Andhra Pradesh Journal of
Agricultural Sciences

Volume 8 **Number 4** **October – December, 2022**

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Andhra Pradesh J Agril. Sci : 8(4): 201-205, 2022

CASE STUDIES OF AGRIPRENEURS IN KARNATAKA-PROSPECTS AND CHALLENGES

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Date of Receipt: 19-08-2022 Date of Acceptance: 06-11-2022

ABSTRACT

The present study was conducted in two districts of Karnataka *viz.,* Chikkaballapur and Kolar districts. The study aimed to investigate the key facts, and figures of successful agripreneurs. Case study method which is a comprehensive study of a social unit comprised of a person, a group, a social institution, a district, or a community was followed to study the selected cases of successful agripreneurs. Case analysis of the successful agripreneurs will help to derive lessons and insights from particular cases. This would in turn help in capacity building of the agripreneurs by enabling them in better leveraging their strengths. The study will also motivate young graduates and other farmers to come forward and adopt such activities taken up by the agripreneurs..

KEYWORDS: Agripreneurs, Agrientrepreneurship, Innovations.

INTRODUCTION

In the last two years, the agriculture industry has seen remarkable expansion. The industry, which is the largest employer of workforce, accounted for 18.8 per cent of the country's Gross Value Added (GVA) in 2021-22, with a growth of 3.6 per cent in 2020-21 and 3.9 per cent in 2021-22. Over the last five years, the livestock sector has grown at an annual rate of 8.15 per cent. It has been a consistent source of revenue for agriculture households, contributing to around 15 per cent of their average monthly income. The green revolution transformed India from a food grain deficient country to a surplus food grain producer. In a span of three decades, India became a net exporter of food grains. Besides providing food security, agriculture has been an important source of raw material for the industry due to which the demand on agriculture sector has been increasing rapidly. Therefore, to meet such demand, agriculture all over the world is going through a phase of transition.

In India, agriculture is viewed as a traditional occupation and way of life. The concept of 'Agrientrepreneurship' is still in its early stage in the agrarian economy, with few players, which makes it difficult to exploit the opportunities available within agriculture sector. As a result, it become vital to promote agrientrepreneurship in the country. A business-like approach to farming is necessary to equip farmers with better opportunities. Agri-entrepreneurs look for opportunities everywhere which make them more efficient which in turn has a great impact in the agriculture sector.

A shift from agriculture to agribusiness is an essential pathway to revitalize Indian agriculture and to make more economic and profitable venture. Agripreneurs have the potential to contribute to a range of social and economic development such as employment generation, income generation, poverty reduction and improvements in nutrition, health and overall food security. Agripreneurship has the ability to promote economic development by diversifying sources of income, providing widespread employment and entrepreneurial opportunities in rural areas. The entrepreneurship skills applied in the field of agriculture may yield positive results and a well-trained agripreneurs may become a role model. Hence, the present research aimed to identify the successful agripreneurs who can serve as a role model for the youth and other venturing farmers in the society.

MATERIAL AND METHODS

Case study method is a comprehensive study of a social unit comprised of a person, a group, a social institution, a district or a community (Young, 1996). It is the social microscope, as stated by Burgess (1993). A case study method was followed in the present study few successful cases of agripreneurs of Chikkaballapur and Kolar districts of Karnataka. The selected agripreneurs were personally inter-viewed and data was collected with the help of a semi-structured interview schedule and open end questions.

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CASE STUDIES OF SUCCESSFUL AGRIPRENEURS

CASE STUDY 1

Profile

India is witnessing a transformation wherein qualified youngsters were leaving cushiony jobs and started farming in rural areas by adopting suitable technologies. This is what happened with 29 years old Mr. Prashant Reddy, S/o Ramesh Reddy who hails from Batlahalli village of Chintamani taluk, Chikkaballapura district of Karnataka state. Received the "Best Youth Agrientrepreneur award" for the year 2020 by the agriculture minister of Karnataka. After pursuing M. Tech, he joined a private firm in Bangalore and was getting a good salary. Looking into the increasing demand for organic fruits and vegetables in Bangalore, he explored the prospects of organic farming, he decided to quit his software job and started organic farming in his native village during 2019-20.

Contributing factors for the success

The agripreneur participated in the Skill Training for Rural Youth (STRY), Programme on biofertilizer production organized by KVK, Chintamani. This training served as push factor and with the guidance of Scientists of KVK, Chintamani, he was successful in getting a good yield. But due to the outbreak of COVID 19 and lockdown, marketing became the biggest challenge and he was unable to market his produce like all other farmers. With his software skills, he was able to develop simple software for marketing the produce and decided to sell the organically grown produce in the apartments of Bangalore City. Software link was shared on different ICT platforms like Whatsapp, Facebook, Instagram, emails etc., to create awareness about it. By clicking on the link, customers were able to get the information like importance of organic products, availability of organic fruits and vegetables available, their price and approximate date of delivery. Based on the customer order he used to supply the organic produce to the customers by maintaining social distance and following hygiene procedures, and was able to generate a net profit of around ₹ 7,00,000 annum.

Table 1. Profile of agripreneur

1.	Name of the agri enterprise	:	Prashant Organics
2.	Location of agri enterprise	:	Batlahalli (village), Chintamani (taluk), Chikkaballapura (district)
3.	Name of owner/partner	:	Mr. Prashant Reddy
4.	Age	:	29
5.	Education	:	M. Tech (Computer and Software applications)
6.	Year of establishment	:	2019
7.	Entrepreneurial experience	:	4 years
8.	Trainings undergone	:	Skill Training for Rural Youth (STRY), programme on biofertilizers production organized by KVK
9.	Annual income	:	₹ 7,00,000
10.	Social participation	:	KVK Groups and FPO Meetings
11.	Source of finance	:	Own finance
12.	Marketing of products	:	Online Marketing, Direct Selling, Wholesale Marketing

Mr. Prashant is hard working and also a smart working young farmer. Looking into increased demand for organic produce from customers, he mobilized farmers growing organically from surrounding villages and started marketing in a collective approach on regular basis. Due to the mobilization of organic farmers, supply increased and further due to the perishability and bulkiness of produce, it became necessary to sell the produce in bulk quantities. Later he decided to sell his produce to Big Basket, Ninjacart, Spudnic farms, wholesale dealers and organic farmers associations in order to make profit. Initially, Mr. Prashant adopted mono cropping by just growing carrots and beetroot. Now after realizing the benefits of direct selling to consumers, he

adopted a staggered sowing method in order to supply all vegetables on a regular basis. Presently he is growing Beetroot, Carrot, Tomato, Green leafy vegetables, Papaya, Guava, Custard apple, Red gram, Sweet corn, Cabbage, Minor millets etc. With the aim of integrated farming, he has started animal husbandry, poultry, beekeeping and rearing fish in farm pond and utilizing resources efficiently towards sustainable farming.

Conclusion

With an increasing demand for organic products, most of the farmers started shifting towards organic farming and it is also important to meet the food needs of growing population. Integrated farming system plays a significant role in the effective management of available resources at the farm level by generating adequate income to the farmers and employment to rural people.

CASE STUDY 2

Profile

Many city inhabitants are curious about village living and farming. Manjunath Naryanappa is 39 years old software engineer, who owns 7 acres of farm at Gudihalli near Chikkaballapur. He started SNS farm and homestay which offers an authentic experience of living on the farm. Visitors from all over Karnataka, especially people from Bangalore, visit the farm to live within the natural blanket of the village. Manjunath is a data scientist working with a top IT company in Bangalore.

Contributing factors for the success

When he decided to pursue his passion and continue the family farming practice, he decided to apply the 5 Why's technique from his work and apply it to farming. This led to a series of revelations about why farmers use chemicals in their farming, why do pests attack certain crops and avoid certain crops and does nature do certain things. This led him to start his journey to natural farming and turned to YouTube and adopted natural farming techniques into his farm. He converted his entire 7 acres of land into natural farming and initially he faced difficulty with low yields and couldn't able to control pests and diseases. Later on, he learned to manage the resources available within the farm and turned them into inputs to control pests and diseases. He owns 7 goats, backyard poultry, 5 desi cows, and started preparing organic fertilizers using dung and urine from desi cows. He could also able to grow most of the vegetables such as Brinjal, Tomato, Cabbage, Beans, Pumpkin, Bottle guard, Chilies, Spinach, Bitter guard, Drumstick, etc., fruit crops such as Papaya (Red lady variety), Guava, Grapes, Sapota, Banana and Dragon Fruit. Thirty per cent of his land is covered with agroforestry and took him 5 years to build an organic farm. Today he has a thriving farm that he could able to run with his family in Chikkaballapur. Everybody from his brother to his wife and kids all helped him on the farm, he earned a net profit of 55,000/- per month by selling fruits, vegetables and desi milk and he earned around 10,000-15,000/-

Table 2. Profile of agripreneur

1.	Name of the agri enterprise	:	SNS farm & Homestay
2.	Location of agri enterprise	:	Gudihalli, Ramachandra Hosur, Chikkaballapur
3.	Name of owner/partner	:	Manjunath Naryanappa
4.	Age	:	39
5.	Education	:	M. Tech
6.	Year of establishment	:	2015
7.	Entrepreneurial experience	:	7 years
8.	Trainings undergone	:	Nil
9.	Annual income	:	₹ 8,50,000
10.	Social participation	:	KVK meetings
11.	Source of finance	:	Own finance
12.	Marketing of products	:	Direct selling and Online marketing

month by offering homestay. Initially, power cut was a big challenge since the farm was located outside the city. Later, he installed solar panels, and the generated electricity was used for the farm and home consumption. He sold organically grown vegetables to the visitors and also ties up with companies like Farmizen and EasyTaaza through which he sold organic fruits and vegetables, from which he could able to make additional profits.

Conclusion

He offers homestay for those who enjoy going to villages, while promoting healthy lifestyle choice and helping people to connect with nature. He has been hosting guests since 2017, he does extra efforts to make the experience of every guest a special one, especially children who enjoy nature while playing with calf and lambs with little innovative efforts he could able to conserve resources and generating revenue and inspiring youth to retain in farming.

CASE STUDY 3

Profile

Many farmers are quitting agriculture nowadays and moving to cities in search of better livelihood. Under these challenging circumstances, Mr. Chalapathi, is 39 years old Chartered Accountant, who hails from Kadudhevandahalli village of Srinivaspur taluk Kolar district of Karnataka, used his professional expertise to convert his fallow land into a dragon fruit farm. Since his childhood, he was passionate about agriculture.

Contributing factors for the success

Earlier he used to cultivate Finger millet during Kharif and for the rest of the seasons, the land was left fallow. So, he always wanted to add more value to farming and started looking at crops or fruits which could sustain the drought conditions and demanded less labour. Since Kolar is a drought prone district where rainwater is a major constraint. He heard about dragon fruit for the first time in 2018. His friend from Gujarat bought dragon fruit to his office, he liked the fruit very much and was very curious to know about it. He started researching where it is sold, from where it is imported and how it is produced. Participated in the training programmes conducted by KVK Kolar and Technical secession held by scientists of IIHR, Bangalore on dragon fruit cultivation.

After research, he came to know that there are hundreds of species, but in India, very few farmers cultivate them. Only two types of dragon fruit are grown in the area. Realizing the prospects of exotic fruit demand in India, he bought 500 dragon fruit plants from a farmer in Gujarat. In 2020 because of lockdown and restrictions he was working from home. In his free time, he used to visit the farm every day and take care of the plants along with his father. In the very first year, he got a good yield. After the fruit was harvested, the question arrived was where to sell it, and whom to sell it in the market. He went to the fruit shops with some fruits initially, and the shop owners were not ready to take them at all. But when he explained the demand for the fruit, they agreed to buy. He utilized the opportunity of lockdown while the import

Table 3. Profile of agripreneur

1.	Name of owner/partner	:	Mr. Chalapathi
2.	Location of agri enterprise	:	Kadudhevandahalli village of Srinivaspur taluk
3.	Age	:	36
4.	Education	:	B. Tech
5.	Year of start	:	2019
6.	Entrepreneurial experience	:	3 years
7.	Trainings undergone	:	Participated in the training programmes conducted by KVK Kolar and Technical secession held by scientists of IIHR, Bangalore on dragon fruit cultivation
8.	Annual income	:	₹ 6,50,000
9.	Social participation	:	KVK group meetings
10.	Source of finance	:	Own finance, Government subsidy
11.	Marketing of products	:	Direct selling and wholesale marketing

of fruits was restricted, and internal demand for healthier fruit was raised. By realizing this he sold the fruits to the companies like Big Basket, More and malls located around Kolar and Bangalore. Since the dragon fruit was new to the district, he was the first to cultivate it. Later he planted Avocado intercropped with Chrysanthemum and Onion which he bought from Coorg. They also kept 5 honey bee hive boxes which are essential to enhance pollination and cause better fruit setting. He sold the dragon fruit at ₹ 100-120 kg, even sometimes at ` 150 per kg and around 20 kg of fruit can be harvested from a single plant. He also had grown vegetables like Chilies, Drumsticks and Brinjal under rainfed. During the rainy season, he harvested rainwater and utilized it for the rest of the seasons. He availed the subsidy from the government of Karnataka under the Krishi Bhagya scheme to construct farm pond for rainwater harvest. Learning about his success, the Department of Horticulture has come forward to support him with subsidies and helped in marketing the fruit. They also created awareness among other farmers. Realizing the growing demand for dragon fruit at present Mr. Chalapathi and other dragon fruit farmers in the district are planning to form an association or a community to sell the dragon fruit, other exotic fruits and horticulture products under a single brand name.

He is an inspiration to many other farmers and young agri-allied entrepreneurs who may also take such initiatives. At present people visited to the orchard to enquire and learn the process of cultivation of the dragon fruits. Now Mr. Chalapathi is an agripreneurs, who works full-time in his field and planning to bring more innovations in his farm.

LITERATURE CITED

Divya, N and Karthikeyan, C. 2021. A case study of an organic Agripreneur adopting integrated farming system model at Kullagoundenpudur village of Erode district in Tamil Nadu, India. *Journal of Applied and Natural Science.* 13(SI): 162-166.

Geetha, M and Manjula, N. 2016. Entrepreneurship development among farm women through finger millet processing and value addition: A case study in Karnataka. *International Journal of Home Science.* 2(3): 07-11.

Pandey, G. 2013. Agripreneurship education and development: Need of the day. *Asian Resonance.* 2(4): 155-157.

Pavan, M.K., Yarzari, S.P., Devegowda, S.R and Kumari, K. 2019. Agripreneurship prospects and initiatives in India. *Extension Education and Rural Development.* 17(12): 117.

Young, D. 1996. Changing tastes and endogenous preferences: Some issues in modelling the demand for agricultural products. *European Review of Agricultural Economics*. 23(3): 281-300.

Andhra Pradesh J Agril. Sci : 8(4): 206-210, 2022

UTILIZATION PATTERN OF SOCIAL MEDIA BY THE FARMERS OF GUNTUR DISTRICT OF ANDHRA PRADESH

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Date of Receipt: 03-06-2022 Date of Acceptance: 08-10-2022

ABSTRACT

The utilization pattern of social media by the farmers was studied in Guntur district of Andhra Pradesh in India. Three mandals were purposively selected based on highest number of farmers using social media. A total of 90 farmers were purposively selected for the study. The results showed that most of farmers use WhatsApp followed by YouTube and Facebook. Regarding purpose of utilization, majority of farmers used social media for market information and price trends followed by weather information, plant protection measures, weed management, fertilizer management, agri inputs availability, irrigation management, seed treatment and farm mechanization *etc.* for increasing the productivity and profitability in agriculture.

KEYWORDS: Social media, Utilization pattern, Agricultural information, farmers.

INTRODUCTION

The greatest challenge of today is the improvement in the quality of human life particularly of the rural people through eradication of poverty, hunger and achieving overall rural balance. Global attention directed at agriculture due to emerging challenges of food security in recent years, resulting partly negligence of dissemination of appropriate technology. Increasing production is a major challenge facing present agriculture. Traditionally, agricultural information was mainly provided by agriculture extension system of state agricultural universities, state departments of agriculture and allied sectors, extension service providers from NGOs and input dealers and mass media sources such as newspapers, radio, television and magazines but in recent years, technology awareness, computer literacy speed of smartphones and internet have changed the way farmers communicate and get agriculture related information. Now farmers are able to get all sorts of information through social media. Social media gives opportunities to farmers for co-creating content and also promotes co-learning among farmers. The present study aims to evaluate the utilization pattern of social media platforms by the respondents in Guntur district of Andhra Pradesh.

MATERIAL AND METHODS

In the present study Ex-post research design was followed. Ex-post facto research is a systematic empirical enquiry in which the scientists do not have control of influencing independent variables, because manifestation has already occurred.

The Guntur district in Andhra Pradesh state was chosen as the locale of the study since the researcher belongs to the same state and familiar with the local language and culture. From the Guntur district, three mandals were purposively selected based on the highest number of respondents utilizing social media (Source: KVK, DAATTC in Guntur). From each of the selected mandals, two villages were selected by following lottery method of simple random sampling procedure. The sample constitute a total of six villages. From, each of the selected villages, fifteen farmers were selected by following purposive sampling procedure. The sample constitute a total of 90 respondents.

RESULTS & DISCUSSION

Component wise utilization pattern of farmers towards social media

I. Awareness on social media

The Table 1 depicted that all the respondents (100.00%) were having awareness on WhatsApp followed by (91.11%) of the respondents were having awareness on YouTube and (28.89%) of the respondents were having awareness on Facebook.

II. Accessibility on social media

The Table 1 depicted that all the respondents (100.00%) were having accessibility on WhatsApp followed by (91.11%) were having accessibility of the respondents on YouTube and only (28.89%) of the respondents were having accessibility on Facebook.

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III. Possession of knowledge on social media

The Table 1 depicted that majority of the respondents (80.00%) were having high knowledge on WhatsApp and remaining (20.00%) were having medium level of knowledge on WhatsApp.

Majority (71.11%) of the respondents were having low level of knowledge on Facebook followed by (22.22%) of the respondents were having medium level of knowledge on Facebook and only (06.67%) of the respondents were having high knowledge on Facebook. This was due to lack of awareness on Facebook and also the respondents were not shown interest towards the use of Facebook.

Majority (62.22%) of the respondents were having medium level of knowledge on YouTube, (28.89%) of the respondents were having high level of knowledge on YouTube and (08.89%) of the respondents were having low level of knowledge on YouTube.

IV. Frequency of use

The Table 1 depicted that the extent or frequency of use of social media by the individual respondents for agricultural practices. The results showed that extent of utilization of social media regularly in priority wise were; WhatsApp 96.67 per cent followed by YouTube (30.00%) and Facebook (03.33%).

The results showed that social media platforms used weekly by respondents in the order of priority wise were YouTube 44.44 per cent followed by Facebook (07.78%) and WhatsApp (03.33%).

The results showed that social media platforms used occasionally by respondents in the order of priority wise were Facebook 17.78 per cent followed by YouTube (16.67%) followed by WhatsApp (05.56%).

Further, the data revealed that, some of the respondents were never used the social media platforms like Facebook 71.11 per cent followed by YouTube (08.89%). This may due to lack of awareness and knowledge to access the social media platforms.

V. Years of using social media

The Table 1 depicted that the years of using social media by the individual respondents for agricultural practices. The results showed that less than one year of using social media in the order; YouTube 30.00 per cent followed by Facebook (08.89%) and WhatsApp (03.33%).

The results showed that 1-2 years of using social media platforms by the respondents in the order; WhatsApp 43.34 per cent followed by YouTube (21.11%) and Facebook (15.56%).

The results showed that 2-3 years of using social media platforms by the respondents in the order; WhatsApp 41.11 per cent followed by YouTube (36.67%) and Facebook (04.44%).

The results showed that 3-5 years of using social media platforms by the respondents in the order; WhatsApp 08.89 per cent followed by YouTube (03.33%) and Facebook (00.00%).

The results showed that only WhatsApp was used by the respondents since more than 5 years. This is because the respondents were recently used the social media platforms. In beginning stage, the respondents were unaware about the use of Facebook and YouTube.

Further, the data revealed that, some of the respondents were never used the social media platforms like Facebook 71.11 per cent followed by YouTube (08.89%). This may due to lack of knowledge and difficulty to understand the how to use of social media platforms by the respondents.

VI. Membership in agricultural groups

The Table 1 depicted that the membership of the individual respondents in agricultural groups. The results showed that the respondents belongs to the membership in one group were, WhatsApp 72.22 per cent followed by YouTube (16.67%) and Facebook (00.00%).

The results showed that the respondents belongs to the membership in more than one group were, WhatsApp (27.78%), Facebook (00.00%) and YouTube (00.00%).

The results showed that the respondents were not belongs to the membership in any group were, Facebook 100.00 per cent followed by YouTube (83.33%) and WhatsApp (00.00%). These respondents were not belongs to any group but they just shown the suggested videos and images for getting the information on agriculture.

The data presentation in Table 1 depicted that the usage of social media by respondents for information on different areas. Figures in the table revealed that majority of farmers used social media for market information and price trends (2.98), weather forecasting (2.97), plant protection measures (2.90), weed management (2.82), fertilizer management (2.73), agri inputs availability (2.58), irrigation management (2.15), seed treatment (2.03), farm mechanization (2.02), selection of variety (1.81), crop insurance (1.74), seed production (1.38), post harvest technology (1.35), land preparation (1.24),

Table 1. Component Wise utilization pattern of respondents towards social media

I. Distribution of farmers according to the awareness on social media

S. No.	Social media	WhatsApp		Facebook		YouTube	
		F	%	F	%	F	%
A	Yes	90	100	26	28.89	82	91.11
B	No	0	0	64	71.11	8	08.89

II. Distribution of farmers according to the accessibility on social media

S. No.	Social media	WhatsApp		Facebook		YouTube	
		F	%	F	%	F	%
A	Yes	90	100	26	28.89	82	91.11
B	No	0	0	64	71.11	8	08.89

III. Distribution of farmers according to the possession of knowledge on social media

S. No.	Social media	WhatsApp		Facebook		YouTube	
		F	%	F	%	F	%
A	High	72	80.00	6	06.67	26	28.89
B	Medium	18	20.00	20	22.22	56	62.22
C	Low	0	00.00	64	71.11	8	08.89

IV. Distribution of farmers according to the frequency of use

S. No.	No.of days	WhatsApp		Facebook		YouTube	
		F	%	F	%	F	%
A	Regular	82	91.11	3	03.33	27	30.00
B	Once in a week	3	03.33	7	07.78	40	44.44
C	Occasionally	5	05.56	16	17.78	15	16.67
D	Never	0	00.00	64	71.11	8	08.89

V. Distribution of farmers according to the years of using social media

S. No.	Years using social media	WhatsApp		Facebook		YouTube	
		F	%	F	%	F	%
A	Less than 1 year	3	03.33	8	08.89	27	30.00
B	1-2 years	39	43.34	14	15.56	19	21.11
C	2-3 years	37	41.11	4	04.44	33	36.67
D	3-5 years	8	08.89	0	00.00	3	03.33
E	More than 5 years	3	03.33	0	00.00	0	00.00
F	Do not use	0	00.00	64	71.11	8	08.89

VI. According to the membership in Agricultural groups

S. No.	Category	WhatsApp		Facebook		YouTube	
		F	%	F	%	F	%
A	Not a member in a group	0	00.00	90	100.00	75	83.33
B	Member in group	65	72.22	0	00.00	15	16.67
C	Member in more than one group	25	27.78	0	00.00	0	00.00

VII. Utilization pattern of social media for specific information

S. No.	Area of information	Always		Sometimes		Rarely		Never		Mean score	Rank
		F	%	F	%	F	%	F	%		
1	Land preparation	5	05.56	22	24.44	53	58.89	10	11.11	1.24	**XIV**
2	Selection of variety	3	03.33	69	76.67	16	17.78	2	02.22	1.81	**X**
3	Seed treatment	15	16.67	66	73.33	6	06.67	3	03.33	2.03	**VIII**
4	Fertilizer management	70	77.78	16	17.78	4	04.44	0	00.00	2.73	**V**
5	Irrigation management	28	31.11	52	57.78	6	06.67	4	04.44	2.15	**VII**
6	Weed management	79	87.78	7	07.78	3	03.33	1	01.11	2.82	**IV**
7	Plant protection measures	83	92.22	5	05.56	2	02.22	0	00.00	2.90	**III**
8	Farm mechanization	35	38.89	32	35.56	13	14.44	10	11.11	2.02	**IX**
9	Seed production	7	07.78	33	36.67	38	42.22	12	13.33	1.38	**XII**
10	Post harvest technology	10	11.11	18	20.00	56	62.22	6	06.67	1.35	**XIII**
11	Weather forecasting	88	97.78	2	02.22	0	00.00	0	00.00	2.97	**II**
12	Agri. inputs availability	56	62.22	22	24.44	7	07.78	5	05.56	2.58	**VI**
13	Market information and price trends	89	98.89	1	01.11	0	00.00	0	00.00	2.98	**I**
14	Crop insurance	5	05.56	59	65.56	24	26.66	2	02.22	1.74	**XI**
15	Subsidies on agri.inputs	10	11.11	4	04.44	2	02.22	74	82.23	0.44	**XVI**
16	Government schemes and programmes	0	00.00	6	06.67	13	14.44	71	78.89	0.27	**XVII**
17	Livestock production and management	6	06.67	12	13.33	55	61.11	17	18.89	1.07	**XV**

livestock production and management (1.07), subsidies on agri inputs (0.44) and government schemes and programmes (0.27), were ranked according to the mean score respectively.

Overall Utilization Pattern of social media by the Farmers

Data regarding utilization pattern of farmers towards use of social media is presented in Table 2 the data clearly points out that majority 65.56 per cent of farmers had medium utilization pattern towards social media followed by low utilization pattern (18.89%) and high (15.55%) utilization pattern towards social media.

The aforementioned data can be used to infer that most farmers had a moderate use pattern of respondents toward social media in terms of disseminating information about agriculture. This is because frequent use of social media was observed during the initial period of establishment and some had diminished overtime due to the static nature of information and the farmers' lack of substantial time for social media use. Farmers' use of social media can be improved if the material is current and based on their needs.

In addition, many farmers stated that they would prefer save time by getting information on their own mobile devices than through extension workers. The

Table 2. Overall utilization pattern of farmers towards social media

S. No.	Category	Frequency	Percentage
1	Low utilization pattern	17	18.89
2	Medium utilization pattern	59	65.56
3	High utilization pattern	14	15.55
Mean: 64.32			**S.D: 6.30**

results was in accordance with Swaroop (2016) and Vivek (2017).

The study clearly indicated that majority of farmers were using WhatsApp and YouTube. The use of remaining social media platform *viz.,* Facebook should be increased by increasing awareness among the farmers and establishing training centres for how to use the social media platforms. Majority of farmers had medium utilization pattern due to multiple reasons and the use of social media can be improved among farmers to providing information is updated and need based. The results also concluded that many farmers expressed that information can be obtained easily through their own mobiles for simple information, rather than spending time for the extension workers.

LITERATURE CITED

Andres, D. and Woodard, J. 2013. Social media handbook for agricultural development practitioners, ISBN: 0-89492-918-6, USAID Washington D.C. United States Retrieved as http://ictforag.org/toolkits/social/index.html#.Vrmq-1SF5dg.

Jijina, C.K and Raju. 2016. Social media and farmers. *International Journal of Research in Engineering and Technology.* 5(19): 20-25.

Kuria, K. and Wangu, C. 2014. Use of social media as a source of agricultural information by small holder farmers: A case study of lower Kabete, kiambu Country. *School of journalism and mass communication*. *M.Sc.(Ag.) Thesis* University of Nairobi.

Pandit, V. 2015. Plant Doctors in Nepal start Facebook group to share expertise on plant health issues, The Plant wise blog.

Prabhu, M.J. 2015. An agriculture officer uses facebook to win new converts to farming.

Rani, R. 2014. Impact of social media in India. *International Journal of Business Economics and Applied Management Research*. 1(1): 158.

Saravanan, R and Bhattacharjee, S. 2014. Social media: New generation tools for "agricultural extension".

Surabhchandra and Singh, A.K. 2019. A study on utilisation pattern of ICTs for selected pulse crops in Banda district of Uttar Pradesh. *M.Sc. (Ag). Thesis*. Banaras Hindu University, Varanasi, India.

Vivek, J.K. 2017. Utilisation of Information and Communication Technologies (ICTs) by the pea growers of Patan block of Jabalpur district of Madhya Pradesh. Jawaharlal Nehru Vishwa Vidyalaya, Jabalpur, India.

Williams, E.E and Agbo, I.S. 2013. Evaluation of the use of ICT in agricultural technology delivery to farmers in Ebonyi State, Nigeria. *Journal of Information Engineering and Applications*. 3(10): 18-26.

Andhra Pradesh J Agril. Sci : 8(4): 211-216, 2022

ANALYSIS OF PROFILE OF FARMER PRODUCER ORGANIZATIONS IN SRIKAKULAM DISTRICT OF ANDHRA PRADESH

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Date of Receipt: 06-06-2022 Date of Acceptance: 08-10-2022

ABSTRACT

In the era of globalization and free trade liberalization, the concept of collectivization or group initiation through local level organization is very essential. Farmer Producer Organizations, principally using the concept of collectivisation, offer small farmers to participate in the market more effectively and collectively, they are in a better position to reduce transaction costs of accessing inputs and outputs, obtaining the necessary market information, securing access to new technologies and allowing them to compete with larger farmers and agribusinesses. Keeping this in view the present study was conducted in Srikakulam district of Andhra Pradesh. Datawas collected from the FPOs through field survey by the interview method with the help of a pre-tested and well structure schedule. The results revealed that the majority (78.94%) of registered FPOs were promoted by NABARD followed by SFAC and BFTW each with 10.52 per cent respectively. The average number of members in FPOs promoted by NABARD was 531, SFAC promoted FPOs was 1250 and BFTW promoted FPOs was 835. The study revealed that in NABARD promoted FPOs 68.73 per cent of members were tribal farmers, in SFAC promoted FPOs it was 99.44 per cent while in the case of BFTW promoted FPOs all the members were tribal farmers only.

KEYWORDS: Farmer Producer Organizations (FPO), Socio-Economic Characteristics, Srikakulam.

INTRODUCTION

Farmer Producer Organizations are the institutions meant for the development of farmers and the rural poor through collective actions of the individual members for increasing their livelihood so that to reduce the poverty. As the co-operatives were failed in the country to develop the rural poor farmers, the alternative solution was Farmer Producers Organizations (FPO's). The main idea of FPO's was to develop the small and marginal farmers. As the marketable surplus of these farmers was very less and are mostly depending on money lenders for their finance and mostly they sell their produce at a lower price in the village itself. As the FPOs had a better bargaining power as the bulk suppliers of the produce and bulk buyers of the inputs, helps the farmers to obtain a better price for their produce and purchasing of inputs at a lower price. In this background the present study was carried out to know the profile of FPOs in Srikakulam district of Andhra Pradesh.

MATERIAL AND METHODS

In Srikakulam district 29 Farmer Producer Organizations were operating under 8 NGO's and were promoted by National Bank for Agriculture and Rural Development (NABARD), Small Farmers Agribusiness Consortium (SFAC) and Bread for the World (BFTW). Out of 29 registered and functional FPOs in the district, 19 FPOs with two completed years of existence were chosen purposively for the study.The selected FPOs were 15 from NABARD, 2 from SFAC and2 from BFTW.

Data collected was interpreted in terms of their frequencies and percentages wherever necessary to know the socio-economic profile of FPOs. The methodology was taken from the reference of Darshan *et al.* (2017) from farmer producing organization for development of farmers in India.

RESULTS AND DISCUSSIONS

Distribution of FPOs according to promoting agencies

In the sample studied, highest number of FPOs were promoted by NABARD (78.94%) followed by SFAC (10.52%) and BFTW (10.52%) respectively. A proper roadmap with guidelines for promotion, selection methodology, budget, registration procedures etc were provided to Promotional Institutions (PI) by central government. Distribution of FPOs according to promoting agency wise was presented in Table 1.

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Table 1. Distribution of FPOs according to promoting agencies

S. No.	Promoting Agencies	Total
1.	National Bank for Agriculture and Rural Development (NABARD)	15 (78.94)
2.	Small Farmers Agribusiness Consortium (SFAC)	2 (10.52)
3.	Bread for the World (BFTW)	2 (10.52)
	Total	**19 (100.00)**

Note: Figures in parentheses indicates percentages to the total

Table 2. Distribution of FPOs according to supporting agencies

S. No.	Name of NGO/ Supporting agency	Promoting agency	No. of FPOs	No. of registered farmers
1	Action in Rural Technology and Services (ARTS)	NABARD	2 (10.52)	940 (7.78)
2	Youth Club of Bejjipuram (YCB)	NABARD	2 (10.52)	1420 (11.75)
3	Vivekananda Innovation for developing Youth Ambition (VIDYA)	NABARD	1 (5.26)	514 (4.25)
4	ChinnayaAadivasiVikasSangham (CAVS)	NABRAD	5 (26.31)	2879 (23.82)
5	Access Livelihood Consulting India Limited (ALC)	SFAC	2 (10.52)	2499 (20.68)
6	Bapuji Rural Enlightenment and Development Society (BRETS)	NABARD	4 (21.05)	1641 (13.58)
7	Human Development Students Association (HDSA)	NABARD	1 (5.26)	520 (4.30)
8	Velugu Association (VELUGU)	BFTW	2 (10.52)	1669 (13.81)
		Total	**19 (100.00)**	**12082 (100.00)**

Note: Figures in parentheses indicates percentages to the total

Distribution of FPOs according to supporting agencies

To promote FPOs the state government also developed its own separate and independent guidelines. All the FPOs in the study area were supported by 8 different Non-Governmental Organizations (NGOs) as shown in Table 2. The highest number of FPOs were supported by Chinnaya Aadivasi Vikas Sangham (CAVS) with 26.31 per cent, followed by Bapuji Rural Enlightenment and Development Society (BRETS) with 21.05 per cent each. Action in Rural Technology and Services (ARTS), Youth Club of Bejjipuram (YCB), Access Livelihood Consulting India Limited (ALC) and Velugu Association (VELUGU) each with 10.52 per cent respectively. Rest 5.26 per cent each were supported by

Table 3. Basic profile of sample FPOs

S. No.	Particulars	No. of FPOs			Total
		NABARD	SFAC	BFTW	
1	**Registered based on**				
	Co-operative society act	0	0	2	2 (10.52)
	Company act	15	2	0	17 (89.47)
2	**Year of registration**				
	2015	0	0	1	1 (5.26)
	2016	1	0	0	1 (5.26)
	2017	1	2	0	3 (15.78)
	2018	0	0	1	1 (5.26)
	2019	13	0	0	13 (68.42)
3	**No. of villages covered**				
	Group I (≤ 49)	14	0	1	15 (78.94)
	Group II (50-83)	1	1	1	3 (15.78)
	Group III (84-117)	0	0	0	0 (0.00)
	Group IV (118-151)	0	1	0	1 (5.26)
4	**No. of farmers in FPOs**				
	Group I (≤ 580)	13	0	1	14 (73.68)
	Group II (581-812)	0	0	0	0 (0.00)
	Group III (813-1044)	2	0	0	2 (10.52)
	Group IV (1045-1276)	0	2	1	3 (15.78)
5	**Equity mobilized (₹ lakhs)**				
	Group I (≤ 8 lakhs)	6	0	0	6 (31.57)
	Group II (9-14 lakhs)	8	2	0	10 (52.63)
	Group III (15-20 lakhs)	1	0	1	2 (10.52)
	Group IV (21-25 lakhs)	0	0	1	1 (5.26)
6	**Turnover (₹ Lakhs)**				
	Group I (≤ 26 lakhs)	7	0	1	8 (42.10)
	Group II (27-40 lakhs)	3	1	0	4 (21.05)
	Group III (41-54 lakhs)	4	0	1	5 (26.31)
	Group IV (55-68 lakhs)	1	1	0	2 (10.52)
7	**Share capital (₹ Lakhs)**				
	Group I (≤ 14 lakhs)	13	2	1	16 (84.21)
	Group II (15-29 lakhs)	0	0	1	1 (5.26)
	Group III (30-44 lakhs)	1	0	0	1 (5.26)
	Group IV (45-59 lakhs)	1	0	0	1 (5.26)

Note: Figures in parentheses indicates percentages to the total

Vivekananda Innovation for developing Youth Ambition (VIDYA) and Human Development Students Association (HDSA).

A total of 12082 small and marginal farmers were registered as members in FPOs promoted by NABARD, SFAC and BFTW. The highest number of registered farmers are in CAVS (23.82%), followed by ALC (20.68%), VELUGU (13.81%), BRETS (13.58%), YCB (11.75%), ARTS (7.78%), HDSA (4.3%) and VIDYA (4.25%) respectively as shown in Table 2.

Basic profile of sample FPOs

The results presented in Table 3 revealed that all the FPOs promoted by NABARD were registered under company act, the SFAC promoted FPOs were also registered under company act, only BFTW promoted FPOs were registered under co-operative society act. In total 89.47 per cent of FPOs were registered under company act and only 10.52 per cent were registered under co-operative society act. Out of 15 FPOs promoted by NABARD, 13 FPOs were formed in the year 2019 and one each was established in 2016 and 2017 respectively. All the FPOs promoted by SFAC were registered in the year 2017 and in BFTW promoted FPOs one was established in the year 2015 and one in 2018. In total 68.42 per cent of FPOs were established in the year 2019

Table 4. Socio-economic profile of sample FPOs

S. No.	Particulars	NABARD promoted FPOs	SFAC promoted FPOs	BFTW promoted FPOs	Overall
1.	Average no. of members	531	1250	835	636
2.	Average no. of small farmers	354 (66.66)	255 (20.40)	835 (100.00)	394 (61.94)
3.	Average no. of marginal farmers	136 (25.61)	748 (59.84)	0 (0.00)	186 (29.24)
4.	Average no. of landless tenants	41 (7.72)	247 (19.76)	0 (0.00)	56 (8.80)
5.	Average no .of male farmers	472 (88.88)	1000 (80.00)	556 (66.58)	537 (84.43)
6.	Average no. of female farmers	59 (11.11)	250 (20.00)	279 (33.41)	99 (18.47)
7.	Average no. of ST farmers	365 (68.73)	1243 (99.44)	835 (100.00)	507 (79.71)
8.	Average no. of SC farmers	55 (10.35)	0 (0.00)	0 (0.00)	40 (6.28)
9.	Average no. of OBC farmers	106 (19.96)	7 (0.56)	0 (0.00)	85 (13.36)
10.	Average no. of general category farmers	5 (0.94)	0 (0.00)	0 (0.00)	4 (0.62)
11.	Equity mobilized (₹ lakhs)	8.15	10.00	20.95	9.69
12.	Turn over (₹ lakhs)	32.75	45.00	34.50	34.23
13.	Share capital (₹ lakhs)	10.15	12.81	16.73	11.12
14.	Share amount per member	1200	1100	110	1074.73
15.	No. of BODs	11	11	11	11
16.	Salary of CEO	27333.30	10000.00	0.00	22631.57

Note: Figures in parentheses indicates percentages to the total

followed by 15.78 per cent in 2017, 5.26 per cent each in 2015, 2016 and 2018 respectively. No. of villages covered by each FPO were classified into four groups i.e., group I (≤ 49 villages), group II (50-83 villages), group III (84-117 villages) and group IV (118-151 villages). Majority of the FPOs promoted by NABARD were fall in the group I followed by group II. In SFAC promoted FPOs one fall in group II and another in group IV. In BFTW promoted FPOs one FPO was fall in group I and other fall in group II. In total 78.94 per cent of FPOs were fall in group I followed by group II (15.78%) and group IV (5.26%). No. of farmers served by each FPO were also classified into four groups i.e., group I (≤ 580 members), group II (581-812 members), group III (813-1044 members) and group IV (1045-1276 members). Majority of the FPOs promoted by NABARD were fall in group I followed by group III. All FPOs promoted by SFAC were fall in group IV and in BFTW promoted FPOs each one fall in group I and group IV respectively. In total majority of the FPOs (73.68%) were fall in group I followed by group IV (15.78%) and group III (10.52%).

The equity mobilized of each FPO was categorized into four groups i.e., group I (≤ 8 lakhs), group II (9-14 lakhs), group III (15-20 lakhs) and group IV (21-25 lakhs). Eight FPOs promoted by NABARD fall in group II followed by six in group I and one in group III. In SFAC promoted FPOs all were fall in group II and in BFTW FPOs each one fall in group III and group IV respectively. Overall 52.63 per cent of FPOs were fall in group II followed by group I (31.57%), group III (10.52%) and group IV (5.26%). The turnover of the FPOs was classified into four groups, group I (≤ 26 lakhs), group II (27-40 lakhs), group III (41-54 lakhs) and group IV (55-68 lakhs). More number of FPOs promoted by NABARD were fall in group I (7) followed by group III (4), group II (3) and group IV (1). In SFAC promoted FPOs each one fall in group II and group IV and in BFTW FPOs each one fall in group I and group III. In total majority of FPOs were fall in group I (42.10%) followed by group III (26.31%), group II (21.05%) and group IV (10.52%) respectively. The share capital also categorized into four groups viz., group I (≤ 14 lakhs), group II (15-29 lakhs), group III (30-44 lakhs) and group IV (45-59 lakhs). Majority of FPOs promoted by NABARD were fall in group I followed by each one in group III and IV respectively. In SFAC promoted FPOs all were fall in group I and in BFTW promoted FPOs each one fall in group I and group II respectively. In total 84.21 per cent of FPOs were fall in group I followed by each 5.26 per cent in group II, III and IV respectively.

From the results it was concluded that majority of FPOs were registered under company act and registered in the year 2019. Most of the FPOs were covering less than 49 villages and having less than 580 number of members. Most of the FPOs mobilized equity in the range of 9 to 14 lakhs, turnover was below 26 lakhs and the share capital was below 14 lakhs. The results were in line with the results of Nalini *et al.* (2017) in their study of farmers producer organizations as farmer collectives.

Socio-economic characteristics of sample FPOs

The average number of members in FPOs promoted by NABARD was 531, SFAC promoted FPOs was 1250 and BFTW promoted FPOs was 835. Overall the average number of members in FPOs was 636. In NABRAD promoted FPOs 66.66 per cent of members were small farmers followed by 25.61 per cent of marginal farmers and 7.72 per cent were landless tenants. In SFAC promoted FPOs 59.84 per cent were marginal farmers. All the members in BFTW promoted FPOs were small farmers. Overall each FPO served 61.94 per cent of small farmers followed by 29.24 per cent of marginal farmers and 8.80 per cent of landless tenants. Gender wise NABRAD promoted FPOs had 88.88 per cent of male farmers and 11.11 per cent of female members. In SFAC promoted FPOs 80 per cent were male members, 20 per cent were female members and in BFTW promoted FPOs 66.58 per cent were male members and 33.41 per cent were female members. Overall 84.43 per cent of FPO members were male farmers and the remaining 18.47 per cent were female farmers respectively. In NABARD promoted FPOs 68.73 per cent of members were fall in ST category followed by 19.96 per cent were fall in OBC category, 10.35 per cent in SC category and 0.94 per cent in General category. In the case of SFAC promoted FPOs 99.44 per cent were from ST category followed by 0.56 per cent from OBC. All the members in BFTW promoted FPOs were from ST category. On an average each FPO served 79.71 per cent of ST farmers followed by 13.36 per cent of OBC farmers, 6.28 per cent of SC farmers and 0.62 per cent of general farmers.

The average equity mobilized was observed more in BFTW promoting FPOs with ₹ 20.95 lakhs followed by ₹ 10 lakhs by SFAC promoting FPOs and ₹ 8.15 lakhs by NABARD promoting FPOs. Overall the equity

mobilized by each FPO was ₹ 9.69 lakhs. The SFAC promoting FPOs had highest turnover with ₹ 45.00 lakhs followed by BFTW promoted FPOs with ₹ 34.50 lakhs and NABARD promoted FPOs with ₹ 32.75 lakhs. Overall the average amount of turnover by each FPO was ₹ 34.23 lakhs. The average share capital was found to be high in BFTW promoted FPOs with ₹ 16.73 lakhs followed by ₹ 12.81 lakhs by SFAC promoting FPOs and ₹ 10.15 lakhs by NABARD promoting FPOs. On an average each FPO had a share capital of ₹ 11.12 lakhs. The highest share amount per member was found in NABARD promoted FPOs with ₹ 1200 and the lowest share amount by BFTW promoting FPOs with ₹ 110 and it was ₹ 1100 in the case of SFAC promoted FPOs. Overall the average amount of share amount per member was ₹ 1074. The number of board of directors in all the FPOs promoted by three agencies was 11 only and the average salary of Chief executive officer was high in NABARD promoting FPOs with ₹ 27333.30 and SFAC promoting FPOs with ₹ 10000 respectively as shown in Table 4. The BFTW promoted FPOs were not appointing chief executive officer and FPOs were maintained by the decisions of the board of directors. The results were in line with the results of Prishila *et al.* (2019) in their study of performance of FPOs in Chhattisgarh plain in terms of ownership and management structure.

From the results it was concluded that majority (78.94%) of registered FPOs are supported by NABARD followed by SFAC and BFTW. Majority (89.47%) of FPOs are registered under Companies Act, rest 10.52 per cent of FPOs are registered under Co-operative Society Act. The highest number of FPOs are registered in CAVS with 26.31 per cent. From the percentage analysis of socio-economic profile that majority (54.16%) of respondents are females followed by 45.83 per cent of males. Most of the farmers who became the members of FPOs were middle aged with 41.66 per cent and they had great predominance of working efficiency. The majority (58.33%) of farmers were illiterates due to lack of formal institutions at village and mandal levels and the land holding is between 2-4 ha with 65.82 per cent of farmers. The highest 62.5 per cent of farmers has 3-5 years of experience in FPOs followed by 58.33 per cent were dependent upon agriculture with livestock farming, 45 per cent have annual income of 1-2 lakhs, 57.5 per cent have pucca houses, 85 per cent of farmers are having both marketing and subsistence as their farming purpose, 53.33 per cent have their own source of land, 39.16 per cent have medium farming experience and 30.83 per cent of members are taking loan from both private and government sector.

LITERATURE CITED

Darshan, N.P., Rajashekar, B., Patil, K.V and Naik, J.P. 2017. Farmer Producing Organizations for development of farmers in India: An Economic perspective. *International Journal of Current Microbiology and Applied Sciences*. 6(9): 1611-1615.

Helen, L and Kevin, C. 2014. Producer Companies in India: Potential to support Increased Productivity and Profitability of Poor Smallholder Farmers. *Smart Lessons*. 1-5.

Hellin, J., Mark, L and Madelon, M. 2008. Farmer Organization, Collective action and market access in Meso-America. *Food Policy*. 34(1): 16-22.

Millns, J and Juhasz, J. 2006. Promoting farmer entrepreneurship through producer organizations in Central and Eastern Europe institutions for rural development, *Food and Agriculture Organization of the United Nations, Rome, Working Paper 6.*

Nalini, B., Mohana, R.R.T and Vaibhav, B. 2017. Farmer Producer Organizations as Farmer Collectives: A Case Study from India. *Development Policy Review*. 36(6): 669-687.

Prishila, K., Gauraha, A.K and Neha, L. 2019. Performance of Farmer Producer Organizations (FPOs) in Chhattisgarh plain in terms of Ownership and Management. *Journal of Pharmacognosy and Phtochemistry*. 8(6): 425-429.

Andhra Pradesh J Agril. Sci : 8(4): 217-222, 2022

MOLECULAR CHARACTERIZATION OF PHYTOPLASMA ASSOCIATED WITH LITTLE LEAF DISEASE OF BRINJAL (*Solanum melongena* L.) IN CHITTOOR DISTRICT OF ANDHRA PRADESH

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Date of Receipt: 06-06-2022 Date of Acceptance: 07-10-2022

ABSTRACT

Brinjal little leaf (BLL) is a prevalent phytoplasma disease in India that induces severe economic losses every year. During 2021, symptoms of little leaf and witches' broom were observed on brinjal plants grown in the horticultural fields of S. V. Agricultural College, Tirupati. Four symptomatic and two symptomless plants collected from the surveyed places were subjected to genomic DNA extraction and used as template in nested PCR assays with universal phytoplasma 16S rRNA primers, P1/P7 and R16F2n/R16R2. Amplification of ~1.25 kb product was obtained only from symptomatic BLL plants and the positive control, but not from any asymptomatic plants.

KEYWORDS: Eggplant/Brinjal, 16S rRNA, Nested PCR assay.

INTRODUCTION

Brinjal (*Solanum melongena* L.) is the most important vegetable cultivated all over the world. India is the second largest producer of brinjal in the world and Andhra Pradesh is a leading brinjal growing state of India (Anonymous, 2019). The crop is challenged by several diseases caused by fungi, bacteria, viruses and other insect pests of which brinjal little leaf (BLL) is one of the most important disease caused by phytoplasma causing considerable economic losses as the infected plant fails to produce a single fruit. Phytoplasma associated diseases in vegetable crops are prevalent in Asian, African, and American continents. So far twenty-eight vegetable species have been reported to be infected by different strains of phytoplasma all around the world (Kumari *et al.,* 2019). Brinjal Little Leaf disease was first recorded by Thomas and Krishnaswami (1939) in India with 100% yield loss (Rao and Kumar, 2017). Five ribosomal groups (16SrI, 16SrII 16SrVI, 16SrIX and 16SrXII) were reported associated with BLL disease at global level (Kumari *et al*., 2019). The phytoplasma groups 16SrI and 16SrVI (subgroup 16SrVI-D) are the most dominant reported to be associated with BLL disease in eggplants showing little leaf, shortening of internodes, witches' broom, phyllody, stunting and yellowing with necrosis symptoms in India (Kumar *et al*., 2017; Rao and Kumar, 2017). The phytoplasma disease of eggplant was reported to be widespread in the areas, where overlapping crop cycles and weeds ensure high populations of leafhoppers and provide natural reservoirs for the different strains of phytoplasma (Rao and Kumar, 2017; Rao, 2021). But limited reports are available from Andhra state of India. Since, most of the farmers in Andhra Pradesh are cultivating brinjal for commercial sale in local markets, an attempt was made to detect, phytoplasma presence associated with BLL in the Chittoor district of Andhra Pradesh.

MATERIAL AND METHODS

During April 2021 survey was conducted in horticultural fields of S. V. Agricultural College, Tirupati, Chittoor district, Andhra Pradesh. The disease incidence of BLL was assessed by counting number of infected plants visually over healthy plants by randomly selecting 5 × 5 meter plot at each location. Moreover symptomatic leaf samples were collected in each surveyed location were brought to the laboratory along with two healthy leaf samples for further processing. DNA was extracted from the symptomatic and non-symptomatic brinjal samples using CTAB method.

DNA extraction

The total genomic DNA was isolated from the leaves of healthy and symptomatic plants by following CTAB (Cetyl Trimethyl Ammonium Bromide) method of Murray and Thomson (1980) with some modifications. The modifications were made to improve the quality of DNA.

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Procedure

1. The leaf samples were grounded into a fine powder with liquid nitrogen.
2. Approximately 100 mg of the powder was transferred into 2 ml eppendorf tube by spatula, to this 1.5 ml of CTAB extraction buffer was added and then incubated in water bath at 65°C for 45 min to 1 hr with occasional vortexing at every 20 min interval.
3. The tubes were removed from the water bath and allowed to cool at room temperature and later centrifuged at 14,000 rpm for 10 min.
4. Then equal volume of Phenol: Chloroform (1:1 v/v) was added to the supernatant and mixed thoroughly by gentle inversion and centrifuged for 20 min at 13,000 rpm at 25°C and then the supernatant was carefully pipetted out into new 2 ml eppendorf tubes.
5. To this supernatant, chloroform: Isoamyl alcohol (24:1 v/v) was added then mixed thoroughly by gentle inversion and centrifuged at 12000 rpm for 15 min at 25°C. Then supernatant was carefully pipetted out into new 1.5 ml eppendorf tubes.
6. The supernatantwas taken to which ice cold isopropanol of about 0.6 volumes (2/3rd of pipetted volume) and 0.1volume of 3M sodium acetate of pH 5.2 was added. The contents were mixed gently by inversion and kept undisturbed for overnight or for 2 hrs at -20°C.
7. Subsequently, the tubes were centrifuged at 13,000 rpm for 20 min at 4°C temperature to pellet out the DNA.
8. The supernatant was discarded gently and the DNA pellet was washed with 70% ethanol and centrifuged at 13,000 rpm for 10 minutes.
9. The supernatant was removed and the tubes were allowed to air dry completely until ethanol smell was lost and then the pellet was dissolved in 40-80 µl of nuclease free water.

Quality and Quantity of DNA

DNA was assessed for its purity and intactness using agarose gel electrophoresis.

1. Quantification of DNA by 1% Agarose Gel Electrophoresis

Preparation of 1% Agarose Gel: 1 g of agarose was placed in a conical flask containing 100 ml 1X TAE buffer. The conical flask along with its contents was placed in an oven until agarose gets melted completely and clear solution was formed and then the flask was taken out from the oven and allowed to cool. 3 µl of Ethidium Bromide (10 mg ml^{-1}) was added to this 100 ml of agarose gel and mixed thoroughly. Later the solution was poured slowly into the gel casting tray which is pre-set with 0.5 mm combs, to avoid the formation of bubbles. After solidification the gel with casting tray was placed in gel tank and the comb was removed gently without disturbing the wells that formed upon solidification.

2) Quantification of DNA by NanoDrop spectrophotometer

The NanoDrop spectrophotometer (model ND1000) was used to assess the quantity and quality of DNA employing the following procedure. Before initializing the NanoDrop Reader, the pedestal was cleaned with tissue paper to remove the dust particles. Then for initializing the instrument, 1-2 µl of distilled water was placed on the lower pedestal, closed the upper one and clicked on measure option. Then the pedestal was cleaned with tissue paper and 1.5 µl of 1X TE buffer was placed on lower pedestal and repeated the procedure for blank measurement. After that, 2 µl of DNA sample was placed to measure the quality and quantity at A260 nm and A280 nm to assess the purity of DNA. The process is repeated for all the DNA samples. A ratio of ~1.8 is generally accepted as "pure" for DNA; a ratio of ~2.0 is generally accepted as "pure" for RNA. If the ratio is lower in either case, it may indicate the presence of protein, phenol or other contaminants that absorb strongly at/or near 280 nm.

Normalization of DNA concentration

Normalization of DNA samples was done to equalize the concentration of all the samples to be used for PCR reaction. The purpose of normalization was to avoid erroneous analyses due to difference in the brightness of the bands obtained after electrophoresing the amplified PCR products. Normalization was done by diluting the DNA samples with sterile distilled water to their required dilution factor which in turn depends upon the initial concentration of DNA sample (from quantification readings) and the type of analysis done (markers used). After normalization of samples the concentration of DNA was 100 ng μl^{-1}.

It was done by using the formula: $N_1V_1 = N_2V_2$

PCR Amplification of Phytoplasmas DNA

Primers used for 16S rRNA gene

The extracted DNA from the plants and insects was amplified for 16S ribosomal DNA with phytoplasma specific universal primer pair P1/P7 (Deng and Hiruki, 1991; Schneider *et al.,* 1995) followed by nested primer

Table 1. Details of Primers used for amplification of phytoplasma DNA in collected sample

Primer name	Sequence	Target gene	Amplicon size (bp)	Reference
P1	5' AAGAGTTTGATCCTGGCTCAGGATT 3'	*16S* rRNA	~1800	Deng and Hiruki, 1991
P7	5' CGTCCTTCATCGGCTCTT 3'			
R16F2n	5' TGACGGGCGGTGTGTACAAACCCCG 3'	*16S* rRNA	~1240	Gundersen and Lee, 1996
R16R2	5' GAAACGACTGCTAAGACTGG 3'			

pair R16F2n/R16R2 (Gundersen and Lee, 1996) (Table 1).

PCR cycles used for amplification

PCR reactions were carried out in a Mastercycler (Eppendorf, Germany) and the cycling protocols for the amplification of different genes used are described herein.

16S rRNA gene

First round of PCR assay for the conserved region of the 16S rRNA gene using P1/P7 primer pair and the cycling protocol used in the study are mentioned here under (Table 2).

Table 2. PCR programme for amplification of 16S rDNA (first round PCR)

Steps	Temperature (°C)	Time
Initial denaturation	94	4 min
Denaturation	94	30 sec
Annealing	56	45 sec
Extension	72	1 min
Number of cycles	30	
Final extension	72	10 min
Hold	4	∞

For nested PCR amplification of 16S rRNA using R16F2n/R16R2 primer pair and the cycling protocol used are mentioned in Table 3.

RESULTS AND DISCUSSION

From all the collected samples, the affected brinjal plants showed the symptoms of littleleaf and witches' broom (Figures 1a and 1b). The disease incidence was recorded from10% to 20%. The association of phytoplasmas in all the symptomatic samples was

Table 3. PCR programme for amplification of 16S rDNA (second round PCR)

Steps	Temperature (°C)	Time
Initial denaturation	94	4 min
Denaturation	94	30 sec
Annealing	56	45 sec
Extension	72	1 min
Number of cycles	30	
Final extension	72	10 min
Hold	4	∞

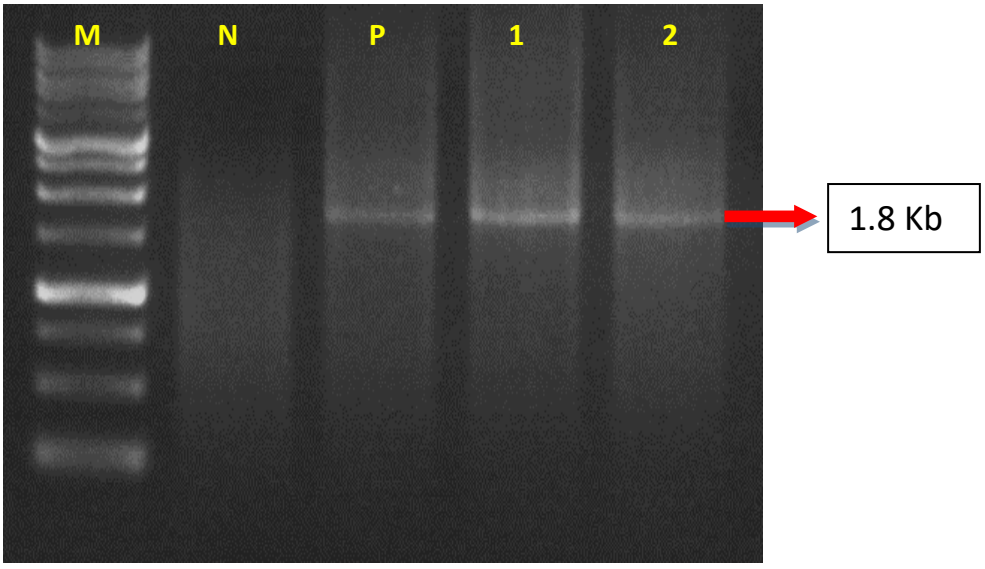
confirmed by PCR amplification of ~1.8 kb products in the first round (Figure 2a). PCR and ~1.2 kb products in nested PCR assays with primer pair P1/P7 and R16F2n/R16R2, respectively, while no amplification was observed in the asymptomatic samples (Figure 2b) which confirmed the association of phytoplasma with symptomatic brinjal plants.

DISCUSSION

Phytoplasma belonging to 16SrII-D subgroup was found as the most widely distributed phytoplasma strain on other plant crops in India (Rao, 2021; Reddy *et al*., 2021). Earlier, the 16SrII-D phytoplasmas were identified on brinjal from Uttar Pradesh and Karnataka (Kumar *et al*., 2017; Yadav *et al*., 2016) and 16SrVI-D (Azadvar and Baranwal, 2012; Kumar *et al*., 2017) was reported from various parts of India whereas, the presence of 16SrVI-D and 16SrI group in Bangladesh (Siddique *et al.,* 2001), 16SrII-A in China (Cai *et al*., 2016), 16SrII-D in Oman (Al-Subhi *et al.,* 2018) was reported in BLL diseased plants.

Naik *et al*. (2018) reported the association of 16SrVI-D sub-group of phytoplasma in Andhra Pradesh.

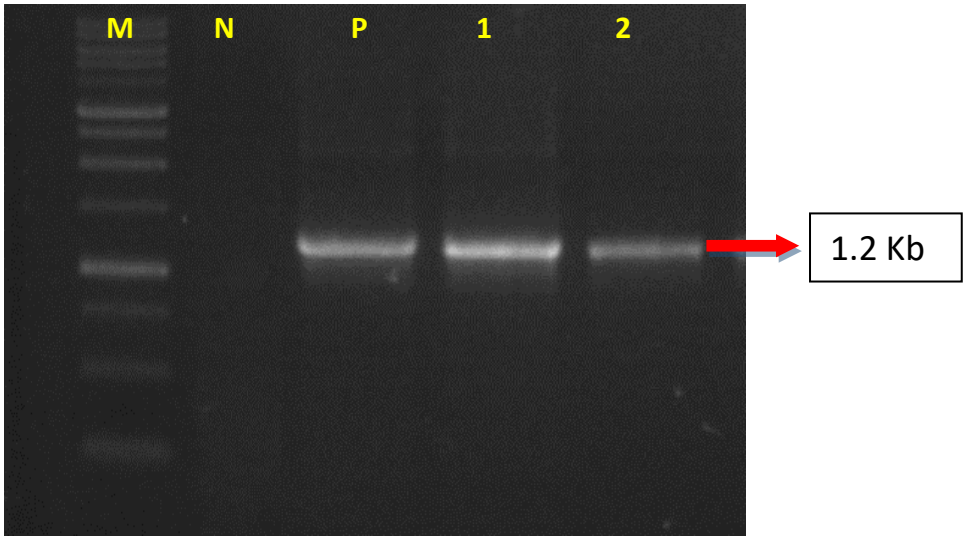
Figure 1a, 1b. Brinjal little leaf disease symptoms at Chittoor district of Andhra Pradesh.



Lane M: 1kb ladder, Lane N: Negative control, Lane P: Positive control, Lane 1: brinjal isolate sample-1 and Lane 2- Brinjal isolate sample-2

Figure 2a. Gel electrophoresis image for direct PCR assay results of phytoplasma showing expected amplicons from symptomatic brinjal plants obtained with primer pairs P1/P7.

In the present study, the association of 16SrII-D from Andhra Pradesh was confirmed based on sequence comparison, phylogeny and RFLP analysis of 16S rDNA sequences. To our knowledge, this is the first report of the showing the association of 16SrII-D sub-group of phytoplasma with little leaf of brinjal in Andhra Pradesh. Recently, 16SrII-D subgroup phytoplasma was identified and characterized from chickpea and weeds from Kadapa, Andhra Pradesh (Reddy *et al*., 2021). In India, brinjal is cultivated in the same season with many other agricultural crops. The scenario of natural phytoplasma spread from brinjal to other plant species and vice versa, through an efficient vector species, is quite possible as reported in other states of India (Kumar *et al.,* 2017).



Lane M: 1 kb ladder, Lane N: Negative, Lane P: Positive control, Lane 1: Brinjal isolate sample-1, Lane 2- Brinjal isolate sample-2

Figure 2b. Gel electrophoresis image for nested PCR assay results of phytoplasma showing expected amplicons from symptomatic sesame plants obtained with primer pairs R16F2n/R16R2.

This indicates that Brinjal Little Leaf disease is widely spreading and association of new sub-groups were reported based on the prevalence of alternate hosts and vectors in a particular locality. Keeping this in view, further studies on epidemiology along with possible natural spread sources and management are therefore a foremost need.

LITERATURE CITED

Al-Subhi, A.M., Hogenhout, S.A., Al-Yahyai, R.A and Al-Sadi, A.M. 2018. Detection, identification, and molecular characterization of the 16SrII-D phytoplasmas infecting vegetable and field crops in Oman. *Plant Disease*. 102: 576-588.

Anonymous, 2019. http://www.mospi.gov.in/ [accessed 02.06.2021]

Azadvar, M and Baranwal, V.K. 2012. Multilocus sequence analysis of phytoplasma associated with brinjal little leaf disease and its detection in *Hishimonas phycitis* in India. *Phytopathogenic Mollicutes*. 2: 15-21.

Cai, H., Wang, L., Mu, W., Wan, Q., Wei, W., Davis, R.E., Chen, H and Zhao, Y. 2016. Multilocus genotyping of a '*Candidatus* Phytoplasma aurantifolia'-related strain associated with cauliflower phyllody disease in China. *Annals of Applied Biology*. 169. 64-74.

Deng, S and Hiruki, C. 1991. Amplification of 16S rRNA genes from culturable and nonculturable mollicutes. *Journal of Microbiological Methods*. 14: 53-61.

Gundersen, D.E and Lee, I.M. 1996. Ultrasensitive detection of phytoplasmas by nested-PCR assays using two universal primer pairs. *Phytopathologia Mediterrenea*. 35: 144-151.

Kumar, M., Madhupriya and Rao, G.P. 2017. Molecular characterization, vector identification and sources of phytoplasmas associated with brinjal little leaf disease in India. *3 Biotech*. 7: 1-11.

Kumari, S., Nagendran, K., Rai, A.B., Singh, B., Rao, G.P and Bertaccini, A. 2019. Global status of phytoplasma diseases in vegetable crops. *Frontiers in microbiology*. 10: 1349.

Murray, M.G and Thompson, W.F. 1980. Rapid isolation of high molecular weight plant DNA. *Nucleic Acids Research*. 8: 4321-5.

Naik, D.V.K., Reddy, B.V.B., Rani, J.S., Devi, S.J.R and Prasad, K.V.H. 2018. *Candidatus* Phytoplasma trifolii associated with little leaf disease of *Solanum melongena* (Brinjal) in Andhra Pradesh, India. *Journal of Pharmacognosy and Phytochemistry.* 7: 3695-3697.

Rao, G.P. 2021. Our understanding about phytoplasma research scenario in India. *Indian Phytopatholog*y. 1-31.

Rao, G.P and Kumar, M. 2017. World status of phytoplasma diseases associate with eggplant. *Crop Protection.* 96: 22-29.

Reddy, M.G., Baranwal, V.K., Sagar, D and Rao, G.P. 2021. Molecular characterization of chickpea chlorotic dwarf virus and peanut witches' broom phytoplasma associated with chickpea stunt disease and identification of new host crops and leafhopper vectors in India*. 3 Biotech.* 11(3): 1-23.

Schneider, B., Seemüller, E., Smart, C.D and Kirkpatrick, B.C. 1995. Phylogenetic classification of plant pathogenic mycoplasmalike organisms or phytoplasmas. In: *Molecular and Diagnostic Procedures in Mycoplasmology*. Vol. 2, pp 369–380. Eds S Razin and JG Tully. Academic Press, New York.

Siddique, A.B.M., Agrawal, G.K., Alam, N and Reddy, M.K. 2001. Electron microscopy and molecular characterization of phytoplasmas associated with little leaf disease of brinjal (*Solanum melongena* L.) and periwinkle (*Catharanthus roseus*) in Bangladesh. *Journal of Phytopathology.* 149: 237-244.

Thomas, K.M and Krishnaswami, C.S. 1939. Little leaf—a transmissible disease of brinjal. *Proceedings of the National Academy of Sciences*. 10: 201-212.

Yadav, V., Mahadevakumar. S., Tejaswini, G.S., Shilpa, N., Amruthavalli and Janardhana, G.R. 2016. First report of 16SrII-D phytoplasma associated with eggplant big bud (*Solanum melongena* L.) in India. *Plant Dise*ase. 100: 517.

Andhra Pradesh J Agril. Sci : 8(4): 223-228, 2022

A STUDY ON EXPORT GROWTH OF CHITTOOR MANGO AND CONSTRAINTS FACED BY DIFFERENT ACTORS IN MANGO VALUE CHAIN

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Date of Receipt: 26-08-2022 Date of Acceptance: 14-11-2022

ABSTRACT

The current study was conducted to analyse the export growth of Chittoor mango and constraints faced by different actors in Chittoor mango value chain. Various stakeholders in mango value chain comprised of mango growing farmers, pre – harvest contractors, input suppliers, APMC/Village traders, institutional buyers, processors, wholesalers, retailers, exporters, consumers, and farmer producer organisations. The Chittoor mango value chain is regarded as complex and diversified because of the involvement of large no. of intermediaries in the value chain making it less efficient. Despite being the Agri Export Zone, Chittoor mango belt and Chittoor processing industry and export industry were facing infrastructure bottlenecks. The compound annual growth rates of quantity of fresh mango exports were estimated as - 6.16 per cent and their value is recorded as 3.81 per cent. The compound annual growth rates of mango pulp exports are estimated as -5.02 per cent and the value of total exports is recorded as 1.04 per cent. The major constraints faced by processors were high working capital (82.00) and poor quality of law material (68.20). The constraints faced by exporters were high freight charges (77.20), stringent norms by importing countries (72.40) and poor post harvest handling by mango growers (62.40).

KEYWORDS: Mango value chain, value chain actors, constraints, processing, exports.

INTRODUCTION

Mango, a tropical fruit, belongs to the family Anacardiaceae, originated from South and Southeast Asia and now is cultivated all around the world. It is known as the "King of Fruits," which makes it the most popular fruit. Indian mango is one-of-a-kind product that exemplifies great quality and plenty of nutrients it contains. India is the world's leading mango producer, accounting for more than half of global mango production. It was recorded as 20.32 MT in 2020. But a very a small per cent, nearly 1 per cent of this production was exported to the foreign countries. India exported 21033 MT of fresh mangoes to major destinations like UAE, UK, Qatar, Oman, Kuwait, Singapore, Bahrain Islands, Germany, Canada, Saudi Arabia. India is also a top exporter of mango pulp. It exported 98370 MT of mango pulp to the major destinations like Saudi Arabia, the Netherlands, Kuwait, Oman, China, the United States, the United Kingdom, Germany, Sudan, and Yemen Republic. In India, Andhra Pradesh state ranks first in area of cultivation with 14.72 per cent. While Uttar Pradesh ranks first in production and productivity of mango (23.47 and 23% respectively) followed by AP (Production: 23.63% *i.e.,* 4.6 million tonnes), Karnataka, Bihar, Gujarat, Tamil Nadu, Odisha, West Bengal, Jharkhand, and Maharashtra. (APEDA, Ministry of Commerce and Industry, Government of India). In India, Chittoor district ranks first in both area and production of the mango. Chittoor district contributes 15.5 lakh tonnes from 1.12 lakh ha, with table variety mangoes such as Banishan (Banginapalle), Dashehari, Kesar, Himayath, and others. While 86000 hectares are home to the Totapuri mango variety, which is primarily used in the pulp industry. The processing industry is concentrated in the Chittoor district, which serves as a major hub for the export of mango pulp to various countries. In Chittoor, the main sucking varieties are Cinnarasam, Peddarasam, and Navaneetham, and the main pickle varieties are Jalal, Amini, and Hyder saheb. (Source: National Mango Database, Department of Biotechnology). In agriculture, the value chain refers to the set of actors (private, public, and service providers) and the sequence of value-adding activities involved in moving a product from production to the final consumer. Farmers, input suppliers, private traders, processors, exporters, and consumers are all involved in the Chittoor mango value chain. The efficiency of value chains is decreasing as the mango value chain diversifies and becomes more complex due to the increased presence of middlemen. The current study is being conducted to examine mango exports from India and identify various challenges faced by different actors of mango value chain in Chittoor district of Andhra Pradesh.

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MATERIAL AND METHODS

Andhra Pradesh was selected for the current study because it stands first in terms of area under mango cultivation and stands second in terms of production and productivity. From this state, Chittoor district was selected because Chittoor district ranks first in both area and production of the mango. Two mandals were selected purposively based on highest production and 2 villages from each mandal were selected purposively based on high mango production. 10 mango growing farmers from each village were selected randomly making up to 40 farmers. Other stake holders like input suppliers, traders, pre – harvest contractors, institutional buyers, FPOs, processors, wholesalers, retailers, exporters and consumers of each 5 actors were selected based on purposive random sampling. The required data will be gathered using survey methods and a pre-tested schedule in 2021-22. Various stakeholders were surveyed to gather information about mango value chains, and value addition facilities, etc. The data obtained was analysed to attain specific objectives by using Annual growth rates, compound annual growth rate, Percentage analysis and Garrett ranking technique to prioritize constraints faced by value chain actors.

RESULTS AND DISCUSSIONS

Status of the fresh mango exports from India

Table 1 interprets that export of the fresh mango in India had significantly decreased from 63441.26 metric tons to 27872.77 metric tons. Unlike, the value of these increased from ₹ 20,974.28 lakhs to ₹ 32,745.12 lakhs. The highest export was recorded in 2012-2013 with 55,584.98 metric tons and the highest revenue was recorded in 2016-17 with ₹ 44366.03 lakhs. The annual growth rate (AGR) with respect to fresh mango export quantity and their value was highest during 2016-2017 with 43.45 per cent and 38.37 per cent respectively. During 2020-2021, the fresh mango exports saw a negative AGR of -57.64 in view of the Covid-19 pandemic situation which caused the halt of exports from the country. The compound annual growth rates (CAGR) of quantity of fresh mango exports reported negative growth rate of -6.16 per cent and their value was recorded as 3.81 per cent.

Table 1. Growth rates of fresh mango exports from India

Fresh mangoes export	Quantity in MT	AGR (%)	Value in ₹ Lacs	AGR (%)
2011-2012	63,441.26		20,974.28	
2012-2013	55,584.98	-12.38	26,471.77	26.21
2013-2014	41,280.01	-25.74	28,542.84	7.82
2014-2015	42,998.31	4.16	30,253.65	5.99
2015-2016	36,779.25	-14.46	32,063.91	5.98
2016-2017	52,760.99	43.45	44,366.03	38.37
2017-2018	49,180.46	-6.79	38,234.02	-13.82
2018-2019	46,510.27	-5.43	40,649.55	6.32
2019-2020	49,658.67	6.77	40,021.34	-1.55
2020-2021	21,033.58	-57.64	27,187.83	-32.07
2021-22	27,872.77	32.52	32,745.12	20.44
CAGR	**-6.16**		**3.81**	

(Source – APEDA)

Table 2. Growth rates of mango pulp exports from India

Mango Pulp export	Quantity in MT	AGR (%)	Value in ₹ Lacs	AGR (%)
2011-2012	1,50,499.06		62,082.85	
2012-2013	1,47,815.70	-1.78	60,855.74	-1.98
2013-2014	1,74,860.34	18.30	77,294.79	27.01
2014-2015	1,54,820.69	-11.46	84,138.56	8.85
2015-2016	1,28,866.01	-16.76	79,618.08	-5.37
2016-2017	1,30,886.06	1.57	84,601.79	6.26
2017-2018	1,10,923.73	-15.25	67,392.13	-20.34
2018-2019	1,05,873.21	-4.55	65,766.98	-2.41
2019-2020	85,725.55	-19.03	58,431.96	-11.15
2020-2021	98,369.77	14.75	71,440.83	22.26
2021-22	1,23,476.70	25.52	92,454.24	29.41
CAGR	**-5.02**		**1.04**	

(Source – APEDA)

Table 3. Constraints faced by farmers during production

S. No.	Particulars	Garrett score	Ranking
1.	Undesirable climatic conditions	73.00	1
2.	Low yields	67.70	2
3.	Irregular bearing	60.22	3
4.	High cost of inputs	51.27	4
5.	Incidence of pests and diseases	51.17	5
6.	Low resource availability	49.82	6
7.	Poor access to new technology	39.65	7
8.	Lack of credit	37.75	8
9.	Lack of labour	34.52	9
10.	Support from Horticulture depts (subsidy, schemes)	24.87	10

(Source – APEDA)

Status of Mango pulp exports from India

The Table 2 interprets that the export of mango pulp in India has significantly decreased from 150499.06 metric tons to 123476.70 metric tons. Unlike, the value of pulp exports increased from ₹ 62,082.85 lakhs to ₹ 92454.24 lakhs. The highest export was recorded in 2013-2014 with 174,860.34 metric tons and the highest value of exports was recorded in 2021-22 with ₹ 92454.24 lakhs. The annual growth rate (AGR) with respect to fresh mango export quantity and their value was highest in the year 2021-2022 with 25.52 per cent and 29.41 per cent respectively. The compound annual growth rates (CAGR) of mango pulp exports are estimated as -5.02 per cent and the value of total exports was recorded as 1.04 per cent. (Source – APEDA).

Constraints faced by farmers during production of mango:

The results from the Table 3 indicates the various constraints faced during production of the mango by the farmers in the study area. It is clearly seen from the scores presented in the table that at the production level the biggest constraints faced by the farmers are undesirable climatic conditions (73.00), lower yields (67.70), where in several farmers experienced the lowest yields due to the undesirable climatic conditions like unprecedented heavy rains received during actual flowering and fruit setting stage, resulting in higher-than-usual moisture in the soil and extended winter cold temperatures led to a delay in flowering, which led to a delay in fruit setting too. This complements the third major constraint irregular bearing (60.22), together led to down fall of yields as low as 50 – 30 per cent. The other main constraints were high cost of inputs (51.27) followed by incidence of pests and diseases (51.17). Few farmers also complained about the low resource availability (49.82) especially the water availability for irrigation of mango orchards. These constraints are followed by poor access to new technologies (39.65), lack of credit (37.75) lack of labour (34.525) and few farmers felt a lack of support from horticulture departments for various subsidies and schemes.

Constraints faced by farmers during marketing of mango:

The results from Table 4 indicates that the primary problem that most of the farmers faced were lack of access to market information (66.70) as most of the farmers were not being able to know the better marketing channels for the better price realisation for their produce. The next constraint was high market commissions (63.40) which were being borne by the farmers in APMC markets as high as 5 – 10 per cent per ton of produce. Many farmers also complained about delay in payments (61.05). Another main constraint was high price fluctuations (60.52) as prices of mango were majorly affected by demand and supply in the market which drastically changes day to day followed by poor amenities at APMC market (50.32) like lesser infrastructure availability for the storage of produce and

Table 4. Constraints faced by farmers during marketing

S. No.	Particulars	Garrett score	Ranking
1.	Access to market information	66.70	1
2.	High market commissions	63.40	2
3.	Delay in payments	61.05	3
4.	High price fluctuations	60.52	4
5.	Poor amenities at APMC market	50.32	5
6.	Delay in sale of produce	49.32	6
7.	High transport costs	48.05	7
8.	Poor quality (un marketable produce)	37.92	8
9.	Shortage of packing material and plastic crates	34.80	9
10.	Poor weighing procedures	26.90	10

Table 5. Constraints faced by the processors

S. No.	Particulars	Garrett score	Ranking
1.	High working capital requirement	82.00	1
2.	Poor quality of raw material	68.60	2
3.	High interest rate of bank	61.00	3
4.	Low margins	55.20	4
5.	Highly dependent on international exports	49.80	5
6.	Shortage of labour	47.40	6
7.	Frequent failure of electric supply	43.00	7
8.	High competition from other processors	40.20	8
9.	Non availability of support from government	27.60	9
10.	Underutilization of plant	25.20	10

lack of facilities to accommodate higher tonnages during bumper season. This complements the next constraint of delay in sale of produce (49.32). Few farmers also complained about high transport costs (48.05), Poor quality (un marketable produce) (37.92), shortage of packing material and plastic crates (34.80) during peak season and poor weighing procedures (26.90).

Constraints faced by the processors in the mango value chain of Chittoor district

The results from Table 5 showed that major constraints faced by processors were high working capital requirements (82.00) as especially the costs for purchasing raw material and packing material was so high. The next major constraint was poor quality of raw material (68.60) affecting the quality of pulp. Many farmers also complained about high bank interest rates (61.00). Other constraints were low margins (55.20) complemented by another constraint highly dependent on international exports (49.80) as they were focussing more on international exports for higher profits. Other constraints include shortage of labour (47.40), frequent failure of electric supply (43.00), high competition from other processors (40.20), non – availability of support from government (27.60) and least score was given to under utilization of plant (25.20).

Constraints faced by the exporters in the mango value chain of Chittoor district

The results from Table 6 showed that major constraints faced by exporters were high freight charges (77.20). The freight charges for export of mangoes to foreign countries had doubled nearly compared to the pre – pandemic stage. This had decreased the profits for exporters in mango exports. The next biggest constraint was stringent norms by importing countries (72.40) as different foreign countries need different specifications about phyto sanitary norms for the products that were being importing by those countries. Many expoeters also complained about the poor post – harvest handling (62.40) as most of the farmers were not following the desapping procedure properly leading to burns on the mango fruit thereby decreases the quality of the mango. Other constraints were High chemical residues in fruits (61.00), heavy documentation process (49.60), as exporters need to maintain many documents / certifications to export their produce, unable to meet certification standards (39.20), poor cold chain facilities (39.00), low confidence for entering into new markets (25.60) and poor logistics at shipyard and airports (25.20).

The Chittoor mango value chain is more diversified and complex because of the presence of number of intermediaries. These intermediaries intervention was decreasing the efficiency of value chains by lowering the margin levels of producers. The farmers were facing problems due to the presence of traders and their commission charges. The processors were facing problems due to high working capital requirements, high bank interest rates and poor quality raw material. The exporters were facing the problems due to stringent norms of importing countries and poor post harvest handling of

Table 6. Constraints faced by the exporters

S. No.	Particulars	Garrett score	Ranking
1.	High freight charges	77.20	1
2.	Stringent norms by importing countries	72.40	2
3.	Poor - post harvest handling	62.40	3
4.	High chemical residues in fruits	61.00	4
5.	Heavy documentation process	49.60	5
6.	Poor support from government agencies	48.40	6
7.	Unable to meet certification standards	39.20	7
8.	Poor cold chain facilities	39.00	8
9.	Low confidence for entering new markets	25.60	9
10.	Poor logistics at shipyard and airports	25.20	10

produce. Therefore, the policy makers should focus on encouraging the infrastructure development in order to make the Chittoor mango value chain more efficient and sustainable.

LITERATURE CITED

Sharma, D.D and Khurana, G.S. 2000. Fertilizers application in mango orchards. *Indian Journal of Extension Education*. 36(1 and 2): 58-64.

Karthick, V., Mani, K and Anbarassn, A. 2013. Mango pulp processing industry in Tamil Nadu - An economic analysis. *American International Journal of Research in Humanities, Arts and Social Sciences*. 2328-3628.

Nandika and Jayasree, K. 2017. The study on Stakeholder Analysis for Farmer inclusive Value chain Development in Mango in Palakkad district of Kerala. *Journal of Extension Education*. 29(1): 2017.

Agricultural and Processed Food Products Export Development Authority of India. 2020. Fresh fruits and vegetables census report 2020-2021. Ministry of Commerce and Industry, Government of India.

Andhra Pradesh J Agril. Sci : 8(4): 229-234, 2022

STUDY ON FARMER'S ACCESS TO MARKETS THROUGH FPOs IN KURNOOL DISTRICT OF ANDHRA PRADESH

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Date of Receipt: 26-08-2022 Date of Acceptance: 08-11-2022

ABSTRACT

In this rapidly developing economy, the agricultural marketing plays a pivotal role in providing the lucrative prices and financial prosperity of the rural economy. FPOs provide access to markets by establishing the effective linkage between the producers and the retailers by streamlining the marketing channel. Kurnool district consists of actively performing FPOs under different departments and was purposively selected as there is a good spread of crops across the mandals and potential scope exists for setting up of multi commodity FPOs in the district. Multi staged stratified random sampling technique is adopted. The sample size constitutes of 100 FPO members and 50 Non FPO members in the study area. The current study was deliberated to analyse the prospects of the marketing channels adopted by the FPO and Non-FPO members. Marketing channel 1 is followed by FPO members while Channel II is followed by non FPO members. Price spread analysis of the current study reveals, the price spread in marketing channel I is relatively less compared to the channel II due the decreased length of the marketing channel of FPO farmers. Producer's share in the consumers' rupee received by the FPO farmers is more than the Non-FPO farmers which accounted to 88.96 per cent in the Channel I which was higher compared to Channel II accounted to 85.41 per cent in the cotton marketing, Like wise in the groundnut marketing, it accounted for 82.71 per cent for channel I and 77.86 per cent for channel II and in redgram marketing, it accounted for 78.40 per cent in the channel I and 70.19 per cent in the channel II in the study area. This difference is due to reduction in the transaction costs and the market margins in the channel I.

KEYWORDS: Market, marketing channels, Price spread, Producer share in consumer rupee.

INTRODUCTION

Farmer producer organizations aim to assure good income for the farmers through the organisation of their own. Small farmers do not have the volume individually (both farming inputs and yield) to reap the benefit of economies of scale. Farmers are the shareholders of a producer organization (PO) where investments are catalysed by the state or donor agencies. FPOs are acclaimed as institutions that can increase the skills, farm income and bargaining power of the smallholder farmers in the production and marketing of the produce.

The majority of the POs benefit their members by reducing their transaction costs, generating employment opportunities, instant revenue payments, capacity building *etc.,* (Singh, 2017). Producer organizations has the potential toward doubling the farm income.

In marketing of agriculture commodities involvement of more number of intermediaries is noticed where the farmer takes only a minimal part of the value the final consumer pays. FPOs has the scope to enhance access to the markets to its members that help them to obtain the realized prices of their produce and capture huge profits. In view of this, an in-depth study on farmer's access to markets through FPOs in Kurnool District of Andhra Pradesh was taken up with the following objective.

1. To analyse the prospects for linking FPO members to alternative markets.

MATERIAL AND METHODS

FPOs are found functioning actively in the state of Andhra Pradesh. At present a total of 852 FPOs have been formed in the state (apagrisnet.gov.in). Kurnool district has 61 actively performing FPOs functioning under different departments. Among actively functioning FPOs, 5 FPOs were purposively selected that is one from each of NABARD, SERP, APDMP, Department of Horticulture and NGO based on the maximum number of members. All the farmers registered under the selected FPOs were listed out and 20 farmers from each of the FPO were selected randomly, thus constituting a representative sample of 100 farmers from 5 FPOs in the study area. A sample of 50 non FPO farmers was also selected randomly for comparison in the study area. The information related to the present study was collected using a well-defined and pre-tested schedule through personal interview method. Detailed information was collected and the information pertained to the agricultural

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year 2020-21. Price spread was worked out by taking the difference between the price paid by the consumer and the price received by the producer per quintal of groundnut, cotton and redgram. Producer's share in the consumer's rupee is the price received by the producer expressed as a percentage in the consumer's price.

RESULTS AND DISCUSSION

Marketing Channel of Cotton

Channel I:(FPO members)

Producer → Processor Retailer → Consumer

Channel II:(Non FPO members)

Producer → Village merchant → Processor Retailer → Consumer

Marketing channel I is followed by FPO members while Channel II is followed by non FPO members

Price spread analysis of cotton marketing channels

The price spread for both the marketing channels of the cotton was analyzed and presented in a Table 1. The figures in Table 1, depicts that the producers share in the consumer's rupee was higher which accounted to 88.96 per cent in the Channel I adopted by the FPO members compared to Channel II which is 85.41 per cent.

The producer's net price was ₹ 30,551.19 for three quintals of cotton as three quintals of cotton yield one quintal of lint, whereas the producers net price in the channel II was ₹ 27628.5. The marketing costs beared by the producer was ₹ 483.81 which was less compared to the producer of Channel II *i.e.* non FPO member. This is because, as FPO members market their produce collectively to processor the marketing cost becomes relatively less compared to the producer of channel II.

The village merchant was not involved in channel I as the FPO members collectively marketed their produce to the processor taking advantage of collective bargaining power. The purchase price of the cotton by village merchant was ₹ 28,125 and the marketing cost and marketing margins comprises of about ₹ 339.15 and ₹ 620 respectively.

The producer in channel I directly sold the cotton to the processor where in the processor converts 3 quintals of cotton into one quintal of lint. The purchase price of cotton by the processor in channel I and channel II were ₹ 31,035 and ₹ 29,084 marketing costs and accounted for ₹ 582.78 and 450.48 and marketing costs and marketing margins were ₹ 1890 and ₹ 1920 of channel I and II respectively.

The retailers purchase price was ₹ 33,507.78 and ₹ 31,454.60 in channel I and channel II respectively and the marketing costs were ₹ 311.16 and 309.57, and marketing margins were ₹ 520 and ₹ 580 in channel I and II respectively. The retailers sale price or the consumer purchase price of channel I and II were ₹ 34,072.94 and ₹ 32,064.20 respectively

The price spread was found lesser in channel I compared to channel II which was ₹ 3787.75(11.04%) of consumers purchase price and ₹ 4716.20 (17.06%) of consumers purchase price of channel II which clearly depicting that producer had gained higher price and higher contribution in consumers price in channel I compared to channel II adopted by the non FPO members.

2. Marketing channels of Groundnut

Channel I: (FPO Members)

Producer → Trader → Retailer → Consumer

Channel II: (Non FPO members)

Producer → Trader → Wholesaler → Retailer → Consumer

From the two marketing channels mentioned above, Channel I was adopted by the FPO members in the study area and the non FPO members market their produce through Channel II.

Price spread analysis of Groundnut marketing channels

The price spread for two marketing channels was analysed and depicted in the Table 2. The figures in Table 2 depicts that the producers share in consumer's rupee for the marketing channel I and II was 82.71 per cent for FPO members and 77.86 per cent for non FPO members. The price spread was lower in the marketing channel I compared to the channel II which was ₹ 1203 (17.29 %) and ₹ 1424.62 (21.85%) respectively

The sale price of the groundnut pods by producer in the channel I was ₹ 5890 where as in the channel II the producer sale price was ₹ 5240. The marketing costs incurred by the producers of the channel I and channel II are ₹ 134.87 and 146.08 respectively. And the producers net price in the channel I and II was ₹ 5755.13 and ₹ 5093.92 respectively.

The sale price of the producer becomes the purchase price of the trader which was ₹ 5890 in channel I and ₹ 5240 in channel II. The marketing costs of the trader in the channel I and channel II are ₹ 259.30 and ₹ 70.51 respectively. The marketing margins of the trader were ₹ 486.70 and ₹ 479.80 in channels I and II respectively.

Table 1. Price spread analysis of cotton marketing channels for one quintal lint

S. No.	Particulars	Channel-I (FPO)		Channel-II (NON FPO)	
		Amount in ₹	Percentage	Amount in ₹	Percentage
1	Producer's sale price	31,035		28125	
	a) Marketing costs	483.81		496.47	
	b) Producer's net price (3 Quintal cotton)	30551.19	88.97	27628.53	83.29
2	village merchant				
	a) Purchase price			28125	
	b) Marketing costs			339.15	
	c) Margin			620	
	d) Sale price (3 Quintal cotton)			29084.15	89.92
3	Processor				
	a) Purchase price	31,035		29084.15	
	b) Marketing costs	582.78		450.48	
	c) Margin	1890		1920	
	d) Sale price (1 Quintal Lint)	33,507.78	97.58	31,454.63	97.25
4	Trader				
	a) Purchase price	33,507.78		31,454.63	
	b) Marketing costs	311.16		309.57	
	c) Margin	520		580	
5	Retailer's sale price/consumer's price	34,338.94	100	32,344.2	**100**
	Price spread	3,787.75	11.030	4,716.2	17.06
	Producers share in consumers rupee	88.96		85.41	

The wholesaler was not involved in the marketing channel I. The purchase price of the wholesaler in the marketing channel II was ₹ 5790.31 which accounted for about 88.50 per cent of the retailer sale price. The marketing costs and the marketing margin of the wholesaler is ₹ 172.03 and ₹ 272 respectively. The wholesaler sale price is ₹ 6234.34 which was 95.29 per cent of the retailer sale price or the consumer purchase price.

The retailers purchase price is the trader's sale price in the case of marketing channel I and wholesaler sale price in the channel II which was ₹ 6636 and ₹ 6234.34 respectively. The marketing costs and the marketing margin of the trader in channels I and II was ₹ 53.44 and ₹ 44.20, Rs 268.90 and ₹ 240 respectively. The retailer's sale price or the consumer purchase price of one quintal groundnut pods is ₹ 6,958.34 and ₹ 6,518.54 respectively in channels I and II.

3. Marketing of Redgram

Channel I : (FPO members)

Producer → Processor → Wholesaler → Retailer → Consumer

Table 2. Price spread analysis of groundnut marketing channels (₹ / qtl)

S. No.	Particulars	Channel-I (FPO)		Channel-II (NON FPO)	
		Amount in ₹	Percentage	Amount in ₹	Percentage
1	Producer's sale price	5890		5240	
	a) Marketing costs	134.87		146.08	
	b) Producer's net price	5755.13	82.71	5093.92	77.86
2	Trader				
	a) Purchase price	5890		5240	
	b) Marketing costs	259.30		70.51	
	c) Margin	486.70		479.80	
	d) Sale price (pods)	6636	95.37	5790.31	88.50
3	Wholesaler				
	a) Purchase price			5790.31	
	b) Marketing costs			172.03	
	c) Margin			272	
	d) Sale price (pods)			6234.34	95.29
4	Retailer				
	a) Purchase price	6636		6234.34	
	b) Marketing costs	53.44		44.2	
	c) Margin	268.90		240	
5	Retailer's sale price/consumer's price	6958.34	100.00	6518.54	99.63
	Price spread	1,203	17.29	1,424.62	21.85
	Producers share in consumers rupee	82.70		77.86	

Channel II:(Non FPO members)

Producer → Trader → Processor → Wholesaler → Retailer → Consumer

In the study area channel I was adopted by the FPO members and channel II was adopted by Non FPO members in the marketing of redgram.

Price spread analysis in Redgram marketing channels

In Table 3, the price spread analysis of the marketing channel I and II was analysed and presented.

The figures in Table 3 depict that the producers share in the consumers rupee was more in the channel I *i.e.* 78.40 per cent which was adopted by the FPO members compared to the channel II whose value is 70.19 per cent and this channel was adopted by the Non FPO members. The price spread was comparatively less in channel I compared to channel II which was ₹ 1547 (21.60%) and ₹ 2101.28 (29.80%) respectively.

The producer's sale price in Channel I and channel II was ₹ 5780 and ₹ 5120 respectively. The marketing

Table 3. Price spread analysis of Redgram marketing channels (₹ / qtl)

S. No.	Particulars	Channel-I (FPO)		Channel-II (NON FPO)	
		Amount in ₹	Percentage	Amount in ₹	Percentage
1	Producer's sale price	5780		5120	
	a) Marketing costs	161.25		170.51	
	b) Producer's net price	5618.75	78.40	4949.49	70.20
2	Trader				
	a) Purchase price			5120	
	b) Marketing costs			140.5	
	c) Margin			372.8	
	d) Sale price			5633.3	79.90
3	Processors				
	a) Purchase price	5780		5633.3	
	b) Marketing costs	199.56		152.71	
	c) Margin	380.24		440	
	d) Sale price	6359.8	88.74	6226.01	88.30
4	Wholesaler				
	a) Purchase price	6359.8		6226.01	
	b) Marketing costs	45.09		52.79	
	c) Margin	372		379.6	
	d) Sale price	6776.89	94.56	6658.4	94.44
5	Retailer				
	a) Purchase price	6776.89		6658.4	
	b) Marketing costs	64.21		64.37	
	c) Margin	325.6		328	
5	Retailer's sale price/consumer's price	7166.7	100.00	7050.77	100.00
	Price spread	1547.95	21.60	2101.28	29.80
	Producer's share in consumer's rupee	78.40		70.19	

costs expended by the producer in marketing channel I and II was ₹ 161.25 and ₹ 170.51 respectively. The producer's net price of both channels is ₹ 5618.75 and ₹ 4949.49 which accounted for 78.40 per cent and 70.20 per cent of the consumer's price.

The traders were not involved in channel I which was adopted by the FPO members. The traders purchase price was ₹ 5120 and the marketing costs and the marketing margins was ₹ 140.5 and ₹ 372.80 respectively. The trader's sale price in the marketing channel II was ₹ 5633.3 which accounted for about 79.90 per cent of the consumers rupee.

The processors purchase price was ₹ 5780 and ₹ 5633.3 of the marketing channel I and II respectively. The marketing costs of the processor in marketing channel I and II was ₹ 199.56 and ₹ 152.71 respectively. The marketing margins of processors in both the channels was ₹ 380.24 and ₹ 440 respectively. The processors sale price was ₹ 6359.80 and ₹ 6226.01 which accounted for 88.74 per cent and 88.30 per cent of the consumer's price.

The purchase price of the wholesaler was ₹ 6359.80 and ₹ 6226.01 in marketing channel I and II respectively. The marketing costs of the wholesaler in both the channels was ₹ 45.09 and ₹ 52.79 respectively. The marketing margins of the wholesaler was ₹ 372 and ₹ 379.6 in both the marketing channels. The wholesaler's sale price of marketing channels I and II was ₹ 6776.89 and ₹ 6658.4 respectively which accounts for about 94.65 per cent and 94.44 per cent of the consumer's price.

The retailer purchase price in the channel I and channel II was ₹ 6776.89 and ₹ 6658.40 respectively. The marketing costs incurred by the retailer was ₹ 64.21 in channel I and ₹ 64.37 in channel II. The marketing margins are ₹ 325.6 and ₹ 328 of the retailer in marketing channel I and II. The retailer's sale price and the consumers purchase price was ₹ 7166.7 and ₹ 7050.77.

From all the above discussions it was obvious that the producers of the channel I obtain a higher price and greater share in comparison with producers in channel II. In channel I, the FPOs enable the producer to directly market their produce to the processor there by reducing the marketing costs and enhance the producers share in consumers rupee where as in the channel II traders are involved in between the processor and producer who imbibes additional marketing costs and margins.

The price per quintal of the produce for FPO members is higher compared to non FPO members due to their aggregate power of bargaining and linking with profitable marketing channels. The two marketing channels were noticed in the study area of which marketing channel I was adopted by the FPO members and channel II was adopted by Non FPO farmers. The price spread in the FPO members marketing channel was relatively less compared to the non FPO members due the decreased length of the marketing channel of FPO farmers. Producer's share in the consumers' rupee received by the FPO farmers of is more than the Non-FPO farmers which accounted to 88.96 per cent in the Channel I which was higher compared to Channel II accounted to 85.41 per cent in the cotton marketing , Like wise in the groundnut marketing, it accounted for 82.71 per cent for channel I and 77.86 per cent for channel II and in redgram marketing it accounted for 78.40 per cent in the channel I and 70.19 per cent in the channel II in the study area. This difference is due to reduction in the transaction costs and the market margins in the channel I. Government should take initiative in establishment of post harvest processing units for creating value addition of the produce and in promotion of packaging ,branding and enhancing export potential of the produce in the study area. Market linkages with top private market players should be created to generate competition among buyers so as to get maximum benefit to the farmer.

LITERATURE CITED

Anika, T. 2014. Linking small farmers to modern retail through producer organizations – Experiences with producer companies in India. *Food Policy.* 45(1): 35-44.

Bingen, J., Serrano, A and Howard, J. 2003. Linking farmers to markets: Different approaches to human capital development. *Food Policy*. 28(4): 405-419.

Elisabeth, F and Matin, Q. 2011. Linking smallholders to markets: Determinants and impacts of farmer collective action in Kenya. *World Development.* 40(6): 1255-1268.

Kandeeban, M and Prabhavathi, Y. 2017. Marketing efficiency and market competitiveness of farmer produce companies (FPCs) – A case study of Telangana and Karnataka states. *The Journal of Research ANGRAU.* 45(2): 100-107.

Andhra Pradesh J Agril. Sci : 8(4): 235-238, 2022

CONSUMPTION PATTERN OF VALUE ADDED MILLET PRODUCTS IN URBAN AREAS OF PRAKASAM DISTRICT OF ANDHRA PRADESH

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Date of Receipt: 26-08-2022 Date of Acceptance: 24-11-2022

ABSTRACT

Millets are small-grained cereal food crops with drought and extreme weather resilience and require minimal chemical inputs such as fertilizers and pesticides to flourish. Millets are also known as "Nutri-cereals" because they contain most nutrients necessary for regular human body function. The objective of the present study is to collect the data on market opportunities for value added millet products in urban areas of Prakasam district of Andhra Pradesh. The study is based on primary data collected from sample of 80 consumers from four urban centres (20 consumers from each urban center). Majority of the consumer's household size is 4 members (76.25%), while (30.00%) consumers were graduates and (36.25%) were from the public sector. Most of the consumers have a medium level of mass media exposure with (77.50%), of consumers buying value added millet products from nearby supermarkets (56.25%) and (70.00%) of consumers were having a medium level of knowledge of value added millet products. Most of the consumers were preferring to consume pearl millet daily (42.50%) and (46.37%) of consumers consuming it at any time. Majority of consumers preferred to consume millet instant mixes and spend the maximum amount on Traditional recipes (58.58%). The market potential in urban areas of Prakasam district for traditional recipes was rupees 72.15 crores followed by pasta products rupees 21.46 crores, for bakery products rupees 16.86 crore, for flaked and popped products rupees 8.29 crores and for instant food mixes rupees 4.02 crores.

KEYWORDS: Nutricereals, Consumption pattern, Consumer preference, Market Potential.

INTRODUCTION

Millets are significant grains that are crucial to the food and nutrition security of developing nations in the semi-arid tropical regions of Asia, Africa, particularly India, Nigeria and Niger. Millets are all-season crops that are grown throughout year and generate numerous securities (food, fodder, health, nutrition, livelihood and environmental), making them agricultural security crops at accessible rates. Sorghum (great millet), bajra (pearl millet), ragi (finger millet), and minor millets such as korra (foxtail millet), little millet, kodo millet, proso millet, and browntop millet are all significant millet crops cultivated in India.

A total of 31.719 (1000 MT) of millets were produced worldwide. The world's greatest producer is India (41.04%), followed by Niger (11.94%) while Africa is the largest consumer of millets. The global millets market was valued at $ 9.95 billion in 2020 and is estimated to rise at a CAGR of 4.49 per cent between 2021 to 2028 to reach $ 14.14 billion. Millets are grown in India over an area of 23.83 million hectares, yielding 51.15 million tonnes with a productivity of 2146 kg ha^{-1}. In India for the year 2020-21, Rajasthan stood first place in production with 4288.34 ('000 tonnes) followed by Uttarakhand (1967.27), Karnataka in (1762.17) and Andhra Pradesh (301.91). With respect to production of individual crops in India (2020-21), pearl millet stood 1st place with 8664.13 ('000 tonnes) followed by sorghum (3475.41), finger millet (1238.70) and minor millets (333.00) respectively. In Andhra Pradesh, millets are cultivated in area of 0.51 million hectares, with a production of 2.45 million tonnes and yield of 4805 kg ha^{-1}.

Some of the startups are also working in millets and millet-based products such as Health Sutra, Manna health foods, Tata Soulful, Slurrp farm, IIMR-Eat rite, Eat any time and Native food stores. Most of the consumers are consuming millets mostly in both ready-to-eat (RTE) and ready-to-cook forms (RTC) is (46.00%), as staple food grains (29.00%), only RTC (13.00%), and RTE (12.00%). The market share of various millet forms like staple grain form was (79.17%) higher followed by RTE (15.88%) and RTC (04.95%).

Value addition in millets impacts numerous aspects, such as increasing the demand and utilization of millets in the diet of consumers. The creation of opportunities for consumers and farmers in consumption and production of millets has been made possible through technological

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intervention. Processing millets into ready-to-eat and ready-to-cook products provides abundant opportunities for the entrepreneurs on a variety of scales and there is a lot of scope, need, and market potential for millets and millet-based products.

MATERIAL AND METHODS

Andhra Pradesh state was purposively selected for the study because the researcher hails from the same state and he is familiar with the local language. Prakasam district of Andhra Pradesh was selected purposively for the study as the researcher hails from the same district. Four urban centers were selected from the Prakasam district purposively based on the high human population namely Ongole, Chirala, Markapur and Giddalur. Two retail outlets were selected from each urban center by using simple random sampling procedure thus making a total of eight retail outlets. From each retail outlet, ten consumers who regularly buy the value added millet based products were selected by following purposive sampling, thus making a sample size of 80 consumers. The data on the consumption of millets and consumer preference towards value added millet products were collected with the help of a structured interview schedule developed based on the study objectives and the collected data was analysed using percentages, frequencies, mean, standard deviation, and garret ranking.

RESULTS AND DISCUSSION

Consumption pattern of value added millet products in urban areas of Prakasam district of Andhra Pradesh

Consumption pattern was defined as the process by which people search, identify, purchase and consume products and services in a way to meet all their needs or desires.

Frequency of millets consumption

From Table 1 it can be concluded that the majority of consumers were consuming pearl millet (53.75 %) and finger millet (40.00 %) daily, pearl millet (42.50 %) and foxtail millet (51.25 %) once a week, little millet (77.50 %) and sorghum (48.75 %) once a month, and finally kodo millet (67.50 %) and proso millet (66.25 %) once in three months.

From Table 1 it can be inferred that pearl millet is consumed daily in different forms such as flat breads, grains to make porridge, and ready to eat snacks like multi-grain cookies etc., because it is easily available at a lesser cost with good taste and nutritional value when compared to other millets. Also, Pearl millet products are the best alternative to chapathi from ancient times. Finger millet is also consumed daily by most of consumers as ragi sangati because the cooking process is simple than millet products.

Form in which value added millet products are consumed

Table 2 shows the Garrett ranking for different forms in which value added millet products are consumed by consumers. Among them “Instant mixes” was ranked first followed by “Ready to cook foods”, “Bakery products”, “Ready to eat” (RTE) foods, “Flaked and Popped products”, and “Pasta products” with ranks second, third, fourth, fifth and sixth respectively.

It is evident that most of the consumers are from the public sector and private sector, hence they do not have enough time for cooking and preferring for instant mixes because it requires only 5 to 7 minutes for cooking just by using hot water. Apart to it, the added advantage from the instant mixes is that it requires no ingredients while cooking and had good storage life. This trend was followed by ready to cook foods because these foods also save the preparation time with less spoilage and also usually more preferred by the children because of its taste.

Monthly consumption pattern of value added millet products

Table 3 shows the average quantity and average price on monthly consumption pattern of value added millet products. Based on the results it was found that majority of them were consuming traditional recipes (67.80 %) followed by bakery products (11.86 %) and pasta products (10.55 %). Based on average price, more than half of consumers were spending amount on traditional recipes (58.58 %) followed by pasta products (17.55 %) and bakery products (13.72 %) respectively.

Majority of the consumers are consuming traditional recipes in the form of breakfast foods like idli, dosa, upma *etc.,* lunch foods like ragi sangati, rice recipes etc., sweets like halwa, kesari, kheer *etc.,* snacks like pakoda, murukku *etc.,* dinner foods like flatbreads etc., made up of millets. On an average, consumers were spending more amount on traditional recipes because this type of consumption was more preferred than others.

In the frequency of millet consumption, pearl millet and finger millet were consumed daily, pearl millet and foxtail millet consumed once a week, little millet and sorghum consumed once a month and kodo millet, proso millet consumed once in three months. Most of the consumers preferred to consume different forms of value

Table 1. Frequency of millets consumption in daily, once a week, once a month and once in three months

S. No.	Types of millets	Daily		Once a week		Once a month		Once in three months	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1.	Sorghum	12	15.00	23	28.75	39	48.75	6	07.50
2.	Pearl millet	43	53.75	34	42.50	3	03.75	0	0
3.	Foxtail millet	29	36.25	41	51.25	7	08.75	3	03.75
4.	Little millet	2	02.50	10	12.50	62	77.50	6	07.50
5.	Finger millet	32	40	37	46.25	9	11.25	2	02.50
6.	Proso millet	0	0	0	0	27	33.75	53	66.25
7.	Brown top millet	0	0	0	0	28	35.00	52	65.00
8.	Kodo millet	0	0	0	0	26	32.50	54	67.50

Table 2. Garrett's ranking for different forms in which value added millet products consumed by the consumers

S. No.	Products	Garret's score	Garret's mean score	Rank
1.	Instant mixes	5188	64.85	**I**
2.	RTC foods	5001	62.51	**II**
3.	Bakery products	4788	59.85	**III**
4.	RTE Foods	3560	44.50	**IV**
5.	Flaked and popped products	2747	34.33	**V**
6.	Pasta products	2724	34.05	**VI**

Table 3. Distribution of categories according to the average quantity and average price per month

S. No.	Category	Quantity (g)		Price (₹)	
		Average quantity	Percentage	Average price	Percentage
1	Traditional recipes	4769.37	67.80	1601.32	58.58
2	Bakery products	834.37	11.86	375.11	13.72
3	Pasta products	742.25	10.55	479.82	17.55
4	Flaked and popped products	437.25	06.21	187.25	06.85
5	Instant food mixes	250.86	03.56	89.83	03.28
	Total	**7034.11**	**100.00**	**2733.35**	**100.00**

added millet products, of which instant mixes followed by RTC foods and bakery products were majorly preferred. A greater percentage of traditional recipes were consumed by consumers and also the average amount spent by consumers on traditional recipes, pasta products, etc.

ACKNOWLEDGMENT

I am very much grateful to the Institute of Agribusiness Management, Tirupati for the financial assistance provided in the form of a stipend during my post-graduate studies.

LITERATURE CITED

Abha, G and Deepak, K.M. 2014. Food consumption pattern in rural India. *Journal of Economic & Social Development*. 1-16.

Amarender, A. 2017. Consumption Pattern, Trade and Production Potential of Pulses. *Economic and Political Weekly*. 39: 4854-4860.

Bommy, D and Kavitha M.S. 2016. Promotion of Millets Cultivation through Consumption. *International Journal of Current Research and Academic Review.* 3:74-80.

https://eands.dacnet.nic.in/PDF/At%20a%20Glance%2021%20Eng.pdf.

https://ipad.fas.usda.gov/cropexplorer/cropview/commodity. Accessed on 24-07-2022.

https://milletstats.com/apy-stats/.

Ibrahim, M., Alastair and Christin, S. 2012. Cereals consumption pattern in Kenya. *International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)*, Nairobi. 1-35.

Ogunniyi, L.T., Ajao, A.O and Oladejo, J.A. 2012. Food consumption pattern in Ogbomoso metropolis of Oyo state Nigeria. *Journal of Agriculture and Social Research.* 12(1): 74-83.

Patil, M and Sankangoudar, S. 2019. Consumption pattern of minor millets among growers and non-growers of minor millets. *Journal of Pharmacognosy and Phytochemistry.* 8(3): 3726-3729.

Andhra Pradesh J Agril. Sci : 8(4): 239-244, 2022

INSECTICIDE RESISTANCE MONITORING OF FALL ARMYWORM (*Spodoptera frugiperda* J.E. Smith) IN CHITTOOR DISTRICT OF ANDHRA PRADESH

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Date of Receipt: 09-09-2022 Date of Acceptance: 21-11-2022

ABSTRACT

Maize (*Zea mays* L.) is considered as queen of the cereals and is one of the most important crop next to rice and wheat in global agriculture. It has very high yield potential and there is no such cereal crop on the earth which has such immense potentiality. Globally it is highly valued for its multiple uses such as food, feed, fodder and raw material for large number of industrial products. Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) is a dangerous transboundary pest, can cause significant yield losses if it is not managed well in time. Hence bioassay studies were conducted on third instar FAW larvae from F1 population of field collections from chittoor of Andhra Pradesh using diet incorporation assay (IRAC test method) to check the resistance monitoring. The studies on the resistance levels in *S. frugiperda* to five insecticides viz., emamectin benzoate, chlorpyriphos, lambda-cyhalothrin, chlorantraniliprole and spinetoram. revealed the high level of resistance to conventional insecticides like chlorpyrifos (114.8 folds), lambda cyhalothrin (19.4 folds), and low level of resistance to new chemicals like chlorantraniliprole (12.5 folds), spinetoram (10 folds) and emamectin benzoate (3 folds).

KEYWORDS: Fall armyworm, Resistance monitoring, Resistance level.

INTRODUCTION

Maize (*Zea mays* L.) is considered as queen of the cereals and is one of the most important crop next to rice and wheat in global agriculture . It has very high yield potential and there is no cereal on the earth which has so immense potentiality. Globally it is highly valued for its multiple uses such as food, feed, fodder and raw material for large number of industrial products.

Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) is a dangerous transboundary pest, able to fly over 100 km in one single night (Naganna *et al*., 2020) with a high potential to spread continually because of natural distributional capacity and international trade. FAW can cause significant yield losses if it is not managed well in time. *S. frugiperda* has recently become the new invasive species in both the West and Central Africa where the outbreaks have been recorded for the very first time in early 2016 (Georgen *et al*., 2016). In India it was first reported in Karnataka during May 2018 (Sharanabasappa *et al*., 2018). This rapid spread and difficulty in controlling *S. frugiperda* is due to its high migration ability, high reproductive capacity, absence of diapause, wider host range, suitable tropical climate as well as polyphagous nature.

The development of the dose mortality responses for the insecticides is necessary to provide baseline data for a future resistance monitoring studies for polyphagous pests like *S. frugiperda*. These invaded FAW populations attacked the maize crop in different South Indian states and also different districts of Andhra Pradesh and to control these voracious feeders, farmers spray different groups of pesticides indiscriminately without any label claim. These invaded FAW population which travelled across continents may be exposed to different groups of pesticides and may have some innate capability to tolerate the insecticides. But there is no baseline toxicity data available for this *S. frugiperda* larvae to different insecticides. Therefore, this study on insecticide resistance monitoring of fall armyworm in Chittoor district of Andhra Pradesh is carried out.

MATERIAL AND METHODS

Collection of field population fall armyworm

Roving survey was conducted Chittoor district of Andhra Pradesh during *rabi*, 2021-2022 to know the severity of incidence of Fall armyworm (FAW) on maize and collected the larval populations from three mandals during the survey period to study the resistance monitoring studies among the collected larval population.

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Fifty larvae were collected from each mandal and kept individually in plastic cups and brought to the laboratory for further studies.

Mass multiplication of FAW, *S. frugiperda*

The collected larvae from Chittoor districts were separately reared on artificial diet (Barreto *et al*., 1999) till pupation. Then the pupae were collected and kept in Acrylic rearing chambers of dimensions 26.5 cm × 29.5 cm × 29.5 cm for adult emergence. The cotton swabs dipped in 40 per cent honey solution were arranged as food for emerging adults and Maize seedlings of 5 to 7 days old were kept inside the rearing chambers for egg laying by *S. frugiperda* adults.

The rearing chambers were checked regularly for replacement of honey solution and egg laying by adult moths of FAW. The egg masses were collected and transferred to plastic troughs and allowed for hatching. After hatching the neonates were allowed to feed on fresh sweet corn kernels until they reach third instar and then transferred to artificial diet boxes for individual feeding to avoid cannibalism.

Preparation of stock solutions

Stock solutions of test insecticides were prepared by using the formula (Naveed, 2005) (Table 2).

Stock solution =

$$\frac{\text{Required concentration}}{\text{Per cent of cormulation of insecticide}} \times 100 *$$

*Quantity of water taken for the preparation of solution

Stock solution of 100 mL was used for the preparation of desired concentration by serial dilution method. Untreated control was also maintained for each insecticide tested and the mortality data was corrected by using modified Abbotts formula (Abbott, 1925) wherever >10% mortality recorded in the untreated control.

Abbott's formula for corrected mortality =

$$\frac{T - C}{100 - C} \times 100$$

T = Mortality in treatment

C = Mortality in control

Bioassay studies with Fall armyworm, *S. frugiperda*

For conducting Bioassay, artificial diet incorporation method was used (IRAC Method, 2020). The stock solution of the insecticides was prepared in 100 ml of distilled water and subsequently, 1 ml of insecticide solution was mixed with 9 ml of diet and allowed to solidify. Then third instar larvae were selected and pre starved separately for 4 hours, then placed into large cell wells containing a cube of the insecticide infused diet. A control diet was maintained without mixing any insecticide. Each treatment was replicated thrice.

Statistical analysis

The larval mortality counts were taken at 24, 48 and 72 hours after treatment. The larvae which did not show any movement and moribund were treated as dead. Data on mortality was subjected to probit analysis (Finney, 1971). LC_{50} and LC_{90} values were calculated using SPSS statistical package.

Assessment of insecticidal resistance in *S. frugiperda*

The degree of development of resistance through different generations was determined by working out LC_{50} values in next generation and thus computing the resistance ratio (RR) by dividing the LC_{50} value of field population with LC_{50} value of the baseline susceptible population (Tabashnik *et al.,* 1987).

Resistance ratio =

$$\frac{LC_{50} \text{ value of field population}}{LC_{50} \text{ value of susceptible population}}$$

RESULTS

The results of the survey indicate that higher incidence of fall armyworm was observed in Tirupati rural (63.81%) followed by Chandragiri (62.55%) and byreddipalli (50.46%) (Table 1). The farmers of chittoor district are not much aware of the latest chemicals and mostly they are using the conventional insecticides like neem formulations, chlorpyriphos, profenophos, cypermethrin *etc.,* which are not so effective against FAW in maize.

The LC_{50} values of different insecticides are Chlorpyriphos, 166.51 µg/ml > chlorantraniliprole, 12.48 µg/ml > lambda cyhalothrin, 10.07 µg/ml > Spintoram,

Table 1. List of mandals and villages of Chittoor district of Andhra Pradesh surveyed for the incidence of FAW on maize during *rabi*, 2021-2022

District	Mandal	GPS (Latitude, Longitude)	Per cent incidence
Chittoor	Chandragiri	13.584116°, 79.32064°	62.55
	Baireddipalli	13.04959°, 78.53004°	50.46
	Tirupati Rural	13.620718°, 79.372778°	63.81

4.81 µg/ml > emamectin benzoate, 1.81 µg/ml. (Table 3 and Fig. 2)

Among the different insecticides used the relative resistance ratios was higher for chlorpryiphos (114.8) followed by lambda cyhalothrin (19.4), chlorantraniliprole (12.8), spinetoram (10) and emamectin benzoate (3) (Table 3 and fig. 1). The differences in the levels of resistance of FAW populations may be due to increased spraying frequencies of new chemicals like emamectin benzoate, chlorantraniloprole and spinetoram in maize ecosystem to manage the FAW even at an early vegetative stage till tasselling stage.

The resistance ratios of emamectin benzoate were in accordance with Grace *et al*. (2019) who studied the resistance of *S. litura* from Kurnool district during 2016-2017. The resistance ratios of Lambda cyhalothrin, chlorantraniliprole and cyantraniliprole were in accordance with Zhang *et al*. (2021) who studied the resistance of *S. frugiperda* from different populations of China during 2019. These findings are in collaboration with Song *et al*. (2020) who reported that the spraying frequency of emamectin benzoate increased to 6.83 times during 2019 in west Yunnan since FAW invaded china.

These results are in line with the reports of Zhang *et al*. (2021) who reported the insecticide resistance in FAW from China to different insecticides like 615-1068 folds to chlorpyriphos, 60-388 folds to spinosad, 26-317 folds to lambda cyhalothrin, 13-29 folds malathion, 3-8 folds to emamectin benzoate and 1-2 folds to chlorantraniliprole, respectively.

Insecticide resistance to FAW has been reported from different American, African and Asian countries which created havoc in maize cultivation and resulted in crop failures, food and nutritional security. The indiscriminate use of insecticide resulted in development of resistance to organophosphate and synthetic pyrethroids in Puerto-Rico (Gutierro-Moreno *et al*., 2019), lambda cyhalothrin, chlorpyriphios (Carvalho *et al*., 2013), lufenuron (Nascimento *et al*., 2016) and spinosad (Okuma *et al*., 2018).

Table 2. Insecticides used for bioassay studies against Fall armyworm, *S. frugiperda*

S. No.	Insecticides	Commercial formulation	Chemical class	IRAC group	Mode of action
1.	Emamectin Benzoate	Gall up 5% SG	Avermectins	6	Chloride channel regulators
2.	Chlorpyrifos	Premain 20% EC	Organophosphates	1B	Cholinesterase inhibitors
3.	Lambda Cyhalothrin	Instant 5% EC	Pyrethroids	3A	Sodium channel modulators
4.	Chlorantraniliprole	Coragen 18% W/W	Diamides	28	Ryanodine receptor activators
5.	Spinetoram	Delegate 11.7% SC	Spinosyns	5	Acetylcholine disruptors

Table 3. The resistance level of fall armyworm, *S. frugiperda* populations collected from Chittoor district of Andhra Pradesh against different insecticides at 72 HAT during *rabi*, 2021-2022

S. No.	Insecticide	LC_{50} (ppm)	95% FL		Slope ± SE	Chi Square	Intercept ± SE	RR**
			Lower limit	Upper Limit				
1	Emamectin Benzoate	1.81	0.88	2.64	2.66 ± 0.25	9.91	-0.68 ± 0.13	3
2	Chlorpyrifos	166.51	131.01	202.38	4.54 ± 0.32	17.46	-10.09 ± 0.74	114.8
3	Lambda Cyhalothrin	10.07	2.68	17.75	1.95 ± 0.17	15.17	-1.96 ± 0.22	19.4
4	Chlorantraniliprole	12.48	6.17	21.46	2.15 ± 0.17	14.88	-2.35 ± .22	12.5
5	Spinetoram	4.81	4.16	5.47	2.70 ± 0.26	4.46	-1.84 ± 0.21	10

** RR-Resistance Ratio; HAT-Hours after treatment

* The baseline LC_{50} values to emamectin benzoate of susceptible strain was taken from Gutierrez-Moreno *et al*. (2018)

* The base line LC_{50} values to chloryriphos of susceptible strain was taken from Yu (1991)

* The base line LC_{50} values to chloryriphos of susceptible strain was taken from Yu (1991)

* The baseline LC_{50} values to chlorantraniliprole of susceptible strain was taken from Gutierrez-Moreno *et al*. (2018)

* The baseline LC_{50} values to spinetoram of susceptible strain was taken from Zhao *et al*. (2020)

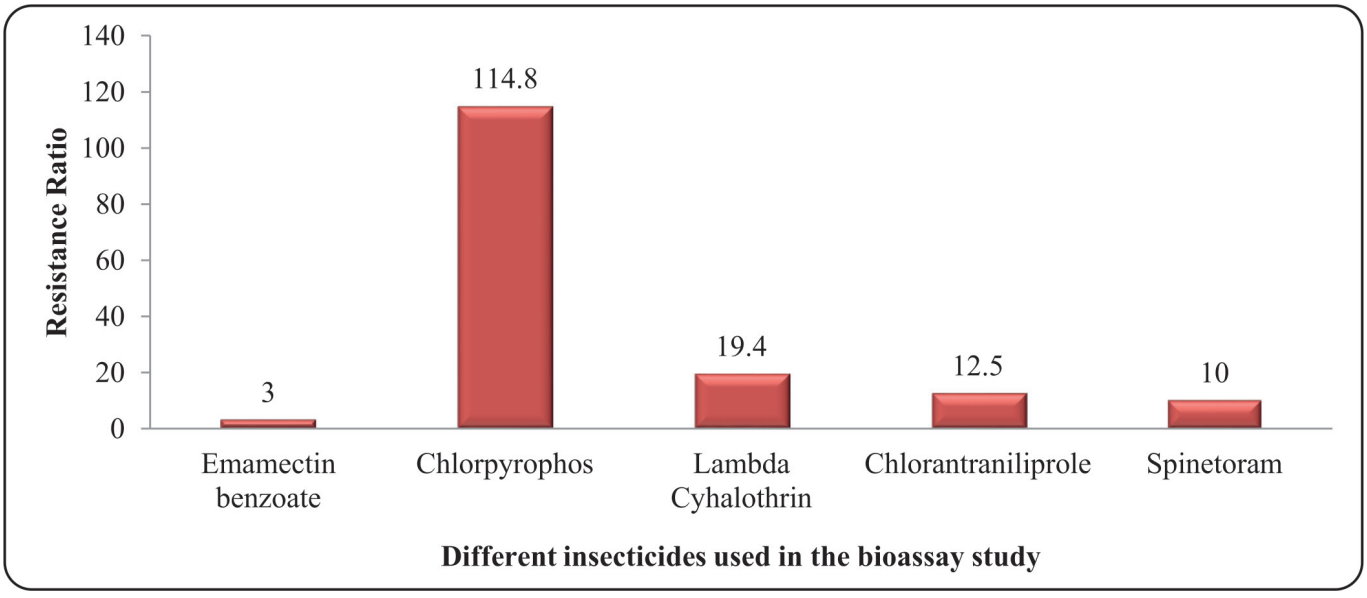

Fig. 1. Relative resistance of fall armyworm, *S. frugiperda* to different insecticides in Chittoor district.

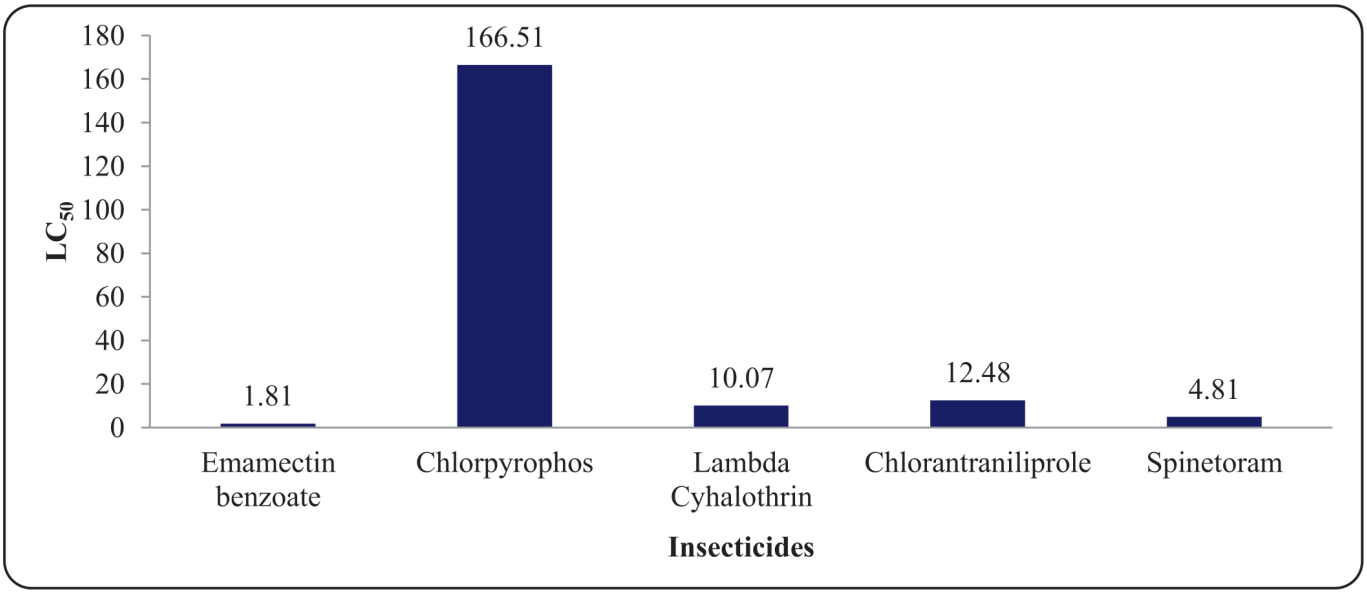

Fig. 2. LC_{50} values of different insecticides used against FAW from Chittoor district.

Fall armyworm, recently introduced transboundary pest into India exhibited insecticide resistance to test insecticides belongs to different groups. This is the first report of resistance development in *S. frugiperda* populations from Andhra Pradesh. The data generated in this study on susceptibility of FAW to different insecticides can be used as a baseline for future IRM studies on *S. frugiperda* populations in Andhra Pradesh. Even though fall armyworm is a new invasive pest it is showing higher level of resistance to different class of insecticides indicating the increased resistance to different class of insecticides.

LITERATURE CITED

Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology.* 18(2): 265-267.

Barreto, M.R., Loguerico, L.L., Valicente, F.H and Paiva, E. 1999. Insecticidal activity of culture Supernants from *Bacillus thuringiensis* Berliner strains against *Spodoptera frugiperda* Smith (Lepidoptera: Noctuidae) larvae. *Proceedings of the Entomological Society of Brazil*. 28(4): 675-685.

Carvalho, R. A., Omoto, C., Field, L. M., Williamson, M. S and Bass, C. 2013. Investigating the Molecular Mechanisms of Organophosphate and Pyrethroid Resistance in the Fall Armyworm *Spodoptera frugiperda*. *PLoS ONE*. 8(4): 1-11.

Finney, D.J. 1971. *Probit analysis*. 3rd Edition. S. chand and Co. Ltd., New Delhi. 333.

Goergen, G., Kumar, P.L., Sankung, S.B., Togola, A and Tamò, M. 2016. First report of outbreaks of the fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera, Noctuidae), a new alien invasive pest in West and Central Africa. *Plos One.* 11(10): 1-9.

Grace, A.D.G., Prasadarao, G.M.V., Krishnayya, P.V., Manoj, V and Srinivasarao, V. 2019. Monitoring of resistance in *Spodoptera litura* (fabricius) (Noctuidae: Lepidoptera) of Kurnool district of Andhra Pradesh to diamide group of insecticides. *Journal of Pharmacognosy and Phytochemistry.* 8(6): 299-303.

Gutierrez-Moreno, R., David, M., Carlos, A.B., Mark, E.W., Henry, T., Concepcion, R and Christiana, D. 2018. Field-Evolved resistance of fall armyworm (Lepidoptera: Noctuidae) to synthetic insecticides in Puerto Rice and Mexico. *Journal of Economic Entomology*. 112(2): 792-802.

Naganna, R., Jethva, D.M., Bhut, J.B., Pankaj, S.W and Akash, K. 2020. Present status of new invasive pest fall armyworm, *Spodoptera frugiperda* in India: A Review. *Journal of Entomology and Zoology Studies*. 8(2): 150-156.

Nascimento, A.B., Farias, J.R., Bernardi, D., Horikoshi, R.J and Omoto, C. 2016. Genetic basis of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) resistance to the chitin synthesis inhibitor lufenuron. *Pest Management Science*. 72(4): 810–815.

Naveed, M.R. 2005. Insecticide Resistance in Diamondback moth *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) and strategies of its management. *Ph.D Thesis* submitted to the Department of Entomology, Faculty of Crop and Food Sciences, University of Arid Agriculture, Rawlpindi, Pakistan.

Okuma, D.M., Bernardi, D., Horikoshi, R.J., Bernardi, O., Silva, A.P and Omoto, C. 2018. Inheritance and fitness costs of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) resistance to spinosad in Brazil. *Pest Management Science.* 74(6):1441-1448.

Sharanabasappa., Kalleshwaraswamy, C. M., Asokan, R., Mahadevaswamy, H. M., Maruthi, M. S., Pavithro, H.B., Hegde, K., Navi, S., Prabhu, S.T and Goergin. G. 2018. First report of fall army worm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) an alien invasive pest on maize in India. *Pest Management in Horticultural Ecosystems*. 24(1): 23-29.

Song, X.P., Liang, Y.J., Zhang, X.Q., Qin, Z.Q., Wei, J.J., Li, Y.R and Wu, J.M. 2020. Intrusion of Fall Armyworm (*Spodoptera frugiperda*) in Sugarcane and Its Control by Drone in China. *Sugar Tech.* 22: 734–737.

Tabashnik, B.E., Cushing, N.L and Johnson, M.W. 1987. Diamondback moth (Lepidoptera: Plutellidae) resistance to insecticides in Hawaii: intra-island variation and cross resistance. *Journal of Economic Entomology*. 80(6): 1091- 1099.

Test Methods | Insecticide Resistance Action Commiee (IRAC). Available online: https://irac-online.org/methods/ (2020).

Yu, S.J., 1991. Insecticide resistance in fall armyworm, *S. frugiperda* (J.E.Smith). *Pesticide Biochemistry and Physiology*. 39: 84-91.

Zhang, D., Yu-tao, X., Peng-jun, X., Xian-ming, Y., Qiu-lin, W and Ming, W.K. 2021. Insecticide resistance monitoring for the Invasive populations of Fall armyworm, *Spodoptera frugiperda* in China. *Journal of Integrative Agriculture.* 783–791.

Zhao, Y., Huang, J., Ni, H., Guo, D., Yang, F., Wang, X., Wu, S and Gao, C. 2020. Susceptibility of fall armyworm, *Spodoptera frugiperda* (J.E. Smith), to eight insecticides in China, with special reference to lambda-cyhalothrin. *Pesticide Biochemistry and Physiology.* 8(3): 1-30.

Andhra Pradesh J Agril. Sci : 8(4): 245-248, 2022

SOURCES OF INCOME FOR FARM HOUSEHOLDS IN ANDHRA PRADESH

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Date of Receipt: 27-09-2022 Date of Acceptance: 01-12-2022

ABSTRACT

The paper had examined the various sources of income to the farm households using primary data collected from 240 farm households in Andhra Pradesh. The results revealed that apart from agriculture which is dominant source of income for farm households, non-farm income also an important source of income for all the three income groups. The non-farm income is more important for the households who have less farm size. The low -income households then diversify their income generation through low-paid, low-return non-farm activities. Institutional source of income was one of the major sources of income to LIG households.

KEYWORDS: Farm income, non-farm income, institutional source of income.

INTRODUCTION

The average total monthly income of farm household in India during 2018-19 was ₹ 10,829 per month, up from ₹ 6,426 a month in 2012-2013. This represents a nominal income growth of about 60 per cent over six years. Out of the total income, the share of farm income was 49.7 per cent which constitutes ₹ 3,798 from crop and ₹ 1,582 from livestock. For the average agricultural household, the largest single-source of income was wages/salary (₹ 4,063). (NSSO report, 2019). If agriculture was the sole income source to the land constrained households, they would remain poor (Chand *et al.,* 2011). To reduce the rural poverty and to increase the farm income many studies inferred to diversify the rural economy towards non-farm activities (Adams and He, 1995; Adams, 2001; Reardon *et al.,* 1998 and 2007; Barrett *et al.,* 2001; Lanjouw and Shariff 2002; Janvry *et al.,* 2005). Non-farm activities enable the farmers to cope up with the shocks of crop failure and enhances their capacity to invest in productivity. The non-farm sector and labour market can serve as the potential entry points for small landholders to enhance their income levels (Birthal *et al*., 2014). In this paper, we have examined farm households' access to different income sources in Andhra Pradesh.

MATERIAL AND METHODS

Sample Selection

Multistage sampling technique was followed for selection of suitable sample for the present study. In the first stage, the three regions of Andhra Pradesh state viz., north coastal region, south coastal region and Rayalaseema region were considered for the study. Two districts were selected from each region based on the highest per-capita income of the districts according to the District Domestic Product published by Directorate of Economics and Statistics of Andhra Pradesh. Two mandals from each district were selected based on highest per capita income of mandals according to Mandal Domestic Product. Two villages were selected from each of the selected mandals based on the revenue of villages and households from each village were selected randomly based on proportionate to size constituting a total of 240 households. The selected households were post stratified into three groups based on the income of household i.e., low-income group (LIG) whose monthly income was less than or equal to ₹ 15000, middle-income group (MIG) whose monthly income was in between ₹ 15000 and ₹ 30000 and high-income group (HIG) whose monthly income was more than ₹ 30000. The data on quantity wise food consumed by sample farm households, prices of food items and expenditure on food items were collected from the sample respondents through a pre-tested questionnaire.

Data Analysis and terms used

Percentage analysis was used to analyse the various sources of income. Chi-square test was done to test the significance among the groups. As agriculture was the major source of income for farm households the sources of income were classified as farm income, non-farm income and off-farm income. Additionally, institutional sources of income was also included in study.

a) Income

Annual earnings from different sources such as farm produce, wages earned, and other services were considered as income.

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b) Farm income

The net returns from cultivating agricultural and horticultural crops and rearing of livestock were considered as farm income.

c) Off-farm income

Off-farm income refers to the portion of farm household income obtained from the farm activities like rent from leased out land, hiring out of machinery, agricultural labour etc.

d) Non-farm income

Income obtained from non-agricultural labour, salaries from job, business, shops, renting of assets etc was considered as non-farm income.

e) Institutional income

Income received from government like transfer payments was considered as institutional income.

RESULTS AND DISCUSSION

The level and percentage of income from different sources/activities are depicted in Table 1.

Farm income

The level and percentage of income from farm activities are depicted in Table 1. Annual farm income per household for LIG, MIG and HIG categories was ₹ 75945, ₹ 143012 and ₹ 402540 respectively. For LIG, 76.16 per cent of farm income was realised from field crops itself, while 13.29 per cent was from horticulture crops and 10.59 per cent was from livestock. The contribution of horticultural crops (21.26 per cent) to farm income was slightly increased for MIG than LIG. Field crops contributed 62.53 per cent and livestock contributed 16.21 per cent of their farm-income. The share of agricultural, horticultural and livestock to farm income was 54.46 per cent, 36.15 per cent and 9.39 per cent for HIG respectively. Overall average farm income depicts that livestock had less share of farm income (11.08 per cent) when compared to field crops (59.13 per cent) and horticultural crops (29.79 per cent).

Off farm income

The levels and percentages of off farm income per annum per household as presented in Table 1 revealed that hiring out of machinery (38.00%) was the major source of off farm income for all categories. For LIG major contribution to off farm income was from agriculture labour activities (38.84%) followed by trade of agricultural produce (27.18%) and equivalent contribution from both rent from leased land (16.17%) and hiring out productive assets (17.81%). The off-farm income was found to be highest for HIG farmers where, rent from leased out land (55.35%) followed by hiring out machinery (30.14%) and trade of agriculture produce (14.51%) made almost equivalent shares of off farm income. Overall, average off farm income per annum per household for all categories was ₹ 74347. Trade of agriculture produce (33.23%) was found to be the major source of off farm income for MIG farmers followed by rent from leased out land (29.43%), as agricultural labour (22.17%) and hiring out of machinery (15.17%).

Non-farm income

As presented in Table 1, the major portion of non-farm income per annum per household in overall sample households was received from salaried job (52.69%) followed by rental income with 31.40 per cent. LIG farmers depended mostly on salaried job (66.12%) for non-farm income. In both MIG and HIG categories, farmers were depending more on non-farm income in which major share was received from salaried job followed by rental income. The share of salaried job and rental income was 36.83 per cent and 33.71 per cent for MIG and for HIG the share of salaried job and rental income was 59.23 per cent and 26.60 per cent respectively. Among all the categories of farmers the dependency on non-agricultural labour activity for non-farm income was very less than other sources of non-farm income. The contribution of business/shops for LIG and MIG farmers was almost similar.

Institutional sources of income

Apart from farm, off-farm, non-farm income sources eligible farmers or members in the household also received some income from the government like transfer payments, grants based on farmer farm size etc. In Table 1, the transfer payments (51.32%) contributed major share for institutional sources of income. Of all the categories MIG farmers were getting more benefits from institutions. The average institutional income per annum per household was ₹ 32908.

Income from livestock, rent for leased out land, mgnrega activities and grants from government were significant among three income groups.

Farm income was the major source of income to all farm households. For LIG, farm income was followed by non-farm income, institutional income and off-farm income. Farm income for LIG households was less when compared to MIG and HIG. This is due to the less operational holdings of LIG. For MIG and HIG, farm income was followed by non-farm income, off-farm

Table 1. Source-wise income of sample households (₹ /Annum)

Source of Income	LIG	MIG	HIG	Overall	Chi-square value
I. Farm income					
Field Crops	57806	89415	219205	122469	204.42
	(76.12)	(62.53)	(54.46)	(59.13)	
Horticultural Crops	10095	30410	145533	61722	55.17
	(13.29)	(21.26)	(36.15)	(29.79)	
Livestock	8044	23187	37802	22956	11.24*
	(10.59)	(16.21)	(9.39)	(11.08)	
Total	**75945**	**143012**	**402540**	**207147**	**127.32**
	(100)	**(100)**	**(100)**	**(100)**	
II. Off-farm income					
Agricultural labour	13587	12356	0	12971	38.22
	(38.84)	(22.17)	(0)	(17.44)	
Rent from leased out land	5661	16418	78279	25185	28.44*
	(16.17)	(29.43)	(55.35)	(33.88)	
Hiring out of machinery	6234	8472	42624	19710	58.32
	(17.81)	(15.17)	(30.14)	(26.52)	
Trade of Agriculture Produce	9518	18536	20535	16481	28.69
	(27.18)	(33.23)	(14.51)	(22.16)	
Total	**35000**	**55782**	**141438**	**74347**	**53.91**
	(100)	**(100)**	**(100)**	**(100)**	
III. Non-farm income					
Non-Agricultural Labour (Mgnrega)	2047	3336	6073	2666	11.22*
	(4.71)	(3.20)	(2.09)	(1.83)	
Salary from Job	28807	38517	173310	77410	44.84
	(66.12)	(36.83)	(59.23)	(52.69)	
Business, Shops	12706	27462	35354	20689	17.32
	(29.17)	(26.26)	(12.08)	(14.08)	
Rental Income	0	35248	77839	46135	24.78
	(0)	(33.71)	(26.60)	(31.40)	
Total	**43560**	**104563**	**292576**	**146900**	**53.26**
	(100)	**(100)**	**(100)**	**(100)**	
IV. Institutional source of income					
Transfer Payments	20301	16943	12749	16888	13.58
	(55.62)	(47.72)	(48.71)	(51.32)	
Grants From Government	16199	18569	13423	16020	10.21*
	(44.38)	(52.28)	(51.29)	(48.68)	
Total	**36500**	**35512**	**26172**	**32908**	**20.93**
	(100)	**(100)**	**(100)**	**(100)**	

Source : Analysed by the author
Note : Figures in parentheses indicate per cent to respective total.
*, ** indicate significance at 5% and 1% respectively.

income and institutional income. The non-farm income is more important for the households who have less farm size. The low -income households then diversify their income generation through low-paid, low-return non-farm activities. Institutional source of income was one of the major sources of income to LIG households.

LITERATURE CITED

Adams, R.H. 2001. Non-farm income, inequality and poverty in rural Egypt and Jordan. *Policy Research Working Paper 2572*. World Bank, Washington, D.C.

Adams, R.H and He, J. 1995. Sources of income inequality and poverty in rural Pakistan. Research Report No. 102. *International Food Policy Research Institute*, Washington, D.C.

Barrett, C.B., Reardon, T and Webb, P. 2001.Non-farm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics and policy implications. *Food Policy*. 26(4): 315-332.

Birthala, P.S., Digvijay, S., Negia, Awadesh, K., Jhab and Dhiraj, S. 2014. Income sources of farm households in India: Determinants, distributional consequences and policy implications. *Agricultural Economics Research Review.* 27(1): 37-48.

Chand, R., Prasanna, P.A.L and Singh, A. 2011. Farm size and productivity: Understanding the strengths of smallholders and their livelihoods. *Economic and Political Weekly*. 54(26/27): 5-11.

de Janvry, A., Sadoulet, E and Zhu, N. 2005. The Role of Non-farm Incomes in Reducing Rural Poverty and Inequality in China. Working Paper 1001. *Department of Agricultural & Resource Economics, University of California, Berkley.*

Lanjouw, P. and Shariff, A. 2002. Rural Non-farm Employment in India: Access, Income and Poverty Impact. Working Paper 81. *National Council of Applied Economic Research*, New Delhi

NSSO. 2019. Situation Assessment of Agricultural Households and Land and Livestock Holdings of Households in Rural India.

Reardon, T., Berdegue, J., Barrett, C.B and Stamoulis, K. 2007. Household income diversification into rural non-farm activities. *Johns Hopkins University Press*, Baltimore.

Andhra Pradesh J Agril. Sci : 8(4): 249-254, 2022

EVALUATION OF *Trichoderma* spp. FOR THE COMPOUNDS RESPONSIBLE FORANTIBIOSIS AND MYCOPARASITISM ACTIVITY *IN VITRO*

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Date of Receipt: 27-09-2022 Date of Acceptance: 08-12-2022

ABSTRACT

Biological control has become an important part of plant disease management, and it is a cost-effective and safe method in a variety of crops. *Trichoderma* spp. has attracted scientific attention due to its biocontrol effectiveness against a variety of economically important aerial, root and soil born diseases. In our current study, twenty strains were collected from different agro-climatic zone of Andhra Pradesh out of which, five strains of *Trichoderma* isolates (AT-1, AT-6, NT-3, KT-1 and KT-3) were screened for their biochemical activity. During the process of mycoparasitism phytopathogen cell walls are degraded by cell wall-degrading enzymes produced from *Trichoderma* were evaluated *in-vitro* through the production of cellulase, Protease, amylase, iron chelators (siderophores), cyanhydric acid (HCN) and ammonia (NH_3). *Trichoderma* isolate AT-6, NT-3 and KT-1 showed positive results for cellulase test. Isolates KT-1 showed positive for protease test. For amylase test KT-3, NT-3 and AT-1 showed positive with halo zone formation and for siderophore assay all the isolates showed positive results and for HCN assay the *Trichoderma* isolate KT-1, AT-6 and NT-3 showed positive results. For NH_3 assay KT-1, NT-3, AT-6 and KT-3 showed positive.

KEYWORDS: *Trichoderma* spp. lytic enzymes, cellulase, amylase, protease, siderophore, NH_3 and HCN.

INTRODUCTION

Disease management in economically significant crops is important for maintaining product quality and quantity. Fungicide treatment to the soil is costly and harmful to non-target microorganisms. *Trichoderma* spp. found all over the world and are commonly associated with soil surrounding plant roots and debris and has also been identified as promising biological agents for controlling plant diseases (Schuster and Schmoll, 2010). *Trichoderma* species are fast-growing free-living or entophytic fungi that thrive in soil and plant root habitats. They have attracted attention as cost-effective and secure biocontrol agents for various plant diseases and as boosters of plant defence mechanisms. There are several mechanisms involved in *Trichoderma* antagonism namely antibiosis; competition for nutrients; and mycoparasitism whereby *Trichoderma* directly attacks the plant pathogen by excreting lytic enzymes such as cellulase, chitinase, β-1, 3 glucanase, amylase and protease (Chet, 1987). In addition, Production of antifungal substances by *Trichoderma* spp. such as iron chelators (siderophore) and hydrogen cyanide may also promote plant growth (Samuels *et al*., 2002 and Ushamailini *et al*., 2008); these metabolites can protect plants against phytopathogens (Benitez *et al*., 2000 and Whipps, 2001). Secondary metabolite production by fungi showing bio-control activity has been most commonly reported from isolates of *Trichoderma* spp. There are several large numbers of antibacterial and antifungal metabolites that have proven relevance for the management of diverse fungal infections. The aim of this study was to evaluate *In-vitro* biochemical properties of *Trichoderma* spp. Twenty isolates were collected from different agro-climatic zones of Andhra Pradesh. Moreover, investigating their enzymatic activity in order to select the promising *Trichoderma* species and these spsecies could be utilised as a potential biofertilizer.

MATERIAL AND METHODS

Trichoderma isolates *viz.,* Anakapalle *Trichoderma isolate* (AT-1 and AT-6) Nandyal *Trichoderma isolate* (NT-3) Kadiri *Trichoderma isolate* (KT-1 and KT-3) were collected from different agro climatic zones of Andhra Pradesh and these *Trichoderma* isolates were designated as the initial letter of the region from where it was collected. The plates were incubated at 26 ± 2°C for 5 days. *Trichoderma* colonies appeared in the plates were noted and maintained regularly by sub culturing. They were purified by single spore isolation method and maintained on potato dextrose agar (PDA) slants for future use.

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Qualitative assay of extracellular enzymes

Enzymatic assay of *Trichoderma* isolates were carried out by plate assay and test tube method on the respective media to study for extracellular enzymes. Assay were based on the formation of clear zones, change of colour and its intensity around the fungal colonies for production of cellulase, amylase, protease, siderophore, NH_3 and HCN enzymes. The independent experiments were performed with three replicates for each isolate.

Cellulase assay

Carboxymethyl cellulose (CMC) agar plate (Hankin and Anagnostakis, 1975) was prepared to screen for cellulase production. The medium composition (per litre): Cellulose 0.5 g, K_2HPO_4 0.099 g, Magnesium sulphate 0.049 g, Yeast extract 0.05 g, Congo red 0.05 g, Agar 20 g, distilled water 1 litre. The medium was aseptically transferred to petri dishes and inoculated with a 6 mm agar disc cut from 5-day old *Trichoderma* culture of each strain separately and incubated at 26 ± 2°C in darkness for 3 to 5 days. Halo zone formation around the fungal colonies indicates the cellulase enzyme production.

Amylase assay

Amylase activity (Hankin and Anagnostakis, 1975) was assessed by growing the *Trichoderma* strains on Starch Agar Medium (Starch 20.00 g, Beef extract 3.00 g, Peptone 5.00 g, Agar 16.00 g, Distilled water 1000 ml). The medium was aseptically transferred to petri dishes and inoculated with a 6 mm agar disc cut from 5-days old culture of each strain separately and incubated at 26 ± 2ºC in darkness for 3 to 5 days. Then the plates were flooded with 1% iodine in 2% potassium iodide. The clear zone formed surrounding the colony was considered as positive for amylase activity

Protease assay

Protease activity of *Trichoderma* isolate was determined according to the modified method of Berg *et al.* (2002). Skim milk agar medium (51.5 g/litre) was used for detection of protease activity. Culture disc from 5-6 days old *Trichoderma* cultures were inoculated on skim milk agar medium and incubated at 28°C ± 2ºC for three to four days. Positive *Trichoderma* spp. strain gave a clear zone indicating the production of protease enzyme.

Siderophores production

The fungal isolates were screened for siderophore production by the universal chrome Azurol S assay as described by Schwyn and Neilands (1987). The culture was inoculated into the autoclaved Kings' B media broth (**Kings' B medium g/litre** Peptone 5.0 g, K_2HPO_4 1.2 g, Magnesium sulphate 1.5 g, Glycerol 2 ml**,** 1 L distilled water**,** pH 7.2) and incubated for 2-3 days at room temperature. The incubated cultures were centrifuged for 12 min at 5000 g. CAS solution was added to the culture supernatant and incubated for 30 min in the dark. Blue to orange pinkish colour change indicates the presence of siderophores.

Ammonia production

Ammonia production was determined by the method given by Dye (1962) growing the different *Trichoderma* cultures in peptone water broth. The tubes were incubated at 30°C for 4 days, after which 1 ml of Nessler's reagent was added to each tube. Observations were recorded in terms of a faint yellow colour to deep yellow colour.

Production of HCN

The fungal isolates were cultured on Potato dextrose agar plates amended with glycine (4.4 g/L). Whatman No. 1 filter paper was soaked in 1% picric acid and sprayed with 1ml of 10% Na_2CO_3 and placed under the Petri dish lids. The plates were carefully sealed with parafilm to prevent the leakage and were kept for incubation for 5 days at 28±2°C. Color change from yellow to reddish brown indicates the production of HCN. Bakker and Schippers (1987) had reported in their study that a change in colour of the filter paper from yellow to light brown or reddish brown indicated the production of HCN.

RESULTS AND DISCUSSION

When twenty isolates were screened *in vitro* against three pathogens *viz., Sclerotium rolfsii, Aspergillus niger* and *Rhizcotonia batatticola* in dual culture, five isolataes (AT-1, AT-6, NT-3, KT-1 and KT-3) were selected as potential strains based on per cent inhibition.

Trichoderma isolates *viz.,* AT-6, NT-3 and KT-1 showed positive for the cellulase activity (Table 1, Plate 1A). Strong evidence for the production of cellulase enzymes was provided by the clear zone that appeared around the colony. Cellulases are the enzymes responsible for the cleavage of the β–1, 4–glycosidic linkages in cellulose. The two enzymes that are crucial in the enzymatic breakdown of the cell walls of phytopathogenic fungi are cellulase and 1, 3-glucanase during mycoparasitic interaction (Kamala and Indira, 2014). Benhamou and Chet (1997) reported that when *Trichoderma* attempts to penetrate the host cell walls result in the production of significant amounts of cellulytic enzymes, which are crucial in breaching the host cell walls.

Table 1. Qualitative assay of biochemicals produced by *Trichoderma* spp.

S. No.	Enzymatic activity	*Trichoderma* isolates				
		AT-1	AT-6	NT-3	KT-1	KT-3
1	Cellulase	-	+	+	+	-
2	Protease	-	-	-	+	-
3	Siderophore	+	+	+	+	+
4	Amylase	+	-	+	-	+
5	HCN	-	+	+	+	-
6	NH_3	-	+	+	+	+

+ indicates positive for enzymatic activity and – indicates the negative for enzymatic activity
(No enzyme activity was produced)

Trichoderma isolate AT-1, NT-3 and KT-3 exhibited amylase activity by forming halo zone (Table 1, Plate 1B). Amylase is the extracellular enzyme that randomly cleaves the 1,4 α -D-glucosidic linkages between adjacent glucose units in the linear amylose chain to produce glucose thus making nutrients available for the bioagent. The results are agreement with Abdenaceur *et al.* (2022) who showed that among the 15 *Trichoderma* isolates isolated from rhizosphere soil in Northern Algeria only five isolates T1, T6, T10, T12 and T15 showed positive for amylase activity by forming starch hydrolysing zone.

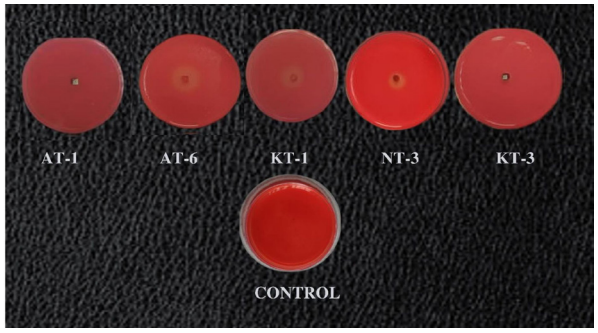
Only one *Trichoderma* isolate KT-1 showed positive for protease activity (Table 1, Plate 1C). It has been suggested that this protease is involved in the degradation of pathogen cell walls, membranes and even proteins released by the lysis of the pathogen, thus making nutrients available for the endophytes (Goldman *et al*., 1994). Fungal proteases play a significant role in cell wall lyses by catalysing the cleavage of peptide bonds in proteins (Mata *et al*., 2001).

All the five-isolate showed positive results for the siderophore by changing the colour from blue to orange and pinkish colour resulting from siderophore removal of Fe from the dye (Table 1, Plate 1D). Siderophores are among the strongest (highest affinity) Fe^{3+} binding agents known and compete with pathogen and can supress the growth of pathogen by depriving the necessary micronutrients. These results are similar with Singh *et al.* (2022) when conducted siderophore production test qualitatively by inoculation of *Trichoderma* isolates on chrome azurol sulfonate (CAS) agar medium. All 25 isolates showed positive results for siderophore production. Among the tested isolates, *Trichoderma* isolates (T3, T4, T5, T7, T8, T9, T10, T11, T14, T15, T18 and T21) exhibited strong siderophore production by pink and orange halo colour development.

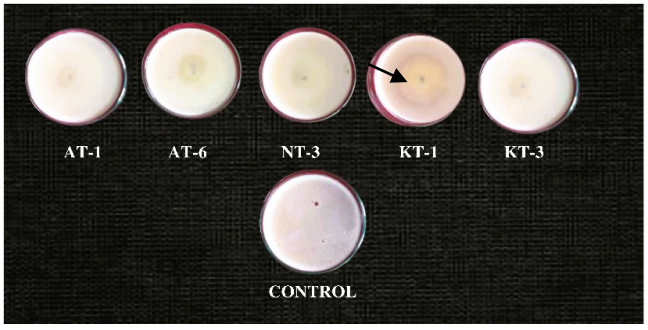
Trichoderma isolates such as KT-1, AT-6 and NT-3 showed positive for HCN assay by changing the filter paper colour from yellow to reddish brown on colour (Table 1, Plate 1E). HCN synthesizes some antibiotics or cell wall degrading enzymes (Ramette *et al*., 2006). HCN toxicity inhibits cytochrome c oxidase as well as other important metalloenzymes (Nandi *et al*., 2017). These results were in agreement with Mohiddin *et al*. (2017) stated that HCN production is an important trait found in many bioagents as it indirectly promote plant growth by controlling some soil borne pathogens, while screening for HCN among five isolates three *Trichoderma* isolate AT-3, AT-5 and AT-7 were found positive and rest were found negative.

Trichoderma spp. isolates AT-6, NT-3, KT-1 and KT-3 showed positive for ammonium production by changing colour from faint yellow to bright yellow colour (Table 1, Plate 1F). Abdenaceur *et al.,* (2022). Quantitative screening of NH_3 production revealed that isolates of *Trichoderma* isolate T2, T4, T6, T11, T12 had showed positive for NH_3 production (Table 1 and Fig. 1).

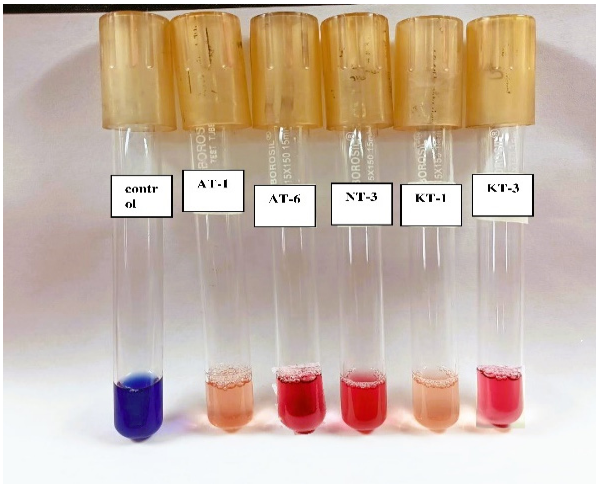
The results obtained showed that the qualitative methods are valid and important in selection of biocontrol agents. These methods in plates reveal feasibility for an initial selection of strains for screening large number of samples. These *Trichoderma* isolates can be applied as biocontrol agents in management of disease and increasing yield and to increase production in the



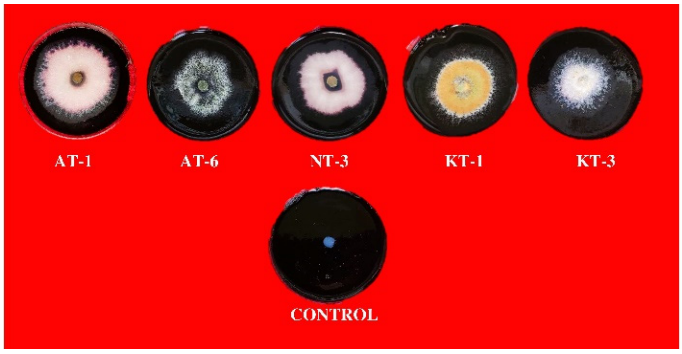
(1A)



(1B)



(1C)



(1D)

(1E)

(1F)

The figure shows the production of (1A) Cellulase; (1B) Protease; (1C) Siderophore; (1D) amylase; (1E) HCN; (1F) Ammonium by *Trichoderma* spp.

Fig. 1. Qualitative assay of biochemicals produced by *Trichoderma* spp.

agriculture. *Trichoderma* isolates KT-1 may have good biocontrol ability as it showed positive for five test out of six qualitative tests performed followed by NT-3 and KT-3. *Trichoderma* isolates AT-1 may be least effective as it shown positive for the two test only. However, knowledge of the types, amounts and characteristics of enzymes produced by *Trichoderma* cited above would be studied for selecting organisms best suited for biocontrol in agriculture and industrial requirements. Further research has to be done to quantify the lytic enzymes and *in vivo* experiments to be conducted against phytopathogens.

ACKNOWLEDGEMENT

The first author is extremely thankful to Acharya N.G. Ranga Agricultural University, Guntur, A.P. for assisting us and conduct of experiment.

LITERATURE CITED

Abdenaceur, R., Benzina-tihar, F., Djeziri, M., Hadjouti, R and Sahir-Halouane, F. 2022. Effective biofertilizer *Trichoderma* Spp. isolates with enzymatic activity and metabolites enhancing plant growth. *Research Square.* 3: 159-165.

Bakker, A.W and Schippers, B.O.B. 1987. Microbial cyanide production in the rhizosphere in relation to potato yield reduction and *Pseudomonas* spp. mediated plant growth-stimulation. *Soil Biology and Biochemistry*. 19(4): 451-457.

Benhamou, N and Chet, I. 1997. Cellular and molecular mechanisms involved in the interaction between *Trichoderma harzianum* and *Pythium ultimum*. *Applied and Environmental Microbiology.* 63(5): 2095- 2099.

Benitez, T., Rey, M., Delgado-Jarana, J., Rincon, A.M and Limon, M.C. 2000. Improvement of *Trichoderma* strains for biocontrol. *Revista Iberoamericana De Micología*. 17(1): S31-6.

Berg, G., Krechel, M., Ditz, R., Sikora, A and Ulrich, J. 2002. Endophytic and ectophytic potato associated bacterial communities differ in structure and antagonistic function against plant pathogenic fungi. *FEMS Microbiology Ecology*. 51(2): 215-229.

Chet, I. 1987. *Trichoderma* application, mode of action, and potential as biocontrol agent of soilborne plant pathogenic fungi. *Innovative Approaches to Plant Disease Control*. 137-160.

Dye, D.W. 1962. The inadequacy of the usual determinative tests for identification of *Xanthomonas* sp. *New Zealand Journal and Science*. 5: 393.

Goldman, N and Yang, Z. 1994. A codon-based model of nucleotide substitution for protein-coding DNA sequences. *Molecular Biology and Evolution*. 11(5): 725-736.

Hankin, L., Anagnostakis, S.L. 1975. The use of solid media for detection of enzyme production by fungi. *Mycologia*. 67: 597-607.

Kamala and Indira, S. 2014. Molecular characterization of *Trichoderma harzianum* strains from Manipur and their biocontrol potential against *Pythium ultimum*. *Internationa Journal of Current Microbiology and Applied Science.* 3(7): 258-270.

Mata, E., Magaldi, S., Hartung, D., Capriles, C., Dedis, L., Verde, G., Perez, E and Capriles, C. 2001. *In vitro* antifungal activity of protease inhibitors. *Mycopathologia.* 152: 135-142.

Mohiddin, F.A., Bashir, I., Padder, S.A and Hamid, B. 2017. Evaluation of different substrates for mass multiplication of *Trichoderma* species. *Journal of Pharmacognosy and Phytochemistry.* 6(6): 563-569.

Nandi, M., Selin, C., Brawerman, G., Fernando, W.G.D. and de Kievit, T. 2017. Hydrogen cyanide, which contributes to *Pseudomonas chlororaphis* strain PA23 biocontrol, is upregulated in the presence of glycine. *Biological Control.* 108: 47-54.

Ramette, A., Moenne-Loccoz, Y and Defago, G. 2006. Genetic diversity and biocontrol potential of fluorescent *pseudomonads* producing phloroglucinols and hydrogen cyanide from Swiss soils naturally suppressive or conducive to *Thielaviopsis basicola*-mediated black root rot of tobacco. *FEMS Microbiology Ecology.* 55:369-381.

Samuels, G., Dodd, S.L., Gams, W., Castlebury, L.A and Petrini, O. 2002. *Trichoderma* species associated with the green mold epidemic of commercially grown *Agaricus bisporus*. *Mycologia.* 94: 146-170.

Schuster, A and Schmoll, M. 2010. Biology and biotechnology of *Trichoderma*. *Applied Microbiology Biotechnology*. 87(3): 787-799.

Schwyn, B and Neilands, J.B. 1987. Universal assay for the detection and determination of siderophores. *Analytical Biochemistry.* 160(1): 47-56.

Singh, R., Ao, N.T., Kangjam, V., Rajesh, G and Banik, S. 2022. Plant growth promoting microbial consortia against late blight disease of tomato under natural epiphytotic conditions. *Indian Phytopathology.* 75: 527-539.

Ushamailini, C., Nakkeeran, S and Marimuthu, T. 2008. Development of biomanure for the management of turmeric rhizome rot. *Arch Phytopathol Plant Pro.* 41: 365-376.

Whipps, J.M. 2001. Microbial interactions and biocontrol in the rhizosphere. *Journal of Experimental Botany.* 52: 487-511.

Andhra Pradesh J Agril. Sci : 8(4): 255-260, 2022

WEED MANAGEMENT PRACTICES ON PHYTOTOXICITY OF DIRECT SEEDED RICE AND RESIDUAL EFFECT OF NUTRIENT AND WEED DYNAMICS ON SUCCEEDING BLACKGRAM

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Date of Receipt: 27-09-2022 Date of Acceptance: 10-12-2022

ABSTRACT

A field experiment was conducted to investigate the residual effect of nutrient and weed dynamics imposed to preceding direct seeded rice on succeeding blackgram at wetland farm of S. V. Agricultural College, Tirupati during *kharif* 2020 and 2021 and *rabi* 2020-21 and 2021-22 was laid out in a split plot design with three replications. There were three main plots comprising of *viz*., 100 % RDF (N_1), 125% RDF (N_2) and 150% RDF (N_3) and five sub plots *viz*., Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS (W_1), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (W_2), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS (W_3), hand weeding twice at 20 and 40 DAS (W_4) and unweeded check (W_5). From this experiment, it was revealed that there were no phytotoxicity symptoms on direct seeded rice and no residual effect on succeeding blackgram in terms of germination percentage, plant height, leaf area index and dry matter production. Therefore, it can be concluded that all the nutrient and weed dynamics were found to be safe and minimal impact on succeeding blackgram and suitable for rice based cropping systems.

KEYWORDS: Direct seeded rice, Weed management practices, Residual effect, Phytotoxicity, Germination percentage.

INTRODUCTION

Rice is grown under a range of climatic conditions and agro-ecological zones. In India, lowland rice occupies 30 per cent of the total cultivated area of rice with an average productivity of 1.55 t ha^{-1} under rainfed condition. India ranks second with 124.37 million tonnes of rice production, in an area of 45.77 million hectares and with a productivity of 2717 kg ha^{-1}. In Andhra Pradesh, rice is cultivated in an area of 2.32 million hectares with a production of 7.88 million tonnes and productivity of 4437 kg ha^{-1} (Ministry of Agriculture and Farmer's Welfare, Govt. of India, 2020-21). India has to increase the rice productivity in order to sustain present food self-sufficiency and to meet future food requirements. Due to heavy weed infestation, the productivity of upland rice is declined. Depending on the weed flora, their density and duration of competition, yield losses varied from 40 to 100% (Choubey *et al*., 2001) and rice emerge simultaneously, which is challenging to figure out the ideal weed control and techniques. Any weeding delay will result in a surge of weed biomass, which has a negative relationship with yield. As a result, the DSR production technology aiming for utmost productivity and profitability must employ an effective and early weed management strategy.

Hand weeding is the conventional and most effective way of weed control in rice, although it is more expensive and often became difficult to keep the crop weed-free during the vital period (critical crop-weed competition) due to labour shortage. In direct seeded rice, manual and mechanical weed control procedures were effective, but labour shortages during peak period and rising labour wages are causing weed control practices to be delayed and costly. It has forced the farmers to continuously use traditional herbicides as a default option to control weeds. Continuous use of herbicide with same mode of action leads appearance of more notorious weeds (Mohapatra *et al*., 2021). To avoid such disaster, it is advised to use novel herbicide molecules with several modes of action to manage this composite weed flora in rice (Gangireddy and Subramanyam, 2020) and to understand the phytotoxic effect of different novel herbicides on crop.

Rice-blackgram cropping sequence plays a vital role in national food security. Rice-pulse is the predominant cropping system of rice growing areas of

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Andhra Pradesh. Recommended dose of nutrient and herbicides may have a positive impact on main and subsequent crops. However, some herbicides can persist for longer periods and effect the succeeding crops (Rani *et al*., 2021). Therefore it is necessary to understand and study the residual effect of both nutrient levels and weed management practices on succeeding blackgram.

MATERIAL AND METHODS

Field experiments were conducted during *kharif*, 2020 and 2021 and *rabi* 2020-21 and 2021-22 at wetland farm of S. V. Agricultural College, Tirupati, geographically situated at 13.5°N latitude and 79.5°E longitude and at an altitude of 182.9 m above the mean sea level in the Southern Agro-Climatic Zone of Andhra Pradesh. The experimental soil was sandy clay loam in texture, slightly alkaline in reaction (0.40 and 0.44 dS m^{-1}), low in organic carbon (0.40 and 0.42%) and available nitrogen (260.7 and 272.9 kg ha^{-1}) and medium in available phosphorus (25.5 and 29.2 kg ha^{-1}) and available potassium (306.5 and 320.0 kg ha^{-1}) during 2020-21 and 2021-22. The treatments in main plot assigned of three nutrient levels *viz*., 100% RDF (N_1), 125% RDF (N_2) and 150% RDF (N_3) under main plots and five weed management practices comprised to sub plots *viz*., Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS (W_1), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (W_2), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS (W_3), hand weeding twice at 20 and 40 DAS (W_4) and unweeded check (W_5). Application of nutrients was done as per the treatments in the form of urea, single super phosphate and muriate of potash, respectively. Nitrogen was applied in three splits at 15 DAS, tillering and at panicle initiation stages. Entire quantity of phosphorus was applied at the time of sowing and potassium was applied in two splits, ½ at the time of sowing and the remaining ½ at panicle initiation stage. Phytotoxicity scoring was taken in rice crop by adopting a scale (range of 0-10). Data on germination percentage of succeeding blackgram was recorded. Healthy and matured seeds of blackgram treated with carbendazim 3 g kg^{-1} of seed were used for sowing. The treated seeds were sown at a spacing of 30 cm between the rows and 10 cm between the plants within a row. The number of plants germinated in the net plot area was counted in all the treatments and the germination percentage was calculated as per the following formula.

Germination percentage =

$$\frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

The data obtained on germination percentage of succeeding blackgram was analysed statistically by the method of analysis of variance for split plot design as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Phytotoxicity

Phytotoxicity rating of herbicides on direct seeded rice was observed at 5th and 10th day after application of pre emergence and post emergence herbicides, respectively as per the method suggested by Singh and Rao (1976) as mentioned in Table 1. Phytotoxicity scoring was taken in rice crop by adopting a scale (range of 0-10). Where, scoring 0 means no injury and no reduction in plant population, 10 means complete crop destruction Table 2.

Germination percentage

After harvest of direct seeded rice, blackgram was cultivated in an undisturbed layout to study the residual effect of nutrient levels and weed management practices applied to preceding direct seeded rice on succeeding blackgram. Germination percentage was found non-significant during both the years of study and in the pooled mean Table 3. The interaction effect due to nutrient and weed management practices was not significantly traceable during both the years of study and in the pooled mean.

Growth parameters

With respect to growth parameters *viz*., plant height, leaf area index and dry matter production of succeeding blackgram were significantly higher with 150% RDF (N_3) followed by 125% RDF (N_2) and 100% RDF (N_1) in decreasing order during both the years of study and in the pooled mean. Among the weed management practices, the above parameters were higher with hand weeding twice at 20 and 40 DAS (W_4) which was statistically at par with PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (W_2), PE application of pyrazosulfuron-ethyl

Table 1. Phytotoxicity scoring chart

Effect	Rating	Visual symptoms
None	0	No injury, normal growth
	1	Slight stunting injury or discolouration
	2	Some stand loss, stunting or discolouration
	3	Injury more pronounced but not persistent
Moderate	4	Moderate injury, recovery is possible
	5	Injury more persistent, recovery is doubtful
	6	Near severe injury, no recovery possible
	7	Severe injury, stand loss
	8	Almost destroyed, few plants surviving
	9	Very few plants alive
Complete	10	Complete destruction

Table 2. Phytotoxicity scoring of direct seeded rice due to application of pre and post emergence herbicides

Treatments	Pre emergence herbicides		Post emergence herbicides	
	5 DAA	10 DAA	5 DAA	10 DAA
W_1 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS	0	0	0	0
W_2 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS	0	0	0	0
W_3 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS	0	0	0	0
W_4 : Hand weeding twice at 20 and 40 DAS	-	-	-	-
W_5 : Unweeded check	-	-	-	-

25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS (W_1) and PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20g ha^{-1} at 20 DAS (W_3). Whereas, lowest values were recorded with unweeded check (W_5) during both the years of study and in the pooled mean Table 4. The interaction effect due to nutrient levels and weed management practices was found to be non-significant.

From the above investigation it can be concluded that the use of different fertilizer doses and pre emergence broad spectrum herbicides and post emergence herbicide mixtures are very safe to direct seeded rice based cropping system with no residual effect, least environmental impact and without any residual effect on succeeding blackgram.

Table 3. Germination percentage of succeeding blackgram as influenced by nutrient levels and weed management practices imposed to preceding direct seeded rice

Treatments	Germination percentage		
	2020	2021	Pooled
Nutrient levels			
N_1 : 100% RDF	90.0	89.7	89.8
N_2 : 125% RDF	90.3	90.0	90.2
N_3 : 150% RDF	90.5	90.3	90.4
SEm ±	**0.35**	**0.37**	**0.36**
CD (P = 0.05)	**NS**	**NS**	**NS**
Weed management practices			
W_1 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS	90.4	90.1	90.2
W_2 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS	90.7	90.6	90.6
W_3 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS	90.1	89.9	90.0
W_4 : Hand weeding twice at 20 and 40 DAS	90.9	90.7	90.8
W_5 : Unweeded check	89.2	89.1	89.1
SEm ±	**0.94**	**0.95**	**0.96**
CD (P = 0.05)	**NS**	**NS**	**NS**
Interaction			
N at W			
SEm ±	**1.93**	**1.92**	**1.96**
CD (P = 0.05)	**NS**	**NS**	**NS**
W at N			
SEm ±	**1.63**	**1.62**	**1.68**
CD (P = 0.05)	**NS**	**NS**	**NS**

Table 4. Growth parameters of succeeding blackgram at 25 DAS as influenced by nutrient levels and weed management practices imposed to preceding direct seeded rice

Treatments	Plant height (cm)			Leaf area index			Dry matter production (kg ha^{-1})		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Nutrient levels									
N_1 : 100% RDF	12.6	12.0	12.3	0.49	0.45	0.47	254	238	246
N_2 : 125% RDF	14.4	13.7	14.1	0.56	0.52	0.54	296	271	284
N_3 : 150% RDF	16.2	15.5	15.9	0.63	0.59	0.61	339	314	327
SEm ±	**0.41**	**0.39**	**0.42**	**0.013**	**0.010**	**0.014**	**7.5**	**6.9**	**7.1**
CD (P=0.05)	**1.6**	**1.5**	**1.7**	**0.05**	**0.04**	**0.05**	**29**	**27**	**28**
Weed management practices									
W_1 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS	18.8	18.0	18.4	0.67	0.65	0.66	370	354	362
W_2 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS	19.2	18.4	18.8	0.69	0.66	0.68	379	362	371
W_3 : Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS	18.6	17.9	18.3	0.66	0.64	0.65	368	349	359
W_4 : Hand weeding twice at 20 and 40 DAS	19.5	18.6	19.1	0.70	0.68	0.69	384	366	375
W_5 : Unweeded check	14.4	13.8	14.1	0.42	0.41	0.42	217	198	208
SEm ±	**0.39**	**0.43**	**0.46**	**0.022**	**0.015**	**0.021**	**7.9**	**7.2**	**7.5**
CD (P=0.05)	**1.2**	**1.3**	**1.4**	**0.06**	**0.05**	**0.06**	**24**	**21**	**23**
Interaction									
N at W									
SEm ±	**0.95**	**0.99**	**0.98**	**0.046**	**0.040**	**0.044**	**18.7**	**16.8**	**14.8**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
W at N									
SEm ±	**0.68**	**0.74**	**0.76**	**0.038**	**0.032**	**0.035**	**13.6**	**12.5**	**11.3**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

LITERATURE CITED

Choubey, N.K., Kolhe, S.S and Tripathi, R.S. 2001. Relative performance of cyhalofop-p-butyl for weed control in direct seeded rice. *Indian Journal of Weed Science*. 33(3 & 4): 132-135.

Gangireddy, G and Subramanyam, D. 2020. Bio-efficacy of pre and post emergence herbicides on weed control and yield of rainfed lowland rice. *Indian Journal of Weed Science*. 52(2):179-182.

Ministry of Agriculture and Farmer's Welfare, Govt. of India, 2020-21.

Mohapatra, S., Tripathy, S.K., Tripathy, S and Mohanty, A.K. 2021. Effect of sequential application of herbicides on productivity and profitability of transplanted rice. *Indian Journal of Weed Science*. 53(2):129-134.

Rani, B.S., Chandrika, V., Reddy, G.P., Sudhakar, P., Nagamadhuri, K.V and Sagar, G.K., 2021. Residual effect of weed management practices executed in preceding maize on succeeding greengram. *Legume Research*. 1:8.

Singh, D.J.C and Rao, K.N. 1976. *Screening Technique in Weed Control by Chemicals*. Sreelakshmi publications, Bapatla, Andhra Pradesh.

Panse, V.G and Sukhatme, P.V. 1985. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi. 100-174.

Andhra Pradesh J Agril. Sci : 8(4): 261-266, 2022

GROWTH AND YIELD OF MAIZE (*Zea mays* L.) AS INFLUENCED BY CROP RESIDUES, RESIDUAL NUTRIENTS AND NUTRIENT MANAGEMENT PRACTICES

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Date of Receipt: 27-09-2022 Date of Acceptance: 30-11-2022

ABSTRACT

During *rabi,* 2014 and 2015 at Agricultural College Farm, Mahanandi plant height of maize differed significantly due to residual nutrients (main plots), nutrient doses ± crop residues (sub plots) at harvest. Leaf area index differed significantly with respect to nutrient doses ± crop residues at harvest during the second year, but interaction was not significant. There was significant influence of residual nutrients and nutrient doses ± crop residues on the dry matter production of maize. Significantly higher grain yield of maize was recorded in N_3P_2 and N_3P_3 in both the years with respect to residual nutrients. With respect to crop residues significantly higher grain yield was recorded with F_2 (125% of F_1) which was however on par with F_4 (F_2 + *Kharif* crop residue incorporation) in both the years.

KEYWORDS: Maize, Nutrient doses, Crop residues, Plant height, Dry matter and Yield.

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal food crop cultivated both in tropical and temperate regions of the world with the highest production and productivity as compared to rice and wheat. India is the sixth largest producer of maize with 22.36 million tonnes of production from 9.40 million hectares, with a productivity of 2.4 t ha^{-1}. Now it is time to refine agricultural research in the line of cropping system approach, recycling of residues and efficient management of important nutrients like nitrogen and phosphorus particularly for staple food crops of rice, wheat and maize.

Crop residues are the parts of crops left over after the usable portions have been removed. Crop residues incorporated into the soil can serve as a source of nutrient recycling for plant growth and maintenance of soil fertility (Cooperband, 2002). The estimated annual production of crop residues in India is 501 million tonnes, containing 8.02 million tonnes of NPK (MNRE, 2009). Jain (1993) reported that in India, large quantities of crop residues are made available every year and about one third of the residues produced are available for direct recycling on the land and if used can add 2.19 million tonnes of NPK annually.

MATERIAL AND METHODS

The field experiment was conducted at College Farm of Agricultural College, Mahanandi campus of Acharya N.G. Ranga Agricultural University during *rabi* seasons of 2014 and 2015, situated at 15.51°N latitude, 78.61°E longitude and at an altitude of 233.5 m above the mean sea level, in the scarce rainfall zone of Andhra Pradesh. A composite soil sample was collected at random from 0-30 cm soil depth and analyzed for physico-chemical properties prior to start of the experiments. The soil was sandy loam in texture, neutral in reaction, low in organic carbon and available nitrogen, high in available phosphorus and potassium. The experiment was conducted in the same plots of *kharif* season and was laid out in a split-plot design with three replications.

Treatments

There were nine main plots consisting of three nitrogen levels and three phosphorus levels of *kharif* season and four sub plots comprising of fertilizer and crop residue management practices.

Main plot treatments

Nine main plots (residual nutrients) consisting combination of three nitrogen levels 200, 250 and 300 kg N ha^{-1} (N_1, N_2 and N_3 respectively) and three phosphorus levels 40, 60 and 80 kg P_2O_5 ha^{-1} (P_1, P_2 and P_3 respectively) of *kharif* season.

Sub plot treatments

Four sub plots (nutrient doses ± crop residues) comprising of fertilizer and crop residue management

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practices. F_1 : Recommended dose of N and P_2O_5 (250 kg N and 80 kg P_2O_5 ha^{-1}) F_2 : 125% of F_1, F_3 : F_1 + *Kharif* crop residue incorporation and F_4 : F_2 + *Kharif* crop residue incorporation. A common dose of 60 kg K_2O ha^{-1} was applied to all the plots.

The crop was sown at a spacing of 75 cm × 15 cm. The test cultivar was P-3396 a single cross hybrid with the yield potential ranging from 7.5 to 8.0 t ha^{-1}. After harvest of the economic produce of *kharif* maize the stover was allowed to dry in the field itself and plot wise weight of the crop residue was recorded.

Plant height was recorded from the five tagged plants in each plot at harvest. It was measured from the base of the plant to the tip of the tassel and the mean plant height was expressed in cm. Leaf area was measured by using LI-COR model LI-300 leaf area meter with transparent conveyor belt (Model I-3050 A) utilizing an electronic digital display. Five plants from gross plot area to measure leaf area in cm^2. Leaf area index was calculated by dividing the total leaf area with corresponding land area as per the formula suggested by Watson (1952). Five plants from the destructive sampling area were cut to the base at harvest, sun dried and then oven dried at 60°C till a constant weight was obtained and expressed in kg ha^{-1}. Grain from net plot was sun dried sufficiently, cleaned thoroughly, weighed and expressed in kg ha^{-1}. The data recorded on various parameters during the course of investigation were statistically analyzed following the method of analysis of variance for split- plot design during *rabi* season as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Plant height

Irrespective of the treatments, plant height of maize progressively increased with age of the crop up to harvest. Variation in plant height was significant with respect to nutrient doses ± crop residues (sub plots) at harvest.

Table 1. Plant height (cm) of *rabi* maize at harvest as influenced by crop residues and nutrient management practices

	***Rabi*, 2014**					***Rabi*, 2015**				
	F_1	**F_2**	**F_3**	**F_4**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**Mean**
N_1P_1	250	251	241	245	**247**	236	238	231	234	**235**
N_1P_2	237	244	242	245	**242**	225	232	230	230	**229**
N_1P_3	244	236	230	248	**239**	225	228	221	232	**227**
N_2P_1	225	238	239	249	**238**	212	239	230	229	**228**
N_2P_2	251	252	248	260	**253**	238	242	235	241	**239**
N_2P_3	246	248	236	248	**244**	237	229	224	230	**230**
N_3P_1	250	253	234	255	**248**	233	248	231	231	**236**
N_3P_2	259	261	249	243	**253**	237	248	223	248	**239**
N_3P_3	246	257	232	260	**248**	235	245	243	245	**242**
Mean	**245**	**249**	**239**	**250**		**231**	**239**	**230**	**236**	

	***Rabi*, 2014**		***Rabi*, 2015**	
	SEm ±	**CD (P = 0.05)**	**SEm ±**	**CD (P = 0.05)**
NP	5.48	NS	6.93	NS
F	2.10	5.9	1.61	NS
NP at F	7.73	NS	8.09	NS
F at NP	10.97	NS	13.85	NS

Table 2. Leaf area index of *rabi* maize at harvest as influenced by crop residue and nutrient management practices

	Rabi, 2014					*Rabi*, 2015				
	F_1	**F_2**	**F_3**	**F_4**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**Mean**
N_1P_1	3.58	3.65	3.65	3.67	**3.64**	3.68	3.71	3.65	3.73	**3.69**
N_1P_2	3.63	3.64	3.56	3.75	**3.64**	3.35	3.57	3.20	3.76	**3.47**
N_1P_3	3.35	3.60	3.33	3.61	**3.47**	3.07	3.37	3.26	3.48	**3.30**
N_2P_1	3.52	4.02	3.36	3.53	**3.61**	3.44	4.10	3.40	3.52	**3.62**
N_2P_2	4.17	3.88	3.58	3.99	**3.91**	3.62	3.85	3.73	3.87	**3.77**
N_2P_3	4.04	4.08	3.56	3.83	**3.88**	3.74	3.88	3.83	3.91	**3.84**
N_3P_1	4.10	3.86	3.64	3.58	**3.80**	3.75	3.78	3.79	3.87	**3.80**
N_3P_2	3.53	4.14	3.72	3.78	**3.79**	3.74	4.01	3.58	3.67	**3.75**
N_3P_3	3.62	3.79	3.76	4.19	**3.84**	3.84	3.89	3.88	3.95	**3.89**
Mean	**3.73**	**3.85**	**3.57**	**3.77**		**3.58**	**3.80**	**3.59**	**3.75**	

	Rabi, 2014		*Rabi*, 2015	
	SEm ±	**CD (P = 0.05)**	**SEm ±**	**CD (P = 0.05)**
NP	0.177	NS	0.131	0.39
F	0.121	NS	0.088	NS
NP at F	0.362	NS	0.264	NS
F at NP	0.355	NS	0.262	NS

There was some evidence of residual nitrogen effect on plant height of maize as higher plant height was observed in N_3P_2 (300 kg N + 60 kg P_2O_5 ha^{-1}) in the first year and N_3P_3 (300 kg N + 80 kg P_2O_5 ha^{-1}) in the second year, which might be due to the recovery of small percentage of nitrogen applied to previous maize crop. These results are in line with the findings of Felix *et al.* (2005) on the recovery of N fertilizers.

Application of 125% of recommended dose of N and P_2O_5 alone or along with crop residues expressed significant effect on plant height, as additional dose of fertilizer nutrients may be required for the mineralization of the incorporated crop residues as well as for the decomposition of the roots of the previous maize. These results are in conformity with the findings of Arshadullah *et al.* (2012), who documented the requirement of additional dose of nitrogen for rice crop when cultivated with straw incorporation. The lower plant height in 100% recommended dose of N and P_2O_5 along with crop residues might be due to the fact that un-decomposed residues with wider C: N ratio immobilized the N in the soil and released less N initially to the crop growth.

Leaf area index

Irrespective of the treatments, leaf area index of maize increased progressively with age of the crop.

Effect of residual nitrogen and phosphorus on LAI of succeeding maize was significant in the present investigation and the results are in accordance with the findings of Ahmad *et al.* (2007). There was evidence for residual effect of nitrogen as maximum LAI was observed in those plots which were supplied with more nitrogen in the previous season, which might be due to the recovery of small per centage of nitrogen applied to the previous maize crop. Similar response to the nitrogen applied in the preceding season was observed by Pandiaraj *et al.* (2015) on silty loam soils.

Table 3. Dry matter production (kg ha^{-1}) of *rabi* maize at harvest as influenced by crop residue and nutrient management practices

	Rabi, 2014					*Rabi*, 2015				
	F_1	**F_2**	**F_3**	**F_4**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**Mean**
N_1P_1	16441	18011	17114	16062	**16907**	15128	15664	15043	15589	**15356**
N_1P_2	16191	17163	16361	16240	**16489**	13986	14770	14075	15308	**14535**
N_1P_3	14762	16087	15941	15428	**15555**	13558	14513	14284	14824	**14295**
N_2P_1	15702	18855	16790	16133	**16870**	14165	16168	15448	15818	**15400**
N_2P_2	18273	17793	16935	17898	**17725**	15682	16582	16133	16629	**16257**
N_2P_3	18125	18211	16416	17792	**17636**	15815	16029	16302	16548	**16174**
N_3P_1	18927	19311	17327	17565	**18283**	15996	16096	16142	16603	**16209**
N_3P_2	16246	20574	18886	17874	**18395**	16337	17285	16477	16546	**16661**
N_3P_3	16396	18968	17306	17959	**17657**	16440	17098	17047	17139	**16931**
Mean	**16785**	**18330**	**17008**	**16995**		**15234**	**16023**	**15661**	**16112**	

	Rabi, 2014		*Rabi*, 2015	
	SEm ±	**CD (P = 0.05)**	**SEm ±**	**CD (P = 0.05)**
NP	277.2	831	365.7	1096
F	168.1	473	183.1	515
NP at F	517.3	1507	600.2	NS
F at NP	554.4	1469	731.4	NS

The highest leaf area index was associated with the application of 125% of recommended dose of N and P_2O_5 alone (F_2), which was however, in parity with the application of 125% of recommended dose of N and P_2O_5 in combination with crop residue incorporation (F_4). Increase in leaf area index with increase in nitrogen levels along with crop residue incorporation was evident due to the favorable effect of nutrients on cell division and enlargement, resulting in production of more number of leaves as well as greater expansion of the individual leaf, there by consistent increase in leaf area per plant. These findings are in conformity with the results of Kiran (2004) and Mala (2008).

Dry matter production

Irrespective of the treatments, dry matter production of maize crop increased progressively with age of crop up to harvest.

Dry matter production differed significantly due to residual nutrient effects (main plots), nutrient doses ± crop residues (sub plots) and their interaction during both the years with exception with respect to interaction in the second year.

Effect of residual nitrogen and phosphorus on dry matter production of succeeding maize was significant and was in accordance with the findings of Verma *et al.* (2013). There was clear evidence of residual nitrogen effect as maximum dry matter was recorded in those plots which were supplied with more nitrogen in the previous season, which might be due to recovery of nitrogen applied to the previous maize crop. Similar response to the higher nitrogen levels applied in the previous season was observed by Pandiaraj *et al.* (2015) on silty loam soils. Dry matter production was not significantly affected by the rate of phosphorus applied in preceding season and observed inconsistent dry matter at different P levels. Similar response in soybean in ferralsols of West Kenya was noticed by Vandamme *et al.* (2014).

Table 4. Grain yield (kg ha^{-1}) of *rabi* maize as influenced by crop residue and nutrient management practices

	Rabi, 2014					*Rabi*, 2015				
	F_1	**F_2**	**F_3**	**F_4**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**Mean**
N_1P_1	6864	6999	6990	7024	**6969**	7055	7116	6998	7152	**7080**
N_1P_2	6954	6969	6813	7185	**6980**	6421	6838	6129	7197	**6646**
N_1P_3	6413	6890	6375	6919	**6649**	5881	6456	6252	6670	**6315**
N_2P_1	6746	7704	6431	6767	**6912**	5819	7421	6521	6749	**6628**
N_2P_2	7990	7436	6862	7649	**7484**	7130	7384	7148	7409	**7268**
N_2P_3	7738	7828	6815	7339	**7430**	7366	7433	7334	7493	**7406**
N_3P_1	7864	7406	6972	6852	**7273**	7183	7249	7261	7408	**7275**
N_3P_2	6765	7931	7129	7252	**7269**	7363	7677	6858	7024	**7230**
N_3P_3	6931	7259	7213	8026	**7357**	7359	7458	7441	7561	7455
Mean	**7140**	**7380**	**6844**	**7224**		**6842**	**7226**	**6882**	**7185**	

	Rabi, 2014		*Rabi*, 2015	
	SEm ±	**CD (P = 0.05)**	**SEm ±**	**CD (P = 0.05)**
NP	144.4	433	321.5	964
F	110.1	310	135.3	381
NP at F	320.4	NS	476.5	NS
F at NP	288.9	NS	643.1	NS

Dry matter production of hybrid maize tended to increase progressively with advance in the age of the crop up to harvest. At all stages of crop growth, increasing the nitrogen levels from 100 to 125 % recommended dose of N and P_2O_5 ha^{-1} with and without crop residue incorporation resulted in increased dry matter production. Nitrogen, being the major constituent of chlorophyll, whose intensity is known to increase with added N supply, along with other nutrients released by the decomposition of crop residues could have promoted satisfactory plant growth under assured and continuous balanced supply of nutrients. Increased absorption of nutrients might have maintained higher meristematic activity with favorable effect on cell division and enlargement, resulting in increased plant height and production of larger leaves. The increase in source size (leaf area) might have resulted in better light interception and utilization of radiant energy, thereby enhancing the photosynthetic efficiency, which eventually resulted in higher dry matter accumulation under adequate nutrition. Enhanced dry matter production, as evidenced in this investigation corroborates with the previous findings of Kiran (2004), Felix *et al.* (2005) and Ahmad *et al.* (2007).

Grain yield

Variation in grain yield was significant due to residual nutrient effects (main plots) and nutrient doses ± crop residues (sub plots) but their interaction was not significant during both the years.

Graded levels of nitrogen exerted favorable influence on grain yield of maize. The highest yield was obtained with the application of 250 kg and 300 kg N ha^{-1} in the previous season but the response to phosphorus was marginal. Higher level of biomass accrual and efficient translocation of assimilates to the sink due to the sufficient and continuous supply of nitrogen and other nutrients throughout the crop period might be the findings of Kiran (2004).

The highest grain yield of hybrid maize was produced with the application of 125% recommended dose of N and P_2O_5 alone, however comparable with crop residue incorporation, application of 100% recommended dose of N and P_2O_5 alone, while it was found to be the lowest with the application of 100% recommended dose of N and P_2O_5 along with crop residue incorporation. The higher level of grain yield was due to the favourable influence of consistent and adequate availability of nutrients especially nitrogen throughout the crop growth period, which favoured the production of more photosynthates coupled with better partitioning to the sink, under higher level of nutrients. The results are in conformity with the findings of Singh *et al.* (2000) and Ramu (2005).

Application of 250 kg N and 60 kg P_2O_5 ha^{-1} during *kharif* season and 125% recommended dose of N and P either with or without incorporation of residues of previous season during *rabi* along with recommended dose of potassium was found to be the optimum fertilizer dose for maize - maize cropping sequence in southern agro climatic zone of Andhra Pradesh.

LITERATURE CITED

Ahmad, N., Amanullah, J.T., Munir, I., Ali, A and Khan, M. 2007. Residual effect of nitrogen applied to maize on yield of barley. *Sarhad Journal of Agriculture*. 23(3): 549-552.

Arshadullah, M., Ali, A., Hyder, S.I and Khan, A.M. 2012. Effect of wheat residue incorporation along with N starter dose on rice yield and soil health under saline sodic soil. *The Journal of Animal and Plant Sciences*. 22(3): 753-757.

Cooperband, L. 2002. Building soil organic matter with organic amendments. Centre for Integrated Agricultural Systems (CIAS), College of Agricultural and Life Sciences, University of Wisconsin-Madison. 1-13.

Felix, B.F., Bruce, A.R., William, D.R., Robert, L.T and Robert, B.H. 2005. Recovery of residual fertilizer-N and cotton residue-N by Acala and Pima cotton. *Science Society of America Journal*. 69: 718-728.

Jain, M.C. 1993. Bio conversion of organic wastes for fuel and manure. *Fertilizer News*. 35(4): 55-55.

Kiran, K.G. 2004. Effect of groundnut crop residue incorporation and nitrogen management on the performance of succeeding maize (*Zea mays* L.). *M.Sc. (Ag.) Thesis*. Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh.

Mala, S. 2008. Response of hybrid maize to crop residue incorporation in combination with graded levels of nitrogen. *Ph.D Thesis*. Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh.

MNRE, 2009. Ministry of New and Renewable Energy. Government of India, New Delhi. *www.mnre.gov.in/biomass resources*.

Pandiaraj, T., Selvaraj, S and Ramu, N. 2015. Effects of crop residue management and nitrogen fertilizer on soil nitrogen and carbon content and productivity of wheat (*Triticum aestivum* L.) in two cropping systems. *Journal of Agricultural Science and Technology*. 17: 249-260.

Panse, V.G and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers. *Indian Council of Agricultural Research*, New Delhi. 205-210.

Ramu, Y.R. 2005. Agrotechniques for enhancing productivity and quality of hybrid maize (*Zea mays* L.). *Ph.D Thesis.* Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh.

Singh, D.P., Rana, N.S and Singh, R.P. 2000. Dry matter production and nitrogen uptake in winter maize (*Zea mays*) based intercropping system under different levels of nitrogen. *Indian Journal of Agronomy.* 45(4): 676-680.

Vandamme, E., Pypers, P., Vanlauwe, B., Baijukya, F and Merckx, R.S. 2014. Residual phosphorus effects in soybean–maize rotations on a P-deficient Ferralsol. *Nutrient Cycling in Agroecosystems*. 98: 187–201.

Verma, N.K and Pandey, B.K. 2013. Effect of varying rice residue management practices on growth and yield of wheat and soil organic carbon in rice-wheat sequence. *Global Journal of Science, Frontier Research in Agriculture and Veterinary Sciences*. 13(3): 33-38.

Watson, D.J. 1952. The physiological basis of variation in yield. *Advances in Agronomy*. 4: 101-105.

Andhra Pradesh J Agril. Sci : 8(4): 267-271, 2022

POST HARVEST SOIL NUTRIENT STATUS AS INFLUENCED BY VARIED DATES OF SOWING, PLANT SPACINGS AND NUTRIENT LEVELS IN GROUNDNUT

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Date of Receipt: 27-09-2022 Date of Acceptance: 09-12-2022

ABSTRACT

A field experiment was carried out during *rabi,* 2019-20 and *rabi,* 2020-21 on sandy loam soils of Krishi Vigyan Kendra, Utukur, Kadapa, Andhra Pradesh. The experimentation was laid out with three replications by adopting split-split design. Groundnut variety Kadiri-6 was used for the investigation. The treatments include combination of three dates of sowing, four plant plant spacings and three nutrient levels. The highest post-harvest soil available nitrogen and potassium was estimated when the crop was sown during I fortnight of October (D_1) while the minimum values of above said nutrients was noticed with I fortnight of November (D_3) sowing. However, post-harvest phosphorus during both the years of study and in pooled mean was not affected due to dates of sowing. Crop sown with 22.5 cm x 10.0 cm plant spacing resulted in higher post-harvest soil available nitrogen, phosphorus and potassium while criss cross sown crop at 22.5 cm of row spacing in both the directions recorded significantly lower values of soil available nutrients. With regard to nutrient levels, significantly higher post-harvest soil available nitrogen, phosphorus and potassium was obtained with the application of 150% RDF (N_3) which was at par with application of 125% RDF and the lowest values were noticed with 100% RDF (N_1) during both the years of study and in pooled mean.

KEYWORDS: Dates of Sowing, Plant spacing, Nutrient levels, Nitrogen, Phosphorus, Potassium, Groundnut.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a predominant annual legume and protein-rich oil seed crop cultivated in tropical and sub-tropical agro climatic regions of Asia, Africa, and America. In India, groundnut contributes a larger share for the national edible oil economy. It is grown in an area of 4.89 million hectares contributing to the production of 9.25 million tonnes with a mean productivity of 1493 kg ha^{-1}. In Andhra Pradesh, groundnut is cultivated over an area of 0.74 million hectares with a production of 1.05 million tonnes and an average productivity of 1426 kg ha^{-1} (Anonymus, 2019-20). The cultivation of groundnut crop during *rabi* under irrigated conditions is much profitable and yields are almost twice or thrice to that of *kharif* due to elimination of moisture stress and high input use. The upper limit of *rabi* groundnut productivity depends on crop weather relations during the crop growth period, which in turn depends on the time of sowing and seasonal variations. Therefore, the optimum time of sowing decides the congenial weather conditions for optimum growth and development during different phenophases leading to higher productivity in *rabi* groundnut. Amongst the different agrotechniques adopted in groundnut, plant density in groundnut have significant effect on dry matter production and economic yield. The optimum spacing provides congenial environment for balanced plant growth which results in timely commencement of reproductive phase leading to increased yield attributes and ultimately enhancing the productivity of *rabi* groundnut. Since the land is stable, the only way to multiply the food production will be through high density planting, improved varieties, increasing cropping intensity and the matching production technology of crops to sustain soil fertilityand crop productivity. India is the world's largest producer of groundnut where nutrient deficiencies cause yield reduction to the tune of 30-70 per cent depending upon the soil types (Veeramani *et al.,* 2012). Imbalanced use of fertilizers like urea and diammonium phosphate in groundnut especially under high plant densities lead to increased deficiency symptoms which in turn reduced the productivity of crop. The optimization of the mineral nutrition is the key to enhance productivity of groundnut. Reinvestigating the nutrient requirement under increased plant population with different dates of sowing is necessary for enhancing yield and profitability of groundnut. Hence, there is a need to develop or identify the important agrotechniques for enhancing the productivity and profitability of *rabi* groundnut under

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high input management, to exploit the fullest possible potential in a given agroclimatic domain of Southern Agro climatic Zone of Andhra Pradesh. Keeping in view of the above aspects, the present investigation was taken up.

MATERIAL AND METHODS

A field investigation was carried out during *rabi,* 2019-20 and *rabi,* 2020-21 at Krishi Vigyan Kendra, Utukur campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh which is geographically located at 14.4^{o} N latitude and 78.8^{o} E longitude at an altitude of 147.0 meters above mean sea level categorised as Southern Agro Climatic Zone of Andhra Pradesh. The soil of experimental field was sandy loam in texture, soil reaction is neytral, organic carbon and available nitrogen are low in availability and available phosphorus and potassium are medium in availability. The investigation was laid out in a split-split plot design which was replicated thrice. The treatments include combination of three dates of sowing viz., I fortnight of October (D_1), II fortnight of October (D_2) and I fortnight of November (D_3), four plant spacings (plant densities) that include 22.5 cm × 10 cm (4.44 lakh ha^{-1}) (P_1), 15.0 cm × 10 cm (6.66 lakh ha^{-1}) (P_2), 15.0 cm × 7.5 cm (8.88 lakh ha^{-1}) (P_3) and criss cross sowing with 22.5 cm of row spacing in both the directions (P_4) and three levels of nutrients of 100% RDF (N_1), 125% RDF (N_2) and 150% RDF (N_3). RDF was fixed based on soil test results. As per the soil test results of the experimental field, available nitrogen was low (193.5 kg ha^{-1}) and therefore, additional 30% over the recommended dosage of nitrogenous fertilizer was applied. Whereas available phosphorus and potassium were medium (27.4 kg ha^{-1} and 185.2 kg ha^{-1} respectively), hence recommended doses were applied. Nitrogen was supplied to the crop in the form of urea, phosphorus through single super phosphate and potassium by using murate of potash. Phosphorus and potassium fertilizers were applied as basal application whereas, nitrogen was applied in 2 splits *viz.,* two thirds of nitrogen was applied as basal at sowing time and remaining one third of nitrogen was applied as top dressing at 30 DAS. Gypsum was applied @ 500 kg ha^{-1} at 40 days after sowing. Required quantity of sound Kadiri-6 kernels were selected based on the crop geometry adopted and utilised for sowing after carrying out seed treatment with Mancozeb @ 3 g kg^{-1} of seed as a prophylactic measure against seed borne diseases. After harvesting of groundnut, soil samples were collected from each net plot and analysed to find out the post-harvest nutrient status of the soil

RESULTS AND DISCUSSION

The soil available nutrients was significantly influenced by the dates of sowing, plant spacings and nutrient levels, but any of the interaction effects were not found significant, during both the years of study and in pooled mean (Table 1).

Soil Available Nitrogen

Post harvest soil available nitrogen was progressively decreased with delay in sowing from I fortnight of October (D_1) to I fortnight of November (D_3) with significant disparity between any two dates of sowing during both the years of study and in pooled mean. The highest soil available nitrogen was estimated with I fortnight of October (D_1) and least was recorded with I fortnight of November (D_3). Reduction in soil available nitrogen with late sown crop might be due to higher nutrient use efficiency of the crop and increase in dry matter production. Increase in post harvest soil available nutrients with varied dates of sowing as resulted from the present experiment is similar with the findings of Meena and Yadav (2015).

Among the plant spacings studied, the post harvest soil available nitrogen was significantly higher with plant spacing of 22.5 cm × 10 cm (P_1) than rest of the crop geometric alterations tried. This might be due to maintenance of lesser plant population which reduced the uptake of nitrogen and increased the status of post harvest soil available nitrogen. These results are in accordance with the findings of Sunilkumar *et al.* (2020). The next best plant spacing in recording higher post harvest soil available nitrogen was 15.0 cm × 10.0 cm (P_2) spacing which was at par with criss cross sowing with 22.5 cm of row spacing in both the directions (P_4) which in turn was comparable with 15.0 cm × 7.5 cm (P_3). The lowest post harvest soil available nitrogen was registered with 15.0 cm × 7.5 cm (P_3) during both the years of investigation and in pooled mean.

The highest soil available nitrogen was resulted with 150% RDF (N_3) which was significantly higher than rest of the nutrient levels studied. Inspite of higher nutrient uptake with 150% RDF (N_3), considerable quantities of nutrients were left over in the soil, which might have

Table 1. Post-harvest soil nutrient status (kg ha^{-1}) of groundnut as influenced by varied dates of sowing, plant spacings and nutrient levels

Treatments	Available N			Available P_2O_5			Available K_2O		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Dates of sowing (D) - 3									
D_1 : I Fortnight of October	175	184	177	33.5	35.5	34.0	183	207	195
D_2 : II Fortnight of October	154	161	155	32.5	34.3	33.3	161	186	174
D_3 : I Fortnight of November	123	140	136	31.7	32.2	32.0	143	160	152
SEm ±	3.6	2.9	3.3	0.26	0.64	0.55	3.4	3.5	2.6
CD (P = 0.05)	14	11	13	NS	NS	NS	13	14	10
Plant spacings (P) - 4									
P_1 : 22.5 cm × 10.0 cm (4.44 lakh ha^{-1})	173	184	179	34.5	36.5	35.7	187	202	195
P_2 : 15.0 cm × 10.0 cm (6.66 lakh ha^{-1})	153	164	159	32.6	34.3	33.5	163	189	176
P_3 : 15.0 cm × 7.5 cm (8.88 lakh ha^{-1})	131	140	136	30.3	32.1	31.2	145	168	157
P_4 : Criss cross sowing with 22.5 cm row spacing in both the directions	143	155	149	31.4	33.2	32.3	154	179	166
SEm ±	3.7	4.0	3.8	0.46	0.44	0.47	4.5	4.2	4.3
CD (P = 0.05)	11	12	11	1.4	1.3	1.4	13	12	13
Nutrient levels (N) - 3									
N_1 : 100% RDF	120	140	135	30.0	32.1	31.1	140	165	153
N_2 : 125% RDF	152	163	157	32.1	34.3	33.2	165	186	176
N_3 : 150% RDF	170	181	176	34.5	35.7	35.1	182	202	192
SEm ±	3.9	3.5	3.5	0.49	3.42	0.37	4.6	4.3	3.9
CD (P = 0.05)	11	10	10	1.4	1.2	1.1	13	12	11
Interaction									
D × P									
SEm ±	6.4	6.9	6.6	0.80	0.77	0.78	7.8	7.2	7.5
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
D × N									
SEm ±	7.0	6.3	6.2	0.89	0.74	0.64	8.1	7.4	7.0
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
P × N									
SEm ±	8.0	7.3	7.2	0.99	0.85	0.74	9.3	8.5	8.1
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
D × P × N									
SEm ±	13.9	11.1	12.4	0.17	1.47	1.28	16.1	14.7	14.0
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

remained after meeting the maximum requirement of the crop. These results are in conformity with the findings of Meena and Yadav (2015) and Lakshmi *et al.* (2020). Application of 125% RDF and 100% RDF were significantly differed with each other and the latter nutrient level recorded the lowest post harvest soil available nitrogen status.

Soil Available Phosphorus

Post harvest soil available phosphorus was not influenced by the varied dates of sowing and all the interaction effects, but plant spacing and nutrient levels showed significant influence on post harvest soil available phosphorus during both the years of study and in pooled mean.

Significantly higher soil available phosphorus was observed with wider spacing of 22.5 cm × 10 cm (P_1) than rest of the plant spacings tried. This might be due to lower uptake by the crop because of lower plant density that resulted in increased availability of available phosphorus in the soil after harvest of crop. These results are in conformity with the findings of Sunilkumar *et al.* (2020). The next best plant spacing in recording higher post harvest soil available phosphorus was 15.0 cm × 10.0 cm (P_2) spacing which was at par with criss cross sowing with 22.5 cm of row spacing in both the directions (P_4) which in turn was comparable with 15.0 cm × 7.5 cm (P_3). The lowest post harvest soil available phosphorus was registered with 15.0 cm × 7.5 cm (P_3) during both the years of investigation and in pooled mean.

The highest soil available phosphorus was resulted with application of 150% RDF (N_3) followed by 125% RDF (N_2) with significant disparity between them. Considerable quantity of phosphorus left over in the soil by groundnut crop. These results are in line with the findings of Reddy *et al.* (2011), Suneetha (2013) and Sunilkumar *et al.* (2020). The lowest post harvest soil available phosphorus was obtained with 100% RDF (N_1) due to exhaustion of nutrients from the soil.

Soil Available Potassium

Among the dates of sowing, the highest post harvest soil available potassium was recorded with crop sown during I fortnight of October (D_1) which was significantly higher over the other two dates of sowing. The next best date of sowing in recording higher soil available potassium was II fortnight of October (D_2). The lowest soil available potassium was observed with I fortnight of November (D_3) sowing. This might be attributed to higher nutrient uptake by the crop sown in I fortnight of November (D_3) resulting in greater reduction of soil available potassium after harvest of groundnut crop. These results are in conformity with Meena and Yadav (2015).

Higher post harvest soil available potassium was estimated with plant spacing of 22.5 cm × 10 cm (P_1) which was significantly superior to rest of the plant spacings. This might be due to lower uptake of potassium by the crop because of lower plant density and thereby increased the availability of soil available potassium compared to higher plant densities. These results are in conformity with the findings of Sunilkumar *et al.* (2020). The lowest soil available potassium was noticed with 15.0 cm × 7.5 cm (P_3)) which was comparable with criss cross sowing at 22.5 cm of row spacing in both the directions (P_4) which in turn was at par with 15.0 cm × 10 cm (P_2) plant spacing.

Among the nutrient levels tried, application of 150% RDF (N_3) recorded significantly higher post harvest soil available potassium than rest of the nutrient levels tried during both the years of study and in pooled mean. This might be due to increased availability of potassium in the soil after meeting the crop requirements. The lowest post harvest soil available potassium was noticed with 100% RDF. These results are in conformity with earlier findings of Bunsa *et al.* (2004) and Suneetha (2013).

From the present experimentation, it was concluded that the highest post-harvest soil available nitrogen and potassium was estimated when the crop was sown during I fortnight of October (D_1), while the minimum values of above said nutrients was noticed with I fortnight of November (D_3) sowing. However, post-harvest phosphorus during both the years of study and in pooled mean was not affected due to dates of sowing. Crop sown with 22.5 cm × 10.0 cm plant spacing resulted in higher post-harvest soil available nitrogen, phosphorus and potassium while criss cross sown crop at 22.5 cm of row spacing in both the directions recorded significantly lower values of soil available nutrients. With regard to nutrient levels, significantly higher post-harvest soil available nitrogen, phosphorus and potassium was obtained with the application of 150% RDF (N_3) which was at par with application of 125% RDF and the lowest values were noticed with 100% RDF (N_1) during both the years of study and in pooled mean.

LITERATURE CITED

Anonymous, (2019-20). *www. indiastat.com.*

Bunsa, P.B., Golakiya, B.A and Polaraj, V. 2004. Influence of potassium along with nitrogen and phosphorus on yield and nutrient uptake by groundnut. *Proceeding of National Symposium on Enhanching Productivity of Groundnut for Sustaining Food and Nutritional Security*. Pp: 11-13.

Lakshmi, M.V., Rao, C.P., Prasad, P.V.N., Rani, P.P and Rani, Y.A. 2020. Studies on yield, nutrient content and nutrient uptake of groundnut as influenced by phosphorus management practices in rice-groundnut sequence. *Journal of Pharmacognosy and Phytochemistry*. 9(2): 257-263.

Meena, R.S and Yadav, R.S. 2015. Yield and profitability of groundnut (*Arachis hypogaea* L.) as influenced by sowing dates and nutrient levels with different varieties. *Legume Research*. 38(6): 791-797.

Reddy, S.T, Reddy, D.S and Reddy, G.P. 2011. Influence of fertilizer management practices on growth, yield and quality of export oriented groundnut (*Arachis hypogaea* L.). *The Andhra Agricultural Journal*. 58(1): 105-109.

Suneetha. 2013. Nutrient management for sustained productivity of newly developed groundnut genotypes. *M.Sc.(Ag.) Thesis*. Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh.

Sunilkumar, T., Sumathi, V., Reddiramu, Y., Kumar, A.R.N and Sagar, G.K. 2020. Evaluation of yield and quality of groundnut under high density plantations with graded levels of phosphorus. *Indian Journal of Pure and Applied Bioscencesi. 8*(4), 184-189.

Veeramani, P., Subrahmaniyan, K and Ganesaraja, V. 2012. Organic manure management on groundnut-A review. *Wudpecker Journal of Agriculture Sciences*. 1(7): 238-243.

Andhra Pradesh J Agril. Sci : 8(4): 272-275, 2022

EVALUATION OF *NAVADHANYA* CROPS UNDER STRIP CROPPING IN FARMERS' FIELD

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Date of Receipt: 30-09-2022 Date of Acceptance: 04-12-2022

ABSTRACT

A field experiment entitled "Evaluation of *navadhanya* crops under strip cropping in farmer's field" was conducted on farmer field at Sanyasipalle village in Chittor district of Andhra Pradesh during *kharif* 2019. Field experiment was conducted with three cropping systems as treatments, *viz.*, T_1- Groundnut + red gram (7:1) intercropping system, T_2- *Navdhanya* as per farmers practice and T_3- *Navdhanya* crops sown under strip cropping. Results revealed that groundnut + red gram (7:1) intercropping recorded maximum RGSEY (1102 kg ha^{-1}), maximum gross returns (₹ 75650 ha^{-1}), maximum net returns (₹ 43199 ha^{-1}) and benefit-cost ratio (2.33) compared with navadhanya as per farmers practice and under strip cropping.

KEYWORDS: *Navadhanya* crops, intercropping, strip cropping, net returns and gross returns.

INTRODUCTION

Groundnut is an important commercial oilseed crop grown by Chittoor District farmers during *kharif* on *alfisols* under rainfed conditions. Unusual monsoon behavior is one of the crucial elements for crop yield in rainfed environments. Due to a delayed monsoon and protracted intermittent dry spells, the practice of growing groundnuts exclusively in the rainy season is occasionally found to be fairly unsafe. A feasible approach to deal with the issue is to stabilize the output of dry-land crops through the widely used technique of intercropping suitable crops. Intercropping has long been acknowledged as a form of biological assurance for vulnerabilities and abnormal rainfall behavior in dryland environments. It increases the cropping intensity, productivity, profitability, optimum utilization of soil, water, nutrients and sunlight (Kumar and Singh, 2006).

In the past, mixed and poly-cropping systems, known regionally by a diverse range of names, were prevalent over the Indian subcontinent (IAASTD, 2009; La Via Campesina, 2010; Deb, 2021). Rainfed farmers of Rayalseema region, which includes the districts of Anantapuram, Chittor, Kadapa, and Kurnool in the southern Indian state of Andhra Pradesh, has one such ancient cropping technique called *Navadhanya*. *Navadhanya* is a mixed farming technique evolved by farmers in the dryland region to successfully tackle and use the irregular rainfall they receive throughout the year. The cropping system is a combination of diverse millets, pulses, and oilseeds grown concurrently, which keeps land cover 9-10 months of the year and provides different food and fodder crops to meet the food and nutrition needs of households and cattles, as well as adequate organic waste for crop nutrition, making it a wonderful sustainable dryland cropping system.

However, present agricultural systems are rapidly shifting toward monocrops (IOPEPC, 2017). It's probable that the move from a mixed or poly-cropping system to a mono-cropping system had a range of repercussions on these small-marginal rainfed farmers (Naidu *et al.* 2019). According to research, farmers who grow peanuts as an irrigated monoculture are particularly vulnerable to suffering losses because of the relatively low returns, high risk of crop failure due to erratic rainfall, and unstable market prices (Kumar and Subramanyachary, 2015; Naidu *et al.* 2019).

Groundnut + red gram in 7:1 or 11:1 intercropping system is the normal practice followed by farmers in *alfisols* under rainfed conditions. *Navadhanya* crops sown under mixed cropping system have certain field problems. Hence, to avoid the operational problems it is pertinent to evaluate different *navadhanya* crops under strip cropping deserves priority. In this view, a field experiment is planned in farmer's field to study the performance of different millets, pulses and oilseeds and identify compatible crops under *navadhanya* as per farmer practice and strip cropping of *navadhanya* crops.

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MATERIAL AND METHODS

A field experiment entitled "Evaluation of *navadhanya* crops under strip cropping in farmer's field" was conducted on farmer field at Sanyasipalle village in Chittoor district of Andhra Pradesh during *kharif* 2019. Field experiment with three cropping systems were used as treatments, *viz.*, T_1- Groundnut + red gram (7:1) intercropping system, T_2- *Navdhanya* as per farmers practice (mixed cropping of red gram, sorghum, field bean and groundnut) and T_3- *Navdhanya* crops (green gram, cowpea, sorghum, pearl millet, finger millet, castor, field bean, red gram and foxtail millet) sown under strip cropping with one row of red gram after every strip of *navadhanya* crop. The experimental farmer's field soil was sandy loam in texture, neutral in reaction (pH - 6.6), low in organic carbon (0.38%), low in available nitrogen (216 kg ha^{-1}), medium in available phosphorus (29.6 kg ha^{-1}) and medium in potassium (278 kg ha^{-1}). The crop varieties used for the study, row-to-row spacing, plant-to-plant spacing and recommended dosage of fertilizers were presented in Table 1. The plots of 32 m × 3.7 m size were used for each treatment. All of the management techniques for different crops were implemented as per the zonal reports of southern zone of Andhra Pradesh. All three cropping systems analyzed on the basis of system equivalent yield, returns and benefit-cost ratio.

The following formulas were used for calculating equivalent yield of crops and cropping systems

Redgram Seed equivalent Yield (RGSEY) =

$$\frac{\text{Yield of intercop} \times \text{Price of intercrop}}{\text{Price of redgram (₹ kg}^{-1})}$$

Equivalent yield of system =

Yield of redgram + Redgram seed equivalent yield

RESULTS AND DISCUSSION

Yield

Maximum red gram seed equivalent yield (1102 kg ha^{-1}) was recorded when groundnut intercropped with red gram in 7:1 (T_1) (Table 2), which was 45.7 per cent and 251.8 per cent higher over *navadhanya* cropping system as per farmers practice and *navadhanya* crops sown under strip cropping, respectively (Table 3 and 4). Groundnut with red gram intercropping resulted in highest yield because of maximum and efficient utilization of growth resources by both crops coupled with better agronomic management. The findings corroborate those of Chandrika *et al*. (2001), who found that groundnut + red gram (7:1) intercropping produced higher net returns and total yield advantage than sole groundnut crop in rainfed *alfisols*. Similar outcomes were noted by Chaudhari *et al.* (2017) and Dutta & Bandyopadhyay (2006). Among

Table 1. Details of cultivation of *navadhanya* crops

Crops	Variety	Spacing (cm)	NPK (kg ha^{-1})
Groundnut (*Arachis hypogaea*)	Dharani	30 × 10	20:50:00
Red gram (*Cajanus cajan*)	TRG - 59	60 × 20	20:50:00
Field bean (*Lablab purpureus*)	TFB - 2	60 × 20	20:50:00
Sorghum (*Sorghum bicolor*)	CSH - 6	30 × 10	80:40:30
Pearl millet (*Penisetum americanum*)	ICTP - 8203	30 × 10	80:40:30
Cowpea (*Vigna anguiculata*)	TPTC - 29	30 × 10	20:50:00
Green gram (*Vigna radiata*)	WGG - 42	30 × 10	20:50:00
Finger millet (*Eleusine coracana*)	Vakula	22.5 × 10	60:30:20
Castor (*Ricinus communis*)	Haritha	90 × 60	45:40:30
Foxtail millet (*Setaria italica*)	SiA-3085	22.5 × 10	20:20:20

Table 2. Performance of groundnut + red gram (7:1) (control – rainfed) during *kharif* 2019

Crops	Pod and seed yield (kg ha^{-1})	RGSEY (kg ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
Groundnut	1179	1513	75650	43199	2.33
Redgram	75	-	-	-	

Table 3. Performance of *navadhanya* as per farmers practice during *kharif* 2019

Crops	Pod /Seed yield (kg ha^{-1})	RGSEY (kg ha^{-1})
Groundnut	661	806
Redgram	50	50
Field bean	20	10
Sorghum	8621	172

Table 4. Performance of *navadhanya* crops under strip cropping during *kharif* 2019

Crop	*Navadhanya* crop yield (kg ha^{-1})	Redgram seed Yield (kg ha^{-1})	RGSEY (kg ha^{-1})	Gross income (₹ ha^{-1})	Net income (₹ ha^{-1})	BC ratio
Greengram (seed)	41	4	53	2650	665	1.34
Cowpea (fodder)	566	6	23	1150	-835	0.58
Sorghum (fodder)	2572	6	58	2900	1972	3.13
Pearl millet (fodder)	617	4	16	800	-897	0.47
Finger millet	4	6	8	400	-1214	0.25
Castor beans	82	2	60	3000	1344	1.81
Field bean veg	103	5	57	2850	2249	4.74
Redgram seed	4	2	6	300	-329	0.48
Foxtail millet	284	6	148	7400	5963	5.15

strip cropping of red gram with *navadhanya* crops (T_3) red gram + foxtail millet resulted in maximum RGSEY followed by red gram + castor strip intercropping system. Lowest RGSEY was recorded with red gram + finger millet strip row intercropping and red gram + red gram strip intercropping system (Table 4).

Economics

Among all three cropping systems groundnut intercropping with red gram (7:1) recorded highest gross returns (75650 ₹ ha^{-1}) , net returns (43199 ₹ ha^{-1}) and benefit-cost ratio (2.33). Lowest gross returns and net returns was recorded with *navadhanya* crops sown under strip cropping, but lowest benefit-cost was recorded with *navadhanya* as per farmer practice (Table 5). Among strip cropping of *navadhanya* crops with red gram, highest gross return (7400 ₹ ha^{-1}), net return (5963 ₹ ha^{-1}) and benefit-cost ratio (5.15) was recorded with red gram with foxtail millet and lowest with red gram + finger

Table 5. Yield, gross return, net return and benefit-cost ratio of *navadhanya* crops under different cropping systems during *kharif* 2019

Treatments	Red gram seed equivalent yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1 : Groundnut + red gram (7 : 1) intercropping system	1513	75650	43199	2.33
T_2 : *Navdhanya* as per farmers practice	1038	51921	13220	1.34
T_3 : *Navdhanya* crops sown under strip cropping	430	21450	8198	1.71

millet strip row intercropping and red gram + red gram strip intercropping system (Table 4).

Groundnut intercropping with red gram in 7:1 ratio is best cropping system for rainfed conditions in *alfisols* of Andhra Pradesh. Strip cropping of red gram along with foxtail millet and field bean may also resulted in high returns and benefits to farmers. However, expressed satisfaction with the performance of crops under *navadhanya* and desired for mechanization for reducing cost of production.

LITERATURE CITED

Chandrika, V., Reddy, K.S and Soundararajan, M.S. 2001. Economic evaluation of groundnut (*Arachis hypogaea*) based cropping systems in rainfed *Alfisols*. *Indian Journal of Agronomy*. 46(1): 45-49.

Chaudhari, D., Vekariya, P., Vora, V., Talpada, M and Sutaria, G. 2017. Enhancing productivity of groundnut based intercropping systems under rainfed conditions of Gujarat. *Legume Research*. 40(3): 520-525.

Deb, D. 2021. Productive efficiency of traditional multiple cropping systems compared to monocultures of seven crop species: a benchmark study. *Experimental Results*. 2(18): 1-10.

Dutta, D and Bandyopadhyay, P. 2006. Production potential of intercropping of groundnut (*Arachis hypogaea* L.) with pigeon pea (*Cajanus cajan*) and maize (*Zea mays*) under various row proportions in rainfed *Alfisols* of West Bengal. *Indian Journal of Agronomy*. 51(2):103-106.

IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for Development). 2009. Agriculture at a cross- roads: global report. B.D. MacIntyre, H.R. Herren, J. Wakhungu, R.T. Watson, eds. Washington, DC, Island Press.

IOPEPC, 2017. Survey of groundnut crop, *Kharif*-2017. Indian Oilseeds and Produce Export Promotion Council, Mumbai.

Kumar, A and Singh, B.P. 2006. Effect of row ratio and phosphorus level on performance of chickpea (*Cicer arietinum*)-Indian mustard (*Brassica juncea*) intercropping. *Indian Journal of Agronomy*. 51(2): 100- 102.

Kumar, S.R and Subramanyachary, P. 2015. Major agricultural crops in Chittoor district. *Indian Journal of Research*. 4(5): 417-418.

La Via Campesina (LVC). 2010. Sustainable peasant and family farm agriculture can feed the world. Via Campesina Views no. 6. 15 pp.

Naidu, C.B., Kumar, S and Rai, A.K. 2019. An economic analysis of production of groundnut (*Arachis hypogea*) in Ananthapur district of Andhra Pradesh. *International Journal of Innovative Science and Research Technology*. 4(5): 2456-2165.

Andhra Pradesh J Agril. Sci : 8(4): 276-281, 2022

EMPIRICAL ESTIMATION OF CLIMATE CHANGE IMPACTS ON CONSUMPTION PATTERNS OF AGRICULTURAL HOUSEHOLDS IN INDIA

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Date of Receipt: 01-11-2022 Date of Acceptance: 10-12-2022

ABSTRACT

Climate change significantly impacts the consumption patterns of farmers. Crop output and quality are affected, resulting in changes in revenues and profits. Given that the agricultural households are producer -consumers, changes in profits translate as changes in disposable incomes, affecting their consumption. This study analyses the changes in consumption resulting from climatic changes after accounting for socio economic factors using heteroscedasticity consistent least squares estimators. Results indicated that consumption increased with increase in climatic factors such as minimum temperature, water deficit and decreased with increase in maximum temperature, rainfall and wind speeds. However, these changes are not statistically significant across social categories among farmers. Farm size is found to be a significant determinant of consumption.

KEYWORDS: Climate Change, consumption function, Farmer's consumption, Socio Economic analysis.

INTRODUCTION

Climate change significantly impacts the consumption patterns of farmers. Changes in climate affect the crop production directly. Changes in crop output and quality resulting from climatic changes affect revenues and profits. Agricultural households act as producer -consumers, allocating the profits generated out of the current crop towards investment and consumption. Hence, changes in profits translate into changes in disposable incomes, affecting the consumption. Consumption is an indicator of socio-economic wellbeing of an economic agent. Consumption provides utility to an individual, and hence, increase in consumption expenditure indicated increase in utility obtained by the individual. Consumption includes expenditure on food and non-food items. This study considers family as a unit for analysing consumption. Consumption depends on economic factors such as, disposable income, savings, agronomic factors such as size of the farm, crop revenues; social factors such as education, social status etc. The objectives of this study are to analyse the determinants of consumption and to estimate the impact of climatic change on consumption, after accounting for agronomic, social and economic conditions faced by the agent.

Previous studies analysed various economic and social factors affecting consumption. Murari *et al*. (2018) found an inverse relation between maximum temperatures and crop yields in rice, sorghum (jowar), finger millet (ragi) and pigeon pea crops in Karnataka at all quantile levels of crop yields. *Down to Earth* (2019) reported a decline in annual trends in rainfall across Karnataka. However, Sanjeevaiah *et al*. (2021) found that monotonic increases in rainfall during crop growing season especially June and August months, affected the season onset and yields. Rao *et al.* (2013) found that an increase of 2°C temperature coupled with 10 per cent decrease in rainfall reduced the yields by 4 per cent. Areef *et al.* (2021) found that monthly percapita expenditure on consumption and per capita income increased with farm size. Also, share of food items in consumption decreased with farm size. Agronomic factors were also identified as significant in affecting consumption of farmers. Aditya *et al*. (2019) found that annual and seasonal weather risks significantly influence savings among rural households. Based on these past studies, an attempt is made here to analyse consumption using heteroscedasticity consistent least squares estimators.

MATERIAL AND METHODS

Agronomic data used in this study was obtained from ICRISAT's Village level Dynamics of South Asia (VDSA) SAT II database and Directorate of Economics and Statistics (DES). The data set utilized in the study is a village level panel data from 2009 to 2018, covering 18 villages, 09 districts across the states of Karnataka, Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh and Telangana. In each village, 40 households were sampled to represent landless labour, small farmers, medium and large farmers. These households are primarily dependent on farming income. Climate data is

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combined from Indian Meteorological Department and ICRISAT's District Level Dataset (DLD), spanning over 120 years, from 1900 to 2020 is used. Data from all these sources is collated and organized into a SAS Database in the year 2021. SAS SQL, SAS IML, and Base SAS routines were utilized for analysis.

Climate data is constructed using weather data on each district. Climate normal for variables such as temperature, rainfall, water deficit and wind speed are calculated as moving average of thirty years. For example, normal temperature for the year 2016 is an average of temperatures recorded for years 1986 through 2015. Similarly, normal temperature for the year 2017 is an average for the years 1987 through 2016. Period of thirty years is used for calculating climate normal from weather data as per the convention in the literature. According to Gerald *et al*. (2009) the climate change (temperature increase, rainfall decrease, in all season shift) makes agriculture more vulnerable. Average monthly maximum and minimum temperatures were considered in this study.

Temperatures play a significant role in crop growth. An increase in minimum temperatures could extend the growing season and the growing degree days. Crops that require cooler temperatures may find rising minimum temperatures as detrimental. However, most crops may find the increased growing in temperatures to be beneficial. The monthly minimum temperature varied within a range of 5.7 °C (Min 19.96 °C to Max 25.6°C, mean 22.7°C). Coefficient of variation is 7 per cent. The parameter estimate on minimum temperature could be positive.

Average monthly maximum temperature varied within a range of 4.02°C (Min 29.21°C to Max 33.23°C, mean 30.9°C). Coefficient of variation is 3.2 per cent. Increase in maximum temperatures could affect plant growth adversely. Higher temperatures could result in reduction of yields and a reduction in farm revenue. The parameter estimate on maximum temperature is hypothesized to be negative. Quantum and distribution of rainfall is an important factor given the predominance of rainfed farming. Monthly rainfall (month of September) varied within a range of 91 mm (Min 60.64 mm, Max 152.09 mm). Coefficient of variation is 22 per cent. Increase in rainfall could increase the crop yields and revenues, hence the parameter estimate on rainfall is hypothesized to be positive. Monthly average wind speed (month of July) were considered in this study. Wind speed ranged at 1.39 (Min 2.25, Max 3.64). Coefficient of variation of wind speed is 13 per cent. Higher wind speeds can reduce the yields and resultant revenues. Impacts of temperature, humidity or other microclimatic conditions could be aggravated by increased wind speeds. Saltation of surface soils can physically injure crop plants. Plants can be physically injured, toppled due to higher wind speeds. Parameter estimate on wind speeds is hypothesized to be negative. Water deficit during crop growing season could affect the crop yields negatively. Monthly water deficit (month of August) during the preliminary stages of crop is considered in this study; observed range of water deficit was 61.73 (Min 0, Max 61.73). Coefficient of variation of water deficit is 91.7 per cent parameter estimate on rainfall is hypothesized to be negative.

Demographic variables such as family size, social category of the farming household are also significant determinants of consumption. Large sized families could consume more compared to smaller sized families. Wider distribution of age among family members could influence the consumption patterns, such as expenditure on education or marriage celebrations. Parameter estimate on family is hypothesized to be positive. Social category of the farming household could also influence the consumption. Practices and customs idiosyncratic to the social classes could dictate the patterns in consumption. Different social categories are represented as dummy variables to capture these fixed effects that are specific to the social categories. For example, dummy variable *SC* takes the value of 1 if the farming household belongs to the scheduled caste category and a value of 0 if the farming household belongs to any other category. 10 per cent of farming households in the data fall under this category. Similarly, variables ST (5% of households), OBC (1% of total households) are defined. The sign on parameters on these variables could not be readily predicted.

Agronomic variables such as size of farm are also important determinants of consumption. Large farmers account for 22 per cent of data, medium farmers account for 23 per cent of data, small farmers account for 32 per cent of data and landless labourers account for 21 per cent of data, respectively. Larger farm size could be associated with higher consumption. This variable is hypothesised to be positive.

Revenue generated from cropping is the main source of income for the farming households. Higher consumption is associated with higher income. Revenue varied within a range of 17.26 lakh Rupees (1.72 million Rs). Coefficient of variation is 166 per cent. Parameter estimate for revenue variable is hypothesised to be positive. Farmer households held their savings predominantly in the form of ornamental gold. The value

Table 1. Descriptive Statistics on the variables used in regression model

Variable	Brief Description	N	Mean	Std Dev	Minimum	Maximum
tcons	Total Consumption in Rupees	4785	128199.41	151999.67	7090.50	3058342.50
tcap	Total Capital in Rupees	3528	454547.72	590718.88	9910.00	7934371.00
tcrev_prod	Total Crop revenue in Rupees	3141	79526.97	132805.42	0.00	1726545.00
cm7wnd	Wind speeds in July Month	5194	2.84	0.37	2.25	3.65
cmn8temp	Average Minimum Temperature in C	5194	22.79	1.68	19.96	25.68
cmx9temp	Average Maximum Temperature in C	5194	30.92	1.03	29.22	33.23
cm9rain	September month Average Rainfall in mm	5194	96.53	21.31	60.65	152.09
cm8wd	August Month Water deficit	5194	20.51	18.83	0	61.74
tgolds	Total Savings in form of gold in Rupees	5193	71705.43	119861.85	0	2000000
n_totmem	Total Members of the family	5194	5.15	2.37	1	24
sc	Dummy Variable. Value=1 if Farmer belongs to SC category. Else, value=0	5194	0.10	0.31	0	1
st	Dummy Variable. Value=1 if Farmer belongs to ST category. Else, value=0	5194	0.05	0.22	0	1
obc	Dummy Variable. Value=1 if Farmer belongs to OBC category. Else, value=0	5194	0.00	0.03	0	1
large	Dummy Variable. Value=1 if Farmer is a large farmer. Else, value=0	5194	0.22	0.42	0	1
lless	Dummy Variable. Value=1 if Farmer is in Landless labor category. Else, value=0	5194	0.21	0.41	0	1
med	Dummy Variable. Value=1 if Farmer belongs to Medium farmer category. Else, value=0	5194	0.24	0.43	0	1
small	Dummy Variable. Value=1 if Farmer belongs to small farmer category. Else, value=0	5194	0.33	0.47	0	1

range is 20 lakh Rupees (2 million Rs) with a CV of 167 per cent across the pooled data. Parameter estimate is hypothesised to be positive, given that an increase in long run savings could lead to increases in consumption.

Consumption is the dependent variable in this study. It included expenditure on food and non-food items. Share of food expenditure varies from 21 per cent to 30 per cent across households of different farm sizes. Consumption range was 30.5 Lakh Rupees (3 million Rs), with a CV of 118 per cent.

ESTIMATION

$$Y = X\beta + \varepsilon \qquad \text{Equation 1}$$

Consumption function has been estimated under Least squares framework as in Equation 1. Consumption is the dependent variable y, and economic, demographic and climatic factors described in the previous section represent the independent variables X, β represents the parameters to be estimated and ϵ is the random error term. Heteroscedasticity Consistent least squares estimation method is utilized in this study. *PROC REG* procedure of *SAS* was utilised for estimating the model. Multicollinearity is expected in this model. Variance Inflation Factors (VIFs) were calculated to diagnose the level of multicollinearity. VIF values greater than 10 are an indication of multicollinearity.

RESULTS AND DISCUSSION

Results from the estimated model are presented in Table 2. The estimated VIF values showed that, the model did not suffer from multicollinearity. The model explains about 43 per cent of variability in the dependent variable (Adjusted R^2=0.4365). Parameter estimate on crop revenues is positive and significant (0.0283) as hypothesized. An increase in crop revenue leads to an increase in the consumption, after controlling for all other factors. Our results indicate that with a 1 per cent increase in crop revenues, the consumption increases by 0.02 per cent. This parameter could also be interpreted as marginal propensity to consume. The sign on the parameter is in accordance with previous studies. Parameter estimate on savings as indicated by amount of gold owned is positive and significant. A 1 per cent increase in savings leads to an increase of 0.25 per cent in consumption. The savings observed in this model are cumulative over time and in the long run. An increase in long run savings indicates a betterment of economic and social status of an agent. Hence, increases in long run savings is positively correlated with consumption. Parameter estimate on total number of family members is positive and significant, indicating that consumption increases with increase in family members. A 1 per cent increase in family size causes an increase of 0.35 per cent increase in consumption.

Parameter estimates on Climatic variables are predominantly significant and show signs as hypothesized. Wind speeds are negatively associated with consumption. A 1 per cent increase in wind speed results in a 2.26 per cent decrease in consumption. Higher wind speeds can cause a reduction in crop revenues, as wind can exacerbate water losses, prevailing heat conditions, rainfall and can also cause physical damage to the plant. Parameter estimate on Average minimum temperatures is positive and significant. A 1 per cent increase in minimum temperature leads to an increase in consumption by 0.84 per cent. Increase in minimum temperatures could mean additional growing degree days resulting in higher revenues. Parameter estimate on average maximum temperature is negative and statistically significant. The results indicate that a 1 per cent increase in maximum temperature results in a decrease of consumption by 6.72 per cent. Higher maximum temperatures could reduce the performance of the crop plants, reducing the resulting crop revenues. Parameter estimates on rainfall and water deficit variables are not statistically significant.

Parameter estimates on farm size are statistically significant. Small farmers experienced more reduction in consumption compared to Land less agricultural labour and medium famers. Parameter estimates on Demographic variables such as social category of the farmer were not statistically significant. However, the farmers belonging to the SC category and ST category experienced more reduction in consumption compared to other categories of farmers. SC category famers experienced more reduction in consumption compared to the ST category farmers. These differences were not statistically significant.

Climate change significantly impacts the consumption patterns of farmers. This study analysed the changes in consumption of agricultural households as a function of climatic variables after controlling for economic, agronomic and demographic factors. Our results indicate that with a 1 per cent increase in crop revenues, the consumption increases by 0.02 per cent. Crop revenues are the main source of income for agricultural households. Changes in income affect the consumption directly. Higher consumption is associated with higher incomes. Agricultural households held their savings predominantly in the form of gold (ornamental). Higher value in gold savings is an indicator of economic betterment and is associated with social status. Results

Table 2. Heteroscedasticity consistent least squares parameter estimates of consumption

Variable	Parameter estimate	Pr > |t|	VIF
Intercept	**30.9034**	**<.0001**	**0.0000**
Log of Total Revenue from Crops	**0.0283**	**0.0050**	**1.5774**
Log of total value of Gold	**0.2599**	**<.0001**	**1.4851**
Log of Total No. of family members	**0.3500**	**<.0001**	**1.0839**
Log of July wind speeds	**-2.2628**	**<.0001**	**5.0750**
Log of August Min temperature	**0.8460**	**0.0774**	**10.1849**
Log of September Max temperature	**-6.7261**	**<.0001**	**12.5176**
Log of September Rainfall	-0.0144	0.8802	2.9785
Log of August water deficit	0.0076	0.7159	3.5673
Schedule Cast (dummy)	-0.0728	0.1026	1.0346
Schedule Tribe (dummy)	-0.0338	0.5133	1.6090
Land less labour	**-0.1395**	**0.0034**	**1.3438**
Medium farmer	**-0.1227**	**<.0001**	**1.5784**
Small farmer	**-0.1901**	**<.0001**	**1.9214**

Dependant Variable: **ln consumption**

Adjusted R^2: 0.436

from our model indicate that higher the long run savings in gold, higher is the consumption associated. Besides the economic factors, family size and farm size are also statistically significant determinants of consumption. Higher the levels of family size and farm size, higher is the associated consumption of the household.

Climatic variables affect the household consumption significantly. Increase in average maximum temperatures has more pronounced impacts than comparative increase in minimum temperature. The results indicate that a 1 per cent increase in maximum temperature results in a decrease of consumption by 6.72 per cent, whereas a 1 per cent increase in minimum temperature leads to an increase in consumption by 0.84 per cent. Wind speeds also affect consumption. A 1 per cent increase in wind speeds results in a 2.26 per cent decrease in consumption. Changes in rainfall, and water deficit during the growing season were not found to be statistically significant in the estimated model. Results from this model could be of use to policy makers in designing better suited relief packages that mitigate weather related or climate related disasters.

ACKNOWLEDGEMENTS

Authors would like to thank ICSSR IMPRESS funding this project under Grant No.P1686/142. Also, Authors express their gratitude to ICRISAT for providing access to their Databases.

LITERATURE CITED

Aditya, R.K., Ashok, K.M and Nedumaran, S. 2019. Consumption, habit formation, and savings: Evidence from a rural household panel survey. *Review of Development Economics.* 23(1):1-19.

Areef, M., Radha, Y., Rao, V.S., Gopal, P.V.S., Paul, K.S.R., Suseela, K and Rajeswari, S. 2021. Consumption expenditure pattern and inequality among agricultural households in south coastal region of Andhra Pradesh State. *Journal of Research ANGRAU*. 49(2): 82-91.

Down to Earth. 2019. Rainfall trends decline sharply across regions in Karnataka. Retrieved from website (https://www.downtoearth.org.in/news/climate-change/rainfall-trends-decline-sharply-across-regions-in-karnataka-64893) on 27.09.2021.

Gerald, C.N., Mark, W.R., Jawoo, K., Richard, R., Timothy, S., Tingju, Z., Claudia, R., Siwa, M., Amanda, P., Miroslav, B., Marilia, M., Rowena, V.S., Mandy, E and David, L. 2009. Climate change: Impact on agriculture and costs of adaptation. International Food Policy Research Institute (IFPRI) Washington, D.C. USA.

Murari, Kamal, K., Mahato, Sandeep, Jayaraman, T and Swaminathan, M. 2018. Extreme temperatures and crop yields in Karnataka, India. *Review of Agrarian Studies*. 8(2).

Rao, A.V.R.K., Wani, S.P., Srinivas, K., Singh, P., Bairagi, S.D and Ramadevi, O. 2013. Assessing impacts of projected climate on pigeon pea crop at Gulbarga. *Journal of Agrometeorology*. 15 (Special Issue-II): 32-37.

Sanjeevaiah, S.H., Rudrappa, K.S., Lakshminarasappa, M.T., Huggi, L., Hanumanthaiah, M.M., Venkatappa, S.D., Lingegowda, N and Sreeman, S.M. 2021. Understanding the temporal variability of rainfall for estimating agro-climatic onset of cropping season over south interior Karnataka, India. *Agronomy*. 11(6):1135.