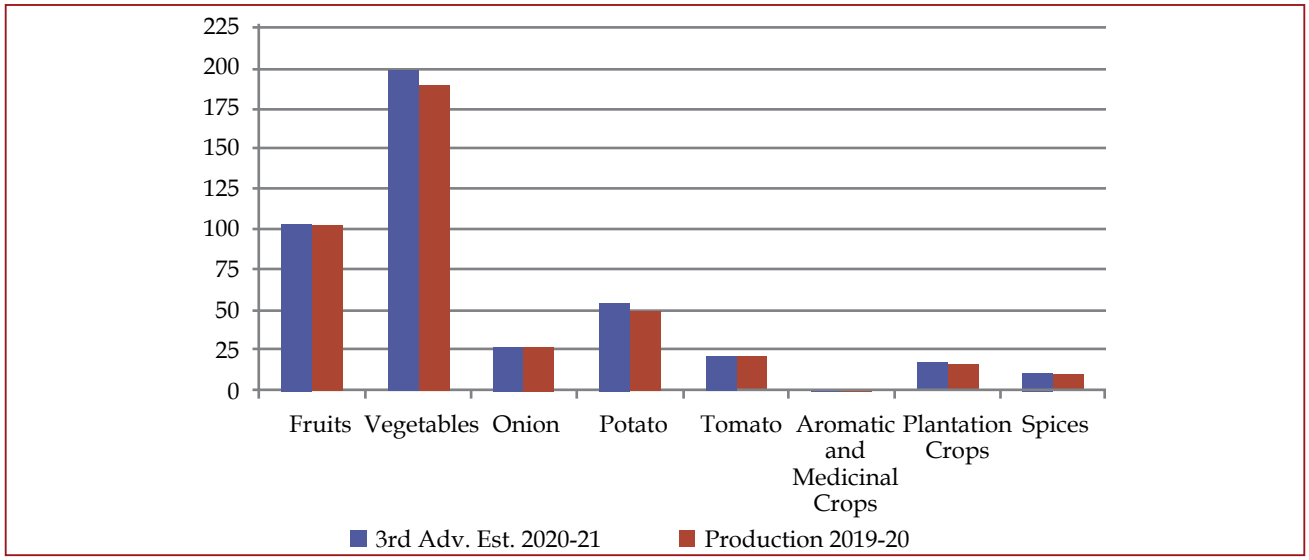
Third Advance Estimates of Area and Production of Horticultural Crops of 2020-21 released

The Department of Agriculture and Farmers' Welfare has released Third Advance Estimates (2020-21) of area and production of various horticultural crops. The horticulture production in the year 2020-21 is estimated to be a record 331.05 million tonnes which is an increase of 10.6 million tonnes (3.3%) over 2019-20.

Total Horticulture	**2019-20 (Final)**	**2020-21 (3rd Adv. Est.)**
Area (in Million Ha)	26.48	27.59
Production (in Million Tonnes)	320.47	331.05

Source: DES, DA&FW, Govt. of India

Highlights of 2020-21 (Third Advance Estimates)



Source: DES, DA&FW, Govt. of India

Major Crops	2020-21 (3rd Adv. Est.)	Production 2019-20 (Final)
Fruits	103 MT	102.1 MT
Vegetables	197.2 MT	188.3 MT
Onion	26.8 MT	26.1 MT
Potato	54.2 MT	48.6 MT
Tomato	21.1 MT	20.6 MT
Aromatic & Medicinal Crops	0.78 MT	0.73 MT
Plantation Crops	16.6 MT	16.1 MT
Spices	10.7 MT	10.1 MT

Source: DES, DA&FW, Govt. of India

General Survey of Agriculture

Trend in Food Prices

The rate of inflation, based on monthly WPI, stood at 12.54% (provisional) for the month of October, 2021 as compared to 1.31% during the corresponding period of last year.

Based on Wholesale Price Index (WPI) (2011-12 = 100), WPI of pulses, fruits and cereals increased by 5.36 percent, 8.22 percent and 3.22 percent, respectively, whereas for vegetables, it decreased by 18.49 percent in October, 2021 over corresponding period of last year.

Among cereals, WPI for paddy decreased by 0.55 percent and for wheat increased by 8.14 percent in October, 2021 over October, 2020.

The WPI for cereals, fruits and vegetables increased by 0.75 percent, 8.87 percent and 31.87 percent, respectively, whereas for pulses, it remained constant in October, 2021 over September, 2021.

Among cereals, WPI for paddy and wheat increased by 0.49 percent and 1.72 percent, respectively, in October, 2021 over September, 2021.

WPI food index (weight 24.38%)

The Food Index consisting of 'Food Articles' from Primary Articles group and 'Food Product' from Manufactured Products group have increased from 159.8 in September, 2021 to 164.8 in October, 2021. The rate of inflation based on WPI Food Index decreased from 1.14% in September, 2021 to 3.06% in October, 2021.

Rainfall and Reservoir Situation, Water Storage in Major Reservoirs

Cumulative Post-Monsoon Season, 2021 rainfall for the country as a whole during the period 1st October, 2021 to 27th October, 2021 has been 38% higher than the Long Period Average (LPA). Rainfall in the four broad geographical divisions of the country during the above period has been higher than LPA by 206% in North-West India, by 23% in South Peninsula, by 20% in East & North East India and by 15% in Central India.

Out of 36 meteorological sub-divisions, 22 meteorological sub-divisions received large excess/ excess rainfall, 09 meteorological sub-division received normal rainfall and 05 meteorological sub-divisions received deficient/large deficient rainfall.

Current live storage in 133 reservoirs (as on 28th October, 2021) monitored by Central Water Commission having Total Live Capacity of 172.46 BCM was 141.72 BCM as against 150.52 BCM on 28.10.2020 (last year) and 130.10 BCM of normal storage (average storage of last 10 years). Current year's storage is 94% of last year's storage and 109% of the normal storage.

Articles

Economics of Rice Production and Productivity in Punjab: Some Recent Trends[#]

DR. NIRMAL SINGH[*]

Abstract

Punjab produces about 13 million tonnes of rice each year, what is about 12 percent of the national production. This paper examines the characteristics of the rice economy of Punjab, addressing questions on the nature of production, marketing, and the prospects of yield growth. The analysis indicates that rice production is robust and growth is driven predominantly by an increase in yield, and to some extent by a shift in the area from other crops. Punjab may emerge as a breadbasket of the entire country in the future depending on income and population growth, posing compliance to India's rising food stocks and hovering food security target of the government.

Keywords: *Rice production, yield, growth, sustainability, cropping pattern, productivity*

1. Introduction

The Green Revolution technology consisting of high-yielding varieties of seeds (initially of wheat and subsequently of rice), chemical fertilizers and assured irrigation spread all over Punjab. Huge public investments in support of agricultural infrastructure including irrigation, roads and price incentives encouraged wheat and rice production especially during 1970s and 1980s. Soon after, Punjab emerged as a dominant food grain surplus state in the country, contributing immensely to meet the national food security targets. With about 3 percent of India's net sown area and 1.5 percent of its farming population, Punjab produces about 12 percent of the country's rice and about 45 percent of total rice procured by the government.

Wheat and rice together account for over eighty percent of the gross cropped area in the state. Before the Green Revolution, rice was virtually invisible and wheat accounted for about 30 percent of the cropped area. This trend changed abruptly with the emergence of new farming techniques. In pace with technological innovations and their adoption, and a supportive price policy and procurement environment, first wheat and then rice flourished. The 1970s and 1980s saw rapid area expansion of these two crops, largely at the expense of other crops, and rapid yield growth. However in the 1990s, the pace of yield growth decelerated considerably. The sluggish growth rate of rice yield has raised serious concerns on the long-term sustainability of the hybrid seeds, intensive fertilizers and irrigation strategy. Given these facts and the importance of rice, this paper examines the rice economy of Punjab.

1.1 Objectives of the study

1. To analyze the growth of rice production in Punjab with special reference to ensure food security of the country.

2. To undertake a comparative analysis of the cost and returns of rice crop grown in Punjab.

3. To empirically examine whether government intervention has influenced

[#]This paper is a part author's ICSSR & MHRD (IMPRESS Scheme 2018-19) Research Project.

[*]Associate Professor in Economics, Sri Guru Gobind Singh College of Commerce, University of Delhi

Received: 16 June, 2021

Editorial Decision: 06 December, 2021

rice production and productivity across the state.

2. Data sources and methodology

The study makes use of data available in various publications of Statistical Abstract of Punjab and reports of Commission for Agriculture Costs and Prices (CACP). Multiple mathematical, statistical and econometrics techniques have been used to analyze the data and test the hypothesis. These techniques include Cobb-Douglas production function, regression models (GLS/OLS), test of significance, compound growth rate, linear growth rate, exponential growth curve, linear trend line, etc.

2.1 Compound growth rate/Semi–log function

This can be depicted as follows:

$$y = ab^t$$

$$\log y = \log a + t \log b$$

$$Y = A + B_t$$

where,

'Y' is the dependent variable for which growth rate is estimated *i.e.* production/yield of various crops.

't' is time variable

'b' is regression coefficient

'a' is intercept

The growth rate 'r' is obtained from the logarithmic form of the equation as follows:

$$\log y = \log a + t \log b.$$

Thereafter, the growth rate ('r' in percent) is calculated as:

$$r = [(\text{Antilog of } \log b) - 1] * 100$$

2.2 Quadratic growth rate of degree two/Second degree exponential growth curves

$$\log Y_t = \log A + bt + ct^2$$

The exponential growth is worked out with the help of a polynomial of degree two or a quadratic function which represents an increasing or decreasing trend or both.

$$Y_t = a_0 + a_1 t + a_2 t^2$$

The derivation of the slope of this function is

$$dY_t / dt = a_1 + 2a_2 t.$$

Now there are four possibilities;

(i) $a_1 > 0, a_2 > 0$

(ii) $a_1 > 0, a_2 < 0$

(iii) $a_1 < 0, a_2 > 0$

(iv) $a_1 < 0, a_2 < 0$

In case (i) Y_t increases monotonically. In case (ii) for small values of t, a_1 may dominate $2a_2 t$ and hence Y_t may increase; but as t takes larger values, the second term will dominate the first term and slope becomes negative implying that Y_t will decrease. In case (iii) we have the reverse of the case (ii) and in case (iv) we have the reverse of the case (i) *i.e.*, Y_t decreases monotonically.

To examine the impact of mechanization on rice crop productivity, the following linear regression model using data on yield (qtl./ha) and farm machine labour used (Rs./ha) in crop production from the CACP Reports has been applied.

$$\log Y_{it} = a + \beta i * \log (ML_{it})$$

where,

Y_{it}= yield of rice crop

ML_{it} = machine labour used in rice crop

βi = elasticity of rice crop

a = constant

3. Results and discussions

3.1 Growth of rice production

The Green Revolution (seed-fertilizer biotechnological innovations) alias the new agricultural strategy for developing the agrarian economy was developed by the US Government and transmitted to India first in wheat during the mid-sixties and later in rice during the early seventies through the World Bank Mission. Given its soil and climatic conditions, and government support through subsidies and minimum support price and procurement, the cropping pattern shifted in favor of wheat-rice rotation during the last four decades. Until recently, the shortage of food grains in other parts of India was a major source of absorption of the surplus produced in Punjab. The State is among the topranking states at the national level in terms of per hectare productivity of rice. The agriculture sector of Punjab is a big donor in buffer stocks of food grains by frequently offering a major chunk of its rice surplus to the central pool. At present, rice constitutes eighty percent share in the net cropped area. The consistent expansion in the area under rice cultivation is because of suitable seasonal cropping patterns for the farmers' which ensures maximum profitability. The non-sustainability in yield and production of other crops makes rice the optimal choice of farmers as it keeps farm income free from any volatility. Consequently, the area under rice is on a rising trend.

Rice is a staple food crop of Punjab and due to its high consumption by people, the crop is grown under vast cultivated area. Its production has been increasing at a fast rate due to variable soil and favourable climatic conditions despite a declining resource base particularly water table, soil fertility and pest resistance.

The remarkable progress of food grain production in the post-Green Revolution period in Punjab was a mixed blessing. It was possible to generate huge surpluses apart from meeting the requirements of the fast growing population of the country and improvement in the economic condition of farmers. The gloomy picture of it was a high rate of resource depletion particularly groundwater and soil fertility, increasing pest resistance and air pollution due to large scale stubble burning and diminishing ecological biodiversity apart from almost stagnation of yield and thus overall slowing pace of farm economy. The average yield of rice was only 1009 kg/ha in 1960-61 but touched a level of 4366 kg/ha in 2017-18. The area under the crop which was 227 thousand hectares in 1960-61 went up to 3065 thousand hectares in 2017-18 and reached a plateau thereafter. On the other hand, as a result of shift in cropping pattern in favour of rice, several other commercial crops such as pulses, oilseeds and maize which had significant area have almost vanished from the cropping pattern of the state. A glance of compound annual growth rates (CAGRs) show that the average yield increased at 5.3 percent in 1970's, 1.3 percent in 1980's but it almost stagnated at 0.96 percent in 1990's. However during the past eighteen years, it has somewhat revived to reach to 1.25 percent due to favorable climatic conditions. The corresponding CAGRs in the area worked out to 13.4 percent, 5.4 percent, 2.51 percent, 2.7 percent and 0.88 percent, respectively. The production of paddy in Punjab was 18.9 million tonnes in 2019-20 from an area of 3.1 million hectares under the crop with an average yield working out to 3814 kg/ha. Out of the total rice area, basmati strains covered 560 thousand hectares accounting for 13 percent of the total area under rice. The area under aromatic basmati rice cultivation has increased across Punjab, especially in districts of Taran Taran, Gurdaspur and Amritsar. Basmati rice fetches around Rs. 3000 per quintal owing to increased demand for export. The comparative average yield of basmati rice was almost half of that of non-basmati and was estimated at 1827 kg/ha.

Therefore, rice has emerged to be an important crop of Punjab covering about two-thirds of the cultivated area of the state. Punjab occupies less than two percent of the geographical area of the nation but contributes almost 15 percent of the national food grain output. The availability of assured irrigation, largely accessed through the use of highly subsidized electricity for irrigation through tube-wells, makes rice crop less risky and highly profitable. Although rice is a highly labour-intensive crop particularly during transplantation,

the supply of skilled labor is assured, especially through migration from Bihar and Uttar Pradesh. Minimum Support Prices have been continuously rising over the last two decades, assuring predictable returns to growers. Large-scale procurement through government agencies prevents market distortions and price volatility. The Green Revolution, along with providing technical support to grow high-yielding varieties of rice, also developed a mechanism to provide Genetically Modified (GM) seeds, new farming practices, storage and transportation facilities for this crop. Although the expected value of an alternative crop portfolio is higher compared to rice, uncertainty in returns is also high for such crops compared to rice.

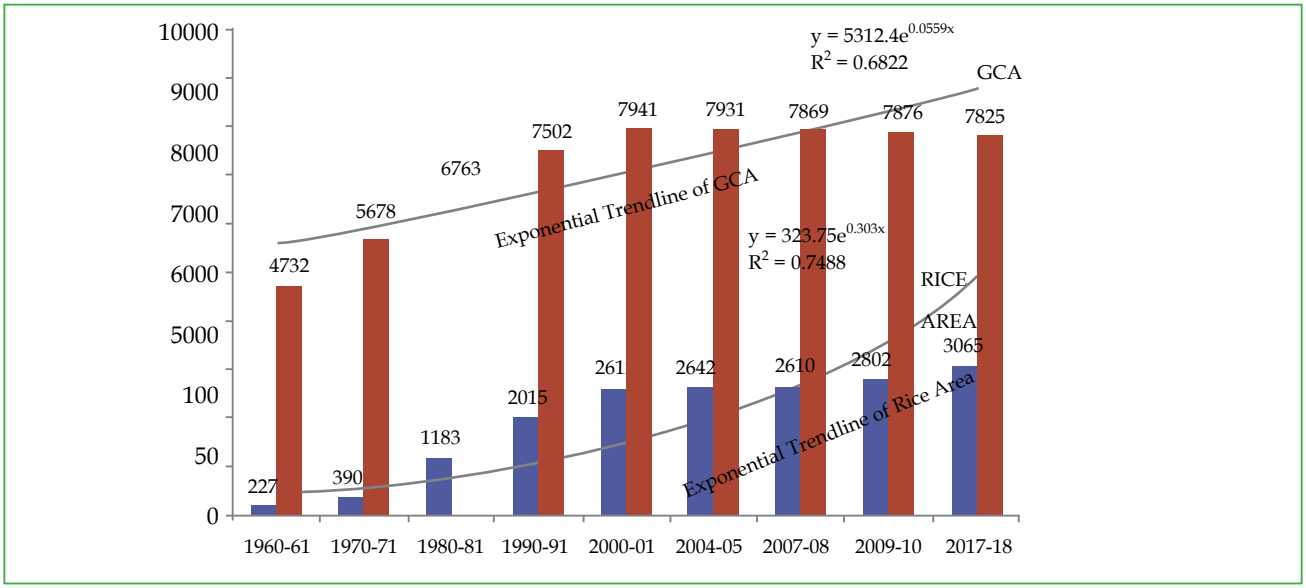
Rice has stable price support with a robust public procurement system leading to low price volatility across markets. On the other hand, volatility in prices of non-food grain commercial crops like vegetables is much higher across different markets in the state. Due to the lack of well developed cold chain infrastructure for perishable crops, farmers cannot store their produce for a longer time and compulsively sell the crop after harvest which leads to a glut in the market resulting in price crashes and farmers unable to get remunerative prices. In addition to above stated facts, a change in cropping pattern to a portfolio of alternative high value crops requires more skilled farm labor to handle perishable produce efficiently. This kind of specialized farm labor hardly exists in the required number at the time of bumper harvest in the state.

Emerging weather shocks like floods, drought, unseasonal rains, ecological pest and disease incidence and yield risk are an inherent part of agriculture. Rice crop has been the focus of long-run genetic research, with a high degree of disease surveillance and investments in new varieties for increasing yield and resistance to known pest attack. Similar investments and inventions in alternative crops have not taken place so far, leading to a significant high yield risk confined to these commercial crops. Apart from yield risk, such commercial crops also having a higher amount of post-harvest losses due to the lack of adequate cold storage, marketing management, well developed farm-to-market supply chain and logistic capacities.

3.2 Cropping pattern of Punjab agriculture

The share of area under the rice to gross cropped area has increased from 4.8 percent in 1960-61 to 40 percent in 2017-18.

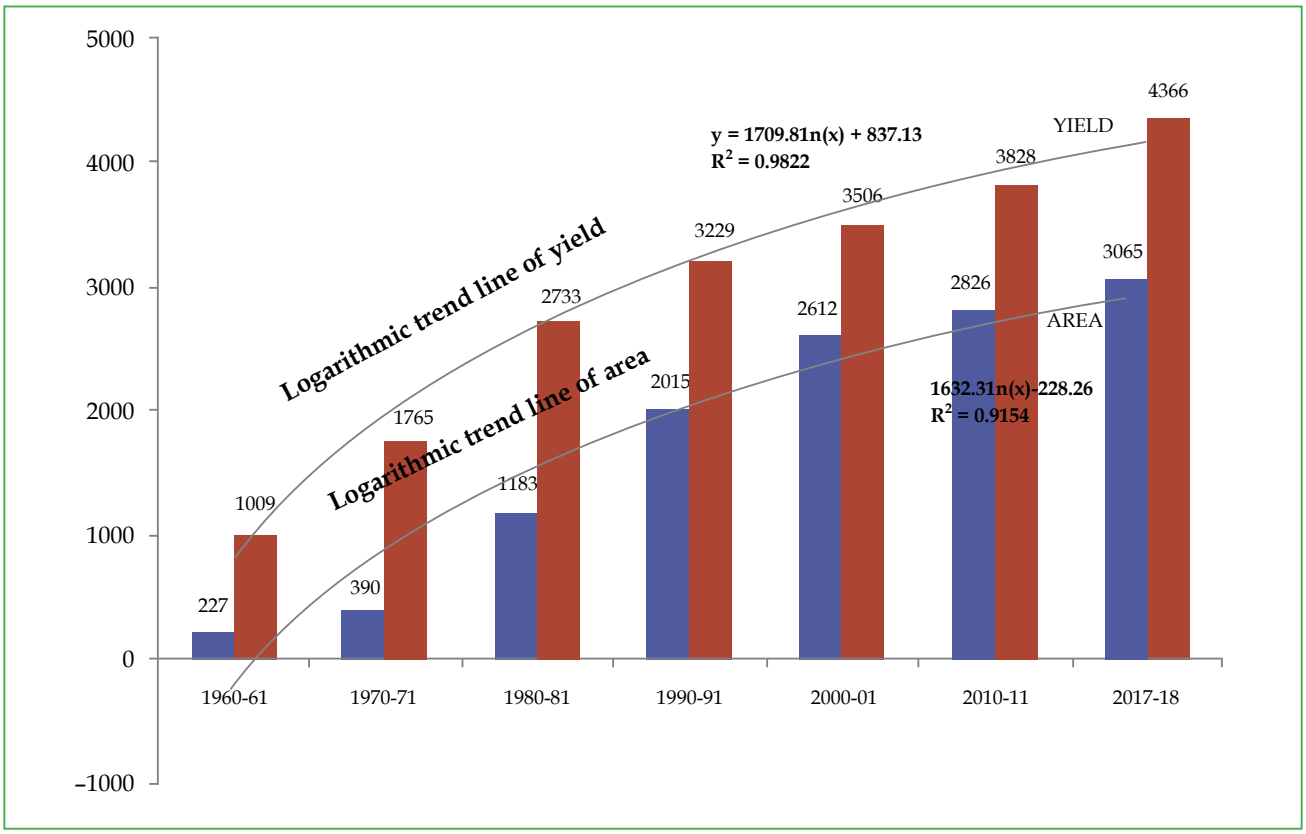
Figure 1: Share of Area under Rice to Grossed Cropped Area in Punjab



Source: Statistical Abstract of Punjab

The trends in output expansion and shares of the area of the individual crops to gross cropped area during the period 1960-61 to 2017-18 reveal the vibrant response of Punjab agriculture to the technological advancement of achieving yield breakthrough in rice, by diverting land away from other crops for which technological changes have yet to take off. The yield per hectare of crops that received the attention of the agricultural revolution increased manifold in the state compared to that of India. The impact of high-yielding variety seeds used for wheat initially and rice later was significant in increasing yield. Owing to the sudden spurt in the yield leading to higher profitability of rice, this crop became popular in Punjab.

Figure 2: Growth Trend in Area and Yield of Rice in Punjab



Source: Statistical Abstract of Punjab

3.3 Trends in aggregate value of crop output

The gross output of each crop for different years has been valued at constant (2007-08) farm harvest prices and added up to arrive at the aggregate value of crop production. The gross value of crop output has been expanded by more than four times between 1970-71 to 2017-18 (Table 1). Rice crops explicitly exhibited the highest growth in output due to improvement in yield and area expansion. As price structure of rice is more remunerative and market clearance relatively easy and assured, it has led to its production spreading to all regions of the state, accounting for more than twenty-eight percent of aggregate output. The value of output of oilseeds, pulses and other coarse cereals has decreased significantly over time. At present, these constitute 2.44 percent of the aggregate value of the output. The value of production of oilseeds has declined by 1.6 percent and that of other cereals by 1.0 percent per annum.

TABLE 1: GROSS VALUE OF CROPS IN PUNJAB AT 2007-08 PRICES

(in Rs. Crore)

Period	Rice	Wheat	Cotton	Oilseeds	Pulses	Sugarcane	Cereals	Aggregate
1970-71	516 (8.1)	4013 (62.5)	266 (4.2)	375 (5.8)	488 (7.6)	43 (0.7)	719 (11.2)	6420 (100)
1980-81	2425 (24.4)	5988 (60.2)	362 (3.7)	310 (3.1)	322 (3.2)	32 (0.32	502 (5.1)	9941 (100)
1990-91	4880 (31.3)	9484 (60.7)	585 (3.8)	161 (1.03)	172 (1.1)	49 (0.31)	281 (1.8)	15612 (100)
2000-01	6868 (34.3)	12130 (60.6)	367 (1.8)	152 (0.8)	64 (0.3)	64 (0.32)	360 (1.8)	20005 (100)
2007-08	7867 (36.7)	12262 (57.2)	720 (3.4)	125 (0.6)	31 (0.2)	55 (0.3)	363 (1.7)	21423 (100)
2017-18	8163.02 (28.5)	11767.8 (41)	26 (0.1)	208 (0.73)	44.5 (0.16)	8024 (28.0)	467 (1.6)	28700 (100)
CAGR %	**7.75**	**2.94**	**-6.5**	**-1.6**	**-6.0**	**15.3**	**-1.0**	**4.23**

Source: Data compilation from Statistical Abstract of Punjab and CACP Reports

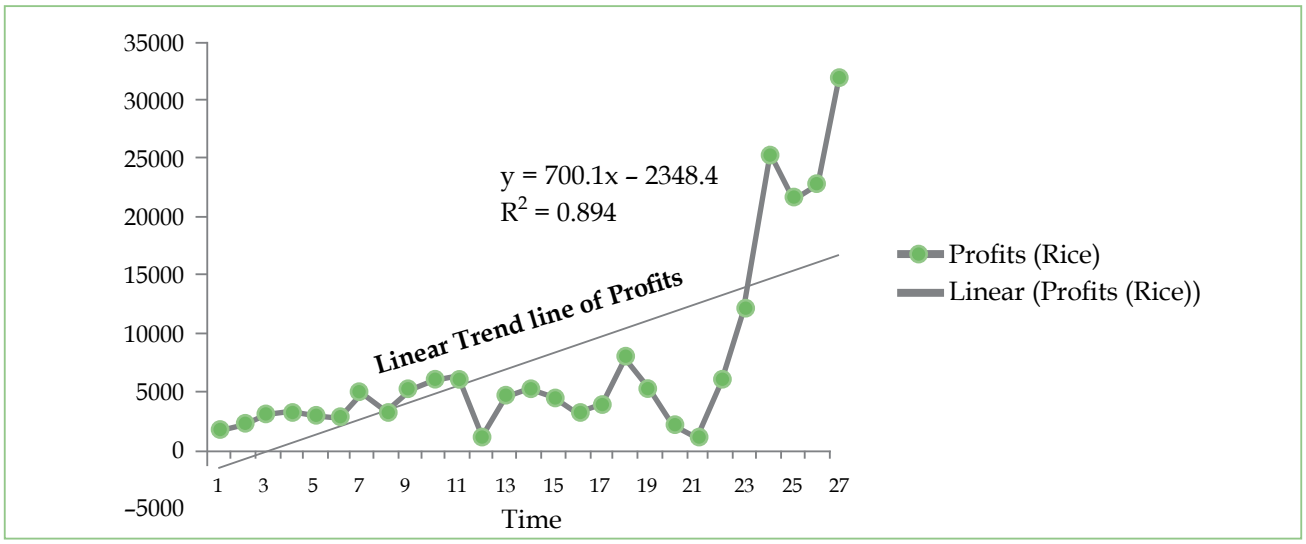
3.4 Factors leading to increase in area under rice

Although Punjab covers less than two percent of the geographical area of the nation, it contributes almost twelve percent of the national rice output. The state's agriculture sector has seen an enormous production of rice since the advent of new agricultural strategy in the mid-sixties. At present, none of the other competing crops are in a position to replace rice. The return per hectare from the cultivation of a crop is defined in terms of the difference between the gross receipts from its sale and the variable cost of production incurred by farmers on its cultivation.

Return per hectare = [MSP – Variable Cost of Production] * Yield per hectare.

The comparatively high return per hectare from rice ensures not only the sustainability of the current production of the crop but also provides a favorable economic climate for further expansion of the production of rice.

Figure 3: Trend Growth Rate of Profits in Rice Cultivation in Punjab (1990-91 to 2017-18)



Source: CACP Reports

The temporal trends in return per hectare from rice presented in Figure 3 shows that the profitability from rice cultivation has grown at the rate of 7.1 percent per year for 1991-92 to 2017-18. The growth in profitability per hectare from rice cultivation was mainly the result of the interaction of two factors; growth of MSP of rice compared to its variable cost of production and growth of its yield over the years. To provide authentic incentives to the farmers to grow more rice and for keeping the buffer stocks intact, the commission in its kharif reports on price policy has been recommending a periodical increase in the minimum support prices for rice.

The process of agricultural transformation is supposed to be interlinked with shifts in production patterns. If a specific crop fetches significantly assured higher returns than others, more area is brought under it substituting other alternatives, subject to the productivity of land, irrigation resources and marketing chain. Rice has continued to grow in area and production at the cost of other crops, and the diversity in the crop output mixture has decreased continuously over the years. This in turn led to complete specialization of rice production all over the state, with the level of specialization varying marginally across regions due to land productivity and groundwater resource constraints. Significant higher returns from rice are a result of increase in irrigation facilities which are at a at subsidized electricity rates for tubewells. Appreciable growth in the production of rice crossed the demand forces under the hovering minimum support price, procurement prices, public stocking and food security regime. Large-scale procurement through government agencies prevents market distortions and price volatility. Thus, stable price support with a robust public procurement system has led to low price volatility across markets.

3.5 Area and yield of different crops: Recent trend and potential for further growth

The main sources of growth in Punjab's agriculture were an extension of the net sown area, an extension of irrigation and increasing cropping intensity. At present, these are at a peak level. By 2017-18, 97 percent of cultivated area in Punjab was irrigated and cropping intensity as well as net sown area had been stagnant. This means that to maintain growth and yield, farmers would need to increase the use of inputs. As per the data available in Statistical Abstract of Punjab, the consumption of inputs has not declined in any manner. Consumption of fertilizer and electricity has increased from 38 kg/hectare in 1970-71 to 240 kg/hectare in 2016-17, while electricity consumption from 0.82 kWh/hectare in 1970-71 to 1470 kWh/hectare in 2016-17. The number of tractors and tube wells has also been increasing since 1970-71.

The growth rate of area and yield of different major crops presented in Table 2 indicates that even a long time after the Green Revolution, the area under rice along with their yield continued to grow, but at a slower rate than the period of 1960-90. The exponential growth of rice crop has been worked out with the help of polynomial of degree two or a quadratic function, which represents an increasing or decreasing trend or both. The slope of the quadratic function shows that yield and area under rice have been increasing since 1960-61 to 2017-18 but at a decreasing rate. This is because for small values of time 't', term a_1 becomes positive and 'Y_t' (area, yield) increases. But as 't' takes larger values, term a_2 becomes negative; the slope of the function also becomes negative implying that 'Y_t' decreases.

TABLE 2: Growth in Rice Area and Yield in Punjab

Quadratic Equation of Rice Area		
1960-2018	**$-237.9 + 79.5x^* - 0.37x^{2*}$**	
Rice Yield		**Exponential Growth**
1960-1990	$981.4 + 0.047x^*$	**4.7***
1990-2018	$3200.8 + 0.009x^*$	**0.9***
1960-2018	$1384.2 + 0.023x^*$	**2.3***
Quadratic Equation of Rice Yield		
1960-2018	**$705.7 + 115.6x^* - 1.040x^{2*}$**	

Source: Statistical Abstract of Punjab
Note: *Significant at 1% level of confidence

The expected changes in cropping pattern turn out to be satisfactory if Government plays an effective role in facilitating an assured pricing and value-added marketing structure for rice. Instead of including numerous crops in the cropping portfolio, the government can look for varietal optimal rice crop combinations for various agro-climatic zones that can be feasibly promoted for sustainable output growth. If sophisticated technology, input prices and labour use lead to per unit cost reduction, then the farmers would cultivate larger areas under rice.

3.6 Supply response of rice production in Punjab

The technological revolution often called the Green Revolution combined the use of high-yielding varieties of seeds along with intensive use of chemical fertilizers and irrigation which resulted in an unprecedented increase in rice output. Large-scale diversion of the area under rice and the emergence of rice as the second most dominant crop in Punjab was primarily a response to the availability of new high yielding varieties of seeds, fertilizers and appropriate market intervention strategy to provide assured procurement prices. A comparison of area, production, irrigation, electricity consumption and fertilizer use reveals that the magnitude of production elasticity to price is much higher. This indicates that the output response of rice crop to its price occurs mainly through the higher yield that is probably obtained due to more intensive use of inputs. The crop output responds more strongly to its own price with improvement in crop production technology as the input elasticity of rice was found to be much higher to irrigation and fertilizer use.

TABLE 3: Estimates of Area, Yield and Production Elasticity for Rice in Punjab

Time	Crop	Area/Yield/ Production	Elasticity with respect to	Regression Coefficient
1991-92 to 2018-19	Rice	Production	Price	0.331* (14.3)
		Area	Price	0.21* (13.9)
		Production	Irrigation	5.8* (8.9)
		Production	Electricity	0.47* (12.7)
		Production	Fertilizer	1.1* (12.7)

Source: CACP Reports
Note: *Significant at 1% level of confidence, values in parenthesis are 't' statistics.

3.7 Analysis of production behaviour

To examine the production behavior, particularly the extent of the impact of major factors in determining rice yield growth in Punjab, there is a need to separate area and yield effects, and to focus on the yield function in states like Punjab since the area, with less scope for further expansion, is not a significant determinant. For rice production growth after the Green Revolution, yield is the major driving force and is likely to remain so in future. To the determinants, a yield function for period 1990-91 to 2016-17 is estimated for rice in Punjab using machine labour as the explanatory variable. This is largely adequate to cover and represent the significant determinant for time-series analysis of rice yield in Punjab.

$$\text{Log } Y_{it} = \boldsymbol{\alpha} + \boldsymbol{\beta i}^{*}\log (ML_{it})$$

where,

Y_{it}= Yield of rice crop

ML_{it} = Machine labour used in rice crop

βi = Elasticity of rice crop

α = Constant

log (rice yield) = 1.23* α + βi* log (ML_{it}) 0.095*
(5.3) (6.9)

N = 26 Adjusted R^2 = 0.645

Note: *Significant at 1% level of confidence, values in parenthesis are 't' statistics

It can be inferred from the above regression equation that farm mechanization has a significant positive impact on rice yield in the state. The impact on rice crop is considered more pronounced as rice is a more labour intensive crop. It authenticates that farm mechanization enhances crop production and productivity due to the timeliness of farm operations and efficiency in the application of inputs.

The growth in rice production also depends upon a couple of factors that could be diagnosed in three segments; (i) seed-water-fertilizer technology (irrigation, chemical fertilizer use, farm mechanization) (ii) Price incentives (MSP) (iii) Infrastructure (electricity consumption for irrigation, public investment in agriculture). In a multiple regression equation, by undertaking log rice production as a dependent regression variable and some other predominant above stated segments of explanatory variables as reliable independent regression variables (in a logarithmic frame, base ten) with data from 1991-92 to 2018-19, following equation has been estimated:

Q = *f* (Cropped Area, Fertilizers, Irrigation, Electricity consumption, Prices)

Ln (Q_{it}) = α + β_1*Ln (Area) + β_2*Ln (Fertilizers) + β_3*Ln (Irrigation) + β_4*Ln (Electricity) + β_5*Ln (Prices)

Rice Production Q = -3.3 + 0.51*Area + 0.10* Prices + 1.2*Irrigation + 0.28*Fertilizers + 0.11*Electricity
(1.8) (1.5) (1.6) 1.9) (0.15)

Adjusted R^2 = 0.879

Note: *Significant at 1% level of confidence, values in parenthesis are 't' statistics

This equation depicts that 88 percent of the growth in rice production during the period 1991-92 to 2018-19 can be explained by certain explanatory variables such as an expansion of irrigation, fertilizer consumption and gross cropped area, with irrigation and fertilizers having performed a significant role. Punjab has already performed excellently in the domain of intensive farm input use and agribusiness infrastructural developments. The state has vigorously brought about 98 percent of the total cropped area under irrigation coverage which is a tremendous achievement.

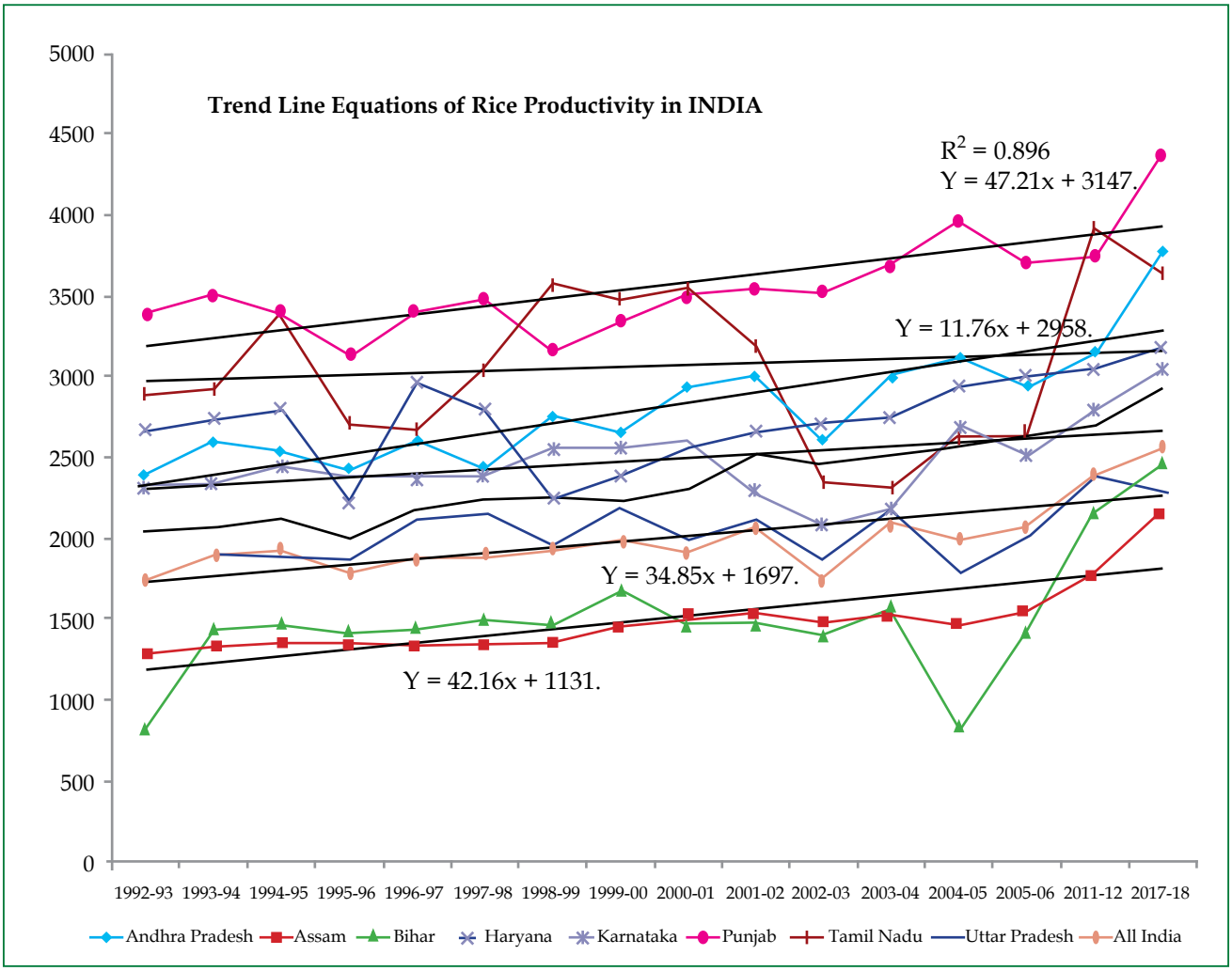
Regression equations based on the above functional forms were estimated using the OLS method deriving the combined effect of all the exogenous variables on rice production. In all the regression equations, the coefficients of absolute price provide a positive and significant explanation of the higher level of production and shift in the area towards rice. The positive and significant regression coefficients of irrigated area and fertilizer consumption happen to be rising and the magnitude of their impact on crop production is positive. So, it can be concluded that because of the developed infrastructure, rice crop production in Punjab responds favorably to its prices and intensive input use. The flexibility for increasing output is quite large, but it gets further strengthened with increased investment in marketing infrastructure.

3.8 Competitiveness of rice production in Punjab

In a dynamic marketing situation, the comparative advantage to a region like Punjab would depend upon the competitiveness of its major crop and other surplus producing regions in India. The comparative efficiency in the production of rice crops in Punjab and other regions in India is examined in Figure 4. At present, the state is a surplus producer of rice. A major proportion of the gross cropped area is devoted to the production of rice whereas a marginal area is devoted to other crops like maize, pulses, sugarcane, oilseeds, fruits & vegetables. In land scarce and labor abundant country, productivity in agriculture is measured in terms of output per hectare. Agriculture being highly sensitive to natural climatic conditions,

there are likely to be high year-to-year variations in the production of different crops across different regions. A comparative picture of land productivity in major states across the country reveals that in terms of the yield of rice, Punjab is found to have remained at the top position among other major states in India. The available evidence of a significant growth trend in rice yield suggests that the average yield in rice may have plateaued at around 4366 kg/ha with the available technology. Only the area expansion was solely responsible for the production growth that took place.

Figure 4: Rice Productivity among Major Rice Producing States in India (1990-91 to 2017-18)

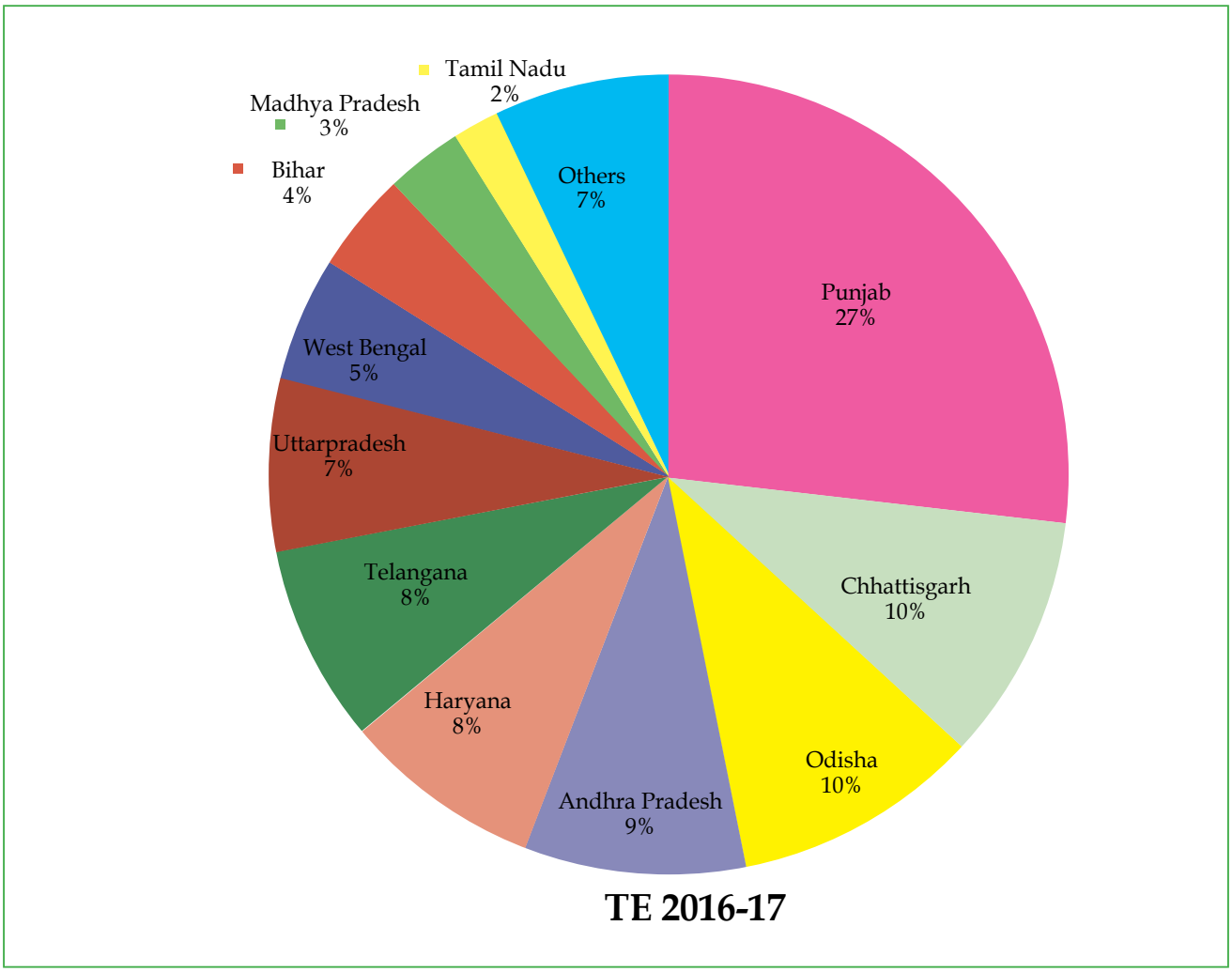


Source: CACP Reports

3.9 Share of Punjab rice to the central pool

Punjab is the largest contributor to central procurement with an estimated share of 27 percent. The procurement stock of rice in the central pool show an increasing trend over time.

Figure 5: Share of Major States in the Central Pool of Rice



Source: CACP Reports

The stock of rice in the central pool as on 2019 was 18.3 million tonnes, as against buffer stock norms of 7.6 million tonnes. Among the states, the total quantity of rice procured was highest in Punjab. The relative difference in price and output behaviour of rice compared to other crops has encouraged the production of rice in the post-Green Revolution era. The domestic rice market has also been rising in India. Since 1980s, the acute shortage of rice in other parts of India has been a major source of absorption of the surplus rice production in Punjab with the contribution by Punjab to the central pool rising significantly.

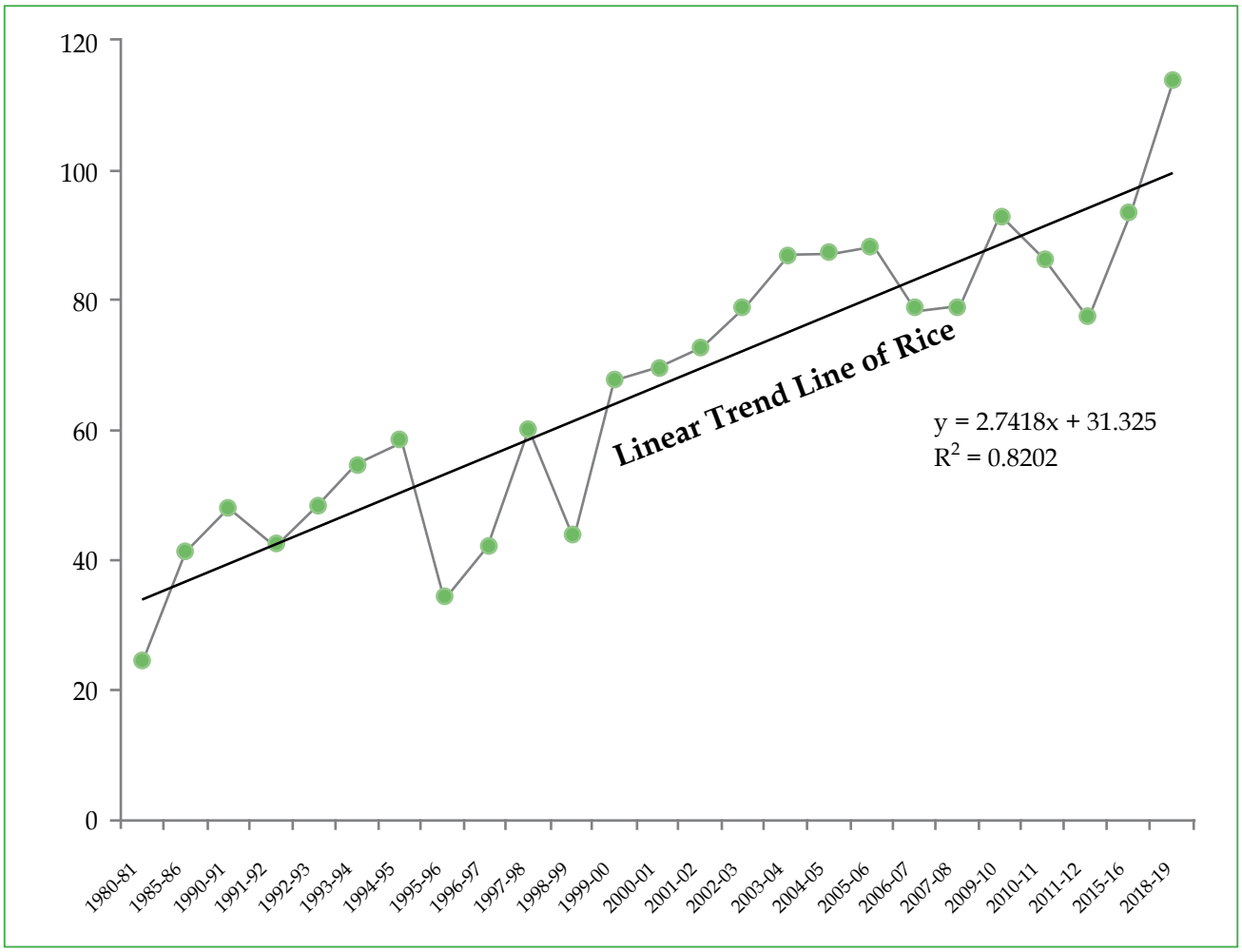
TABLE 4: CONTRIBUTION OF PUNJAB RICE TO THE CENTRAL POOL

Year	Contribution to the Central Pool (Rice) (in lakh tonnes)	% Deficit in ROI* (Rice)
1980-81	25.2	54.7
1985-86	41.8	56.8
1990-91	48.2	59.0

Year	Contribution to the Central Pool (Rice) (in lakh tonnes)	% Deficit in ROI* (Rice)
1991-92	42.5	53.3
1992-93	49.0	57.7
1993-94	54.9	59.8
1994-95	58.3	56.5
1995-96	34.6	65.2
1996-97	42.2	61.6
1997-98	60.4	62.2
1998-99	43.8	62.8
1999-00	67.9	60.7
2000-01	69.4	66.7
2001-02	72.8	58.5
2002-03	79.4	51.2
2003-04	86.7	62.1
2004-05	87.2	62.8
2005-06	88.6	68.0
2006-07	78.3	68.8
2007-08	79.1	72.2
2009-10	92.8	71.1
2010-11	86.3	74.7
2011-12	77.3	77.9
2015-16	93.5	72.7
2018-19	114	74

Source: Statistical and Economic Advisor, Government of Punjab
Note: *ROI implies the Rest of India. This deficit is fulfilled by other states in India

Figure 6: Trend Line Equation of Contribution of Punjab Rice to the Central Pool



Source: Statistical and Economic Advisor, Government of Punjab

4. Conclusion and policy implications

Soil and water are the two most important resources boosting rice yield. Due to suitable soil and climatic conditions and the high importance of rice in the consumption basket of the consumers, the crop is grown on a large scale. This crop has occupied a prominent place in the cropping pattern of the state and food security of the country. Almost the entire cultivated area of rice crop has assured surface and groundwater supply system. The significant effect of fertilizers including micro-nutrients such as zinc, manganese and ferrous is becoming important with continuous harvesting of rice crop on rotation, year after year. Some of the policy measures that are needed on the production and productivity frontier are discussed below:

(i) A long-term stringent groundwater use and its conservation strategy is required for sustainable growth in rice yield. Although the productivity of rice has increased over the years as a result of technological advancement, the declining resource base particularly groundwater and genetic diversity of rice crop seems to be more appropriate to sustain the yield acceleration. A new variety of aerobic rice that consumes fifty percent less water than conventional types and prevents the release of methane may be promoted. Since it requires less water, it can be grown in deficient rainfall areas and can earn carbon credit as it prevents the release of methane.

(ii) Production of organic paddy should be further enhanced, which extends yield up to twenty-five quintals per hectare by using the conventional techniques of cultivation. Once the product is certified as hundred percent organic, it would fetch a higher price than the conventional paddy.

(iii) The system of rice intensification, nowadays, has come as additional benefits to farmers, who would be required to apply less water to the water-intensive crops to get better yields. Rice yield has the potential to increase in the range of seventy to one hundred and fifty quintals per hectare, depending upon the regional environment. The system of rice intensification can achieve improvement in yields and factor productivity by changing some of the plant, soil, water, and nutrient management practices. It promotes greater root growth that is easily verifiable and more soil biological activity. The system is independent of purchased external inputs like chemical fertilizers and pesticides. In place, it increases the productivity of land, labor, water, and capital developed to irrigate rice production by capitalizing on existing genetic potential and by biological processes, particularly in the soil. These improved varieties of rice cultivation should be further developed and popularized among farmers for getting significant land productivity.

(iv) The mechanized harvesting of rice using combine harvesters is a common practice in the state. In the process, the straw residue is left behind the combined harvesters in a narrow strip in the field. Disposal of the leftover stubble in a short period of ten to twenty days for timely planting of rabi wheat crop is a difficult task. The farmers commonly burn rice residue/ stubble in the combined harvested fields. This huge quantity of rice residue may be collected and utilized in livestock fodder, mushroom cultivation, paper and pulp board manufacturing, etc. Therefore, it is necessary to promote crop residue processors, implements, and machines like rotavator, straw reaper, paddy straw chopper, mulcher, baler, etc. This would help the farmers to undertake wheat sowing without the hassle of crop residue or put it to fire.

References

Bathla, S. (1997). Groundwater sustainability: A case study of Ludhiana District. Indian Journal of Agriculture Economics, 52(3): 546-54.

Byerlee, D., Diao, X. & Jackson, C. (2009). Agriculture, Rural Development and Poor Growth: Country Experiences in the Post-Reform era. Agriculture and Rural Development, Working Paper 21, World Bank, Washington D.C.

Chand, R. (1999). Emerging Crisis in Punjab Agriculture, Severity and Options for Future. Economic and Political Weekly, 34(13): A2-10.

Chand, R. (2017). Doubling Farmers' Income: Rationale, Strategy, Prospects and Action Plan. NITI Policy Paper 01-2017, Government of India, New Delhi.

Chand, R., Saxena, R., & Rana, S. (2015). Estimates and analysis of farm income in India, 1983–84 to 2011– 12. Economic and Political Weekly, 139-145.

Fan, S., Hazell, P.B.R. & Thorat, S. (1999). Linkages between Government Spending, Growth and Poverty in Rural India. Research Report No. 110. International Food Policy Research Institute, Washington D.C.

Gulati, A. & Saini, S. (2016). From Plate to Plough: Raising Farmers' Income by 2022. The Indian Express, March 28, 2016.

Johl, S.S. (2002). Agricultural Production Pattern Adjustment Programme in Punjab for Productivity and Growth. Expert Committee Report, Government of Punjab.

Mellor, J. (1999). Faster, more Equitable Growth-The Relationship between Growth in Agriculture and Poverty reduction. Agricultural Policy Development Project, Research Report No.4, Washington D.C.

Rudra, A. (1982). Indian Agricultural Economics– Myths and Realities. Allied Publishers, New Delhi.

Schultz, T.W. (1964). Transforming Traditional Agriculture. Yale University Press, New Haven.

Sidhu, H.S. (2002). Crisis in Agrarian Economy in Punjab Some Urgent Steps. Economic & Political Weekly, 37(18):3132-38.

Singh, J. & Sidhu, R.S. (2004). Factors in Declining Crop Diversification: Case Study of Punjab. Economic & Political Weekly, December 25.

Singh, K. (2011). Groundwater Depletion in Punjab; Measurement and Countering Strategies. IJAE, Vol. 66, October - December.

Singh, N. (2016). Agricultural Diversification and Contract Farming in Punjab. Agricultural Situation in India, Vol. LXXII, January, 2016.

Singh, N. (2020). Rural Transformation and Farmers' Income in Punjab. Agricultural Situation in India, Vol. LXXVII, July, 2020.

Sidhu, R.S. & Grewal, S.S. (1991). Demand for Human Labour in Punjab Agriculture: An Econometric Analysis. Indian Journal of Agricultural Economics, Vol.46, No. 2.

Sidhu, R.S. & Johl, S.S. (2002). Three Decades of Intensive Agriculture in Punjab: Socio-Economic and Environmental Consequences. Future of Punjab Agriculture, Centre for Research in Rural and Industrial Development, Chandigarh.

Sidhu, R.S. & Johl, S.S (2005). Income, Employment and Productivity Growth in the Farming Sector of Punjab: Some Issues. Journal of Indian School of Political Economy, Vol.17, No. 12.

Vyas, V.S. (1996). Diversification of Agriculture: Concept, Rationale and Approaches. Indian Journal of Agricultural Economics, Vol. 51, No. 4.

Water Management and Cropping Pattern: A Case Study of Mahabubnagar District

DR. R. K. MISHRA[1] AND DR. M. MASCHENDAR GOUD[2]

Abstract

Water is a life sustaining product and is the most important natural resource for human survival on earth. It is an essential element required for daily household chores. The scarcity of water for drinking, agriculture, industry and domestic purposes in the recent years is worrying for all. The reasons for the scarcity are both natural and artificial. Unless serious efforts are made in the water harvesting front, society will have to face bitter consequences in the near future. Reduce, Reuse, Recycle, Restore and Recover technology in water resource management has to be adopted. The current study tries to examine the production of selected agriculture commodities like paddy, vegetables and jowar in Mahabubnagar district of Telangana with the objectives of analyzing the status of water availability towards agriculture and domestic uses; studying the socio-economic conditions of the farmers; analyzing the revenue, cost and profit in the production of selected crops; the cropping pattern of the farmers and the factors influencing the shift in the cropping pattern; and the impact of water scarcity on production of crops in the study area.

Keywords: *Water scarcity, revenue, cost structure, cropping pattern*

1. Introduction

India is growing at a rapid pace and sectors like agriculture, industry, transport and power invariably need sufficient water. The ever increasing population and the resultant increase in urbanization, increased demand for food, etc. are putting enormous pressure on the water resources of the country. Fresh water resources have become increasingly scarce due to sharp rise in demand of water for food production, drinking, sanitation and in economic activities like industrial production, hydroelectricity generation, fisheries, navigation, etc. Water is a scarce and precious national resource which needs to be planned, developed and conserved as such, and on an integrated and environmentally sound basis, keeping in view the requirements of the states concerned. Planning and development of water resources need to be governed by national perspectives. National Water Policy was formulated by the Ministry of Water Resources of the Government of India to govern the planning and development of water resources and their optimum utilization.

1.2 Objectives of the study

The study proposes to:

1. Examine the production of selected agriculture commodities like paddy, vegetables and jowar in the study area.

2. Analyze the status of water availability towards agriculture and domestic purpose, and the socio-economic conditions of the farmers.

3. Analyze the revenue, cost and profit in the production of selected crops, the cropping pattern of the farmers and the factors influencing the cropping pattern, and the impact of water scarcity on production of crops in the study area.

[1]Professor and Former Director, Institute of Public Enterprise, Osmania University Campus, Hyderabad
[2]Research Assistant Professor, Institute of Public Enterprise, Osmania University Campus, Hyderabad–500007 e-mail maschendargoud @ipeindia.org
Received on: 25 March, 2021
Editorial Decision: 06 December, 2021

2. Data sources and methodology

The study based on 180 beneficiaries has been conducted in Mahabubnagar district of Telangana which is considered as a backward district. The primary data used for the study has been collected by making use of questionnaire method while secondary data is collected from existing reports, journals and various internet sources. For selecting sample respondents, convenience sampling technique is applied. The study examines the socio-economic conditions of the farmers, cost of cultivation per acre across seasons, gross yield/ income gained from crops, changing cropping pattern, reasons for change in crops, etc. Null hypothesis tested with the help of chi-square test, ANOVA and regression techniques have been used to derive various conclusions. Averages, percentages and mean are the simple quantitative techniques used in the analysis and interpretation of the data.

3. Results and discussion

3.1 Demographic and socio-economic conditions

Gender is an important variable in a given social situation in India which invariably affects any social or economic phenomenon and globalization is not an exception to it. Majority of the respondents are males in this study.

Age of the respondents is one of the most important factors in understanding their views about a particular problem. By and large, age indicates the level of maturity of individuals and in that sense, age becomes an important factor while collecting the response of the respondents.

Education is an important factor that might affect any person's attitude, perception and understanding of any social phenomena. The response of an individual is likely to be determined by his educational status and therefore it becomes imperative to know the educational background of the respondents.

Family size is an important parameter in determining the socio-economic as well as living conditions of farmers. The type of the family in which a person lives and gets socialized has immense importance in deciding his values, beliefs and behavioral patterns.

Economic status of an individual is indicative of his life style and the pattern of his behavior. The person from a low socio-economic background will show some peculiar social and psychological characteristics which in turn will be reflected in his responses towards a particular problem. The poverty line itself is only for policy considerations and there is no much difference in the standard of living of those families which are just above or just below the poverty line.

Information regarding **housing, income levels** and **land holdings** for farmers of the sample district have also been collected.

TABLE 1: DEMOGRAPHIC AND SOCIO-ECONOMIC STATUS OF RESPONDENTS

Gender	No of Respondents	Percentage
Male	142	78.89
Female	38	21.11
Total	**180**	**100.0**
Age		
Less than 25 years	15	8.33
26 to 35 years	45	25
36 to 45 years	95	52.78
Above 45 years	25	13.89
Total	**180**	100

TABLE 1: DEMOGRAPHIC AND SOCIO-ECONOMIC STATUS OF RESPONDENTS *Contd.*

	No of Respondents	Percentage
Economic Status		
Below Poverty Line (BPL)	135	75
Above Poverty Line (APL)	35	19.44
Neutral	10	5.56
Total	**180**	**100.0**
Types of House		
Pucca	80	44.44
Kuccha	46	25.56
Semi Pucca	54	30
Total	**180**	**100.0**
Income levels		
Less than Rs. 1,00,000	54	30
Rs. 1,00,000 to Rs. 1,50,000	86	47.78
Rs. 1,50,000 to Rs. 2,00,000	23	12.78
More than Rs. 2,00,000	17	9.44
Total	**180**	**100.0**
Land holding in acres		
Less than 2.5 acre	35	19.44
2.6 acres to 5 acres	65	36.11
5 acres to 7.5 acres	42	23.33
More than 7.5 acres	38	21.11
Total	**180**	**100.0**

Source: Primary Data

TABLE 2: EDUCATIONAL AND FAMILY TYPE OF RESPONDENTS

Educational Status	Secondary Occupation	No. of Respondents	Percentage
Illiterate	None	85	47.22
Primary education	Labour work	45	25
Secondary education	Petty Business	35	19.44
Graduation and above	Private	15	8.33
Total		**180**	**100.0**
Size of the Family	**Type of Family**		
Up to 4 members	Nuclear Family	97	53.89
5 to 6 members	Joint Family	65	36.11
More than 6 members	Joint Family	18	10
Total		**180**	**100**

Source: Primary Data

Cost of cultivation per acre across seasons has been calculated for paddy, vegetables and jowar. Average cost per acre in the production, yield per acre, returns from main product and by-product, and net returns per acre are presented in Table 3.

TABLE 3: COST OF CULTIVATION AND RETURNS OF SELECTED CROPS

Expenses	Crops (Amount in Rs. per acre)		
	Paddy	**Vegetables**	**Jowar**
Seed	1,800	900	500
Human labour	5,100	6,000	4,500
Labour displacing machinery	10,000	6,900	6,000
Agriculture implements	2,500	2,500	2,500
Agriculture motors, pumps & power supply	2,500	3,000	2,300
Chemical fertilizers	3,500	5,500	1,500
Pesticides	780	3,600	500
Irrigation	2,000	2,000	1,500
Land tax	100	100	100
Repair of agriculture implements	1,000	1,100	1,660
Total Cost of Cultivation in Rs.	**29,280**	**31,600**	**21,060**
Gross Yield/Income			
Sources of Income	**Paddy**	**Vegetables**	**Jowar**
Yield	28 Quintals	16.5 Quintals	12 Quintals
Income received per quintal	1,815/Quintal	3,500/Quintals	1,300/Quintals
Returns from main product (Rs./acre)	50,820	57,750	15,600
Income from by–product	6,500	650	6,000
Internal crops	2,500	1,000	2,500
Gross returns in Rs.	59,820	59,400	24,100
Total cost of cultivation in Rs.	29,280	31,600	21,060
Net Returns (in Rs.)	**30,540**	**27,800**	**3,040**

Source: Primary Data

Table 3 shows that farmers have incurred an average cost of Rs. 29,280 per acre in production of paddy with the highest cost incurring in labour displacing machinery and human labour. Similarly in case of vegetables and jowar, labour displacing machinery and human labour form the major chunk of expenses. The gross return from paddy is Rs. 59, 820 per acre while the net return is Rs. 30,540. In the case of vegetables and jowar, the net return is Rs. 27,800 and Rs. 3,040, respectively.

3.2 Cropping pattern

The cropping pattern of the district differs with the farming situation. Rice, wheat, millets, pulses, condiments & spices, sugarcane, vegetables and

fruits constitute food crops. Rice is the major staple crop in food crops. Table 4 presents the cropping pattern of the respondents in the study area.

TABLE 4: SEASONAL CROPPING PATTERN

Season	Condition	Crops Grown	Cultivated Area (in acres)	No of Respondents*
Rainfed/Kharif	Irrigated	Paddy Rice	834	304
Rabi	Irrigated	Vegetables	399	593
Rabi	Irrigated	Jowar	500	461
Rainfed/Kharif	Irrigated	Red Gram	893	632
Rainfed/Kharif	Rainfed	Green Gram	312	202
Rainfed/Kharif	Rainfed	Wheat	582	240
Rainfed/Kharif	Irrigated	Maize	102	78
Rabi	Irrigated	Sunflower	792	382
Rabi	Rainfed	Bengal Gram	294	248
Rabi/Kharif	Irrigated	Ground Nut	204	133
Rainfed/Kharif	Irrigated	Cotton	133	74

Source: Primary Data

Note: * data from more than 180 respondents/farmers (actual sample size) has been collected for this particular information.

3.3 Changing cropping pattern

Changing of cropping pattern is important for retaining sustainability of land resource and more importantly, it demonstrates the flexibility of farmers to change the crops according to the agronomic conditions. The non-flexible cropping pattern shows that farmers are not practicing crop rotation and stick on to same type of farming. The following table shows the changes in cropping pattern in the study area.

TABLE 5: CHANGING CROPPING PATTERN

Particulars	No of Respondents	Percentage
Frequently	99	55.0
Occasionally	40	22.22
Not often	41	22.78
Total	**180**	**100.0**

Source: Primary Data

From the above table, it is clear that out of the 180 respondents, 99 (55%) changed their cropping pattern, 41 (22.78%) rarely changed while 40 (22.22%) of them changed their cropping pattern occasionally. Changing the cropping pattern depends on availability of water, seeds, fertilizers and sometimes on weather conditions and availability of labour also. Different reasons for changing the pattern of the crops in the study area have been mentioned in Table 6.

TABLE 6: REASONS FOR CHANGE IN CROPS

Reasons for change in crops	No of Respondents	Percentage
Insufficient water	120	66.67
Lack of sufficient vented dams	135	75.00
Labour problem	35	19.44
Low profitability	56	31.11
High cost of cultivation	55	30.56
Climate change & weather conditions	45	25.00
Crop failure	123	68.33
Seasonal migration	115	63.89
Economic conditions	145	80.56
Total No of Respondents	**180**	**100**

Source: Primary Data

The data shows that water related problems are more crucial and critical in influencing the change in cropping pattern. But non-water related reasons also sometimes influence the cropping pattern intensity. The study shows that insufficient quantity of water, crop failure, seasonal migration and socio-economic conditions are the major factors that influence the change in cropping pattern from more irrigation intensive crops to less irrigation intensive crops. Out of 180 respondents, 145 (80.56%) farmers made changes in the cropping pattern due to socio-economic conditions, 135 (75%) farmers made changes in cropping pattern because of lack of sufficient dams for protecting water while 123 (68.33%) changed due to crop failure. The non-water related reasons for the change in the cropping pattern are low profitability, high cost of cultivation, climate change & weather conditions and labour problem.

To analyze the change in economic status before and after changing the cropping pattern, chi-square test is applied to determine the following hypothesis.

H0: there is no change in economic status before and after change in cropping pattern

H1: there is a change in economic status before and after change in cropping pattern

TABLE 7: CHI-SQUARE TEST RESULTS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	161.703[a]	4	.000
Likelihood Ratio	178.554	4	.000
Linear-by-Linear Association	119.747	1	.000
N of Valid Cases	180		
a. 2 cells (22.2%) have expected count less than 5. The minimum expected count is 2.22.			

Source: Generated from SPSS

The test results show that the calculated value of chi-square is 161.703 which is less than its critical value. Hence at 5% level of significance, the degree of freedom is 4 and the both P values are less than

0.05. So the null hypothesis is rejected. Hence we can conclude that there is a change in economic status before and after the change in cropping pattern.

A second chi-square test is performed to determine the following hypothesis.

H0: there is no significant relation between climate change & weather conditions and change in cropping pattern.

H1: there is a significant relation between climate change & weather conditions and change in cropping pattern.

TABLE 8: CHI-SQUARE TEST RESULTS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	49.091[a]	2	.000
Likelihood Ratio	66.017	2	.000
Linear-by-Linear Association	40.670	1	.000
N of Valid Cases	180		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.00.			

Source: Generated from SPSS

In our statistical results, the calculated value of chi-square is 49.091 and its critical value is 66.017, the degree of freedom is 2 and the both p-values are less than 0.05. Hence, we can reject the null hypothesis and conclude that there is a significant relationship between climate change & weather conditions and change in cropping pattern.

3.4 Regression model

SPSS statistics generated few tables of output for a linear regression. The assumptions to carry out linear regression included insufficient water, lack of sufficient vented dams, labour problem, low profitability, high cost of cultivation, climate change & weather conditions, crop failure, seasonal migration and economic conditions.

The first table of interest is the Model Summary table as shown below:

TABLE 9: VARIABLES ENTERED/REMOVED[A]

Model	Variables Entered	Variables Removed	Method
1	Economic conditions, climate change and weather conditions, crop failure, low profitability, labour problems, lack of sufficient vented dams, seasonal migration, insufficient water, high cost of cultivation[b]	.	Enter
a. Dependent variable: Change in cropping pattern			
b. All requested variables entered.			

Source: Generated from SPSS

TABLE 10: MODEL SUMMARY[B]

Model	R	R Square	Adjusted R Square	Std. error of the estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	0.780[a]	0.667	0.302	0.68795	0.337	9.591	9	170	.000	0.267

a. Predictors: (Constant), economic conditions, climate change and weather conditions, crop failure, low profitability, labour problems, lack of sufficient vented dams, seasonal migration, insufficient water, high cost of cultivation

b. Dependent variable: Change in cropping pattern

Source: Generated from SPSS

Table 10 provides R and R^2 values. The R value represents the simple correlation and is 0.780 which indicates a high degree of correlation. The R^2 value indicates how much of the total variation in the dependent variable can be explained by the independent variable. The R^2 in this case is 0.667 which implies that 66.7% variation can be explained which is very large.

Table 11 is an ANOVA table which reports how well the regression equation fits the data (*i.e.* predicts the dependent variable).

TABLE 11: ANOVA[A]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	40.853	9	4.539	9.591	.000[b]
Residual	80.458	170	.473		
Total	121.311	179			

a. Dependent variable: Change in cropping pattern

b. Predictors: (Constant), economic conditions, climate change and weather conditions, crop failure, low profitability, labour problems, lack of sufficient vented dams, seasonal migration, insufficient water, high cost of cultivation

Source: Generated from SPSS

The table indicates that the regression model predicts the dependent variable significantly well. "Regression" and "Sig." column indicates the statistical significance of the regression model that is run. Here, $p<0.0005$, which is less than 0.05, indicates that overall, the regression model statistically significantly predicts the outcome variable (*i.e.*, it is a good fit for the data).

Table 12 provides us with the necessary information to predict reasons for change in crops as well as determine whether income contributes statistically significantly to the model ("Sig." column). Furthermore, we can use the values in the "B" column under the "Unstandardized Coefficients" column, as shown below:

TABLE 12: COEFFICIENTS[A]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.775	0.167		10.625	0.000
	Insufficient water	-0.900	0.200	-1.598	-4.507	0.000
	Lack of sufficient vented dams	0.613	0.190	1.061	3.235	0.001
	Labour problems	0.353	0.190	0.559	1.856	0.065
	Low profitability	-1.084	0.166	-1.863	-6.515	0.000
	High cost of cultivation	0.174	0.250	0.286	0.695	0.488
	Climate change and weather conditions	0.546	0.140	0.809	3.905	0.000
	Crop failure	0.343	0.187	0.600	1.837	0.068
	Seasonal migration	0.391	0.218	0.652	1.794	0.075
	Economic conditions	-0.453	0.221	-0.736	-2.044	0.043

a. Dependent variable: Change in cropping pattern

Source: Generated from SPSS

The regression equation can be presented as:

Reasons for changing crops = 1.775 + 0.613 (Lack of sufficient vented dams) + 0.353 (Labour problems) + 0.174 (High cost of cultivation) + 0.546 (Climate change and weather conditions) + 0.343 (Crop failure) + 0.391 (Seasonal migration).

TABLE 13: RESIDUALS STATISTICS[A]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	0.4753	2.7346	1.6778	0.47774	180
Std. Predicted Value	-2.517	2.212	0.000	1.000	180
Standard Error of Predicted Value	0.104	0.249	0.157	0.042	180
Adjusted Predicted Value	0.4166	2.8984	1.6781	0.48125	180
Residual	-1.73458	1.75754	.00000	0.67044	180
Std. Residual	-2.521	2.555	0.000	0.975	180
Stud. Residual	-2.638	2.668	0.000	1.000	180
Deleted Residual	-1.89840	1.91689	-.00029	0.70660	180
Stud. Deleted Residual	-2.685	2.718	0.001	1.005	180
Mahal Distance	3.059	22.489	8.950	5.190	180
Cook's Distance	0.000	0.066	0.005	0.009	180
Centered Leverage Value	0.017	0.126	0.050	0.029	180
a. Dependent Variable: Change in Cropping Pattern					

Source: Generated from SPSS

Water is an important factor in crop production. Traditionally, farmers depended on rainfall for irrigation but sources like ponds, tanks, canals, embankments, bore wells, open wells, tube wells, rivers and other micro irrigation facilities have found use now. The major sources of irrigation used by the respondents in the study area are presented in Table 14.

TABLE 14: SOURCES OF IRRIGATION

Sources	No of Respondents	Percentage
Ponds	105	58.33
Tanks	25	13.89
Canals	95	52.78
Embankments	47	26.11
Bore well	120	66.67
Open well	115	63.89
Tube well	75	41.67
Rivers	87	48.33
Other micro irrigation facilities	25	13.89
Total	**180**	**100**

Source: Primary Data

Out of the 180 farmers, 120 (66.67%) have bore wells in their agriculture land, 115 (63.89%) have open wells for irrigation, 105 (58.33%) farmers are using ponds, 95 (52.78%) using canals, 87 (48.33%) depend on rivers, 75 (41.67%) farmers are using tube wells, etc. The data clearly shows that bore well, open well and ponds form the major sources of irrigation. In the months of January to May and even in the first half of June, bore wells, open wells, ponds and other irrigation facilities which are dependent on rain for their replenishment start to dry up. Thus a proper planning for watershed management programmes for protecting water is required in this area. The farmers adopting sprinkler method were found to be significantly higher in number while compared farmers who had adopted drip method. The following table depicts the months in which farmers are facing the problem of water scarcity.

TABLE 15: NON-AVAILABILITY OF WATER

Months	No. of Farmers	Percentage
April to June	75	41.67
July to September	10	5.56
October to December	15	8.33
January to March	180	100
Total	**180**	**100**

Source: Primary Data

The scarcity of water for agricultural irrigation in the months of January to May is due to summer season, lack of rains, trans-evaporation of surface water, non-utilization of surface water and excessive dependence on tube wells and others.

Table 16 shows the yield per acre of selected crops when sufficient water is available and when there is scarcity of water for irrigation.

TABLE 16: EFFECT OF WATER SUFFICIENCY ON YIELD

Sufficient Water		Water Scarcity	
Available Crops	**Quintals Acre**	**Available Crops**	**Quintals Acre**
Paddy	28	Paddy	18
Vegetables	16.5	Vegetables	11
Jowar	12	Jowar	8

Source: Primary Data

From the table, it is clear that there is a reduction in the production of paddy, vegetables and jowar to the tune of 10 quintals, 550 kgs and 400 kgs, respectively, due to insufficient water available for agriculture. Correspondingly, the income from the produce is also affected as water scarcity not only affects the crop of present year but also the next year crop (Table 17).

TABLE 17: EFFECT OF WATER AVAILABILITY ON INCOME LEVELS

Income Affected	No of Respondents	Percentage
Yes	150	83.33
No	30	16.67
Total	**180**	**100.0**

Source: Primary Data

To determine whether there is any change in income level of respondents due to a change in cropping pattern, a chi-square test is performed.

H0: there is no significant change in the level of income by change in the cropping pattern

H1: there is a significant change in the level of income by change in the cropping pattern

TABLE 18: CHI-SQUARE TEST RESULTS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	122.049[a]	2	.000
Likelihood Ratio	114.515	2	.000
Linear-by-Linear Association	92.868	1	.000
N of Valid Cases	180		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.67.			

Source: Generated from SPSS

In the above statistical results, the calculated value of chi-square is 122.049 and its critical value is 114.515 with the degree of freedom being 2. As both p-values are less than 0.05, we can reject the null hypothesis and conclude there is a significant change in the level of income by change in the cropping pattern.

3.5 Drinking water

Table 19 lists the sources of drinking water to farmer households. Out of 180 farmers, majority of the farmers (160, 88.89%) depend on water purifiers facilitated by gram panchayat whereas 75 (41.67%) farmers use community water tap, 87 (48.33%) farmers use both open wells and tube wells. The data clearly show that the majority of the farmers are using both water purifier and community water tap for domestic purposes. Water supply is the provision of water by public utilities, civil society organizations, community endeavors or by individuals, usually via a system of pumps and pipes.

TABLE 19: SOURCES OF DRINKING WATER

Sources of water	No of Respondents	Percentage
Filter drinking water	160	88.89
Bore well	40	22.22
Community water tap	75	41.67
Open Well	63	35
Tube Well	24	13.33
River	9	5
Total	**180**	**100.0**
Water sufficiency for domestic use		
Yes	125	69.44
No	55	30.56
Total	**180**	**100**

Source: Primary Data

4. Conclusion

Agriculture is the main stay of the economy of Mahabubnagar district, with 82% of the farmers being of small and marginal category. Farmers dependent on ground water resources (depending on rainfall) is what constitutes 83.2% of net irrigated area irrigated followed by surface and other sources. The various sources of irrigation are ponds, tanks, canals, embankments, bore wells, open wells, tube wells, rivers, and other micro irrigation facilities provided by Government. Paddy has been a stable crop since ages in the agrarian district that mostly grows under canals, tanks and other wells and other principal crops like jowar, bajra, castor and gram which are mostly rain fed. Commercial crops like vegetables, cotton and groundnut are grown under irrigation. Hence, the study tried to investigate the production of selected agriculture food grains like paddy rice, vegetables and jowar among different types of crops in the Mahabubnagar district. The study shows that the majority of farmers grow these crops. The insufficient quantity of water is a major factor which influences the change in cropping pattern from more irrigation intensive crops to less

irrigation intensive crops. Water related problems are more crucial and critical in influencing the shifting of cropping pattern. The majority of farmers agreed that there was reduction in the production due to water scarcity. Generally in rural areas, the open wells and bore wells are the main source of agriculture. Lack of rainfall in the seasons, especially in summer, causes the water level to decrease drastically, thereby decreasing the area under rabi and kharif crops. Soil water conservation works in the area will help in protecting the rain water and will lead to increase of water table which in turn will increases water in open wells and bore wells. The increased supply of water will help to improve productivity and consequently the income of farmers also will also be increased.

5. Policy suggestions and way forward

1. Government may provide watershed development programmes, adequate training and extension facilities to the farmers so they can overcome the ground water related problems like water level depletion, shifts in abstraction structures from dug well to bore well, reduction in well yields, failure of bore wells, etc.

2. In view of depletion of groundwater, there is an imminent need to recharge the ground water. For this, a proper legislation may be brought, and usage of water saving and recharge techniques like artificial recharge structures on suitable locations may be put to use.

3. Farmers may be encouraged farmers to grow less water intensive crops and alternative irrigation methods like drip and sprinkler irrigation may be put into use, and farmers may be given loans with enhanced subsidy.

4. Government may encourage organic farming practices so as to reduce the excess use of fertilizers and pesticides by farmers.

5. People's Participatory Programme along mass awareness programmes may be conducted widely on regular basis in the rural areas to educate the farmers on the water management and improve their knowledge.

6. Government may provide complete institutional loan cover to small and marginal farmers for drilling deep bore wells in ground water potential areas, and for procuring water saving equipments like drip and sprinkler systems.

7. Government may provide support by issuing grants facility with subsidy to the farmers to minimise the dependence on agriculture only and to initiate dairy and poultry farm for supplementary income.

References

Arora, A.N. & Goyal, R. (2002). Environmental and Socio-Economical Impacts of Water-logging in Hanumangarh and Sri Gangannagar Districts. Journal of Nature, Environment and Pollution Technology, 1(3), 307-316.

Singh, R.A. (1991). Soil and Water Conservation Measures in Ravinous land of Bundelkhand – A Key to Production and Prosperity. Bhagirath, Vol 38 No. 2, April-June 1991, 63-70.

Alagh, Y.K. (1988). Planning and Management of water resources. Bhagirath, Vol. 35 No. 1, January-March 1988, 2-7.

Pandit, C. (2011). Alternative National Water Policy: A Critique. Economic & Political weekly, Vol XLVI No. 37, September 10, 2011, 77-82.

Mishra, K.C. & Mishra, R.C. (2009). Watershed Development: Key to Agricultural Development in Rural India. Kurukshetra, January issue, 24-26.

Diwakara, H. (2005). Perceptions of Groundwater Sharing and Community Prosperity: An Ordered-Probit Approach. Journal of Social and Economic Development, 7(2), 218.

Kalra, B.S., Wadkar, S.K., Sarangi, A., Singh, D.K., Chaturvedi, A., & Singh, S.P. (2014). Farmers' Perception on Water Management and Land Degradation in the Tail Reach of Western Yamuna Canal Command. Journal of Rural Development, 33(3), 343-350.

Patle, G.T. (2013). Water harvesting methods and storage structures in Sikkim. Indian Farming. Vol. 63 No. 3, June, 2013, 37-40.

Radhakrishnan, N. (2006). Distributional and availability problem of piped water in an urban centre in Kerala: Findings of a micro level research study. The Asian Economic Review, Vol. 48 No. 2, August, 2006, 263-274.

Agro-Economic Research

Improving Water Use Efficiency in India's Agriculture: The Impact, Benefits and Challenges of Micro Irrigation under PMKSY-PDMC in Uttar Pradesh*

PROF. G. C. TRIPATHI

1. Introduction

The utility of conventional flow irrigation practice cannot be ruled out. However, the increasing demand of water for irrigation and low efficiency associated with conventional irrigation methods calls for special attention of policy makers and national planners towards initiation of advanced and innovative irrigation infrastructure and its efficient management. There is an urgent need of raising water use efficiency in respect of crop irrigation and also for proper management of irrigation components like water-pumping, lifting, harvesting, shifting from water abundant to water scarce areas, etc. Towards improving water use efficiency in respect of crop irrigation, the Micro Irrigation (MI) technique, mainly consisting of drip/sprinkler irrigation device holds promise. The present study evaluates Per Drop More Crop (PDMC) component of Pradhan Mantri Krishi Sinchayee Yojna (PMKSY) towards the impact, benefits and challenges of MI system for the farming community in particular and the overall agriculture sector in general.

1.1 Objectives of the study

The PDMC component of PMKSY mainly focuses on water use efficiency at the farm level through precision/micro (drip and sprinkler) irrigation. The main objective of the study is to analyse various benefits of MI to farmers including input use, cost and returns; with following specific objectives.

(a) To examine savings of various inputs such as water, fertilizers, power, pesticides and labour.

(b) To study the impact of MI on enhancement of productivity, quality and other benefits in selected agriculture/horticulture crops including water intensive crops such as sugarcane and banana, and on employment generation.

(c) To examine the adoption of MI including some of its determinants/features such as need/importance of subsidy, culture of water conservation, issues of fragmented land holdings, capital cost, maintenance cost and the distribution of subsidy across states.

(d) To study overall impact on farmer incomes and cost-benefit in selected crops.

(e) To identify any issues/problems in the benefit transfer work flow and monitoring by the implementation agency.

2. Methodology of the study

A field survey has been conducted for agricultural year 2018-19 using a multi (four) stage stratified random sampling with district forming first stage, block/taluka the second stage, village the third stage and finally the farmer (MI adopter/non-adopter) as the fourth stage or the ultimate unit of sampling.

As per "MI–sampling plan" of the present study, the selection procedure has been as: 2 districts per state; 2 blocks/taluka per district; 3 villages/cluster in each block/taluka; 8 adopters and 2 non-adopters in each village; which ultimately gives a sample of 96 adopters and 24 non-adopters in each state resulting in a sample of 120 farmers. The two districts selected in the state of Uttar Pradesh for the present study are Sonbhadra and Saharanpur.

*Agro-Economic Research Centre, University of Allahabad, Prayagraj

NOTE: Detailed report is available on the website of the respective Agro-Economic Research Centres

3. Major findings of the study

A. PDMC in Uttar Pradesh

(i) The action plan area of PDMC component of PMKSY in Uttar Pradesh covers all 75 districts with MI programmes equally applicable to horticulture, agriculture and sugarcane crops.

(ii) "Agriculture Department" has been nominated as the nodal agency for PMKSY while the Department of Horticulture and Food Processing is the implementation agency for PDMC component of PMKSY.

(iii) On overall basis, Progressive M.I. coverage up to 2019-20 has been 277282 ha, area under M.I. during 2019-20 is 56953 ha and the progressive M.I. as a percentage of total irrigated area in 2019-20 has been 1.93%. Of the total adopted area (56953 ha) under MI, 59.80% has been under horticulture crops like potato, tomato, onion and cauliflower while 40.20% is under agriculture crops like wheat, pulses, sugarcane and maize.

(iv) Crops like mango, guava, banana, citrus, papaya, garlic, ginger, linseed and groundnut also have area under micro irrigation, but to a very meagre extent.

B. Sample MI adopters and their profile

(i) All MI adopters (96) in the study area started using MI technique with effect from 2018-19.

(ii) Among the MI adopters, majority (59.38%) of the farmers belonged to small (1-2 ha) land holding category, followed by medium (2-10 ha) category (34.37%) and marginal (<1 ha) land category (6.25%). None of the selected farmers were landless/tenant or belonging to large farmers (>10 ha) category.

(iii) "Tube-well" has been the main source of irrigation for 95.53% of MI adopters. 96.88% of farmers felt that there has been no scarcity of water while 3.12% were subjected to occasional scarcity or excess water situation.

(iv) Category wise, the extent of irrigated area is more than 95% in each category, with overall sample average being 97.73%. The breakup of irrigated area as micro irrigated and non-micro irrigated is 66.86% and 33.14%, respectively.

(v) With respect to rainfall, 82.29% of the total MI adopters were subject to average rainfall, while 17.71% had heavy rainfall.

(vi) With regard to type of soil, majority of the sample farmers (62.50%) had medium soil, 34.37% had heavy soil and 3.13% light soil. No adopter had hilly terrain with majority (77.08%) having flat terrain and 22.92% having up & down terrain.

C. Cropping profile and fertigation: MI adopters

(i) Among 96 MI adopters, the major kharif crops grown were paddy (80), maize (20), chilli (15), tomato (14) while major rabi crops being wheat (84), berseem (19), chilli (16), tomato (13) and mustard (12); with sugarcane as a perennial crop grown by 28 farmers.

(ii) For MI adopters, the per farmer average area under various crops has been 1.26 ha under sugarcane; 1.10 ha under wheat; 1.05 ha under paddy; 2.02 ha under tomato (0.99 ha in kharif + 1.03 ha in rabi); 0.85 ha under arhar (tur); 0.82 ha under maize; 0.91 ha under chilli (0.41 ha in kharif + 0.50 ha in rabi); 0.56 ha under onion (0.25 ha in kharif + 0.31 ha in rabi).

(iii) In kharif season; paddy, maize, gourd, cucumber and fodder had entire crop area irrigated by non-micro sources while arhar, til, jowar had entire area as unirrigated.

(iv) In rabi season, all crops were fully irrigated by micro or non-micro sources, except gram, which had partially unirrigated area.

(v) Tomato and chilli used drip irrigation method while sprinkler irrigation was used for wheat, pea, mustard, berseem and sugarcane. Irrigation using both drip and sprinkler systems was done for onion crop.

(vi) The extent of fertigation on per farmer area basis is highest in sugarcane (96.00%), followed by onion (75% in rabi and 50% in kharif), chilli (62% in rabi and 60% in kharif), wheat (58.33%) and pea (50%).

D. Impact of MI adoption on change in area, yield and other related factors for major crops

(i) It is noteworthy that in case of all the three major MI adopting crops in the study area, *viz*., tomato, wheat and sugarcane, the extent of farmers reporting for change (higher increase/increase) has been relatively much higher in yield as compared to area.

(ii) For tomato, out of 14 reporting farmers, 78.47% recorded change in yield against that of only 57.14% in area. In case of wheat, out of 84 reporting farmers, 76.19% recorded change in yield against that of only 40.14% in area while out of 28 farmers growing sugarcane, all of them reported for change in yield on 100 percent basis, without even a single farmer reporting for change in area.

(iii) It is emphatically found that adoption of micro irrigation has benefitted the farmers substantially in a number of ways by:

(a) Enhancing crop production, crop price, total sales revenue and net profit/income.

(b) Reducing expenses (costs) on items like seeds/plants, fertilizers, pesticides, diesel, hours of pumping (irrigation), farm power and equipments, labour cost and total cost.

E. Drip/sprinkler irrigation kit details

(i) Out of total 96 MI adopters, 43 farmers availed drip irrigation kit/set while 53 availed sprinkler irrigation kit/set. It may be clearly stated that a farmer (MI adopter) was allowed to avail only one of the two kits.

(ii) On average per farmer basis (a) Rs. 132384 was the total cost for drip kit, 14.84% of which was paid by farmer and 85.16% was subsidy. (b) Rs. 22531 was the cost of sprinkler kit, of which 70.25% was paid by farmer and 29.75% was the subsidy. (c) The total cost of pumps and tubewell (only if additional for MI) were Rs. 32933 and Rs. 9720, respectively, and were paid by the farmer as there was no subsidy on these.

(iii) No maintenance cost was paid by any of the MI (adopter) as a three year AMC was provided by the contractor/supplier.

F. Impact of MI adoption on various factors like agronomic, agro-economic and others

(i) There is strong footage to the fact that agronomically, apart from resulting in higher yield/output, MI techniques also reduced water use, fertilizer use, pest problems/ pesticide use, weed problems and labour use as reported by 67% to 96% of total MI users on strongly agree/agree basis.

(ii) Towards agro-economic potential and effective demand as well, factors like MI raises output quality/price, increases profitability, capital cost of MI is not high are supported by 80.63% to 94.79% of MI adopters while factor like information on MI is easily available, MI technology is easy to understand/operate and subsidy for MI is easy to get are supported by 64.59% to 95.83% of total MI adopters.

(iii) The responses of farmers in respect of "Aggregate Supply" and "Distribution" factors like - there are large number of MI equipment supplying companies; quality and reliability of MI equipment is good; there are large number of dealers; the dealers arrange for subsidy/credit, etc.; has been found to be relatively low and to the order of 60.41% to 88.12%.

(iv) In regard to perceived advantages and disadvantages of micro irrigation, the item "MI results in higher yields" is taken as a strong advantage/advantage by all the 96 MI adopters on cent percent basis, while other items like "Better output quality", "High output price", "Less water need", etc. have been felt by 67.71% to 95.83% of total MI adopters. Items "Easy marketing of output" and "Employment for youth" have been

supported by just 43.75% and 56.25% of total MI adopter farmers, respectively.

G. Farmers (MI adopters) reporting towards larger impact of MI and its related benefits

(i) Most of the groups/factors have significant extent of favorable reporting by the farmers towards "Larger Impact of Micro-Irrigation" on them. The order of top five groups/factors as per positive reporting (substantially positive/positive taken together) by the farmers are (i) Village as a whole - 98.96% (ii) Water conservation/availability - 98.96% (iii) Environment - 86.46% (iv) Upper caste - 82.29% (v) Labour/Poor - 73.96%.

(ii) The mean scores of the above mentioned five groups/factors are in the range of 3.81 to 4.23 *i.e.* above the "No impact" mean score of 3.

(iii) As per the reporting of sample farmers (MI adopters) on the performance of micro irrigation, the four items in order of preference are

(a) Performance of MI on improving water use efficiency is excellent/good: 78.13%

(b) Overall performance of micro irrigation is excellent/good: 73.96%

(c) Performance of MI in reducing input cost (such as fertilizers, pesticides, labour/ electricity) is excellent/good: 70.84%

(d) Performance of MI on increasing farm income/profits is excellent/good:65.63%

(iv) The respective mean scores of the above four items are 4.06, 4.13, 3.83 and 3.82. All the scores are above the mean score of 3 which indicates the utility and positive results of MI adoption.

(v) Among all MI adopters, 94.79% strongly agree/agree to continue the use of MI, while 87.50% strongly agree/agree to further expand the use of MI techniques.

H. Major problems faced by MI adopter/non-adopter farmers and their suggestions

(i) The major problems faced by farmers, as on the basis of their strongly agreeing/ agreeing (taken together) have been: (i) Lack of fencing and damage by animals, each reported by 69.79% of the total MI adopters. (ii) Poor marketing arrangement 25.00%) (iii) High cost of wells/tubewells (20.83%). (iv) Lack of knowledge/training for micro irrigation and land fragmentation, each corresponding to 19.79% and (v) Lack of own wells/tube-wells and water table going down fast, each reported by 18.75% of sample MI adopters.

(ii) Among various suggestions by MI adopters in respect to increasing the adoption and impact of micro irrigation, the top five on "Strongly Agree/Agree" basis are:

(a) More subsidy/Government assistance : 97.92%

(b) Provision/ Support for farm fencing : 94.79%

(c) Better micro irrigation technology/ Equipment : 92.70%

(d) Better marketing arrangements: 91.67%

(e) Improved water availability : 88.55%

(iii) The three main reasons mentioned by non-adopters of MI (24 in number) for non-adoption are (i) High investment cost of micro-irrigation (66.67%), (ii) Crop damage by animals (62.50%) and (iii) Lack of fencing (58.33%) on "Strongly agree/ Agree" and "non-mutually exclusive basis." The other reasons felt by non-adopters are unavailability of MI equipment, high operating cost of MI system, insufficient subsidy for micro irrigation, unavailability of credit for MI, lack of enough information for MI, fragmentation of land and

unsuitability of MI to farmers land and crops grown.

(iv) As a sign of development and prosperity, it may be mentioned in respect of "Non-MI adopters group" that: (i) There is not even a single non-adopter farmer who is illiterate and without irrigation facility, (ii) Majority of them (66.27%) have tubewell as major source of irrigation, (iii) Among kharif crops, paddy, followed by maize, tomato, chilli, arhar have cent percent irrigated area except arhar, (iv) Among rabi crops, wheat, followed by fodder, mustard, gram and chilli are fully irrigated, (v) Perennial crop sugarcane adopted by 46.83% of total non-MI adopters is also 100% irrigated.

4. Policy implications

The various policy implications as emerging out on the basis of major findings of the present study are as under:

1. There is wide scope for development of agriculture, horticulture and sugarcane crops in Uttar Pradesh, subject to adoption of advanced irrigation techniques like micro irrigation. The use of this technique can increase and even double fold the farmers' incomes and thus contribute towards state as well as national economy.

2. As more than 85 percent of MI adopters support (strongly agree/agree) to continue the use of MI as well as expand it further, it is desirable that this advanced irrigation technique must be continued and further extended even more, along with its specified subsidies.

3. In view of suggestion by 88.55 percent to 97.92 percent of MI adopters, the following points must be taken for due consideration towards further extension and applicability of MI system in generation of more income from agriculture sector. (i) More subsidy (government assistance), (ii) Provision/ support for farm fencing, (iii) Better marketing arrangements and (iv) Improved water availability.

4. Considering (i) Lack of fencing, (ii) Damage by animals, (iii) Poor marketing arrangements, (iv) High cost of wells/ tube-wells, (v) Lack of knowledge/training towards micro-irrigation, (vi) Lack of own well/tubewells; as the major problems faced by MI adopter farmers, it is earnestly suggested and recommended that the above problems be tackled on priority basis. This will make usefulness and applicability of micro irrigation more effective and beneficial to farming community in particular and the entire country in general. This can be done by (i) Providing fencing to safeguard damage of crops by animals, (ii) Improving marketing arrangements for MI produced crops, (iii) Arranging more demonstration and field trials to improve knowledge levels of farmers in respect of MI, (iv) Providing "boring" facilities to farmers, mainly small & marginal, who form the bulk of farming community as this will help them to have their own source of water to support crop irrigation using MI techniques.

5. On overall basis, special attention has to be given by the concerned Departments of Central/State Government and the national planners and policy makers towards tackling and solving the problems faced by MI adopters and non-adopters so as to safeguard the interest of farming community and the country as a whole which in turn will help in enhancing the crop production and agriculture sector's contribution to National economy.

6. As a way forward, PDMC (MI) component of PMKSY also needs (i) special emphasis in view of its enhanced utility towards reducing conveyance and application losses as compared to conventional flow irrigation practices and (ii) due consideration towards employment for youth in the direction of enhancing MI's value added applicability.

References**

Bhamoriya, V. (2013). An Analysis of Resource Conservation Technology: A Case Study of Micro-Irrigation System (Drip Irrigation). REPORT, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad.

Department of Agriculture, Cooperation and Farmers' Welfare (2019). Pradhan Mantri Krishi Sinchai Yojna. Ministry of Agriculture and Farmers' Welfare, Government of India.

Gandhi, V. P. (2014). Growth and Transformation of Agri-business Sector: Drivers, Models and Challenges. Indian Journal of Agribusiness Economics, Vol.69, No. 1, Jan- March.

Gandhi, V.P., Johnson, N. (2019). Research Proposal. Improving water use and its Efficiency in India's Agriculture: The impact of Pradhan Mantri Krishi Sinchayee Yojna (PMKSY) - Per Drop More Crop. Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad.

Namara, R.E., Nagar, R.K. & Upadhyay, B. (2007). Economics, adoption determinants and impacts Micro-irrigation technologies: Empirical results from India. Irrigation Science, 25(3), 283-297.

Narayanamoorthy, A., Devika, N., & Bhattarai, M. (2016). More Crop and Profit per Drop of Water. Drop Irrigation for Empowering Distressed Small Farmers. IIM Kozikode Society and Management Reviews. 5(1), 83-90.

Palanisami, K., Kakumanu, K.R. & Raman, S. (2011). Spread and Economics of Micro-Irrigation in India: Evidence from Nine States. Economic and Political Weekly, xivi (26 &27), 81-86.

Raman, S. (2010). State-wise micro-irrigation potential in India-An assessment. Unpublished Paper, Natural Resources Management Institute, Mumbai.

Sharma, S.B. (2019). Director, Horticulture and Food Processing, Uttar Pradesh, Lucknow; Letter No. 411/MI03-A/Evaluation/2019-20: Dated 23.11.2019 on subject Impact Evaluation Study of Per Drop More Crop-Micro-Irrigation under PMKSY 2018-19.

**Complete references can be found on the website of respective Agro-Economic Research Centres

Commodity Review

Foodgrains

Procurement of Rice

The total procurement of rice during kharif marketing season 2021-22 up to 29.10.2021 is 8.64 million tonnes as against 12.05 million tonnes during the corresponding period of last year. The details are given in Table 1. A comparative analysis of procurement of rice for the period of marketing season 2021-22 (up to 29.10.2021) and the corresponding period of last year is given in figure 1.

TABLE 1: PROCUREMENT OF RICE IN MAJOR STATES

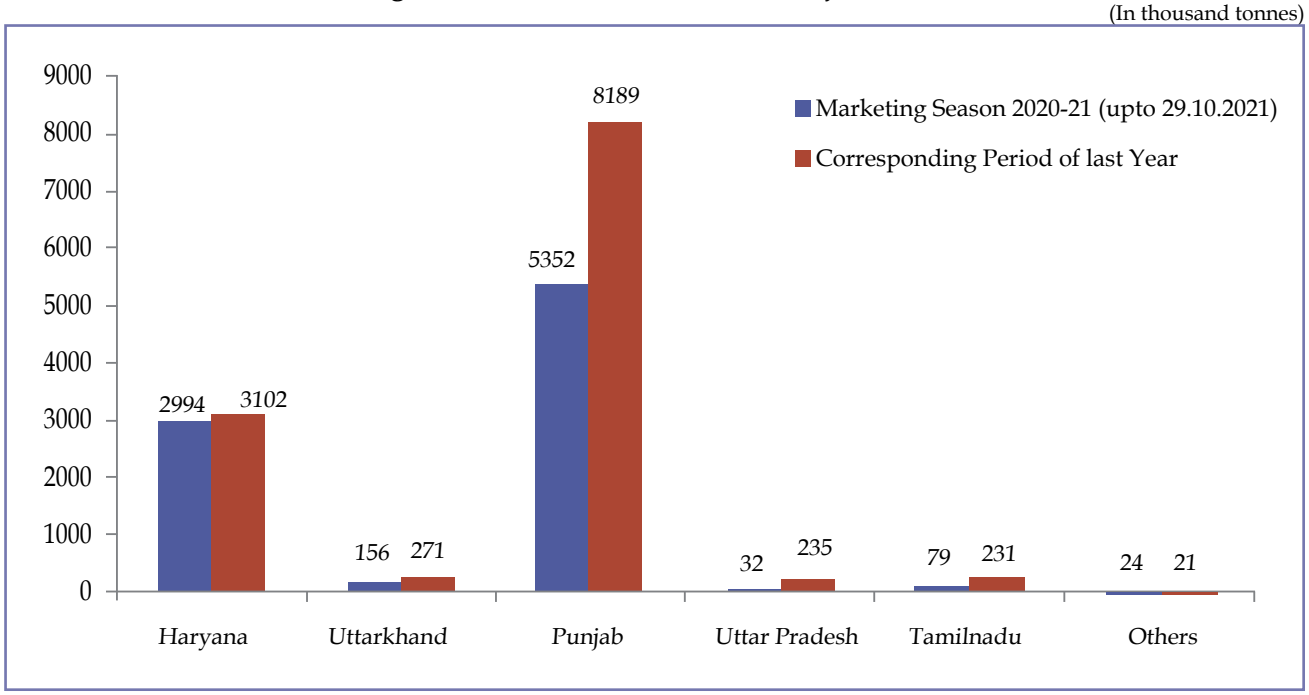
(In thousand tonnes)

State	Marketing Season 2021-22 (upto 29.10.2021)		Corresponding Period of last Year 2020-21	
	Procurement	Percentage to Total	Procurement	Percentage to Total
1	2	3	4	5
Haryana	2994	34.7	3102	25.7
Uttrakhand	156	1.8	271	2.3
Punjab	5352	62.0	8189	68.0
Uttar Pradesh	32	36.9	235	2.0
Tamilnadu	79	0.9	231	1.9
Others	24	0.3	21	0.2
All India Total	**8637**	**100**	**12049**	**100**

Source: Department of Food & Public Distribution, Govt. of India.

Figure 1: Procurement of Rice in Major States

(In thousand tonnes)



Source: Department of Food & Public Distribution, Govt. of India.

Procurement of Rice

The total procurement of rice during kharif marketing season 2020-21 up to 29.10.2021 is 60.08 million tonnes as against 51.61 million tonnes during the corresponding period of last year. The details are given in Table 2. A comparative analysis of procurement of rice for the period of marketing season 2020-21 (up to 29.10.2021) and the corresponding period of last year is given in figure 2.

TABLE 2: PROCUREMENT OF RICE IN MAJOR STATES

(In thousand tonnes)

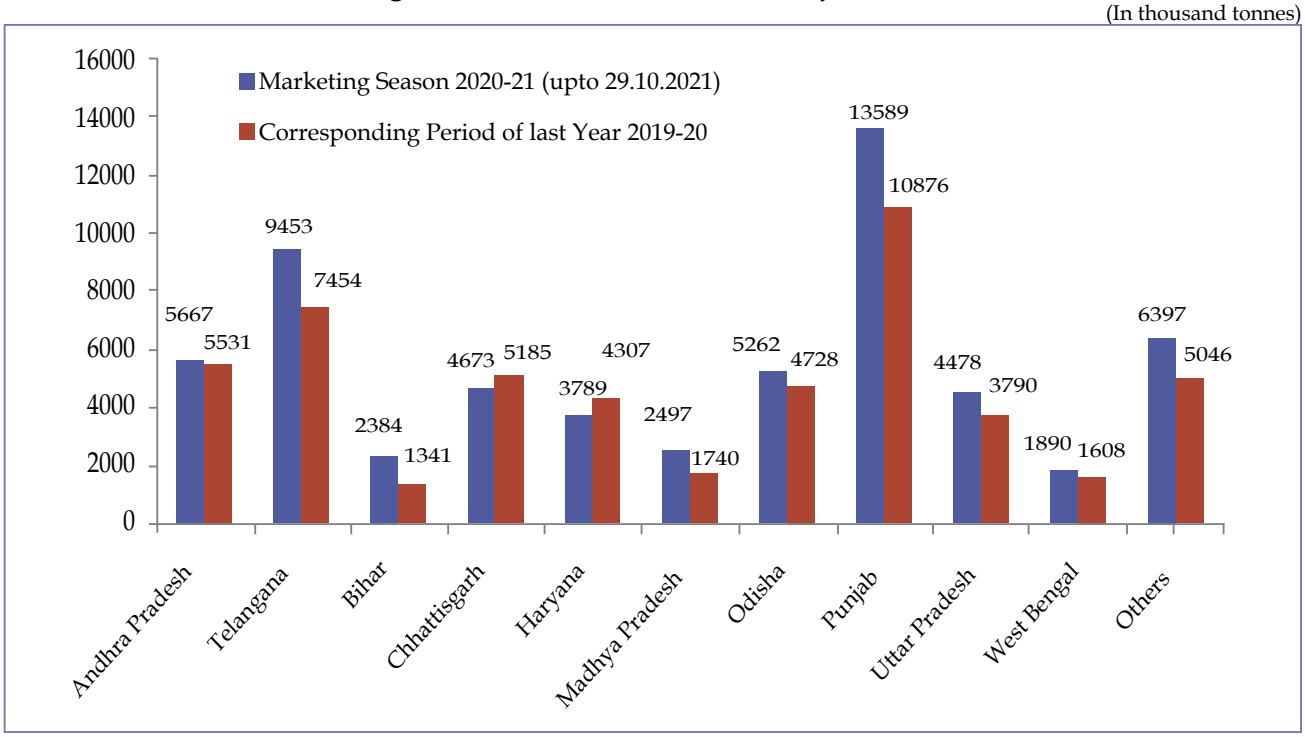
State	Marketing Season 2020-21 (upto 29.10.2021)		Corresponding Period of last Year 2019-20	
	Procurement	Percentage to Total	Procurement	Percentage to Total
1	2	3	4	5
Andhra Pradesh	5667	9.4	5531	10.7
Telangana	9453	15.7	7454	14.4
Bihar	2384	4.0	1341	2.6
Chhattisgarh	4673	7.8	5185	10.0

State	Marketing Season 2020-21 (upto 29.10.2021)		Corresponding Period of last Year 2019-20	
	Procurement	Percentage to Total	Procurement	Percentage to Total
1	2	3	4	5
Haryana	3789	6.3	4307	8.3
Madhya Pradesh	2497	4.2	1740	3.4
Odisha	5262	8.8	4728	9.2
Punjab	13589	22.6	10876	21.1
Uttar Pradesh	4478	7.5	3790	7.3
West Bengal	1890	3.1	1608	3.1
Others	6397	10.6	5046	9.8
All India Total	**60079**	**100.0**	**51606**	**100.0**

Source: Department of Food & Public Distribution, Govt. of India.

Figure 2: Procurement of Rice in major States

(In thousand tonnes)



Source: Department of Food & Public Distribution, Govt. of India.

Procurement of Wheat

The total procurement of wheat during rabi marketing season 2021-22 up to 18.08.2021 is 43.34 million tonnes as against 38.99 million tonnes during the corresponding period of last year. The details are given in Table 3. The figure 3 depicts the comparison of procurement of wheat during the marketing season 2021-22 (up to 18.08.2021) with the corresponding period of last year.

TABLE 3: PROCUREMENT OF WHEAT IN MAJOR STATES

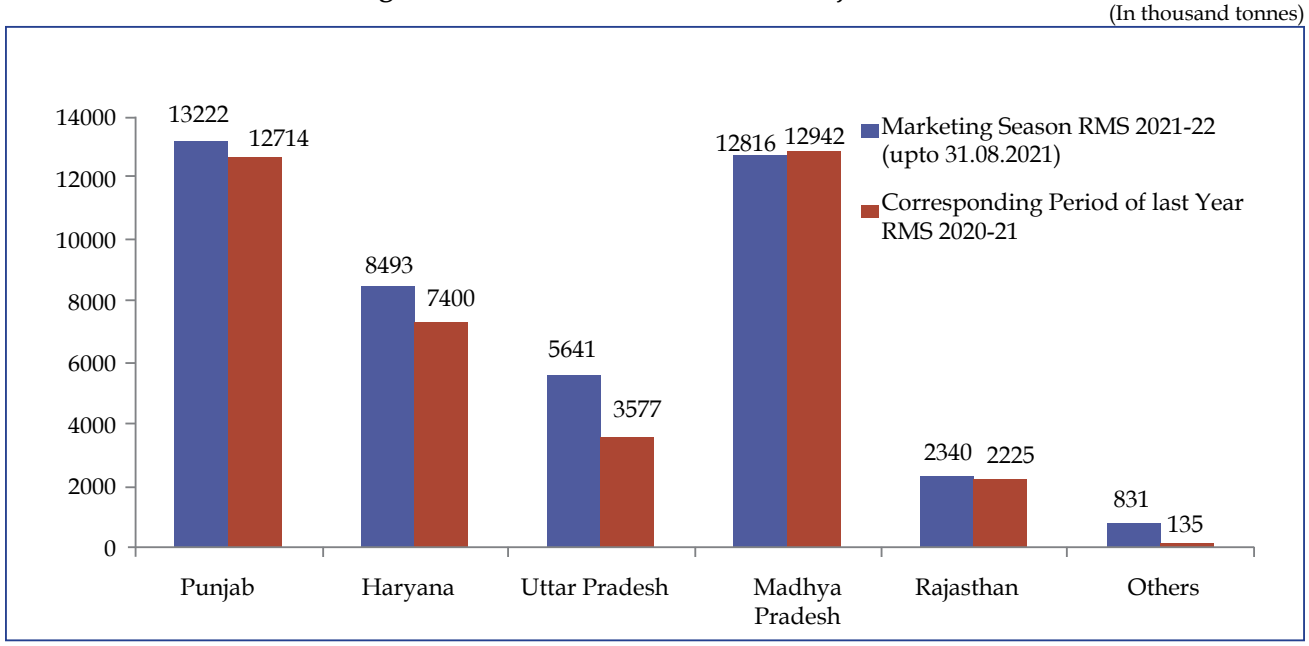
(In thousand tonnes)

State	Marketing Season RMS 2021-22 (upto 18.08.2021)		Corresponding Period of last Year RMS 2020-21	
	Procurement	Percentage to Total	Procurement	Percentage to Total
1	2	3	4	5
Punjab	13222	30.5	12714	32.6
Haryana	8493	19.6	7400	19.0
Uttar Pradesh	5641	13.0	3577	9.2
Madhya Pradesh	12816	29.6	12942	33.2
Rajasthan	2340	5.4	2225	5.7
Others	831	1.9	135	0.3
All India	**43343**	**100.0**	**38993**	**100.0**

Source: Department of Food & Public Distribution, Govt. of India.

Figure 3: Procurement of Wheat in major States

(In thousand tonnes)



Source: Department of Food & Public Distribution, Govt. of India.

Commercial Crops

Oilseeds

The Wholesale Price Index (WPI) of nine major oilseeds as a group stood at 199.7 in October, 2021 showing a decrease of 15 percent over the previous month and increased by 26.4 percent over the corresponding month of the previous year.

The WPI of all individual oilseeds showed a mixed trend. The WPI of rape & mustard seed (2.2 percent), gingelly seed (sesamum) (1 percent), niger seed (4.5 percent), safflower (0.1 percent) increased over the previous month. However, the WPI of groundnut seed (1.5 percent), copra (0.5 percent), sunflower (1.9 percent) and soyabean (31.6 percent) decreased over the previous month and WPI of cotton seed remained unchanged over the previous month.

Manufacture of Vegetable and Animal Oils and Fats

The WPI of vegetable and animal oils and fats as a group stood at 186.4 in October, 2021 which shows a decrease of 0.8 percent over the previous month. Moreover, it increased by 32.6 percent over the corresponding months of the previous year. The WPI of sunflower oil (0.7 percent), groundnut oil (0.6 percent), rapeseed oil (1.4 percent) increased over the previous month. However, the WPI of mustard oil (1 percent), soyabean oil (3.3 percent), and copra oil (4.4 percent) cotton seed oil (0.9 percent) decreased over the previous month.

Fruits & Vegetable

The WPI of fruits & vegetable as a group stood at 200.8 in October, 2021 showing an increase of 22.4 percent over previous month and decrease of 10.3 percent over the corresponding month of the previous year.

Potato

The WPI of potato stood at 199.6 in October, 2021 showing an increase of 4.9 percent over the previous month. Moreover, it also decreased by 51.3 percent over the corresponding month of the previous year.

Onion

The WPI of onion stood at 290.3 in October, 2021 showing an increase of 31.7 percent over the previous month and a decrease of 25 percent over the corresponding month of the previous year.

Condiments & Spices

The WPI of condiments & spices (group) stood at 155.1 in October, 2021 showing a decrease of 0.1 percent over the previous month and an increase of 1.4 percent over the corresponding month of the previous year. The WPI of black pepper increased by 4.9 percent while chillies (dry) decreased by 2 percent and turmeric decreased by 0.6 percent over the previous month.

Raw Cotton

The WPI of raw cotton stood at 141.5 in October, 2021 showing an increase of 6.7 percent over the previous month and an increase of 42.1 percent over the corresponding month of the previous year.

Raw Jute

The WPI of raw jute stood at 270.5 in October, 2021 showing an increase of 3.1 percent over the previous month and an increase of 13.4 percent over the corresponding month of the previous year.

Wholesale Price Index of commercial crops is given in Table 4. A graphical comparison of WPI for the period of October, 2021 and September, 2021 is given in figure 4 and the comparison of WPI during the October, 2021 with the corresponding month of last year has been given in figure 5.

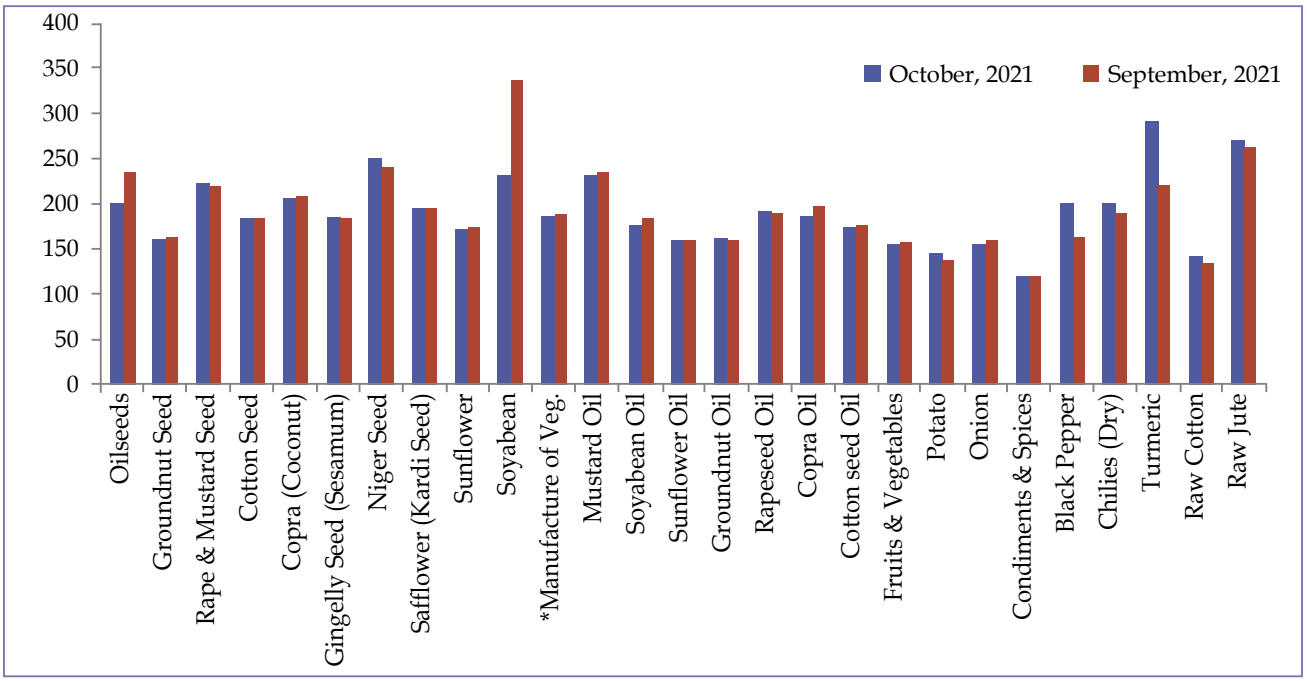
TABLE 4: WHOLESALE PRICE INDEX OF COMMERCIAL CROPS

(Base year: 2011-12)

Commodity	October, 2021	September, 2021	October, 2020	Percentage variation over the	
				Month	Year
Oilseeds	199.7	235.0	158.0	-15.0	26.4
Groundnut Seed	160.4	162.9	145.1	-1.5	10.5
Rape & Mustard Seed	224.0	219.1	166.4	2.2	34.6
Cotton Seed	182.3	182.3	159.5	0.00	14.3
Copra (Coconut)	207.3	208.4	192.4	-0.53	7.7
Gingelly Seed (Sesamum)	184.9	183.0	176.2	1.0	4.9
Niger Seed	251.9	241.0	215.2	4.5	17.1
Safflower (Kardi Seed)	193.9	193.8	161.6	0.05	20.0
Sunflower	171.5	174.9	129.3	-1.9	32.6
Soyabean	230.6	337.1	168.7	-31.6	36.7
Manufacture of Vegetable and Animal Oils and Fats	186.4	187.9	140.6	-0.8	32.6
Mustard Oil	232.7	235.1	164.5	-1.0	41.5
Soyabean Oil	176.7	182.7	128.6	-3.3	37.4
Sunflower Oil	160.5	159.4	134.2	0.7	19.6
Groundnut Oil	160.9	159.9	140.6	0.6	14.4
Rapeseed Oil	192.3	189.6	139.4	1.4	37.9
Copra Oil	186.5	195.0	180.3	-4.4	3.4
Cotton Seed Oil	175.4	177.0	131.1	-0.9	33.8
Condiments & Spices	155.1	155.3	152.9	-0.1	1.4
Black Pepper	144.7	137.9	123.2	4.9	17.5
Chillies (Dry)	156.4	159.6	164.3	-2.0	-4.8
Turmeric	119.1	119.8	111.5	-0.6	6.8
Fruits & Vegetables	200.8	164.1	223.9	22.4	-10.3
Potato	199.6	190.2	410.0	4.9	-51.3
Onion	290.3	220.4	387.1	31.7	-25.0
Raw Cotton	141.5	132.6	99.6	6.7	42.1
Raw Jute	270.5	262.4	238.5	3.1	13.4

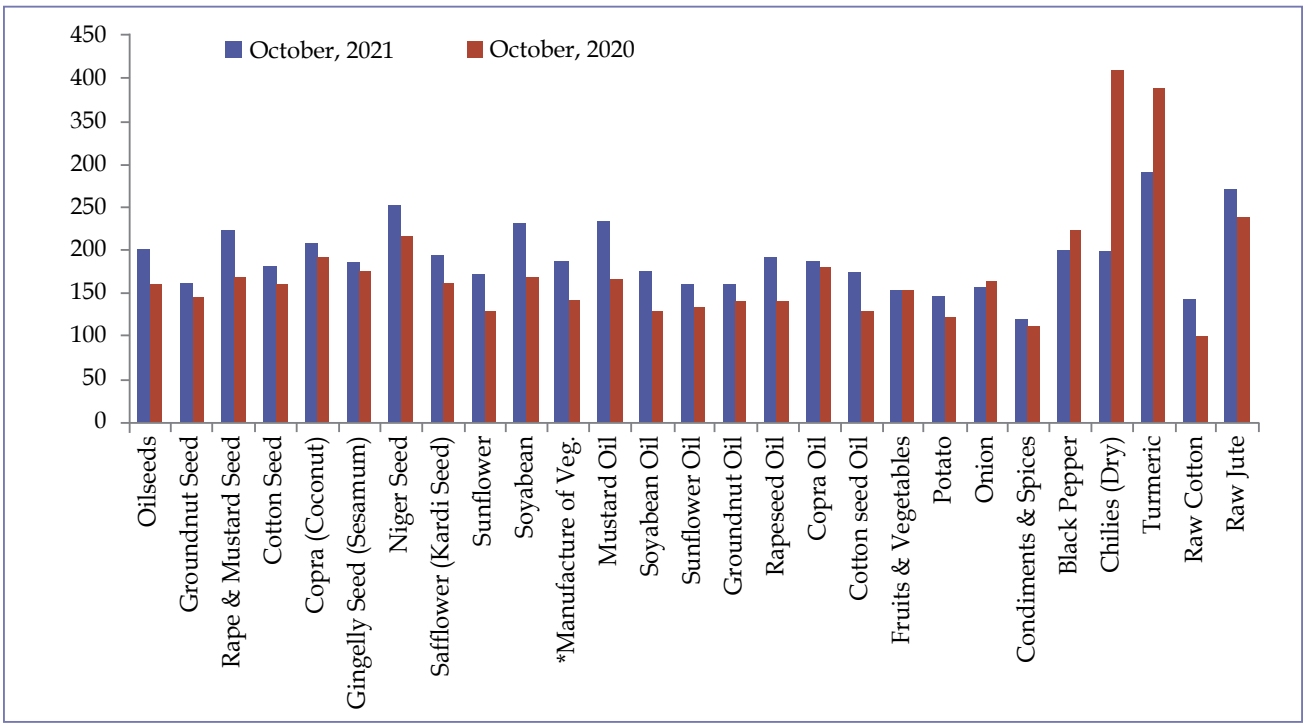
Source: DPIIT, Ministry of Commerce and Industry, Govt. of India.

Figure 4: WPI of Commercial Crops during October, 2021 and September, 2021



Source: DPIIT, Ministry of Commerce and Industry, Govt. of India.

Figure 5: WPI of Commercial Crops during October, 2021 and October, 2020



Source: DPIIT, Ministry of Commerce and Industry, Govt. of India.

Statistical Tables
Wages

1. STATE-WISE AVERAGE DAILY WAGES OF FIELD LABOURERS

(Value in Rs)

State	Month & Year	Normal Working Hours	Field Labour								Other Agri. Labour		Herdsman		* Field Labour		Skilled Rural		
			1. Plogting		2. Sowing		3. Weeding		4. Reaping & Harvesting								Carpenter	Blacksmith	Cobbler
			M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	M	M
KARNATAKA	Mar, 20	8	NA	NA	NA	NA	NA	NA	NA	NA	362	334	383	325	364	332	404	363	389
HIMACHAL PRADESH	June,21	8	458	NR	334	334	330	330	334	334	330	330	330	330	NA	NA	516	510	514
GUJARAT	June,21	8	295	290	287	260	242	239	252	251	245	237	236	208	NA	NA	516	509	499
MAHARASHTRA (P*)	Dec,20	8	NA	NR	NA	NA	NA	NA	NA	NA	381	231	350	200	291	200	440	375	247
ASSAM(P*)	June,21	8	350	NR	350	250	350	250	NR	NR	350	250	NR	NR	NA	NA	NR	NR	NR
BIHAR	June,21	8	332	293	316	274	312	267	315	292	313	304	284	250	NA	NA	493	483	NR
KERALA	June, 21	8	886	NR	NR	539	NR	534	728	558	699	581	NR	NR	NA	NA	959	918	NR
TELANGANA	April, 21	8	NA	NA	NA	NA	NA	NA	NA	NA	456	363	325	-	386	293	437	426	317
UTTARAKHAND	June, 21	8	487	NR	326	313	379	250	367	345	382	348	300	300	NA	NA	625	624	NR
WEST BENGAL	June, 21	8	397	NR	316	282	300	271	317	281	305	279	277	270	NA	NA	NR	NR	NR
HARYANA	June, 21	8	535	NR	507	417	462	415	466	421	460	402	NR	NR	NA	NA	644	614	NR
JHARKHAND	June, 21	8	NA	NA	NA	NA	NA	NA	NA	NA	252	227	184	187	254	235	392	383	326
ODISHA	June, 21	8	363	350	341	297	327	285	341	296	371	310	302	264	NA	NA	513	463	431
UTTAR PRADESH	June, 21	8	308	NR	292	278	295	278	294	276	295	279	250	250	NA	NA	505	NR	NR
RAJASTHAN	June, 21	8	427	323	432	297	339	298	339	305	NR	NR	333	276	NA	NA	508	466	388
ANDHRA PRADESH	June, 21	8	NA	NA	NA	NA	NA	NA	NA	NA	491	223	343	200	470	314	478	390	350
CHHATTISGARH	June, 21	8	318	NR	195	171	175	157	189	165	229	188	203	185	NA	NA	388	309	283
MADHYA PRADESH	June, 21	8	267	NR	234	196	228	218	221	193	272	235	236	219	NA	NA	428	409	326
PUNJAB	June, 21	8	452	NR	443	369	419	361	444	376	423	365	NR	NR	NA	NA	532	523	NR
TAMIL NADU	June, 21	8	682	NR	425	201	402	198	430	207	467	214	NR	NR	NA	NA	620	517	NR
TRIPURA	Dec, 20	8	315	NR	263	180	338	243	263	180	233	173	400	300	NA	NA	340	NR	NR
GOA	March, 21	8	NR	NR	NR	NR	700	475	725	463	625	375	375	300	NA	NA	1025	650	650

Source: State Government
Note: 1 Other agricultural labour include field waterping,carrying load, well diggers, cleaning silt from waterways and embankment, etc
2. * States of Andhra Pradesh, Jharkhand, Karnataka, Maharashtra and Telangana do not give operation–wise details as they furnish data for the group
3. P* - Provisional, 4. NA: Not Applicable, 5. NR: Not Reported

Prices

2. Wholesale Prices of Certain Agricultural Commodities and Animal Husbandry Products at Selected Centres in India

Commodity	Variety	Unit	State	Centre	Oct-21	Sep-21	Oct-21
Wheat	PBW 343	Quintal	Punjab	Amritsar	2165	1850	1800
Wheat	Dara	Quintal	Uttar Pradesh	Chandausi	1925	1840	1700
Wheat	Lokvan	Quintal	Madhya Pradesh	Bhopal	2043	1896	1820
Jowar	-	Quintal	Maharashtra	Mumbai	3000	3100	3200
Gram	No III	Quintal	Madhya Pradesh	Sehore	4325	4926	4740
Maize	Yellow	Quintal	Uttar Pradesh	Kanpur	1675	1690	1250
Gram Split	-	Quintal	Bihar	Patna	6670	6600	6200
Gram Split	-	Quintal	Maharashtra	Mumbai	6600	6450	6100
Arhar Split	-	Quintal	Bihar	Patna	9580	9580	9480
Arhar Split	-	Quintal	Maharashtra	Mumbai	9200	9000	8800
Arhar Split	-	Quintal	NCT of Delhi	Delhi	9500	11000	8300
Arhar Split	Sort II	Quintal	Tamil Nadu	Chennai	9100	9300	10000
Gur	-	Quintal	Maharashtra	Mumbai	4500	4350	4500
Gur	Sort II	Quintal	Tamil Nadu	Coimbatore	4500	4100	4500
Gur	Balti	Quintal	Uttar Pradesh	Hapur	3600	3300	2900
Mustard Seed	Black (S)	Quintal	Uttar Pradesh	Kanpur	7650	7250	4940
Mustard Seed	Black	Quintal	West Bengal	Raniganj	7200	7500	NA
Mustard Seed	-	Quintal	West Bengal	Kolkata	8600	8800	5800
Linseed	Bada Dana	Quintal	Uttar Pradesh	Kanpur	7500	6800	4950
Linseed	Small	Quintal	Uttar Pradesh	Varanasi	7750	7000	4900
Cotton Seed	Mixed	Quintal	Tamil Nadu	Virudhunagar	3300	3200	2100
Cotton Seed	MCU 5	Quintal	Tamil Nadu	Coimbatore	3900	3900	3000
Castor Seed	-	Quintal	Telangana	Hyderabad	NT	NA	NA
Sesamum Seed	White	Quintal	Uttar Pradesh	Varanasi	9300	9350	8200
Copra	FAQ	Quintal	Kerala	Alleppey	10150	10300	12400
Groundnut	Pods	Quintal	Tamil Nadu	Coimbatore	4500	6000	5000
Groundnut	-	Quintal	Maharashtra	Mumbai	9000	9800	8500
Mustard Oil	-	15 Kg.	Uttar Pradesh	Kanpur	2450	2310	1525
Mustard Oil	Ordinary	15 Kg.	West Bengal	Kolkata	2800	2850	2050
Groundnut Oil	-	15 Kg.	Maharashtra	Mumbai	2150	2330	2050
Groundnut Oil	Ordinary	15 Kg.	Tamil Nadu	Chennai	2500	2500	2250
Linseed Oil	-	15 Kg.	Uttar Pradesh	Kanpur	2290	2300	1545
Castor Oil	-	15 Kg.	Telangana	Hyderabad	2100	2025	1890

2. WHOLESALE PRICES OF CERTAIN AGRICULTURAL COMMODITIES AND ANIMAL HUSBANDRY PRODUCTS AT SELECTED CENTRES IN INDIA - *Contd.*

Commodity	Variety	Unit	State	Centre	Oct-21	Sep-21	Oct-21
Sesamum Oil	-	15 Kg.	NCT of Delhi	Delhi	3050	2900	2000
Sesamum Oil	Ordinary	15 Kg.	Tamil Nadu	Chennai	3300	3200	3320
Coconut Oil	-	15 Kg.	Kerala	Cochin	2445	2460	2565
Mustard Cake	-	Quintal	Uttar Pradesh	Kanpur	2950	2750	2100
Groundnut Cake	-	Quintal	Telangana	Hyderabad	NT	NA	NA
Cotton/Kapas	NH 44	Quintal	Andhra pradesh	Nandyal	8000	7550	5000
Cotton/Kapas	LRA	Quintal	Tamil Nadu	Virudhunagar	5800	6800	3900
Jute Raw	TD 5	Quintal	West Bengal	Kolkata	6500	6600	5775
Jute Raw	W 5	Quintal	West Bengal	Kolkata	6650	6750	6275
Oranges	-	100 No	NCT of Delhi	Delhi	NA	NA	NA
Oranges	Big	100 No	Tamil Nadu	Chennai	2300	2000	400
Banana	-	100 No.	NCT of Delhi	Delhi	417	417	375
Banana	Medium	100 No.	Tamil Nadu	Kodaikkanal	592	600	600
Cashewnuts	Raw	Quintal	Maharashtra	Mumbai	90000	90000	80000
Almonds	-	Quintal	Maharashtra	Mumbai	55000	54000	64000
Walnuts	-	Quintal	Maharashtra	Mumbai	72500	70000	70000
Kishmish	-	Quintal	Maharashtra	Mumbai	23000	25000	21000
Peas Green	-	Quintal	Maharashtra	Mumbai	8000	7800	9500
Tomato	Ripe	Quintal	Uttar Pradesh	Kanpur	3800	1900	3200
Ladyfinger	-	Quintal	Tamil Nadu	Chennai	2900	1900	2000
Cauliflower	-	100 No.	Tamil Nadu	Chennai	3200	3000	2200
Potato	Red	Quintal	Bihar	Patna	1220	1220	3350
Potato	Desi	Quintal	West Bengal	Kolkata	1700	1080	3200
Potato	Sort I	Quintal	Tamil Nadu	Mettuppalayam	2837	2590	4187
Onion	Pole	Quintal	Maharashtra	Nashik	2000	1800	4550
Turmeric	Nadan	Quintal	Kerala	Cochin	12000	12000	11000
Turmeric	Salam	Quintal	Tamil Nadu	Chennai	12000	12500	9500
Chillies	-	Quintal	Bihar	Patna	15500	17140	14700
Black Pepper	Nadan	Quintal	Kerala	Kozhikode	43000	38500	29000
Ginger	Dry	Quintal	Kerala	Cochin	19000	20000	28000
Cardamom	Major	Quintal	NCT of Delhi	Delhi	57200	57200	100000
Cardamom	Small	Quintal	West Bengal	Kolkata	155000	137500	180000
Milk	Buffalo	100 Liters	West Bengal	Kolkata	6000	6000	6000
Ghee Deshi	Deshi No 1	Quintal	NCT of Delhi	Delhi	59333	59363	60030

2. WHOLESALE PRICES OF CERTAIN AGRICULTURAL COMMODITIES AND ANIMAL HUSBANDRY PRODUCTS AT SELECTED CENTRES IN INDIA - *Concld.*

Commodity	Variety	Unit	State	Centre	Oct-21	Sep-21	Oct-21
Ghee Deshi	-	Quintal	Maharashtra	Mumbai	40000	40000	39000
Ghee Deshi	Desi	Quintal	Uttar Pradesh	Kanpur	41600	40960	40500
Fish	Rohu	Quintal	NCT of Delhi	Delhi	10000	11000	9000
Fish	Pomphrets	Quintal	Tamil Nadu	Chennai	44000	45000	35000
Eggs	Madras	1000 No.	West Bengal	Kolkata	5000	5095	5476
Tea	-	Quintal	Bihar	Patna	26500	26500	24800
Tea	Atti Kunna	Quintal	Tamil Nadu	Coimbatore	11235	11389	NT
Coffee	Plant-A	Quintal	Tamil Nadu	Coimbatore	37500	37500	39500
Coffee	Rubusta	Quintal	Tamil Nadu	Coimbatore	20600	20600	29500
Tobacco	Kampila	Quintal	Uttar Pradesh	Farukhabad	8500	8500	9750
Tobacco	Raisa	Quintal	Uttar Pradesh	Farukhabad	4250	4300	4800
Tobacco	Bidi Tobacco	Quintal	West Bengal	Kolkata	13200	13300	13200
Rubber	-	Quintal	Kerala	Kottayam	16500	15500	13900
Arecanut	Pheton	Quintal	Tamil Nadu	Chennai	81000	82000	65000

Source: DPIIT, Ministry of Commerce and Industry, Govt. of India.

Crop Production

Sowing and Harvesting Operations Normally in Progress during the Month of November, 2021

State	Sowing	Harvesting
(1)	(2)	(3)
Andhra Pradesh	Paddy, Jowar (in some areas), Bengal Gram, horsegram, condiment, spices and potato	Kharif paddy, ragi, other Kharif cereals ginger and groundnut
Assam	Rabi paddy, gram, mustard, winter vegetables and potato	Kharif paddy, jute, tea and winter potato
Bihar	Wheat, Barley, Gram, rapeseed & mustard & sweet potato	Kharif paddy and Potato
Gujarat	Paddy, wheat, gram pulses and potato.	Paddy, Kharif, jowar, groundnut, bajra and cotton
Himachal Pradesh	Wheat, barley and gram	Winter paddy, rabi kharif, sugarcane, ginger (dry), chillies (dry), tobacco, cotton, tumeric and sunnhemp
Jammu & Kashmir	Wheat (in Kashmir), barley, linseed, rapeseed and mustard	Maize (in Jammu)
Karnataka	Bengal gram, potato and rabi paddy	Kharif paddy, jowar, bajra, ragi, groundnut and sweet potato
Kerala	Paddy, pulses & sweet potato	Kharif paddy, sugarcane, ginger and tapioca
Madhya Pradesh	Wheat, barley, gram, rabi pulses, potato, rapeseed, mustard and castored	Kharif paddy, jowar, bajra, ragi, kharif, pulses, potato, chillies, tobacco, cotton sweet potato and turmeric
Maharashtra	Wheat, gram, barley, jowar and pulses	Kharif paddy, jowar, groundnut, bajra, cotton and sugarcane
Manipur	_	Winter paddy, tur, groundnut, sesamum, sweet potato and tumeric
Orissa	Wheat, sugarcane, tobacco, mustard gram and linseed	Kharif paddy, groundnut, sugarcane, cotton and sunnhemp
Punjab	Wheat, barley, gram & linseed	Jowar, bajra, maize, cotton and sugarcane
Rajasthan	Wheat, barley, gram, potato, tobacco, rapeseed, mustard and lineseed.	Paddy, jowar, bajra, sugarcane and cotton

SOWING AND HARVESTING OPERATIONS NORMALLY IN PROGRESS DURING THE MONTH OF NOVEMBER, 2021
Contd.

State	Sowing	Harvesting
(1)	(2)	(3)
Tamil Nadu	Rabi paddy, jowar, cotton tobacco, horsegram, chillies, rapeseed and mustard	Kharif paddy, kharif jowar, cumbu ragi, maize, groundnut (unirrigated), cotton varagu, samai, tapioca & ginger
Tripura	Pulses, potato, rapeseed and mustard	Winter rice
Uttar Pradesh	Wheat, barley, gram, lineseed and cotton	Kharif paddy, jowar, bajra, sugarcane, groundnut, cotton, tobacco and sunnhemp
West Bengal	Wheat paddy, wheat, barley, linseed, rapeseed, mustard and potato	winter paddy, sugarcane, sesamum and cotton
Delhi	Wheat, barley, gram, pulses, tobacco, lineseed, rapeseed and mustard	Jowar, kharif pulses, sugarcane, sesamum and sweet potato

(K) – Kharif (R) – Rabi

Note to Contributors

The Journal brought out by the Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare aims at presenting an integrated picture of the food and agricultural situation in India on month to month basis. The views expressed are not necessarily those of the Government of India.

Articles on the State of Indian Agriculture and allied sectors are accepted for publication in the Directorate of Economics & Statistics, Department of Agriculture & Farmers Welfare's monthly Journal "Agricultural Situation in India". The Journal aims to provide a forum for scholarly work and disseminate knowledge; provide a learned reference in the field; and provide platform for communication between academic and research experts, policy makers. Articles in Hard Copy as well as Soft Copy (publication.des-agri@gov.in) in MS Word may be sent in duplicate to the Editor, Publication Division, Directorate of Economics & Statistics, M/o Agriculture & Farmers Welfare, 103, F-Wing, Shastri Bhawan, New Delhi-110001 along with a declaration by the author(s) that the article has neither been published or submitted for publication elsewhere. The author(s) should furnish their email address, phone no. and their permanent address only on the forwarding letter so as to maintain anonymity of the author while seeking comments of the referees on the suitability of the article for publication. The Article should be prepared according to the following guidelines:

(a) Articles should not exceed five thousand words (including footnotes), typed in double space on one side of foolscap paper in Times New Roman font size 12.

(b) Typescript should be arranged in the following order: title, abstract, introduction, data or methodology, text, conclusions, policy suggestions, and references.

(c) Abstract (with keywords) is required and should not exceed 300 words in length.

(d) The title page should contain the title, author name(s) and institutional affiliation (s).

(e) The text should follow UK English and number bullets should be used wherever required.

(f) Reference List should be given in alphabetical order of surname. The American Psychological Association (APA) style for reference lists should be followed. For example:

i. For Books (online/Offline):
Author A surname, author A Initial., & Author B Surname, author B initial. (Year). Title (Edition). Place of Publication: Publisher.

ii. For Journal:
Author Surname, Author Initial. (Year). Article Title. Journal Title, Volume Number (Issue Number), Page Range. doi: DoI Number

Although authors are solely responsible for the factual accuracy and the opinion expressed in their articles, Editorial Board of the Journal reserves the right to edit, amend and delete any portion of the article with a view to making it more presentable or to reject any article, if not found suitable. Articles which are not found suitable will not be returned unless accompanied by a self-addressed and stamped envelope. No correspondence will be entertained on the articles rejected by the Editorial Board.

Disclaimer: Views expressed in the articles and studies are of the authors only and may not necessarily represent those of Government of India.

Soft copy of the journal may be seen in PDF at the following URL: *http://desagri.gov.in/document-report- category/agricultural-situation-in-india/*

Abbreviations used

N.A. — Not Available.
N.Q. — Not Quoted.
N.T. — No Transactions.
N.S. —No Supply/No Stock.
R. — Revised.
M.C. — Market Closed.
N.R. —Not Reported.
Neg. — Negligible.
Kg. — Kilogram.
Q. — Quintal.
(P) — Provisional.

Plus (+) indicates surplus or increase. Minus (-) indicates deficit or decrease.

ISSN 0002-1679
Regn.No.:840

P. Agri. 21-10-2021
450

Other Publications of the Directorate

Agricultural Statistics at a Glance*

State of Indian Agriculture

Glimpses of Indian Agriculture

Land Use Statistics at a Glance*

Agricultural Prices in India*

Agricultural Wages in India

Cost of Cultivation of Principal Crops in India

Farm Harvest Prices of Principal Crops in India*

***Copies are available at:**
The Controller of Publications, Civil Lines, Delhi-110054