

GUJARAT AGRICULTURAL UNIVERSITIES RESEARCH JOURNAL



S.D. Agricultural University
Sardarkrushinagar



Anand Agricultural University
Anand



Junagadh Agricultural University
Junagadh



NAVSARI AGRICULTURAL UNIVERSITY

Navsari Agricultural University
Navsari

VOLUME : 48 NUMBER : 3

JULY, 2023

GAU RES. J. 48 (3)

PATRONS

Dr. R. M. Chauhan
Vice Chancellor
S. D. Agril. University
Sardarkrushinagar

Dr. K. B. Kathiria
Vice Chancellor
Anand Agril. University
Anand

Dr. V. P. Chovatia
Vice Chancellor
Junagadh Agril. University
Junagadh

Dr. Z. P. Patel
Vice Chancellor
Navsari Agril. University
Navsari

ADVISORY BOARD

Dr. C. M. Muralidharan, Director of Research & Dean PGS, S.D.A.U., Sardarkrushinagar

Dr. T. R. Ahlawat, Director of Research & Dean PGS, N.A.U., Navsari

Dr. S. D. Solanki, Principal, C. P. College of Agriculture, S.D.A.U., Sardarkrushinagar

Dr. Y. M. Shukla, Principal, B. A. College of Agriculture, A.A.U., Anand

Dr. C. D. Lakhani, Principal, College of Agriculture, J.A.U., Junagadh

Dr. R. D. Pandya, Principal, N. M. College of Agriculture, N.A.U., Navsari

Dr. Samit Dutta, Dean, College of Food Processing and Bio Energy, A.A.U., Anand

Dr. P. M. Chauhan, Dean, College of Agril. Engg. & Tech., J.A.U., Junagadh

EDITORIAL BOARD

Dr. C. M. Nuralidharan (Editor in Chief)

SDAU, Sardarkrushinagar

Dr. C. K. Patel, Assistant Research Scientist (Farm)
Dr. P. S. Patel, Associate Research Scientist (Edu.)
Lt. Dr. Simple Jain, Assistant Professor (Extension Edu.)

AAU, Anand

Dr. S. N. Shah, Associate Director of Research (Agri.)
Dr. D. B. Sisodiya, Associate Research and Head
(Entomology)

JAU, Junagadh

Dr. R. B. Madariya, Director of Research
Dr. A. G. Pansuriya, Associate Research Scientist
Prof. Pinky S. Sharma, Assistant Extension Educationist

NAU, Navsari

Dr. V. R. Nayak, Associate Director of Research (Agri.)
Dr. K. G. Patel, Professor and Head (Soil Sci. & Agri. Chem.)
Dr. R. K. Patel, Associate Professor (Plant Breeding)

Contents

Research Papers

Impact of Technology Demonstration Component of NICRA Project on Socio-economic Aspects of Beneficiary and Non-beneficiary Respondents	Mandavkar P.M., S. S. Sisodia, P. A. Sawant, B. Upadhyay and R. Bairathi	171
Determination of Carbon Footprint of Selected Major Cereals.	N. Komathy and R. Radha	177
Dealers Outlook Towards Various Insecticide Brand and Constraints Faced by Onion Growers in Amreli District	Savaliya N. G., Dubey L. R., Faldu N. V., Chudasama. R. and Modi R.M.	185
The Nudged-Belief: Trigger to Preventive SBCC Action against Covid-19	Dua S. and Anand S.	195
Knowledge Level of <i>Mung</i> Growers about Post Harvest Technology of <i>Mung</i>	Patel D. B. and Biswas A.	207
Profile of Respondents and their Relationship with Adoption of Technology Interventions of Different Field Crops under NICRA Project	Mandavkar P. M., S. S. Sisodia, P. A. Sawant, B. Upadhyay, R. Bairathi, R. H. Meena and A. Verma	213
Logistic Management of Handloom Industry	Goswami R and Jain R.	221
Comparison of Selection Indices Based On Per Cent Relative Efficiency in Finger Millet Crop	R. L. Ghetiya and A. D. Kalola	228
Determinants of Parent's Attitude on Pre-Requisite Skills of Children with Autism	Saikia S. and Bhaskar R.	245
Screening of plant growth promoting attributes and extracellular hydrolytic enzyme production by soil dwelling fungi	Kishan Vachhani, Yogesh Paneliya, Yogesh Patel, Gaurav Dave	254

Official Publication of

Gujarat Agricultural Universities, Gujarat State



S.D. Agricultural University
Sardarkrushinagar



Anand Agricultural University
Anand



Junagadh Agricultural University
Junagadh



Navsari Agricultural University
Navsari

Impact of Technology Demonstration Component of NICRA Project on Socio-economic Aspects of Beneficiary and Non-beneficiary Respondents

Mandavkar P.M.^{*1}, S.S. Sisodia², P.A. Sawant³, B. Upadhyay⁴ and R. Bairathi⁵

^{1,2,4 & 5} Rajasthan College of Agriculture, MPUAT, Udaipur

³ Directorate of Extension Education, DBSKKV, Dapoli,

*Email: pramodmandavkar102@gmail.com

ABSTRACT

The development in the field of agriculture was systematically started after independence. Government at central as well as state level started different agriculture programmes. The Indian Council of Agricultural Research (ICAR) has launched a major project entitled "National Innovations on Climate Resilient Agriculture (NICRA)" during 2010-11 (February, 2011) with an outlay of Rs. 350 crores for the XI Plan. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. Under this consideration, the study was undertaken in Ratnagiri district from Konkan region and Aurangabad (*Chattrapati Sambhajinagr*) district from Marathwada region of Maharashtra state to study impact of Technology Demonstration Component of NICRA project on socio-economic aspects of beneficiary and non-beneficiary respondents. The study was based on ex-post facto research design and data were collected through interview schedule. The results revealed that there was significant difference between beneficiary and non-beneficiary respondents with regard to their social participation and information seeking behavior in Konkan and Marathwada region. The highly significant difference in yield and returns from all the crops was due to medium to high level of adoption of technology intervention demonstrated on beneficiary respondents' field. This highly significant difference was due to good quality production with higher yield obtained by beneficiary respondents.

Key Words : Impact, Technology, Project, Socio-economic, Beneficiary, Respondents

INTRODUCTION

The development in the field of agriculture was systematically started after independence. Government at central as well as state level started different agriculture programmes. The Indian Council of Agricultural Research (ICAR) has launched a major project entitled "National Innovations on Climate Resilient Agriculture (NICRA)"

during 2010-11 (February, 2011) with an outlay of Rs. 350 crores for the XI Plan. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. The technology demonstration component of the project metes out with demonstrating authentic technologies for adaptation of various production system to climatic variability. This

project was initially implemented in 100 districts of the country by way of location specific technology interventions. These districts were selected based on the drought, cyclone, actual occurrence of floods and droughts etc. criteria.

The crop demonstration module consists of introducing drought or flood tolerant varieties, advancement of planting dates of *rabi* season crops in areas with terminal heat stress, water saving paddy cultivation methods i.e. plantation techniques, seeding methods, fertilizer management etc., community seedling nurseries under delayed monsoon situation, custom hiring centers for in time operations, location specific inter-cropping systems with elevated sustainable yield index.

With this background of climatic situation, this investigation was studied to know impact of Technology Demonstration Component of NICRA project (NICRA-TDC) on socio-economic aspects of beneficiary and non-beneficiary respondents.

MATERIALS AND METHODS

This investigation was conducted in the year 2021-22 in Ratnagiri district from Konkan region and Aurangabad (*Chatrapati Sambhajinagr*) districts from Marathwada region of Maharashtra state. All the ten operational villages of the NICRA Project that are Harale, Parule, Raipatan, Whel and Talawade from Ratangiri district and Shekta, Vajanapur, Gopalwadi, Shankarpur and Shiresaygaon from Aurangabad (*Chatrapati Sambhajinagar*) district were selected. From these villages 140 farmers (14 farmers from every village) were selected as beneficiary. For this study 140 farmers were taken from the nearby 10 villages (14 farmers from every

village) as non-beneficiary on random basis for comparison. Thus, a sample size was 280 respondents for the investigation. An interview schedule was developed taking into consideration the social aspects of respondents and yield and returns in paddy, horse gram, maize and Bengal gram crops under study. For this study, ex-post facto design of research was applied. The 'z' test was applied to know significant difference between beneficiary and non-beneficiary respondents with regard to their socio-economic aspects in both the region.

RESULTS AND DISCUSSION

The impact or the effect of technology interventions was measured by comparing the responses of beneficiary and non-beneficiary respondents. In the present study impact was measured on two dimensions, viz. social impact and economic impact. The social dimensions comprised of social participation and information seeking behavior of respondents, whereas, economic dimensions comprised of yield and returns of different crops under study.

A) Social Impact

Social Participation

It refers to the participation and involvement of respondents in various formal social organizations. Usually extension programme comprised of group activities like result demonstrations, method demonstrations, group meetings, trainings, field days, etc. This may lead to greater awareness and cohesiveness among respondents. As a result, respondents begin to take interest in the activities of formal social organizations. The NICRA project was also associated with such group activities.

Impact of NICRA-TDC on Social Participation of Respondents

The data presented in Table 1 depicts that mean score of social participation of beneficiary and non-beneficiary respondents which were 9.68 and 5.17, respectively in case of Konkan region respondents. The calculated 'z' value of social participation is 9.80 which found significant. In case of

Marathwada region respondents, mean score of social participation of beneficiary and non-beneficiary respondents were 9.05 and 4.85, respectively and calculated 'z' value of social participation is 12.69 which found highly significant. This indicates that there was significant difference between beneficiary and non-beneficiary respondents with regard to their social participation in both the region.

Table 1 : Impact of -NICRA-TDC on social participation and information seeking behaviour of respondents

Sr. No.	Character	Konkan region			Marathwada region		
		Mean score Bs (n =70)	NBs (n =70)	'z' value	Mean score Bs (n =70)	NBs (n =70)	'z' value
1.	Social participation	9.68	5.17	9.80**	9.05	4.85	12.69**
2.	Information seeking behaviour	18.17	8.05	17.33**	31.9	19.57	20.57**

** Significant at 0.01 level, Bs= Beneficiaries, NBs= Non-beneficiaries

Thus, it was inferred that there is significant impact of NICRA-TDC in improving the social participation of beneficiary respondents.

Information Seeking Behaviour

It refers to the sources and channels utilized by respondents for seeking information on improved agricultural practices. Extension activities associated with the programme in a particular area often develops the unfelt needs of respondents into felt needs. As a results respondents starts to take interest in developmental efforts and seek information from various sources and channels for latest know-how on improved agricultural practices.

Impact of NICRA-TDC on Information Seeking Behaviour of Respondents

The data presented in Table 1 indicates that,

in Konkan region the mean score pertaining to information seeking behaviour of beneficiary and non-beneficiary respondents were 18.17 and 8.05, respectively. The calculated 'z' value is 17.33 which is highly significant. In case of Marathwada region respondents, mean score of information seeking behaviour of beneficiary and non-beneficiary respondents were 31.9 and 19.57, respectively and the calculated 'z' value is 20.57 which is also highly significant.

This indicates that, in both the regions there was significant difference between beneficiary and non-beneficiary respondents with regard to their information seeking behaviour. Thus, it was inferred that there was significant impact of NICRA-TDC which led comparatively high level of information seeking behaviour of beneficiary respondents.

A) Economic impact**Impact of NICRA-TDC on Yield of Different Crops**

Yield refers to the production of a crop per unit area. The ultimate aim of any agricultural extension programme is to increase the yield of crops at respondents' fields, thereby improving their income and socio-economic condition. It is evident from Table 2 that,

mean yield pertaining to the yield of paddy was 42.28 q/ha and 28.30 q/ha for beneficiary and non-beneficiary respondents, respectively. The calculated 'z' value is 111.57 which indicates highly significant difference at 0.01 level of probability. It denotes that beneficiary respondents obtained significantly higher yield of paddy than those of non-beneficiary respondents.

Table 2 : Impact of NICRA-TDC on yield of different crops

Sr. No.	Crops	Mean yield (q/ha)		'z' value
		Beneficiary (n =70)	Non-beneficiary (n =70)	
1.	Paddy	42.28	28.30	111.57**
2.	Horse gram	06.81	04.52	51.09**
3.	Maize	57.87	47.00	53.31**
4.	Bengal gram	22.93	17.59	49.79**

** Significant at 0.01 level

In case of horse gram, mean yield of beneficiary and non-beneficiary respondents were 6.81 q/ha and 4.52 q/ha, respectively. The calculated 'z' value of mean difference is 51.09 which is highly significant at 0.01 level of probability. This shows that beneficiary respondents obtained significantly higher yield of horse gram than those of non-beneficiary respondents.

As far as the yield of maize is concerned, mean yield of beneficiary and non-beneficiary respondents were 57.87 q/ha and 47.00 q/ha, respectively. The calculated 'z' value is 53.31 which is highly significant at 0.01 level of probability. This implies that beneficiary respondents obtained significantly higher yield of maize than those of non-beneficiary respondents.

As regards the yield of Bengal gram, mean yield of beneficiary and non-beneficiary respondents were 22.93 q/ha and 17.59 q/ha, respectively. The calculated 'z' value of mean difference is 49.79 which is highly

significant at 0.01 level of probability. This shows that beneficiary respondents obtained significantly higher yield of Bengal gram than those of non-beneficiary respondents.

This highly significant difference in yield of all the crops was due to medium to high level of adoption of technology intervention demonstrated on respondents' field by beneficiary respondents.

Similar results were recorded by Jasna and Berman (2015), Mahesh babu (2016), Nagaraj *et al.* (2017), Sonune and Mane (2018) and Tajpara *et al.* (2018), while results are somewhat in line with Abirami *et al.* (2014).

Impact of NICRA-TDC on Returns of Different Crops

Crop returns refers to the price incurred by sale of the total production produced in the field. The socio-economic conditions of respondents will improve when he gets remunerative price to the produce.

Table 2 : Impact of NICRA-TDC on yield of different crops

Sr. No.	Crops	Mean yield (q/ha)		'z' value
		Beneficiary (n =70)	Non-beneficiary (n =70)	
1.	Paddy	0.80	0.54	74.02**
2.	Horse gram	0.52	0.34	44.03**
3.	Maize	1.03	0.86	40.45**
4.	Bengal gram	1.04	0.81	33.86**

** Significant at 0.01 level

Results presented in Table 3 indicates that, mean returns pertaining to paddy by beneficiary and non-beneficiary respondents were Rs.0.80 lakh and Rs.0.54 lakh, respectively. The calculated 'z' value is 74.02 which is highly significant at 0.01 level of probability. It shows that beneficiary respondents obtained significantly higher returns than non-beneficiary respondents of paddy.

As regards returns from horse gram, mean returns of beneficiary and non-beneficiary respondents were Rs.0.52 lakh and Rs.0.34 lakh, respectively. The calculated 'z' value is 44.03 which is significantly high at 0.01 level of probability. It reveals that beneficiary respondents obtained significantly higher returns than non-beneficiary respondents of horse gram.

As far as returns of maize is concerned, mean returns of beneficiary and non-beneficiary respondents were Rs.1.03 lakh and Rs.0.86 lakh, respectively. The calculated 'z' value is 40.45 which is highly significant at 0.01 level of probability. This implies that beneficiary respondents obtained significantly higher returns from maize than non-beneficiary respondents.

With respect to returns from Bengal gram, mean returns of beneficiary and non-beneficiary respondents were Rs.1.04 lakh and Rs.0.81 lakh, respectively. The calculated 'z' value is 33.86 which is highly significant at

0.01 level of probability. This shows that beneficiary respondents obtained significantly higher returns from Bengal gram than non-beneficiary respondents.

This highly significant difference was due to good quality production with higher yield obtained by beneficiary respondents. Therefore, it can be inferred that NICRA-TDC resulted in comparatively higher returns than non-beneficiary fields.

The identical results were reported by Balasubramaniam *et al.* (2009) and Malik *et al.* (2019) and results are somewhat in line with Medhi *et al.* (2018).

CONCLUSION

It was concluded that there was significant difference between beneficiary and non-beneficiary respondents with regard to their social participation and information seeking behavior in Konkan and Marathwada region. The highly significant difference in yield and returns from of all the crops was due to medium to high level of adoption of technology intervention demonstrated on beneficiary respondents' field. This highly significant difference might be due to good quality production with higher yield obtained by beneficiary respondents. Therefore, it can be inferred that NICRA-TDC resulted in comparatively higher social participation and information seeking behavior of beneficiary

respondents as well as high yield and returns than those of non-beneficiary fields.

REFERENCES

- Abirami, G., Vijayabhinandana, B., Krishna, G. T. and Rao, D. V. S. (2014). Socio-economic impact of Irrigated Agriculture Modernization and Water Bodies Restoration and Management (IAMWARM) Project in Pudukkottai District of Tamil Nadu. *The Andhra Agricultural Journal*, 61(1): 228-232.
- Balasubramaniam P, Manickam S and Vijayaraghavan R. (2009). Consequences of adoption of micro – irrigation systems in canal command areas. *Journal of Extension Education* 21(1), pp- 91-95.
- Jasna, V. K. and R. Roy Berman. (2015). Impact of Climate Resilient Technologies in Rainfed Agro-Ecosystem". *Indian Journal of Agricultural Sciences* 87(6), pp 816-824.
- Mahesh Babu, T. (2017). Impact of Andhra Pradesh Micro Irrigation Project (APMIP) in Chittoor district of Andhra Pradesh. M. Sc. (Agri.) Thesis (Unpublished) Acharya N. G. Ranga Agricultural University, Hyderabad.
- Malik, H. A., Tripathi B. N., Nusrat Jan J. A., Quadri Sabiha Ashraf and Naqash F. (2019). Impact of Diversified Agriculture Support Project (DASP) on Beneficiaries and Non-beneficiaries of District Allahabad (Uttar Pradesh), India. *International Journal of Current Microbiology and Applied Sciences* 8(02): 2569-2576.
- Medhi, S., Islam M., Barua U., Sarma M., Das M. G., Syiemlich E. C., Bardoloi P. and Mukhim, B. (2018). Impact of Climate Resilient Practices under NICRA Project in Ri Bhoi District of Meghalaya. *Economic Affairs* 63(3):653-664.
- Nagaraj, K. H., Kamala B. S. and Kulkarni L. R. (2017). Technology dissemination and impact of KVK activities in the district of Ramanagaram. *International Journal of Current Microbiology and Applied Science*. 6(1):3831-3839.
- Sonune, S. V. and Mane, S. B. (2018). Impact of climate resilient varieties on crop productivity in NICRA village. *Journal of Pharmacognosy and Phytochemistry*; pp 3210-3212.
- Tajpara, M. M., M. A. Vakaliya and B. N. Kalsariya. (2018). Impact of climate resilient technology in NICRA village of Rajkot district of Gujarat. *Guj. J. Ext. Edn. Special Issue on National Seminar*. pp-77-80.

Determination of Carbon Footprint of Selected Major Cereals

N. Komathy^{*1} and R. Radha²

^{1,2}Department of Food Service Management and Dietetics,
Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-43,

*Email Id : komathynagarajan3898@gmail.com¹, radha_fsmd@avinuty.ac.in²

ABSTRACT

A significant portion of the global population relies on cereals, a family of grasses, as their primary source of food that provide essential nutrients and energy. However, 30% of greenhouse gas emissions worldwide are now attributable to the global food system as a whole. When food is grown, transformed, packaged, transported, sold, and consumed, greenhouse gas emissions are created. Methane, nitrous oxide, and carbon dioxide are the three primary greenhouse gases. Hence, this study aims to investigate the carbon footprint associated with the production and consumption of cereals in Coimbatore, a bustling city in Tamil Nadu, India. To determine the carbon footprint, all stages of cereal production including cultivation, water consumption, land use and transportation were considered. Primary data is collected through surveys and secondary data from scientific literature, government reports, and databases. The carbon footprint of the foods was determined per year. The study result highlights that rice (1252.01 kgco₂e/yr) have a high carbon footprint when compared to other cereals followed by Italian millet (860.48kgco₂e/yr) which have high negative impact on environment whereas tender maize (100.35kgco₂e/yr) emits less carbon compared to others and has low impact on environment. By providing a comprehensive analysis of the carbon footprint of cereals in Coimbatore, this study helps to create awareness on the importance of sustainable agricultural practices. Legislators, cultivators, and other partners in the cereal supply chain may use the insightful information it provides to adopt focused actions aimed at reducing emissions and enhancing environmental sustainability.

Keywords : Carbon footprint, Cereals, Cultivation, Water consumption, Land use and Transportation

INTRODUCTION

A significant amount of dietary energy and nutrients are obtained from cereals and cereal products, which are staple foods in the majority of human diets in both developed and developing nations (McKevith, 2004; Kushiet *al.*, 2009; McIntosh, 2001). They make up over 75% of carbohydrates, mostly starches, and 6-15% protein. Globally, they

account for more than 50% of the energy supply (WHO, 2003). The fact that cereal production, which totals around 2600 million tons annually, is the primary factor affecting global food security further supports the significance of cereals and cereal products (FAO, 2018).

Xuet *al.*, (2021) opines that grains constitute an essential part of the world's food systems and a vital source of nourishment for millions

of people. However, there are environmental costs associated with the production and use of grains, chiefly in the form of carbon footprint and greenhouse gas (GHG) emissions. It's essential to comprehend and deal with cereals' carbon footprint in order to create sustainable farming methods and slow down global warming.

The Food and Agriculture Organization (FAO, 2018) estimates that 14% of the world's greenhouse gas emissions are related to agriculture, particularly the production of cereals. This covers emissions from changing land use, fertilization, crop cultivation, processing, shipping, and packing, among other phases of the grain production cycle. Significant volumes of methane (CH₄), nitrous oxide (N₂O), and carbon dioxide (CO₂) are released during these operations. These gases are powerful contributors to climate change (Patiet *al.*, 2017; Mohapatra *et al.*, 2017).

It is essential to take into account every step of the manufacturing process, from seed to plate, in order to fully assess the carbon footprint of cereals. Changes in land use, especially the conversion of grasslands and forests to croplands, release a significant amount of CO₂ into the atmosphere. Commonly employed in cereal farming, synthetic fertilizers increase emissions of N₂O, a gas with a far greater warming potential than CO₂. Furthermore, the carbon footprint is increased by energy-intensive procedures related to transportation, automation, and irrigation (Yongchanget *al.*, 2018).

Balafoutiset *al.*, (2017) highlighted that lowering the carbon footprint of cereals necessitates a multifaceted strategy that includes advancements in technology, sustainable agricultural methods, and alterations in consumer behaviour. Important tactics for reducing emissions include promoting precision agricultural practices, minimizing fertilizer usage, implementing renewable energy sources, and enhancing supply chain effectiveness. Positive change may also be sparked by educating customers on the carbon footprint of cereals and promoting sustainable consumption practices. Therefore, the purpose of this study is to look into the carbon footprint related to the production and consumption of grains in Coimbatore, Tamil Nadu, India's busy metropolis.

MATERIALS AND METHODS

Selection of samples

According to Pingali., (2017), for a substantial proportion of the world's population, grains are important sources of nutritional value and dietary energy. These are adaptable crops that work well in a variety of climates and environments, making them appropriate for a wide range of geographical locations and cultural contexts. Furthermore, cereals are frequently inexpensive, the mainstay of daily meals, and a major weapon in the fight against hunger and malnutrition, particularly in poor nations. Totally 12 cereals that are often found in Coimbatore, such as Rice (*Oryza Sativa*), Wheat (*Triticum Aestivum*),

Maize (*Zea Mays*), Italian millet (*Setaria Italica*), Sorghum (*Sorghum Bicolor*), Pearl millet (*Pennisetum Glaucum*), Barley (*Hordeum Vulgare*), Proso millet (*Panicum Miliaceum*), Finger millet (*Eleusine Coracana*), and Little millet (*Panicum Sumatrense*) have been chosen as the dietary category for the carbon footprint calculation.

Carbon footprint

The total quantity of greenhouse gas produced over a product's life cycle is known as its "carbon footprint." The Carbon Footprint has gained popularity and acceptance in scientific and industrial domains; however, since it is an output indicator pertaining to a single environmental effect, it must be complemented by the use of an all-encompassing input indicator to analyze biotic and abiotic material flows in a

more comprehensive manner (Schmidt, 2008).

The data regarding the places where cereals are received for sales were collected. By using that data, distance from that place to Coimbatore was estimated and also data about the mode of transport, irrigation methods, such as fertiliser used, watering methods, harvesting methods, mode of vehicles used during the process and total yield of food were collected as secondary data.

Primary data is collected through surveys and secondary data from scientific literature, government reports, and databases. The carbon footprint of cereals and grains was determined for a year. The total emission factor of irrigation and transport for cereals and grains were applied in the carbon footprint formula.

The carbon footprint of the food ingredients were calculated per year by using the formula,

$$\text{Carbon footprint} = \text{Consumption of items / day (kcal/day)} \times 365 \times \text{Emission factor (kgco}_2\text{ekcal)}$$

(Formula - 1)

Whereas here,

- | | |
|---------------------------------------|---|
| Consumption of items / day (kcal/day) | - The energy in kcal of selected food items consumed by the subjects, the energy was calculated for each food items using IFCT nutritive value book (2017). |
| 365 | - Number of days in a year |
| Emission factor | - Adjusted daily emission factor for a particular harvested area |

RESULTS AND DISCUSSION

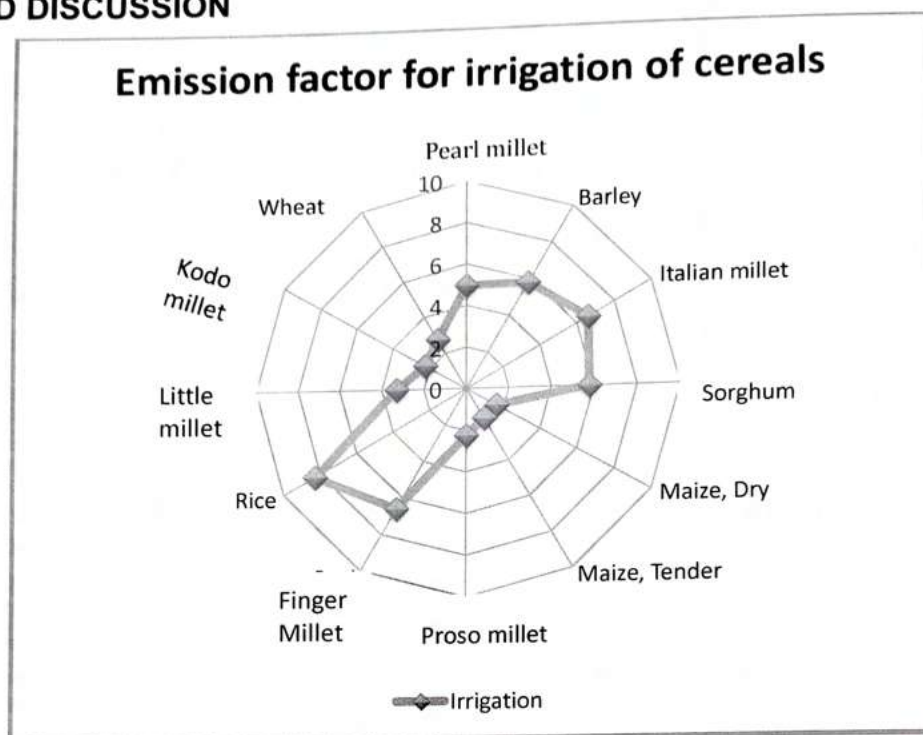


FIGURE I : Emission factor for irrigating the cereals

Figure I presents emission factor for irrigating the cereals and highlighted that the emission factor for irrigation of maize was lower and

emits less carbon when compared to others and emission factor for irrigation of rice was higher and emits more carbon during irrigation when compared to others.

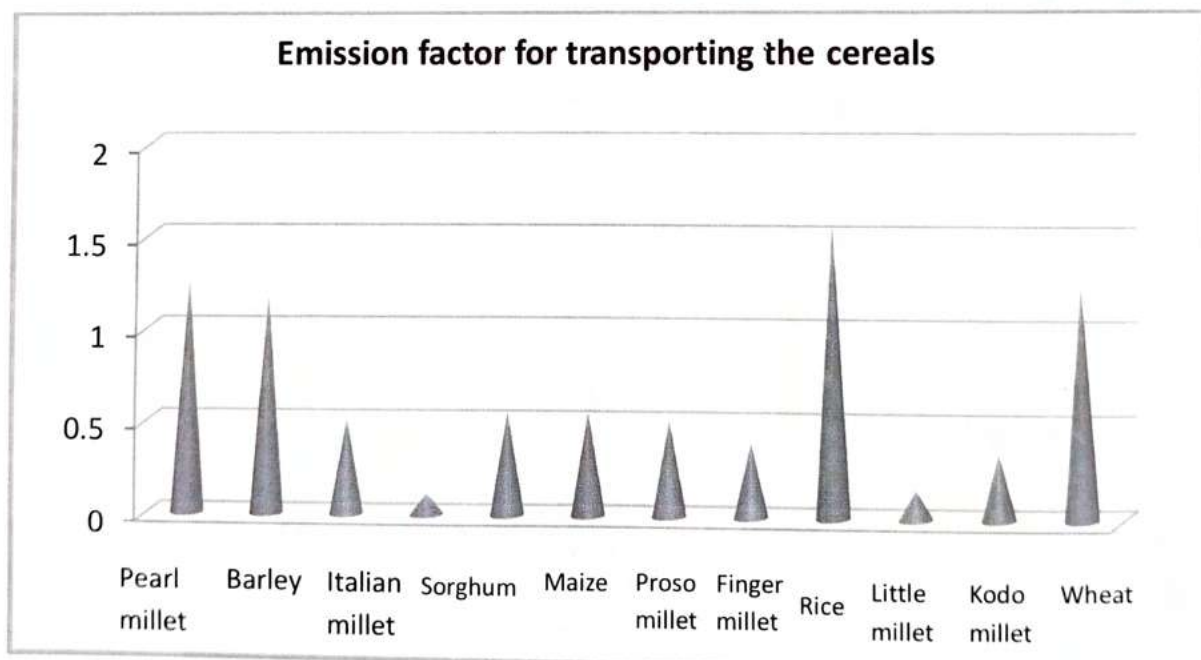


FIGURE II : Emission factor for transporting the cereals

Figure II provides Emission factor for transporting the cereals. It shows that the

emission factor of jowar was lower and the emission factor of rice was higher followed by wheat than others.

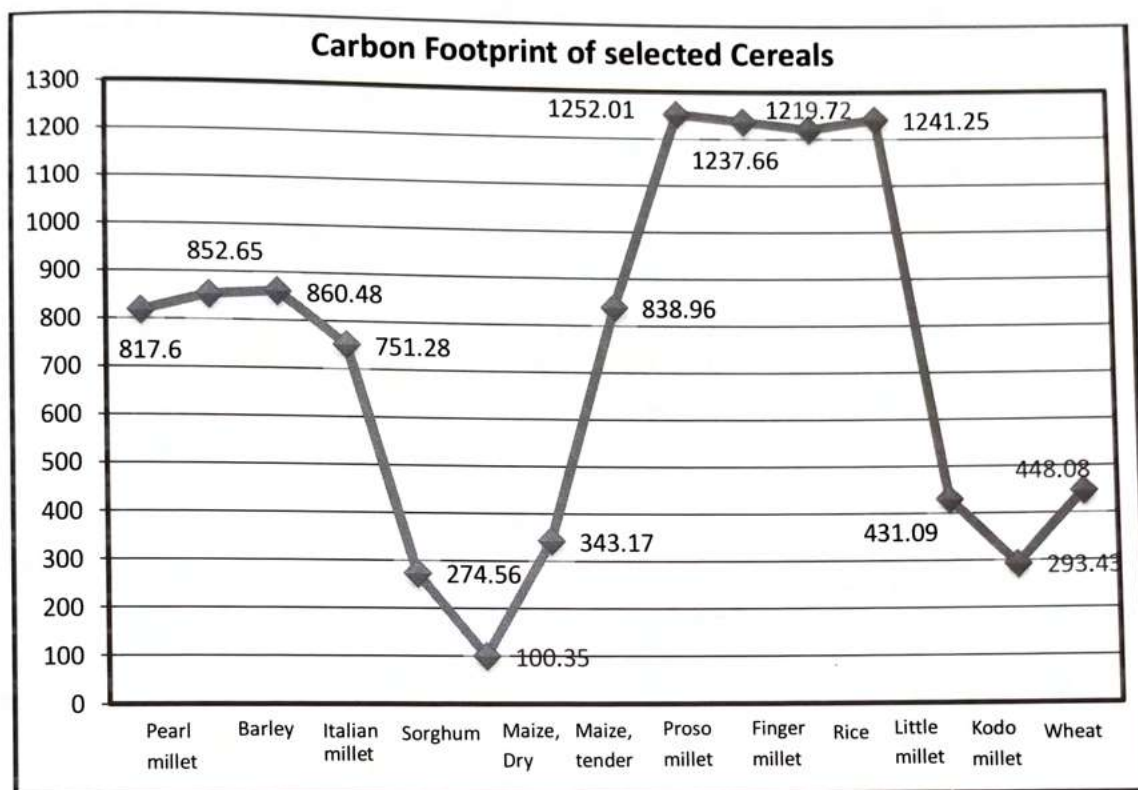


FIGURE III : Carbon Footprint of selected Cereals

The data elucidated in figure III reveals that the carbon footprint of parboiled milled rice was higher compared to all the other cereals followed by raw milled rice and which was clear that these cereals have high negative

impact on environment and should be consumed in lesser quantity. And also shows that tender maize have lesser carbon footprint and less impact on environment which can be recommended in higher quantity.

DISCUSSION

The findings indicate that each package of 4 kilogramme of polished rice has a 7.7 kg⁻⁶CO₂eq carbon impact. Production of raw materials has a significant impact, particularly regarding methane emissions from paddy fields (Yoshikawa., 2010).

Agricultural activities are responsible for

more than 10% of the anthropogenic emissions of CH₄, with rice fields making up the majority of these releases (Scheehle and Kruger, 2006). In continuous flooding settings, the carbon emission in rice varies between 21.96 and 60.96 Tg C yr⁻¹ due to variations in urea doses, as reported by Pathaket *al.* (2012).

Blengini and Busto (2009) estimated rice has

a 2.90 kg CO₂-e kg⁻¹ yield carbon footprint from sowing to the farm to gate. The Intergovernmental Panel on Climate Change (IPCC, 2007) estimates that Egypt's rice fields produce between 20 and 100 Tg annually on average to global emissions. This amounts to around 5–20% of total CH₄ emissions originating from human activities. Measurements were taken in paddy fields in the US, Spain, Italy, China, India, Australia, Japan, and Thailand (IPCC, 1997). The primary contributors to this carbon footprint are the methane produced by flooded rice (67%) and the deforestation brought on by the continuous use of 149 000 hectares of hillside slash-and-burn land for rice farming (29%) (Bockele et al., 2010).

As to a research conducted by Cheng *et al.* (2011), the average carbon intensity in China changed between 1993 and 2007 for cultivated lands, ranging from 0.64 tCE ha/yr to 0.92 tCE ha/yr, and between 1993 and 2007 for total production, which was 0.11 tCE t/yr.

In addition to other pollutants including carbon monoxide (CO), particulate matter (PM), and dangerous polycyclic aromatic hydrocarbons (PAHs), burning rice residue is another source of emissions that generates carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) (Lemieux *et al.*, 2004).

CONCLUSION

The carbon footprint of cereals, encompassing the entire production chain from cultivation to consumption, is a significant environmental concern in the context of sustainable agriculture and climate change mitigation. This article has provided

insights into the factors contributing to the carbon footprint of cereals. Efforts to reduce the carbon footprint of cereals require a multi-pronged approach. Sustainable farming practices play a crucial role in emissions reduction. Precision agriculture techniques, such as optimized nutrient management and water conservation, can minimize the use of synthetic fertilizers and irrigation-related emissions. Conservation tillage and soil carbon sequestration practices can further contribute to mitigating emissions. Innovation in post-harvest processes, such as adopting renewable energy sources for processing and transport, utilizing sustainable packaging materials, and shortening supply chains, can also help reduce emissions. These steps not only lower the carbon footprint but also promote overall resource efficiency and resilience in the cereal industry.

Consumer choices and behaviour have a significant impact on the carbon footprint of cereals. By making informed decisions, such as opting for sustainably produced cereals, reducing food waste and supporting local and seasonal produce, consumers can contribute to emissions reduction. Policy interventions and industry initiatives are crucial for driving systemic change. Government regulations can incentivize sustainable farming practices; promote renewable energy adoption, and support research and development for low-carbon technologies. Industry collaborations, certification schemes, and labelling initiatives can further encourage sustainable practices across the cereal supply chain.

While progress has been made in understanding and addressing the carbon footprint of cereals, further research is

needed to refine measurement methodologies, evaluate regional variations, and assess the effectiveness of mitigation strategies. Additionally, ongoing monitoring and assessment of the carbon footprint of cereals will be essential to track progress and inform future sustainability efforts. In conclusion, mitigating the carbon footprint of cereals is essential for achieving sustainable agriculture and combating climate change. By implementing sustainable farming practices, adopting innovative technologies, promoting responsible consumption, and enacting supportive policies, it is possible to reduce emissions and create a more resilient and environmentally friendly cereal industry. Collectively, these efforts will contribute to a more sustainable and climate-resilient future.

REFERENCE

- Balafoutis, A.; Beck, B.; Fountas, S.; Vangeyte, J.; Wal, T.V.d.; Soto, I.; Gómez-Barbero, M.; Barnes, A.; Eory, V. (2017). Precision Agriculture Technologies Positively Contributing to GHG Emissions Mitigation, Farm Productivity and Economics. *Sustainability*, 9, 1339.
- Blengini, G. A., & Busto, M. (2009). The life cycle of rice: LCA of alternative agri-foodchain management systems in Vercelli (Italy). *Journal of Environmental Management*, 90, 1512–1522.
- Bockel, L., Grever, U., Fernandez, C., Bernoux, M. (2010) EX-ACT user manual Estimating and Targeting GHG Mitigation in Agriculture (Rome: Food and Agriculture Organization of the United Nations)
- Cheng, K., Pan, G., Smith, P., Luo, T., Li, L., Zheng, J.M, Y. (2011). Carbon footprint of China's crop production-An estimation using agro-statistics data over 1993–2007. *Agriculture, Ecosystems and Environment*, 142, 231–237.
- FAO cereal supply and demand brief. (n.d.). Retrieved 7 July 2018, from <http://www.fao.org/worldfoodsituation/c-sdb/en/>
- IPCC, (2007). Summary for policymakers. In Solomon D, Qin M and Manning Z.
- Kushi, L. H., Meyer, K. A., & Jacobs, D. R. (2009). Cereals, legumes, and chronic disease risk reduction: evidence from epidemiologic studies. *The American Journal of Clinical Nutrition*, 70(3), 451S–458S.
- Lemieux, P. M., & Lutes, C. C. (2004). DA: Emissions of organic airtoxics from open burning: a comprehensive review. *Progress in Energy and Combustion Science*, 30, 1–32.
- McIntosh, G., (2001). Cereal foods, fibres and the prevention of cancers. *Aust. J. Nutr. Diet*;58:S35–S48.
- McKevith, B., (2004). Nutritional aspects of cereals. *Br. Nutr. Found. Nutr. Bull*;29:111–142. doi: 10.1111/j.1467-3010.2004.00418.x.
- Mohapatra, U., Sahoo, T. R., & Sethi, D. (2017). Impact of Climate Change on Agriculture in India. *RashtriyaKrishi*, 12, 4–8.
- Pathak, H., & Aggarwal, P. K. (2012). *Low Carbon Technologies for Agriculture: A Study on Rice and Wheat Systems in the Indo-Gangetic Plains*. New Delhi, India: Indian Agricultural Research

Institute.

- Pati, S., Rubina, K.; Kundu, D., Pal, B., Saha, B., Hazra, G.C. (2017). Impact of Global Climate Change on Agriculture. In *Indian Farmer*, 4, pp. 363–367.
- Pingali, P., (2017). The green revolution and crop biodiversity. In: Hunter, D. (Ed.), *Handbook of Agricultural Biodiversity*. Routledge Press.
- Scheehle, E. A., & Kruger, D. (2006). Global anthropogenic methane and nitrous oxide emissions. *Energy Journal*, *SI2006(01)*. doi:10.5547/issn0195-6574-ej-volsi2006-nosi3-2
- Schmidt, J. H. (2008). Development of LCIA characterisation factors for land use impacts on biodiversity. *Journal of Cleaner Production*, 16(18), 1929–1942.
- World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. WHO; Geneva. (2003). Switzerland.
- Xu, X., Sharma, P., Shu, S., Lin, T.-S., Ciaia, P., Tubiello, F. N., Jain, A. K. (2021). Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. *Nature Food*, 2(9), 724–732. doi:10.1038/s43016-021-00358-x
- Yongchang Zhu, Muhammad Ahmed Waqas, Yu'e Li, XiaoxiaZou, Defeng Jiang, Andreas Wilkes, Xiaobo Qin, Qingzhu Gao, Yunfan Wan, GanjurjavHasbagan, (2018), Large-scale farming operations are win-win for grain production, soil carbon storage and mitigation of greenhouse gases, *Journal of Cleaner Production*, (172).
- Yoshikawa, N. (2010). Report on carbon footprint of rice: Journal of life cycle assessment. *Journal of Life Cycle assessment*, 75, 152-163.

DEALERS OUTLOOK TOWARDS VARIOUS INSECTICIDE BRAND AND CONSTRAINTS FACED BY ONION GROWERS IN AMRELI DISTRICT

N. G. Savaliya¹, L. R. Dubey², N. V. Faldu³ and V. R. Chudasama⁴

^{1,2,3&4} College of Agribusiness Management, S.D.A.U., Sardarkrushinagar-385506
Dist: Banaskantha (Gujarat)
Email : laxmirani.d@sdau.edu.in

ABSTRACT

Onion (*Allium cepa* L.; Family: Amaryllidaceae) is one of the most important commercial vegetable crops. Onion is a cool season crop. India stands at second position in onion production. In India, Gujarat stands at second position in onion cultivation. The present study has been under taken in Rajula, Savar Kundla, Khambha and Dhari talukas of Amreli district, as all four talukas have higher areas under onion cultivation. A multistage sampling technique was adopted to select the districts, talukas, and villages. The study was mainly based on primary data, which were collected through personal interviews with the help of a structured survey schedule. Generally, most of the growers preferred to purchase insecticides by dealer's recommendation. It was also observed that across different insecticide companies dealer's margins varied from 10 to 17 per cent. The majority of the onion dealers have business experience of 11 to 15 years. The most important factor considered by dealers for selling onion insecticides was reported price followed by other factors i.e. quality and brand image. Onion dealers' major expectations from insecticide companies were reported as increasing margins and farmer satisfaction. The major constraints faced by onion growers during the purchase of insecticides were high prices followed by unavailable on time, and low effectiveness of insecticides, whereas for dealers competition among them was the major constraint. Companies should plan for effective field demonstrations, so that, onion growers can understand the difference between poor and good quality insecticide and important steps to be taken care of before use. Companies should also keep growers updated with the latest schemes and benefits launched from time to time.

Key words : Dealer's outlook, Dealer's margin, Likert scale, Constraints, Garrett's ranking, Onion and Growers

INTRODUCTION

Agricultural chemicals are vital to our welfare and the protection of the health of our families and pets. Unless and until, better more efficient, and more cost-effective means of

pest control are developed, pesticides will remain a major weapon in our constant battle against pests. Indian growers need to be aware of the latest developments in this sector (John Kent, 1992). About, 2 million tonnes of pesticides are utilized per annum

worldwide and increasing rapidly whereas China is the major contributing country, followed by the USA and Brazil. However, by the year 2020, global pesticide usage has been estimated to increase up to 3.5 million tonnes. India is the leading exporter of pesticide to Brazil, USA and Bangladesh with quantity 129942 million MT, 85577 million MT and 36618 million MT respectively. Apart from fertilizers, pesticides played an important role in the green revolution during the last five decades. Indian exports of agrochemicals have shown impressive growth over the last five years (DPPQs, 2022).

India ranks second in the production of vegetables followed by China. India produced 137.99 million MT of vegetables in the year 2021. China is in the top of the charts by producing 600.01 million MT of vegetables (2021) in the world. India's total production of vegetables was recorded as 191769 MT in an area of 10353.88 ha in the year 2019-20. In the country's total production, West Bengal produces 29293.24 MT in the area of 1496.07 ha, Uttar Pradesh produces 27195.17 MT in the area of 1274.80 ha, Madhya Pradesh produces 19144.37 MT in an area of 967.23 ha, followed by Bihar, Maharashtra, Gujarat, Tamil Nadu, Andhra Pradesh, etc. In the year 2021, vegetable's primary production for the world was reported as 1154 million MT. Tomatoes and onion production are reported as the highest globally. The global vegetable production in the year 2021 showed that approximately 189.13 million metric tonnes of tomatoes and 106.59 million metric tonnes of onion were produced worldwide (www.statista.com).

Onion (*Allium cepa* L.; Family: *Amaryllidaceae*) is one of the most important commercial vegetables. Onion production in China is 24,966,366 tonnes in an area of

1,128,970 ha with a yield of 22,114.3 Kg/ha. India produces 22,819,000 tonnes of onions under an area of 1,220,000 ha with the yield of 18,704.1 Kg/ha. The total production of onion in India is 26.15 million Tonnes in an area of 1.43 million hectares with yield of 16875 (Kg/ha) in the year 2019-20, which is the highest production and area in the last 20 years [ATLASBIG (2020)]. The total production of onions is 228.19 lakh tonnes and 268.55 lakh tonnes in the year 2018-19 and 2019-20 respectively. The major share is occupied by the Maharashtra state, and it produced 80.47 lakh tonnes and occupied 35.26 per cent share in 2018-19 and produced 113.63 lakh tonnes and occupied 43.31 per cent share in 2019-20. Gujarat produced 11.11 lakh tonnes and occupies 4.87 per cent share in 2018-19 and produced 12.43 lakh tonnes and occupied 4.63 per cent share in 2019-20 [AGRICOOOP (2020)]. In Gujarat, the highest production of onion is in the Bhavnagar district with a production of 1191400 MT and productivity of 25.90 MT/ha in an area of 46000 ha and Amreli district is having production 400350 MT and productivity of 25.50 MT/ha in an area of 15700 ha (Anon., 2022^d). The present study was undertaken to know the dealer's outlook, to find out major promotional measures followed by insecticide companies, and constraints faced by onion growers and dealers.

MATERIALS AND METHODS

The study was mainly based on primary data and a multi-stage sampling method was adopted as an appropriate sampling procedure for the study. In the first stage, Amreli district was purposively selected for the study. Amreli district had 2nd rank in area and production of onion crop in overall

Gujarat state. In the second stage, four talukas from Amreli district were selected purposively i.e., Rajula, Savar Kundla, Khambha and Dhari talukas as these four talukas have higher areas under onion crop cultivation. In the third stage, from each taluka, five villages were selected and from each village, six onion growers were selected randomly, and thus a total of 120 onion growers were selected for the study. The dealers were selected based on the extent of purchase of insecticides used in onion crop by the growers and hence, a total of 20 dealers were selected to obtain the information required for the study. In order to analyze the various types of promotional measures carried out by different insecticide companies for onion growers, a personal interview method was employed with the help of a structured schedule (Patterson, 2006). The schedule contained statements under

the following heads viz. major influencing factors which were considered by the onion growers in purchasing insecticides were considered as dealers, field officer, fellow farmer, progressive farmer, media and own experience etc. Various promotional activities carried out by the insecticides companies as per onion growers were considered as farmer meeting, radio and television, field demonstrations, fairs and exhibitions, wall paintings, posters, banners, social media, and advertisements/newspapers. To explore the dealers outlook about insecticides companies in the study area various parameters were used i.e., distribution of insecticide dealers according to their business experience, dealers association with various onion insecticide companies over the year and dealer's margin across the different brands of onion insecticides.

$$\text{Dealers margin} = \frac{\text{per unit sales price of dealers} - \text{per unit purchase price of dealer}}{\text{unit purchase price of dealers}} \times 100$$

Likert scale technique

The dealer's rating for different insecticides on various parameters was found out by using Likert scale techniques and various parameters were used i.e., price, quality, brand image, demand, time availability, promotional scheme, and credit policy.

Likert scale was recorded on a 5-point Likert scales of 1- Highly disagree and 5- Highly agree. After gathering all the completed schedules from the respondents, the total responses for each item were gathered and tabulated. In order to use the Likert scale for interpretation, a weighted mean to represent each question will be computed. To compute the weighted mean, each value must be multiplied by its weight. Products should then

be added to obtain the total value. The total weight should also be computed by adding all the weights. The total value is then divided by the total weight. Statistically, the weighted mean is calculated by using the formula mentioned below:

Cumulative Score =

$$(F_1X_1 + F_2X_2 + F_3X_3 + \dots + F_nX_n)$$

Where,

F_n = Weight given to each response

X_n = Number of responses

$$\text{Weighted Mean} = \frac{(F_1X_1 + F_2X_2 + F_3X_3 + \dots + F_nX_n)}{\text{Total number of responses } (X_t)}$$

Where,

X_t = Total number of responses

Garrett's ranking technique

The Garrett's ranking technique was used to analyse the constraint faced by growers and insecticides dealers and similar method was adopted by Kumar *et al.*, (2019), Sharma *et al.*, (2020) and Zalkuwi *et al.*, (2015). As per this method, respondents were asked to assign the rank for all factors and the outcome of such ranking was converted into

score value with the help of the following formula:

$$\text{Percent position} = \frac{100(R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} = Rank given for the i^{th} variable by j^{th} respondents

N_j = Number of variables ranked by j^{th} respondents

RESULTS AND DISCUSSION

1. Major factors considered by the onion growers in purchasing insecticides

Table 1: Factors considered by growers in purchasing of insecticides (n=120)

Sr. No.	Particulars	Frequency	Percentage
1.	Dealers	83	69.17
2.	Marketing officer	06	05.00
3.	Fellow farmer	54	45.00
4.	Progressive farmer	53	44.17
5.	Media	01	00.83
6.	Own experience	60	50.00
7.	Others	03	02.50

The results showed that 69.17 per cent onion growers purchased onion insecticides as per dealer's suggestion followed by 50.00 per cent onion growers purchased the onion insecticides on their own experience. Similarly, 45.00 per cent of farmers purchased onion insecticides according to the advice of fellow farmer followed by 44.17

per cent of growers consulted progressive farmers and 05.00 percent of growers consulted marketing officer. Only 02.50 per cent followed other people who were working in agricultural branches or insecticide companies of their relatives and 00.83 per cent onion growers have purchased onion insecticides based on media like television and radio etc.

2. Promotional activities carried out by the companies

Table 2 : Promotional activities carried out by the companies as per onion growers (n=120)

Sr. No.	Particulars	Frequency	Percentage
1.	Farmer meeting	80	66.67
2.	Radio & Television	41	34.17
3.	Field demonstration	90	75.00
4.	Fair and exhibition	53	44.17
5.	Wall painting, Poster, Banner	18	15.00
6.	Social media	38	31.67
7.	Advertisement/News paper	40	33.33

3. Business experience of onion insecticides dealers

Table 3 : Distribution of onion dealers according to their business experience (n=20)

Sr. No.	Business experience	Frequency	Percentage
1.	Up to 5 years	02	10.00
2.	6 to 10 years	04	20.00
3.	11 to 15 years	07	35.00
4.	16 to 20 years	04	20.00
5.	Above 20 years	03	15.00
TOTAL		20	100.00

The onion dealers were categorized into five groups based on their business experience. The highest per cent (35.00%) of onion dealers belonged to 11 to 15 years category followed by 6 to 10 years and 16 to 20 years category (20.00%), above 20 years category

(15.00%), only a few of them belonged to the category of up to 5 years (10.00%). This pattern of business experience showed that the majority of onion dealers belonged to the 11 to 15 years of business experience category.

4. Dealers association with insecticides companies

Table4 : Dealer association with insecticide companies over the year (n=20)

Sr. No.	Dealer association	Frequency	Percentage
1.	Less than 2 years	01	05.00
2.	2 to 5 years	01	05.00
3.	6 to 10 years	04	20.00
4.	11 to 15 years	07	35.00
5.	More than 15 years	07	35.00
TOTAL		20	100.00

The results showed that 35.00 per cent of onion dealers associated from more than 15 years followed by 35.00per cent of onion dealers associated from 11 to 15 years, 20.00 per cent of onion dealers associated from 6 to

10 years, 05.00 per cent of onion dealers associated less than 2 years and 05.00per cent onion dealer associated with 2 to 5 years. This result showed the emergence of day-to-day new dealerships with new insecticide companies.

Table 5 : Dealer association with different insecticide companies over the year (n=20)

Dealer association	UPL	Agrichem Life Science Private Limited	PI Industries Limited (PI)	GSP Crop Science Private Limited	Dhanuka Agritech Limited	Dharmaj Crop Guard Limited
Less than 2 years	00	01	00	01	06	00
2 to 5 years	02	10	07	04	04	06
6 to 10 years	05	09	05	07	05	14
11 to 15 years	06	00	04	06	05	00
More than 15 years	07	00	04	02	04	00

The results showed that 07 dealers associated with United Phosphorus Limited insecticide company for more than 15 years, 10 dealers associated with Agrichem Life Science Private Limited insecticide company for 2-5 years, 07 dealers associated with PI Industries Limited insecticide company for 2-

5 years, 07 dealers associated with GSP Crop Science Private Limited insecticide company for more than 6-10 years, 06 dealers associated with Dhanuka Agritech Limited insecticide company for less than 2 years and 14 dealers associated with Dharmaj Crop Guard Limited insecticide company for more than 6-10 years.

5. Different brand wise dealer's margins in onion insecticide marketing

Table 6 : Dealer's margin across the different brands of insecticides used in onion crop

(n=20)

Sr. No.	Companies name	Margin (%)
1.	United Phosphorus Limited	12.57
2.	Agrichem Life Science Private Limited	17.18
3.	PI Industries Limited (PI)	13.55
4.	GSP Crop Science Private Limited	14.63
5.	Dhanuka Agritech Limited	10.98
6.	Dharmaj Crop Guard Limited	13.88

The results revealed that dealers were getting 17.18 per cent margin on Agrichem Life Science Private Limited, 14.63 per cent on GSP Crop Science Private Limited, 13.88 per cent on Dharmaj Crop Guard Limited., 13.55 per cent on PI Industries Limited (PI),

12.57 per cent on United Phosphorus Limited. and 10.98 per cent on Dhanuka Agritech Limited Company's onion insecticides marketing. UPL and Dhanuka Agritech Limited had the lowest margin among these companies.

6. Dealer's rating for insecticides used in onion on various parameters

Table 7 : Dealer's rating for onion insecticides on various parameters

(n=20)

Rating parameter	Always (5)	Mostly (4)	Often (3)	Rarely (2)	Never (1)	C. S.	Mean	Rank
Price	5(25)	8(32)	4(12)	1(2)	00	71	3.55	I
Quality	4(20)	8(32)	3(9)	1(2)	00	63	3.15	II
Brand image	3(15)	8(32)	4(12)	00	00	59	2.95	III
Demand	2(10)	8(32)	4(12)	00	00	54	2.70	IV
Time availability	4(20)	4(16)	2(6)	00	00	42	2.60	V
Promotional scheme	2(10)	2(8)	3(9)	5(10)	00	37	1.85	VI
Credit policy	4(20)	2(8)	2(6)	00	00	34	1.70	VII

(Always-5, Mostly-4, Often-3, Rarely-2, Never-1)

(Note: Figure in parenthesis are individual scores obtained through multiplication of frequency and weight)

The above table indicated that price (1st) was the first and most important factor for growers while purchasing insecticides followed by quality (2nd), brand image (3rd), demand (4th), time availability (5th), promotional scheme (6th), and credit policy (7th). Brand image plays an important role at

the time of the sale of insecticide to growers. More demand and lower-priced insecticides give more margin to dealers. This finding is in accordance with the finding of Reddy *et al.* (2015), those were also reported that the quality parameter ranks second according to the dealer's rating.

7. Expectations of dealers from the company

Table 8 : Expectations of dealers from insecticides companies

Sr. No.	Expectation	Garrett's Score	Rank
1.	Increasing margin	56.50	I
2.	Grower's satisfaction	50.85	II
3.	Easy and on-time availability	50.75	III
4.	More promotional measures by the company	48.25	IV
5.	Bonus	41.65	V

The expectations of onion growers from the company are presented in Table 8. Increasing margin ranked first which shows that the dealers also expect more margin from the company and more profit in business and grower's satisfaction ranked second which shows onion growers are satisfied with the product followed by third-

ranked was easy and on-time availability of insecticides because at the time of cultivation season, the onion insecticides were available within this time period, more promotional measures by company ranked fourth which showed that the dealers also expect highest production varieties from insecticides company to increase the exposure of the

brand and also increase growers output and last fifth rank was bonus like tour and gifts from the companies. From the above

discussion, it revealed that most of the respondents have expectations of increasing margins from the companies.

8. Constraints faced by growers during the purchase of insecticides

Table 9 : Constraints faced by onion growers during the purchase of insecticides (n=120)

Sr. No.	Constraints faced by growers	Garrett's Score	Rank
1.	High price of insecticides	57.91	I
2.	Unavailable on time	57.11	II
3.	Low effectiveness of insecticides	54.54	III
4.	More distance to the point of purchased insecticides	53.17	IV
5.	Wrong information	53.05	V
6.	Packaging	47.81	VI
7.	No discount	23.54	VII

The results showed Garrett's mean score and ranking of various constraints faced by growers. Among the seven problems, the high price of insecticides was given the first rank followed by unavailable on time (second rank), low effectiveness of insecticides (third rank), more distance to point of purchase

insecticides (fourth rank). Other constraints faced by the onion growers were wrong information (fifth rank), packaging (sixth rank), and no discount (seventh rank). Similar results have been reported by Prajapati *et al.* (2016), that the higher price of insecticides was the major constraint faced by growers.

9. Constraints faced by growers during the use of insecticides

Table 10 : Constraints faced by onion growers during the use of insecticides (n=120)

Sr. No.	Constraints faced by growers	Garrett's Score	Rank
1.	Hazardous effect	55.26	I
2.	Lack of knowledge about the use of insecticides	50.56	II
3.	Adulteration and poor-quality of chemicals	48.50	III
4.	Effect of toxicity on crop residue	47.69	IV
5.	Damage to the crop plant	45.99	V

The results of the study showed that onion growers faced major constraints as the hazardous effect of insecticides on human health followed by a lack of

knowledge about the use of insecticides, adulteration and poor quality of chemicals, effect of toxicity on crop residue, and damage to the crop plant.

10. Constraints faced by dealers during the selling of insecticides

Table 11 : Constraints faced by dealers during the selling of insecticide used in onion crop

		(n=20)	
Sr. No.	Constraints faced by dealers	Garrett's Score	Rank
1.	Competition among dealer	51.90	I
2.	Fluctuation of selling on seasonal basis	51.35	II
3.	Less number of brands available	51.20	III
4.	Lack of staff	50.10	IV
5.	Lack of promotional scheme	49.15	V
6.	High cost of advertisement	45.30	VI

The results showed Garrett's mean score and various ranks for constraints faced by dealers during the selling of insecticides, whereas, competition among dealers was given the first rank followed by fluctuation of selling on seasonal basis (second rank), less number of brands available (third rank), lack of staff (fourth rank). Other constraints faced by the onion growers were lack of promotional scheme (fifth rank) and high cost of advertisement (sixth rank).

CONCLUSION

The study found that most of the onion growers purchased onion insecticides as per the dealer's suggestion. Most of the onion growers responded that companies organized field demonstrations and leveraged farmer meeting platforms for promotional purposes. The results revealed that dealers were getting good margins from Agrichem Life Science Private Limited and GSP Crop Science Private Limited. The majority of the onion dealers have business experience of 11 to 15 years. The most important factor considered by dealers for selling onion insecticides was reported price

followed by other factors *i.e.* quality and brand image. According to the study dealer's major expectations from the insecticide, companies were increasing margin and more promotional measures by the company followed by farmers' satisfaction, easy and timely availability and bonus. The results of the study showed that onion growers faced major constraints during the purchase of insecticides as the high price of insecticides followed by low effectiveness insecticides and unavailability on time whereas dealers faced major constraints as competition among dealers followed by the fluctuation of selling on a seasonal basis, lack of field staff, and less number of brands available. Companies should plan for effective field demonstrations, so that, onion growers can understand the difference between poor and good quality insecticide and important steps to be taken care of before use. Companies should also keep growers updated with the latest schemes and benefits launched.

REFERENCES

AGRICOOOP (2021). State wise area and production of vegetable crops in India.

- Available at https://agricoop.nic.in/sites/default/files/202021%20%28Final%29%20Advance%20Estimates%2020-21%20%281%29_0.pdf accessed on February 3rd 2023.
- Anonymous, (2022). Annual Report. Directorate of Plant, Protection, Quarantine and Storage, Govt. of India, New Delhi.
- Anonymous, (2022^d) District wise Area and Production of onion during the Year 2021-22. Available at https://doh.gujarat.gov.in/Images/directorofhorticulture/pdf/statistics/ap_2022.pdf last accessed on 28th January, 2023.
- ATLASBIG (2020). Production of onion in the world. Available at <https://www.atlasbig.com/en-in/countries-by-onion-production> accessed on 29th January, 2023.
- Kent, J. (1991). Education and training in farm chemical management. Proc. conf. Agriculture, Education and Information Transfer. Murrumbidgee College of Agriculture, 1991.
- Kumar, A. J. A. Y.; Yadav Sumita, M. K. and Rohila, A. K. (2019). Constraints faced by the farmers in production and marketing of vegetables in Haryana. The Indian Journal of Agricultural Sciences. 89(1): 153-160.
- Patterson, I. (2006). Trust and technology adoption in Australian agribusiness supply chains: a gap analysis approach. Doctoral dissertation, University of Southern Queensland. 15(4): 112-116.
- Prajapati, V. V.; Gohil, C. A. and Tunvar, M. A. (2016). Constraints Faced by farmers in purchase of agrochemicals in vegetable crops. *Gujarat Journal Extension Education*. 27(1): 63-66.
- Reddy, V.; Seema and Radha, Y. (2015). Dealers' perception on various brands of agrochemical products and their promotional activities in Nalgonda district of Telangana State. *Journal of Research Professor Jayashankar Telangana State Agricultural University*. 43(1/2): 97-99.
- Sharma, M.; Suryavanshi, P. and Singh, Y. (2020). Garrett's ranking analysis of constraints influencing off season vegetable growers in District Mohali. *Journal of Pharmacognosy and Phytochemistry*. 9(2): 46-49.
- STATISTA (2021). Global Production of Vegetables by Varieties in Year 2021. Available at <https://www.statista.com/statistics/264065/global-production-of-vegetables-by-type/> > accessed on 30th January, 2023.
- Zalkuwi, J., Singh, R., Bhattarai, M., Singh, O. P. and Rao, D. (2015). Analysis of constraints influencing sorghum farmers using Garrett's Ranking Technique; A comparative study of India and Nigeria. *International Journal of scientific research and management*. 3(3): 2435-2440.

THE NUDGED-BELIEF: TRIGGER TO PREVENTIVE SBCC ACTION AGAINST COVID-19

Sunaina Dua¹ and Sarita Anand²

^{1&2}Dept of Development Communication & Extension, Lady Irwin College, Delhi University.

*Email : sunaina.batra@lic.du.ac.in, sa_anand2007@yahoo.com

ABSTRACT

The Covid-19 pandemic continues to affect humanity incessantly. Even though, vaccine science has been able to lower the curve, yet people's behaviour is far from desired. To address this gap a strategic SBCC strategy is needed to provide a blueprint of manoeuvres needed to motivate individuals to contemplate, prepare, act and maintain preventive behaviours. The current research, carried out with urban adults in Delhi-NCR explored the synergistic approach "Nudged-belief", combination of Health Belief Model and Nudge theory for behaviour change actions. Research results indicated that majority of the participants were well aware of the preventive actions to be taken. Nearly hundred percent of them confirmed that when nudged to take the action, there are high chances they would go for it. Approximately 90% of them confirmed using a sanitizer, if placed at their building entry; wearing mask before going out, if kept handy or following social distancing norms, if a circle was drawn at grocery store. Participants believed that when visibility of preventive actions to be taken is increased, they would follow them. Thus, study reaffirms the potential of nudging in behaviour change. The study recommends innovative-nudging and creative-communication to motivate people to adopt preventive actions, thereby managing the pandemic's destructive mode with science of human behaviour.

Keywords : *Preventive action, Corona, SBCC, Health Belief, Nudge, Innovative nudging, Nudged-Belief*

INTRODUCTION

According to World Health Organisation (2020), Coronavirus disease (COVID-19) is an infectious disease that is spread by the lately discovered, novel coronavirus. As per WHO (2020), 'the best way to prevent and slow down transmission is be well informed about the COVID-19 virus, the disease, its causes and how it spreads'. It has been suggested by WHO to indulge in frequent hand washing or to use an alcohol based sanitizer frequently and avoiding to touch your face for as long as

possible. CDC (2020), reiterates, 'Everyone should wear a mask in public settings and when around people who don't live in your household, especially when other social distancing measures are difficult to maintain'. Despite the preventive actions in place and being advocated extensively, the entire world has been hit by the virus and is recovering at its own pace today.

As the world has witnessed lately appropriate vaccinations to alter the Covid 19 trajectory, but still prevention practices and remedial actions have to be relied upon for guarding off

the virus. Public behaviour that is compliant with WHO guidance has been recognized as a critical element in reducing virus transmission (UNDP, 2020).

India & Covid 19:

As a country that started really smooth and even appreciated globally for its efforts to contain the virus, ironically today, it is one of the nations who has submitted to the virus crash. As per The Times of India (September, 10, 2020), India's Covid tally rose to over 44 lakhs as the country registered 95,735 cases, inching closer to the grim reality of recording one lakh fresh cases in a day during the second wave. Today the nation stands in awe of yet another variant that may manifest as the fourth wave. With majority of the residents vaccinated or have gained herd immunity, Covid appropriate behaviours certainly cannot be taken lightly yet. Given the various socio-economic factors, such as increased number of migrants, unemployment, a dipping economy coupled with lack of awareness, the recovery path seems an arduous game for the country. A study carried out in Kerala in India by Jose et al (2020), found that more than ninety percent of the participants followed the recommendations by government to combat COVID 19, and more than half of them updated themselves about COVID 19 several times a day.

Gap between awareness & actions

The problem that the current pandemic behests is that despite awareness of actions to be taken, regrettably actions are being threatened. To address this gap what is needed is a dedicated and strategic SBCC strategy that can provide a blueprint of manoeuvres needed to motivate one to contemplate, prepare, act and maintain his/her preventive behaviours against Covid-19.

There is a need to focus on human behaviour and try and understand the heuristics and biases involved in following the desired behavioural actions. Bavel et al (2020), further recommend that insights from the social and behavioural sciences can be used to help align human behaviour with the recommendations of epidemiologists and public health experts.

Theoretical Framework:

The study proposes here, something that can work, which is a combination of the Health Belief Model and the Nudge theory. The synergistic approach the "Nudged-belief" can thrive the pandemic. Each one of us being aware of the susceptibility, the severity and the preventive actions for Covid-19 and the perceived barriers in taking up those actions, we all need cues to act; and a nudge can be a crucial cue to action prompting us to deem the "Nudged-belief" as imperative (See figure 1).

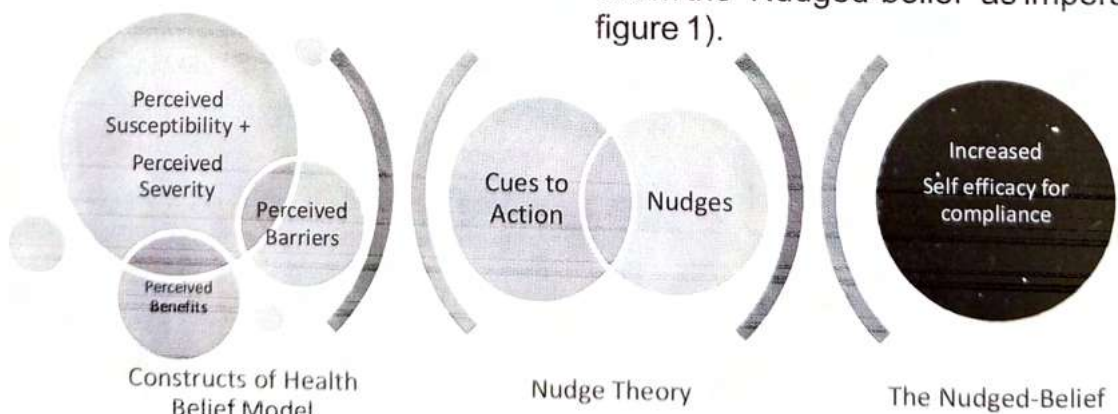


Figure 1 : Conceptual framework of the Study

Health Belief Model

Health Belief Model (HBM) theorizes six constructs predict health behavior (Champion & Skinner, 2008). Specifically, the model posits that people will take action to avert an ailment, if they regard themselves as susceptible to it (perceived susceptibility), if they deem that it could have serious consequences (perceived severity). Given the perceived susceptibility and perceived severity, if it is believed that a specific action can lead them to a reduced susceptibility and severity, and better outcomes (perceived benefits), then chances are the actions are encouraged, yet to continue with the actions, certain obstacles may be encountered (perceived barriers). A study done by Jose et al (2020) in Kerala state of India found that perceived susceptibility to be infected by the Corona Virus was more in two third of the respondents, whereas, perceived severity was less in forty four percent of the respondents and 55.7% felt that if infected it would be severe for them.

An advertisement of preventive behaviour, a talk by a health care provider, a poster or any media could then act as cue to the action that may motivate the person to take the desired preventive action. For instance, exposure to a campaign on H1N1 vaccine was positively related to vaccination behaviour in a study done by Jones, et al (2010).

As per Raamkumar, Tan & Wee (2020), the constructs of the HBM will be influenced by the interaction of information from news and media reports, government policy actions, and feedback from the public throughout the course of the outbreak. These act as cues to action.

The Nudge Theory

A nudge increases one's efficiency by making the desired action more approachable,

doable and simpler. Why a nudge? It is important to consider the use of nudges in the response strategies to assure prompt and sustained preventive action. The UK government's strategy is influenced by nudge theory, pioneered by the behavioural economist Richard Thaler and political scientist Cass Sunstein, which proposes behavioural "nudges": wash your hands, don't touch your face, don't shake hands with others, stay at home if you feel ill, and self-isolate if you have a continuous cough (Yates, 2020). A research carried out by Caris, M. in Netherlands has found that creative posters acting as nudges increased the use of an alcohol-based hand rub when the posters were shown next to dispensers (Green, 2020). Availability of a sanitizer dispenser at the apartment entry is a nudge, which will trigger you to sanitize your hands. Nudges that incite social distancing might include having circle marked on the ground outside/around/ near the grocery stores, markets etc., or having a painting of a six-foot ruler at the entrances of markets will remind the community members to keep safe distance from others. Within India, the Prime Minister (PM) frequently nudged the nation on staying at home, adhering to lockdown rules, improving immunity through yoga and Ayurveda and contributing to the PM-CARES fund (Debnath & Bardhan, 2020).

However, it must be realised that nudges activate good intentions, but people find it hard to follow through because of all the other influences on their behaviour that crowd out nudges on this occasion (Rigby, S., 2020). It is here when focus has to be on one's self efficacy against the background of his/her perceived susceptibility, severity, benefits and barriers, hence the theory of a Nudged-belief is recommended; where a nudge like a

cue to action can make an individual enhance his self-efficacy to comply with the desired action. According to the research published by Rigby (2020), while nudges increased respondents' intention to comply with guidelines to tackle COVID-19, they did not have the expected result of actually changing their behaviour.

MATERIALS AND METHODS

Thus, against the background of understanding if the concept of a 'Nudged-Belief', a fusion of the Nudge theory and the Health Belief Model, can actually work in the present case of the pandemic and drive an individual to abide by the desired behaviour, the current research was thought of. With the aim to understand people's perception about susceptibility and awareness about the pandemic, the researchers also endeavored to understand if a nudge could trigger them to take the desired preventive action. The Google form listed a series of nudges and the accompanying desired behaviours and tried to seek the perception of the respondents on

their self-efficacy to perform the desired behaviour. Primarily the study was carried out with 178 urban adults of India to know their perception about if a given nudge can accelerate a desired preventive behaviour.

Data Analysis

The frequencies and percentages were analysed to comprehensively arrive at deducing the major proposition of the efficacy of the 'Nudged-Belief' in the prevention against Covid 19. Quantitative analysis was done for this study to understand the responses to various nudges related to Covid-appropriate behaviours.

RESULTS AND DISCUSSION

The detailed findings are reported below.

Demographic Profile of the respondents

Since the current research targeted the adult population of India, hundred percent of the respondents were above 18 years of age. Nearly one fourth of them were in the age bracket of 18-25 years and 26-35 years respectively; whilst nearly 30% belonged to the age bracket of 36-45 years and a little

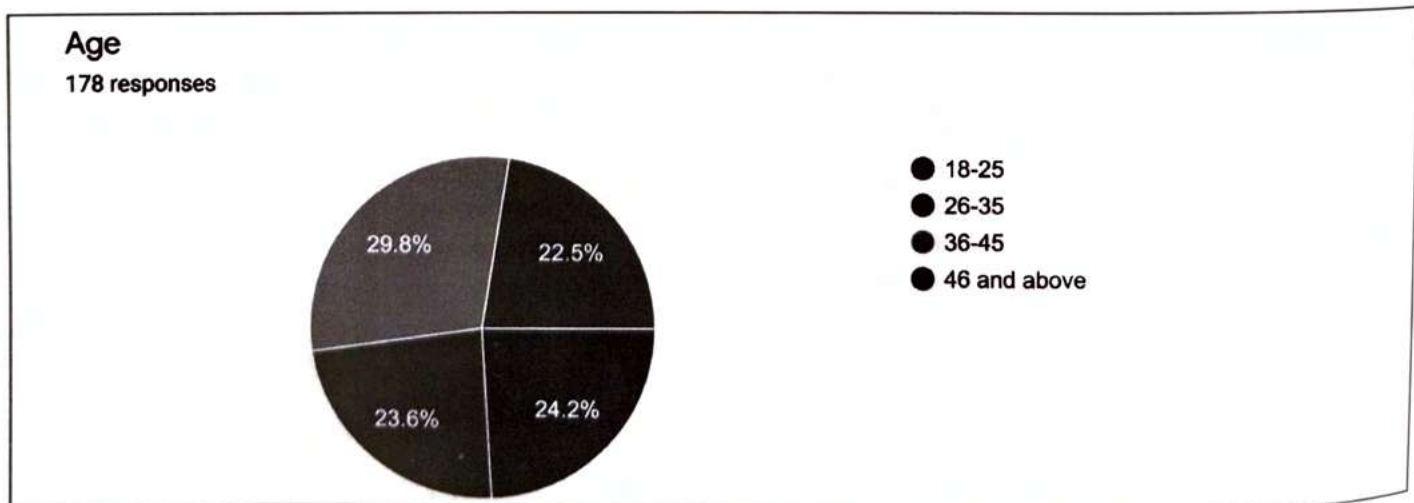


Figure 2: Distribution of Respondents by Age

more than 20% were above 46 years of age (See figure 2). Hence a mixed set of sample was reached out to have a holistic view of their self-efficacy compliance when nudged for a specific behaviour.

Majority of the respondents were females i.e.

nearly eighty three percent, whilst the remaining were males.

Majority of the participants, i.e. eighty percent of them resided in Delhi/NCR. Just about one fifth of the respondents belonged to other parts of India. (See figure 3).

Are you currently a resident of Delhi/NCR?

178 responses

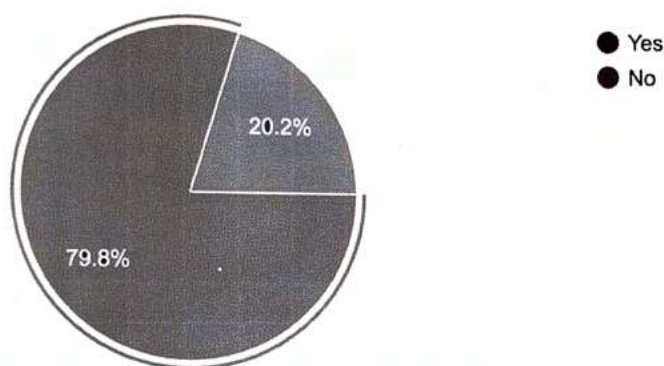


Figure 3 : Distribution of respondents by region

Perceived Susceptibility and Awareness of Preventive Behaviours pertaining to Covid 19:

When inquired if the respondents perceive themselves as susceptible to getting infected

from the virus almost cent percent of them agreed and confirmed, that anyone could succumb to the virus.

Nearly hundred percent of the responders affirmed that they were aware of the preventive behaviours against Covid-19.

Are you aware about the preventive behaviours against Covid-19

178 responses

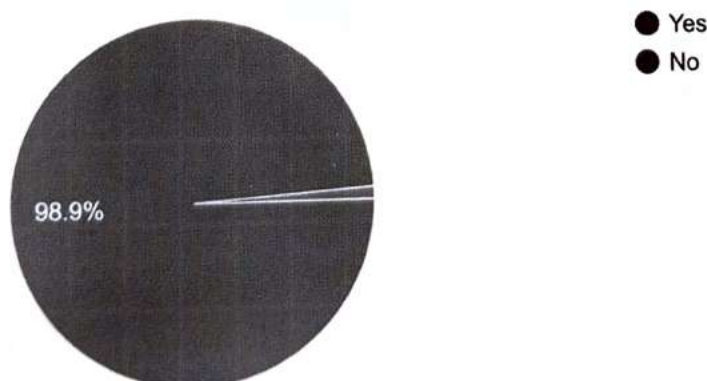


Figure 4 : Awareness about preventive behaviours against Covid 19

More than ninety percent of the respondents were aware of the preventive behaviours such as frequent handwashing, wearing a mask, social distancing, eating healthy and immunity enhancing diet.

A few respondents also reiterated maintaining hygienic environment at home, doing Yoga and Pranayam, exercising, being sensitive towards one's body temperature and staying at home for as long as possible as some of the preventive behaviours against Covid 19.

Nudges for Preventive behaviour:

Interestingly, majority of the respondents affirmed going for the preventive behaviour when encountered with a nudge to follow that

behaviour. The respondents were prodded with nudges that were doable, easy and cheap to avoid and tried to look at their compliance self-efficacy through their responses. The findings under this section are indeed encouraging and certainly advocate the theorem of the 'Nudged-Belief'. Listed below are compliance responses of the respondents when nudged to do a particular behaviour.

- Nearly ninety percent of the respondents confirmed that they would bother to use a sanitizer, if they see a sanitizer dispenser when they enter from outside to their apartment/house building (See figure 5).

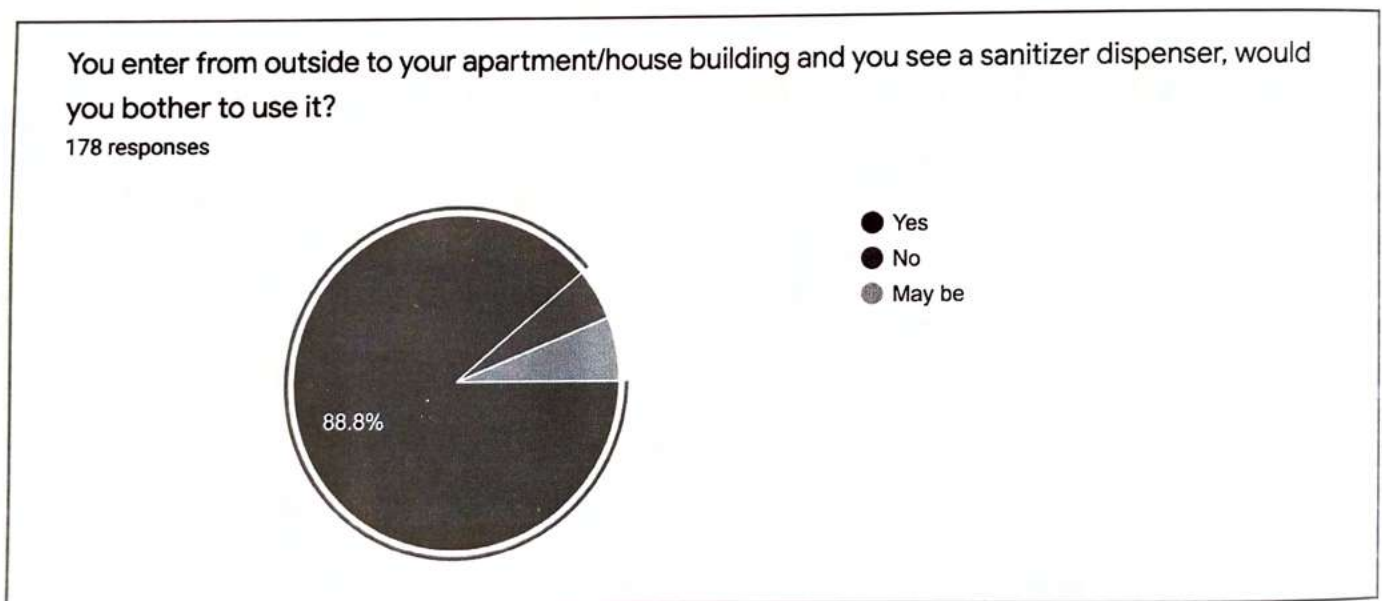


Figure 5: Compliance to use a Sanitizer if seen at the apartment entry

- Similarly, 93% of the respondents also confirmed that if a sanitizer bottle is kept at the main door or entry of the house, they would stop to sanitize their hands the moment they enter their house from outside (See figure 6).

You keep a sanitizer bottle at the main door of the house. The moment you enter from outside you sanitize your hands.

178 responses

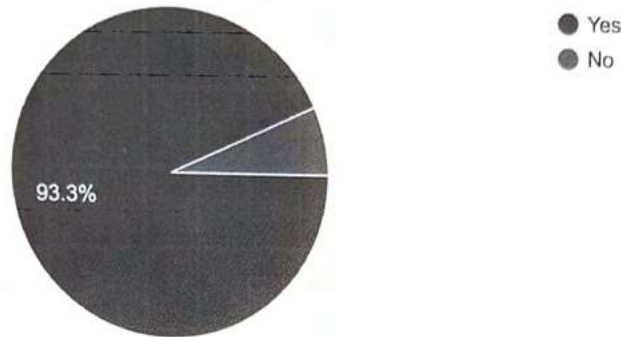


Figure 6: Compliance to use sanitizer if kept at house entrance

- An overwhelming 97% of the respondents confirmed that if they would keep their masks handy at the exit/entry of the house, they would not forget to wear them when they have to venture out

You hang/keep your mask handy so that when you have to venture out, you do not forget to wear it.

178 responses

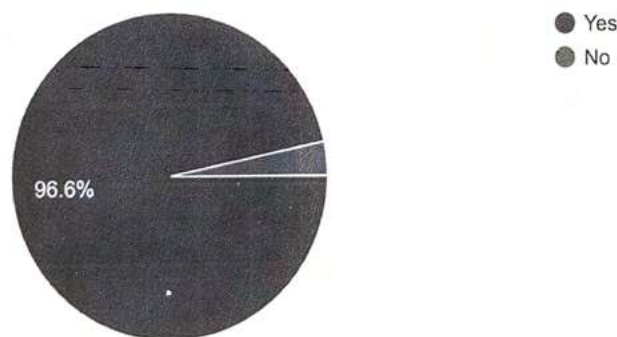


Figure 7: Compliance to wear a mask if kept handy

- If a family member reminds one of washing their hands, slightly more than one fourth of the respondents agreed to the reminders and washed their hands, whilst a little less than half of them asserted that if was the other way round where they were giving constant reminders to their family members to wash their hands (See figure 8). In either case reminders seem to be working in both cases and leading to increased hand washing by individuals within a household.

A family member reminds you to wash your hands and you wash your hands.

178 responses



Figure 8 : Compliance to hand washing when reminded

- Almost cent percent of the respondents agreed that they would follow social distancing norms, if they saw circles drawn at distance at a grocery store

(See figure 9). A circle drawn was acting as a nudge and motivated the respondents to maintain the requisite distance.

You go to a grocery store, and see a circle drawn on the ground to maintain social distance. You go ahead and maintain the distance.

178 responses

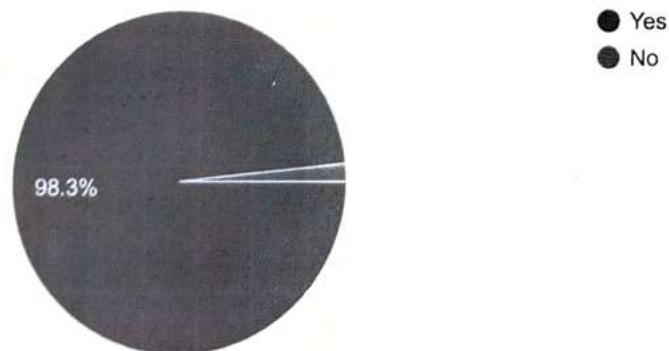


Figure 9 : Compliance to follow social distancing, if a circle of physical distancing is seen at a grocery store

- An encouraging 97% also agreed that when hiring a cab or using a public elevator, if they happen to read the

safety manual with respect to the do's and the don'ts for Covid-19 prevention, they would be more cautious (See figure 10).

You are in a hired cab/ a public elevator and happen to read about the do's and don'ts in the safety manual. You become more cautious.

178 responses

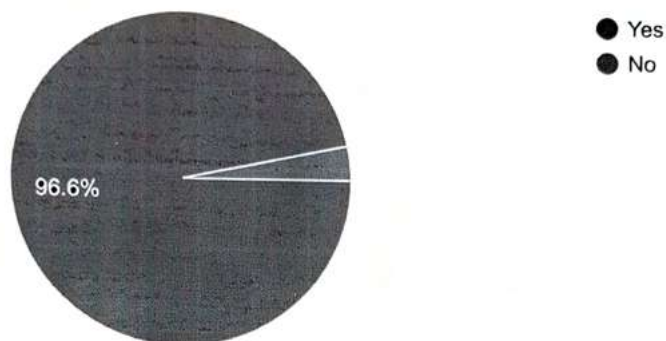


Figure 10 : Compliance to be cautious in a cab/elevator, if happen to read a safety manual

- Aarogya Setu is a mobile application developed by the Government of India to connect essential health services with the people of India in combined fight against COVID-19. (App description as on Play Store). It was interesting to learn that 97% of the

respondents confirmed that if their Arogya Setu App showed close to 50 cases within a 1kilometer radius, they would avoid going out, unless absolutely necessary (See figure 11). Thus, it can be said that increased cases on the app can nudge the respondents to stay indoors.

Your Arogya Setu App clearly indicates close to 50 cases within the 1 km radius, and you had to venture out. You:

178 responses

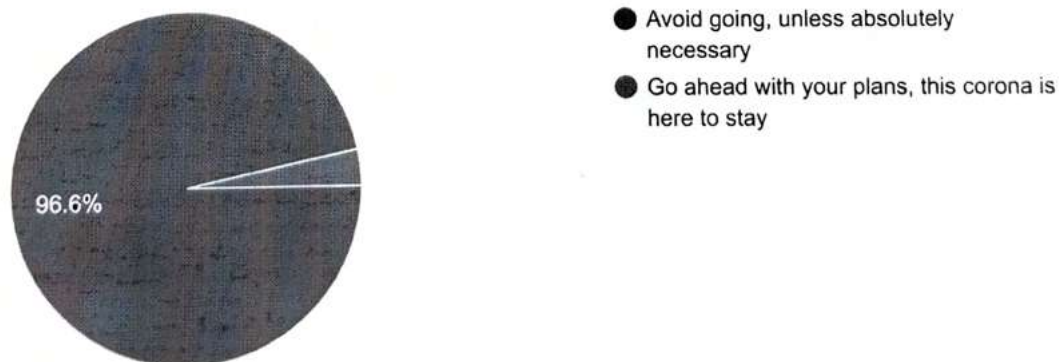


Figure 11: Compliance to stay indoors, if Arogya Setu App indicates high number of cases

- A feared nudge of seeing people around walking freely without masks would also motivate the respondents to ensure that

they are at least wearing theirs'. Almost 99% of the respondents confirmed to this (See figure 12).

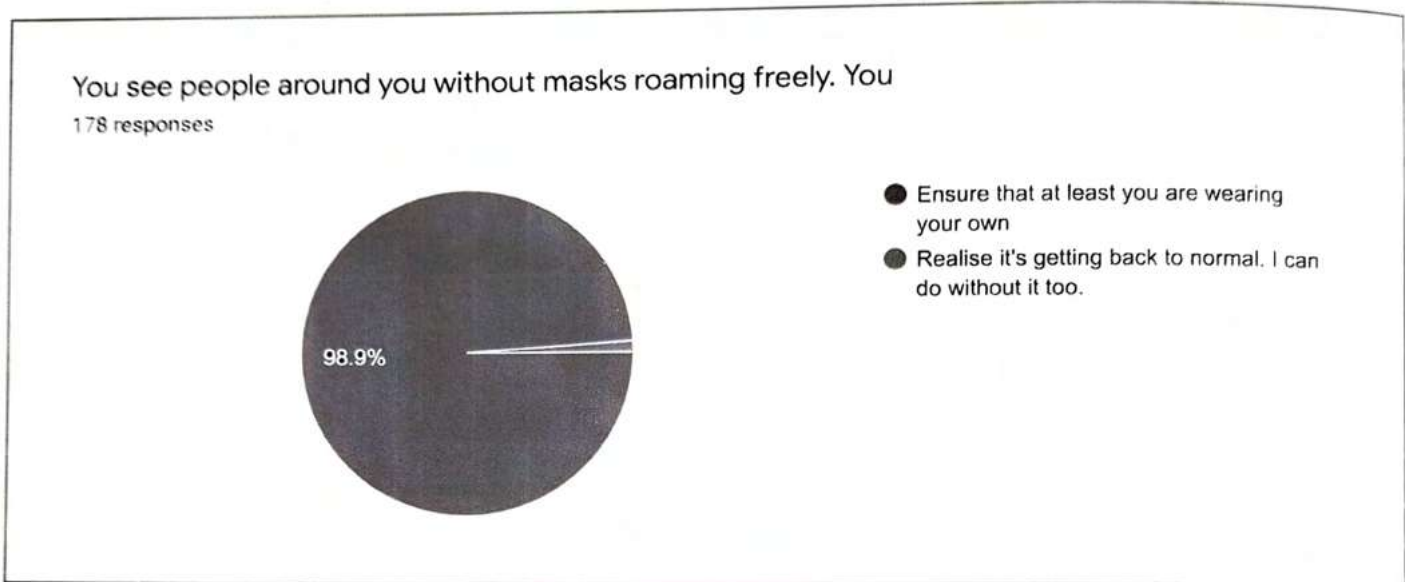


Figure 12 : Compliance to wear a mask, if fearful of seeing others without one

- Since the respondents are well aware about preventing any sort of contact with people or exchange of things/items, they ensured that all items are delivered at home and hence almost 60 percent specifically for cashless transaction only. A little less than one third of them mentioned avoiding cash transactions as long as it's not an urgency. For the remaining ten percent, going cashless was not possible at all. Hence compliance to go for cashless transactions seem to be higher, if eased options of e-wallets and availability of multiple card acceptance was indicated by the shopkeepers.

The list above clearly indicates that one will try to comply with a behaviour if a

nudge is easily visible and doable; thus, leading to a compounding effect of one's self efficacy for compliance of desired preventive actions against Covid-19.

Sustaining the 'Nudged Belief'

It is important that a nudge continues to poke an individual to abide by the desired action. Afterall, it is only then that the compliance self-efficacy shall multiply. For that, a nudged message must come from a reliable source. Almost cent percent of the respondents confirmed to practicing preventive behaviours, when information or prevention advisory from reliable sources like WHO, Ministry of Health etc. was received (See figure 13). This is specifically relevant, given the interspersed Covid-19 pandemic with an infodemic.

You get information or prevention advisory from reliable sources like WHO, Ministry of Health etc.
You read them and try to practice those behaviours.

178 responses

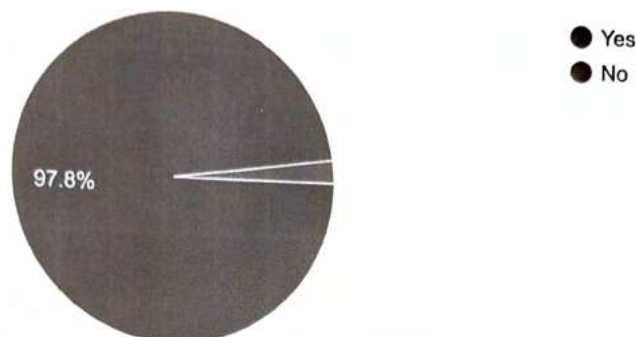


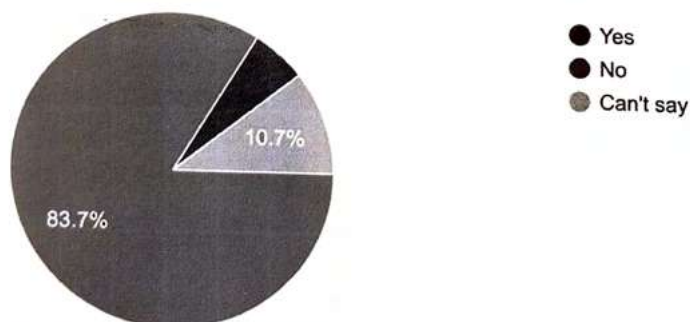
Figure 13: Compliance to preventive behaviours and reliability of information

Further, approximately 84% of the respondents confirmed that repeated visibility of messages around them nudged them or motivated them to adopt preventive

behaviours against Covid-19 (See Figure 14). When messages are reinforced again and again, they like a cue to action, nudge you to take the required preventive action.

Do you think repeated visibility of messages around you nudge you or motivate you to adopt preventive behaviours against Covid-19?

178 responses



CONCLUSION

The findings of the current research clearly indicate the potential of nudging to believe into taking the preventive action, being well aware of one's susceptibility and the actions that are to be undertaken. Nudges are nothing but a push and a reminder to do what we ought to do. The human mind, even though is well aware of what needs to be done, still succumbs to heuristics and biases that may lead a person to ignore the desired

behaviour. It is here that a nudge can do the needful. In all the cases of nudge and respective compliance behaviour it was observed that the compliance rate was almost over ninety percent for majority of the preventive behaviours. Nudges certainly act as a cue to action, increasing one's self-efficacy to comply with the desired behaviour. The research thus recommends, innovative nudging and creative communication to motivate people to take preventive actions, as this pandemic's destructive mode has to

be managed with science of human behaviour.

REFERENCES

- Bavel, J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten, J., Kitayama, S., ... Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature human behaviour*, 4(5), 460–471. <https://doi.org/10.1038/s41562-020-0884-z>
- Champion, V. & Skinner, C.S. (2008). The Health Belief Model. In: Glanz K, Rimer B, Viswanath K, editors. *Health behavior and health education*. 4. San Francisco, CA: Jossey-Bass; 2008. pp. 45–65.
- Debnath, R. & Bardhan, R. (2020). India nudges to contain COVID-19 pandemic: a reactive public policy analysis using machine-learning based topic modelling. Retrieved from <https://arxiv.org/abs/2005.06619> on September, 2, 2020.
- Green, E. (2020). Coronavirus highlights how 'nudge theory' could address hand hygiene and other challenges in healthcare. NS Healthcare. Retrieved from <https://www.ns-healthcare.com/analysis/coronavirus-nudge-theory-hygiene-challenges-healthcare/> on July, 12, 2020.
- Jones, C.L., Jensen, J.D., Scherr, C.L., Brown, N.R., Christy, K. & Weaver, J. (2015). The Health Belief Model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. *Health Communication*, 30(6):566–576. [PMC free article] [PubMed]
- Jose, R., Narendran, M., Bindu, A., Beevi, N., Manju, L. & Benny, P.V. (2020). Public perception and preparedness for the pandemic COVID 19: A Health Belief Model approach. *Clinical Epidemiology and Global Health*. DOI:<https://doi.org/10.1016/j.cegh.2020.06.009>
- Raamkumar, A.S. Tan, S.G. & Wee, H.L. (2020). Use of Health Belief Model-Based Deep Learning Classifiers for COVID-19 Social Media Content to Examine Public Perceptions of Physical Distancing: Model Development and Case Study. *JMIR Public Health Surveill.* Jul-Sep; 6(3): e20493. doi: 10.2196/20493. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7363169/>
- Rigby, S. (2020). Psychological nudges change intentions but not behaviour. *PA Science*. <https://www.sciencefocus.com/news/covid-19-psychological-nudges-change-intentions-but-not-behaviour/>
- Yates, T. (2020). Why is the government relying on nudge theory to fight coronavirus? *The Guardian*. <https://www.theguardian.com/commentisfree/2020/mar/13/why-is-the-government-relying-on-nudge-theory-to-tackle-cnavirus>

Other Web-References

- https://www.who.int/health-topics/coronavirus#tab=tab_1
- <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html>
- <https://timesofindia.indiatimes.com/india/coronavirus-live-updates-indias-active-cases-poised-to-cross-9-lakh/liveblog/78007256.cms>
- <https://blogs.harvard.edu/nudge/what-is-a-nudge/>
- https://play.google.com/store/apps/details?id=nic.goi.aarogyasetu&hl=en_IN

KNOWLEDGE LEVEL OF *MUNG* GROWERS ABOUT POST HARVEST TECHNOLOGY OF *MUNG*

D. B. Patel¹ and Arnab Biswas²

^{1&2}S. D. Agricultural University, Sardarkrushinagar

*Email : dbpatel821963@gmail.com

ABSTRACT

Mung forms an important part of Indian dietary habit. More than half of Indian population is vegetarian for whom mung is the major sources to fulfil their protein requirement. The post-harvest aspects in mung also hold significant consideration as the losses are higher during storage. So this study was conducted by using an *ex-post facto* research design with 120 respondents selected randomly from 3 talukas of Kachchh district. The result of the study indicated that nearly half of the mung growers (47.50%) were in the old age group and had higher secondary education, had more than 4.00 ha. of land holding, were using tube well as a source for irrigation, had membership in one organization, utilizing Agricultural scientist/KVK, Mobile/Internet, Television, Extension officer/ATMA and village level workers/ Extension officers their sources of information. Majority of the farmers possessed good knowledge about harvesting (99.17%), best time of harvesting (93.33%). Overall the respondents had medium to high level of knowledge (75.00%) about mung crop.

Key words: mung, post harvest technology, knowledge

INTRODUCTION

Mung is the main sources of vegetable protein. Mung forms an important part of Indian dietary habit. More than half of Indian population is vegetarian for whom mung is the major sources to fulfil their protein requirement. Hence, it becomes essential to have enough production of mung.

Gujarat occupies about 70 thousand hectare under mung cultivation with production of 30 thousand tones and productivity of 433 kg/ha (2018-19). The major mung growing districts of the state are Kachchh, Banaskantha and Mehsana. The Kachchh district is one of the main mung growing districts in Gujarat. It ranks first position in area and production.

The post-harvest aspects in mung also hold significant consideration as the losses are higher during storage. In regard to this, it is felt necessary to study the knowledge level of mung growers regarding post harvest technology of mung.

METHODOLOGY

The present study was confined to *ex-post facto* research design as the independent variable has already operated in the study area. In this study, purposive sampling technique was used for selection of district, taluka. While, the villages and respondents were selected by using simple random sampling technique. The present study was

carried out in Kachchh district as the district has maximum area under mung cultivation. Out of 10 talukas of Kachchh district, 3 talukas (Rapar, Bhachau and Abdasa) having maximum area under mung cultivation were selected purposively. From each taluka, 4 villages were randomly selected and from each village 10 mung growers were selected randomly. Thus total 120 villagers were selected randomly for the study.

A teacher made knowledge test was developed to assess the knowledge level of the mung growers about the post harvest

technology of mung. The data was collected by personal interview. The interview schedule was developed after thorough discussion with experts, scientists, post harvest technologist and extension officers working in the district. The appropriate statistical tools were used to analyse the data.

RESULTS AND DISCUSSION

Profile of the respondents:

The data regarding profile of the mung growers are presented in table 1.

Table 1: Profile of the respondent

n = 120

Sr. No.	Variable	Category	Frequency	Percentage
1	Age	Young (Up to 35 years)	23	19.17
		Middle (36 - 50 years)	40	33.33
		Old (Above 50 years)	57	47.50
		Illiterate	18	15.00
2	Education level	Primary	23	19.17
		Secondary	20	16.67
		Higher secondary	37	30.83
		Graduate and above	22	18.33
3	Social Participation	No membership	11	9.17
		Membership in one organization	86	71.68
		Membership in more than one organization	16	13.33
		Office bearer in organization	07	5.83
4	Source of information	Village level worker/ Extension officer	24	20.00
		Agricultural scientist / KVK	53	44.17
		Agriculture officer / ATMA	33	27.50
		Kisan call centre/ Farmer training centre	12	10.00
		Book	13	10.83
		Television	36	30.00
		Radio	06	5.00

Sr. No.	Variable	Category	Frequency	Percentage
		News paper	20	16.67
		Agricultural magazine	07	5.83
		Agri. Fair / Agri. Mela	18	15.00
		Mobile/Internet	45	37.50

It is clear from the above table that nearly half (47.50 per cent) of the mung growers were in the old age group. While, 33.33 per cent of the mung growers belonged to middle age group and only 19.17 per cent of the mung growers were in young age group. In case of education level 30.83 per cent of the mung growers had higher secondary education, followed by primary education (19.17%) and graduate and above (18.33%), while, 15.00 per cent of mung growers were illiterate. It is clear from the above table that majority of mung growers (71.68%) had membership in

one organization, while 9.17 percent had no membership in any organization. The data from the table also indicate that majority of the mung growers were utilizing Agricultural scientist/KVK (44.17%), Mobile/Internet (37.50%), Television (30.00%) and Agriculture officer/ATMA (27.50%) as their main sources of information.

To measure the knowledge level of the mung growers about post harvest technology of mung a teacher made knowledge test was developed and the responses were collected in dichotomous options (Yes/No). The data are presented in table 2.

Table 2 : Knowledge level of the mung growers

(n = 120)

Sr. No.	Practices	Frequency	Percent
A	Harvesting		
1	Picking of pod when it turns brownish colour	48	40.00
2	Early harvesting reduces grain quality and yield	79	65.83
3	Shattering loss of mung seed occur in late harvesting	104	86.67
4	Harvest with serrated and sharp sickle	119	99.17
5	Disease infected plants be removed before harvesting	22	18.33
6	Best time to harvest when 80% of the pods are fully matured	112	93.33
B	Threshing		
1	Harvest must be collected at one place	118	98.33
2	Harvest must be kept in dry and clean place	57	47.50
3	Seeds of the dry pods should be separated by thresher	117	97.50

Sr. No.	Practices	Frequency	Percent
C	Cleaning and Grading	118	98.33
1	Remove dust from grains	79	65.83
2	Remove living and dead insects and pests	36	30.00
3	Diseased and infected grain must be separated	16	13.33
4	Uniform grains should be separated with grading operation	43	35.83
5	Remove rodent hair and excreta	42	35.00
6	Remove broken seeds	50	41.67
7	Grain must be free from odour		
D	Storage	116	96.67
1	Grain should be stored in dry and clean place	115	95.83
2	Storage bins should be free from insect and fumigate before storage	42	35.00
3	Moisture should be less than 10 % in stored grain	102	85.00
4	Use of 10% <i>neem</i> leaves with grains	27	22.50
5	Mix ash (1:4) or talcom powder(1:6) in stored Grains	9	7.50
6	Use the EDB (Ethiyon dry bromide) in Stored grains	10	8.33
7	Use Aluminium phosphide	8	6.67
8	Proper aeration and ventilation must be needed	6	5.00
9	Storage structure must be moisture free		
E	Packing	109	90.83
1	Packing should be attractive	28	23.33
2	Packing should be air tight	65	54.17
3	1kg, 2kg and 5kg pack etc. for sale		
F	Value addition	111	92.50
1	Quality grains gives good return	72	60.00
2	Selling of <i>dal</i> gives more return	7	5.83
3	Making <i>papad</i> gives high return	81	67.50
4	Preparation of mung halwa	68	56.67
5	Sprouted mung preparation	54	45.00
6	Mung dal vada	13	10.83
7	Graded grains used in animal feed gives extra income		

The knowledge was measured in six dimensions *i.e.* harvesting, threshing, cleaning and grading, storage, packing and value addition. The details of knowledge level of the mung growers in the above 6 dimensions are discussed below:

Harvesting:

Most of the farmers (99.17%) possessed knowledge regarding harvesting crop with serrated and sharp sickle followed by best time to harvest when 80% of the pods are fully matured (93.33%), shattering loss of mung seed occur in late harvesting (86.67%), early harvesting reduces grain quality and yield (65.83%).

Threshing:

Farmers possessed good knowledge regarding collection of harvested products (98.33%) but they have lack of knowledge regarding storage in clean and dry place (47.50%).

Cleaning and Grading:

Farmers possessed knowledge regarding removing of dust from grains (98.33%) followed by removing living and dead insects and pests (65.83%). on the other hand they had little knowledge about removing of rodent hair and excreta (35.83%), removing of broken seeds (35.00%) and separation of

diseased and infected grain (30.00%), grading operation (13.33%).

Storage :

The respondents possessed considerably low knowledge on use of Aluminum phosphide (8.33%), use of EDB (Ethion dry bromide) in stored grains (7.50%). They also had very little knowledge about proper aeration and ventilation (6.67%) and moisture free storage structure (5.00%).

Packing :

Farmers possessed good knowledge regarding attractive packing (90.83%) and about retail availability of packing size (54.17%) in air tight packing (23.33%).

Value addition:

Farmers possessed good knowledge regarding quality grains (92.50%). They processed the raw mung by preparing halwa (67.50%) and selling of dal gives more return (60.00%). More than half of the respondents (56.67%) had passed knowledge regarding preparation of sprouted mung and selling them in market for higher return. They also processed their products by preparing mung dal vada (45.00%). But they had lack of knowledge in using graded grains in animal feed (10.83%) and making of papad (5.83%).

The overall knowledge of the respondents were also worked out and the data are presented in Table 3.

Table 3 : Overall knowledge level of the farmers about post-harvest technology of mung

Sr. No.	Level of knowledge	Frequency	Per cent
1	Low (Below 9.08 Score)	30	25.00
2	Medium (In between 9.08 Score to 23.26 Score)	46	38.33
3	High (Above 23.26 Score)	44	36.67
	Total (n)	120	100.00

S.D. = 7.09

Mean = 16.17

The results in Table 3 portrayed that less than half of the respondents (38.33%) were having medium level of knowledge followed by 36.67 percent of respondents who had high level of knowledge and 25.00 per cent of farmers had low level of knowledge about post-harvest technology of mung crop.

CONCLUSIONS

It can be concluded from the study that nearly half of the mung growers were in the old age group and had higher secondary education, had more than 4.00 ha. of land holding, were using tube well as a source for irrigation, had membership in one organization, utilizing Agricultural scientist/KVK, Mobile/Internet, Television, Extension officer/ATMA and village level workers/ Extension officers their sources of information. Majority of the farmers possessed good knowledge about harvesting, best time of harvesting. Overall the respondents had medium to high level of knowledge about mung crop.

REFERENCES

Bhabhor, G. K.; Patel, U. M. and Makwana, N. D. (2017). Factors affecting the technological gap of mung growers.

Gujarat Journal of Extension Education.28 (1): 90-92.

Chaudhary, R.; Bhadu, K. and Poonia T. (2018). To study of gap in Technology Adoption in mung Cultivation in Ambala. *Bulletin of Environment, Pharmacology and Life Sciences*. 7 (7): 63-67.

Dhodia, A. J.; Naik, R. M. and Tandel, B. M. (2014). Attitude of farmers towards training programme of Mega Seed Project. *Gujarat Journal of Extension Education*.25 (1): 9-12.

Jamanal, S. K. and Sadaqath, S. (2017). Socio-economic characteristics of mung growers. *Journal of Pharmacognosy and Phytochemistry*6 (5): 2766-2768.

Kavhar, S. T.; Katole, R. T.; Gawande, S. A.; Nemade, D. K. and Gomase, A.S. (2020). Knowledge of recommended cultivation practices of gram (*Cicer arietinum L.*) by the farmers. *Asian Journal of Extension Education*.38:105-112.

Patel, V. M., Mistry, J. J. and Patel, D. B. (2016). Knowledge level of recommended green gram cultivation technology of tribal FLD farmers. *Gujarat Journal of Extension Education*. 27 (1): 53-55.

PROFILE OF RESPONDENTS AND THEIR RELATIONSHIP WITH ADOPTION OF TECHNOLOGY INTERVENTIONS OF DIFFERENT FIELD CROPS UNDER NICRA PROJECT

Mandavkar P.M.¹, S.S. Sisodia², P.A. Sawant³, B. Upadhyay⁴, R. Bairathi⁵,
R. H. Meena⁶ and A. Verma⁷

^{1,2,4,5,6&7} Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan

³ Directorate of Extension Education, DBSKKV, Dapoli

ABSTRACT

The National Innovations on Climate Resilient Agriculture (NICRA) is a network project of Indian Council of Agricultural Research (ICAR), New Delhi. Under this project, the Technology Demonstration Component was implemented in selected vulnerable districts of the country by organizing location specific interventions in agriculture. This study was undertaken in Ratnagiri district from Konkan region and Aurangabad (*Chattrapati Sambhajinagar*) district from Marathwada region of Maharashtra state to know profile of the respondents and to find the relationship between profile and adoption of technology interventions of different field crops. The study was based on ex-post facto research design and data were collected through interview schedule. Majority of respondents found under middle age group and 46.79 per cent of respondents were educated up to secondary class. In this study area, 50.00 per cent respondents possessed land holding small to semi-medium size and 85.36 per cent respondents belong to medium level of annual income. Further, 63.57 per cent of respondents were reported to have medium mass media exposure. The relationship between profile and adoption of technology revealed that relationship between the personal variables viz. age, education and mass media exposure and adoption was non-significant. Whereas, size of land holding as well as annual income were highly correlated with adoption. Further regarding non-beneficiary respondents, it was seen that, education, annual income and mass media exposure were positive and significantly correlated with adoption.

Key Words : Profile, Relationship, Adoption, Technology, Project

INTRODUCTION

The National Innovations on Climate Resilient Agriculture (NICRA) is a network project of Indian Council of Agricultural Research (ICAR), New Delhi implemented in various districts of the country since 2011. The project was focused to enhance resilience of Indian agriculture to climate change and climatic vulnerability through strategic research and demonstration of technologies. The technology demonstration

component of the project metes out with demonstrating authentic technologies for adaptation of various production system to climatic variability. This project was implemented in hundred districts of the country by way of location specific interventions. These districts were selected based on the drought, cyclone, actual occurrence of floods and droughts etc. criteria besides the strength of KVKs.

The crop demonstration module consists of

introducing drought or flood tolerant varieties, advancement of planting dates of *rabiseason* crops in areas with terminal heat stress, watersaving paddy cultivation methods i.e. plantation techniques, seeding methods, fertilizer management etc., community seedling nurseries under delayed monsoon situation, custom hiring centers for in time operations, location specific inter-cropping systems with elevated sustainable yield index.

So, considering above reality, this investigation was studied to know profile of respondents and to determine the relationship between profile and adoption of technology interventions of different field crops under Technology Demonstration Component of the NICRA project.

MATERIALS AND METHODS

This investigation was supervised in the year 2021-22 in Ratnagiri district from Konkan region and Aurangabad (*Chattrapati Sambhajinagr*) districts from Marathwada region of Maharashtra state. All the ten operational villages of the NICRA Project that are Harale, Parule, Raipatan, Whel and Talawade from Ratangiri district and Shekta, Vajanapur, Gopalwadi, Shankarpur and Shiresaygaon from Aurangabad (*Chattrapati Sambhajinagr*) district were selected. From these villages 140 farmers (14 farmers from every village) were selected as beneficiary. For this study 140 farmers were taken from the nearby 10 villages (14 farmers from every village) as non-beneficiary on random basis for comparison. Thus, a sample size was 280 respondents for the investigation. In this study, ex-post facto design of research was applied. An interview schedule comprised of 10, 7, 12 and 12 items related to improved technology in paddy, horse gram, maize and Bengal gram, respectively was developed.

Score of 2, 1 and 0 were assigned to each item for full adoption, partial adoption and no adoption, respectively. The individual raw scores of the respondents were later converted into standardized scores to get the adoption index with the help of the following formula:

$$\text{Adoption index} = \frac{\text{Obtained adoption score}}{\text{Highest obtainable score}} \times 100$$

The adoption of the respondents was further categorized as 'low', 'medium' and 'high' by using the formula mean $\pm$ standard deviation. The correlation was found between the profile (personal variables) of respondents and adoption by calculating correlation coefficient.

RESULTS AND DISCUSSION

Profile of Respondents

Respondents profile gives an idea of their socio-economic and communicational characteristics at a glance. The respondent's level of knowledge, attitude and adoption are influenced by these characteristics. The data incorporated in Table 1 revealed that, most of respondents belongs to 40 to 59 years of age group. This age group alone constitutes 65.35 per cent of the total sample. Whereas, 20.36 and 14.29 per cent respondents were less than 40 years and more than 59 years of age groups, respectively. This finding is similar to results of Kumari (2014) and Kalyan Babu (2019).

The data depicted in Table 2 revealed that, 46.79 per cent of respondents were educated upto secondary class. In same category Konkan and Marathwada region respondents were 45.00 per cent and 48.57 per cent, respectively. Whereas, 18.92 per cent respondents were educated upto primary class, 13.93 per cent were educated

upto higher secondary class, 11.43 per cent were found educated upto college and 7.50 per cent respondents educated upto pre-primary. Only 1.43 per cent respondents found educated upto post-graduate. The results are somewhat in line with Kalyan Babu (2019).

The data of Table 3 shows that, 37.50 per cent of total respondents were having upto 1 ha land holding (marginal), followed by 27.86 per cent of them having semi-medium size i.e. 2.01 to 4 ha and 22.14 per cent were having 1-2 ha size of land holding (small). However, 12.50 per cent of them were having land holding upto medium size i.e. above 4 hectares. The large land holders were not included in NICRA programme. Identical results were observed by Agrawal *et al.* (2016) and Pise *et al.* (2018).

Figures depicted into Table 4 visualize that, among 240 respondents, 82.50 per cent

respondents were having medium of annual income (Rs. 54,953/- to Rs. 5,46,909/-) from all sources and 13.57 per cent respondents earned family income higher than Rs. 5,46,909/- per annum, while remaining 3.93 per cent of respondents earned family income lower than Rs. 54,953/- per annum from all income sources. The findings are in line with the judgements of Praveen babu *et al.* (2016) and Kalyan Babu (2019).

The evidence presented in Table 5 revealed that out of 240 respondents, 63.57 per cent respondents were reported to have mass media exposure at medium level of, whereas, 17.50 per cent respondents reported to have low level mass media exposure and remaining 18.93 per cent of respondents noticed in higher level of mass media exposure. The present findings are relevant to results reported by Ramalakshmi Devi *et al.* (2013) and Praveenbabu *et al.* (2016).

Relationship Between Personal Variables and Adoption of Technology Interventions by Respondents

Table 6 : Relationship between personal variables and adoption of technology intervention by respondents

Sr. No.	Personal variable	Adoption							
		Konkan region				Marathwada region			
		Beneficiary (n =70)		Non-beneficiary (n =70)		Beneficiary (n =70)		Non-beneficiary (n =70)	
		'r'	't'	'r'	't'	'r'	't'	'r'	't'
1.	Age	0.065	0.53 ^{NS}	-0.412	-3.72 ^{**}	-0.264	2.25 [*]	-0.099	-0.82 ^{NS}
2.	Education	0.122	1.01 ^{NS}	0.319	2.77 ^{**}	0.394	3.53 ^{**}	0.148	1.23 ^{NS}
3.	Size of land holding	0.306	2.65 ^{**}	0.092	0.76 ^{NS}	0.239	2.02 [*]	0.171	1.43 ^{NS}
4.	Annual income	0.326	2.84 ^{**}	0.235	1.99 [*]	0.294	2.53 [*]	0.198	1.66 ^{NS}
5.	Mass media exposure	0.150	1.25 ^{NS}	0.413	3.74 ^{**}	0.287	2.47 [*]	0.260	2.22 [*]

** Significant at 1% level,

* Significant at 5% level,

NS= Non-significant

Data in Table 6 indicates that, in Konkan region age, education and mass media exposure of beneficiary respondents were found non-significantly correlated with adoption. It means that no relationship found among age, education and mass media exposure and adoption of recommended interventions. Whereas, variables land holding size and annual income were found positive and highly correlated with adoption. This implies that as the size of farm and annual income increases, the adoption also increases.

In case of non-beneficiary respondents from Konkan region, age was negative and highly correlated with adoption level of technology intervention. This means that as the age increases, adoption by respondents decreases. The results are similar with finding of Bhatia (2015). Further it was seen that, education, annual income and mass media exposure were positive and significantly correlated with adoption of technology interventions. However, land holding size was found non-significant with adoption with respect to non-beneficiary respondents. Identical results were obtained by Gohil *et al.* (2016).

Table 6 data indicates that, age, education, land size, annual income and mass media exposure of beneficiary respondents were found positive and significantly correlated with adoption of beneficiary from Marathwada region. This reveals that as the level of age, education, size of land, income and mass media exposure increases adoption also increases. Gopala *et al.* (2010) reported similar results.

Further regarding non-beneficiary respondents of Marathwada region, it is revealed that, personal variables age, education, land size and income of respondents found non-significantly correlated with adoption. It means that there

is no relationship between these variables and had no influence on adoption of recommended interventions. However, variable mass media exposure indicated correlation positive and significant with adoption of technology interventions. The outcomes are in line with results of Etwire *et al.* (2013) as well as Sandeep *et al.* (2013).

CONCLUSION

The above study inferred that most of respondents belongs to 40 to 59 years i.e. middle age group. Regarding education, 46.79 per cent were found educated upto secondary class. Further data specify that beneficiary respondents were better educated than non-beneficiary respondents except Marathwada regions higher secondary and college level category. In the study area, 50.00 per cent respondents possessed land holding small to semi-medium size and more than eighty per cent respondents were having medium annual income from all sources. Out of 240 respondents, 63.57 per cent respondents have reported medium level of mass media exposure in which beneficiary respondents had more mass media exposure than non-beneficiary respondents.

In Konkan region, beneficiary respondents' land holding as well as annual income were found positively and highly correlated with the adoption of technology interventions. This implies that as the size of farm and annual income increases, adoption also increases. In case of non-beneficiary respondent's education, annual income and media exposure were positive and significant with adoption. Results indicated that, variables age, education, land holding, annual income and media exposure of beneficiary respondents from Marathwada region had a significantly positive

relationship with adoption of technology interventions. Further regarding non-beneficiary respondents' personal variables age, education, land holding and income were seen non-significantly correlated with adoption. It means that there is no relationship between these variables and had no influence on adoption of recommended interventions.

REFERENCES

- Agrawal, S., Khare, N. K and Nitin Soni. (2016). A study on the effect of watershed on socio-psychological profile of the beneficiaries. *International Journal of Agriculture Sciences*, 8(40):1817-1820.
- Bhatia, R. (2015). Farming knowledge and adoption of organic paddy farming practices in Haryana. Ph.D. (Agri.) Thesis (Unpublished), CCSHAU, Hisar.
- Etwire, P. M., Al-Hasan, M. R., Kuwornu, J. and Osei-Owusu, Y. (2013). Small holder farmers' adoption of technologies for adaptation to climate change in Northern Ghana. *Journal of Agricultural Extension and Rural Development*. 5(1):121-129
- Gohil, G. R., Raviya, P. B. and Barad, V. G. (2016). Association between the adoption of crisis management practices and selected profile characteristics of cotton growers. *Gujarat Journal of Extension Education*, 27(1): 67-69.
- Gopala, Y. M., Raghuprasad K. P., Krishnamurthy B. K. (2010). Impact of farmer's participation in Farmer Field School on adoption level of cultivation practices of maize. *Journal of Extension Education*, 22(4).pp-162-166.
- Kalyan Babu. (2019). Impact of National Innovations on Climate Resilient Agriculture Project in Anathpuram District of Andhra Pradesh. M.Sc. (Agri.) Thesis (Unpublished), submitted to Acharya N. G. Ranga Agricultural University, Guntur, Andhra Pradesh.
- Kumari, K. B. (2014). A study on farmers' perception and adaptability of the farmers towards climate variability in Kurnool district of Andhra Pradesh. M.Sc.(Ag.) Thesis.(Unpublished) Acharya N. G. Ranga Agriculture University, Hyderabad.
- Pise G. K., Ahire R. D. and N. D. Kale. (2018). Impact of National Innovations on Climate Resilient Agriculture (NICRA) project on its beneficiaries. *Int.J.Curr.Microbiol.App.Sci.*, Special issue-6:2928-2935.
- Praveenbabu, R., Sivanarayana, G., Gopikrishna, T and Raghunadha Reddy. (2016). Profile characteristics of paddy farmers in East Godavari district. *The Andhra Agricultural Journal*. 63 (1): 226-229.
- Ramalakshmi Devi, S., Satya Gopal, P. V., Sailaja, V and Prasad, S.V. (2013). Profile characteristics of sugarcane farmers in Chittoor district of Andhra Pradesh. *Journal of Research, ANGRAU*. 41 (1): 96-100.
- Sandeep, C. Singh, S. R. K., Pande A. K. and Gautam, U. K. (2013). Dynamics of improved sugarcane cultivation in Madhya Pradesh. *Indian Research Journal of Extension Education*. 13(2): 26-30.

Table 1: Distribution of respondents according to their age (n =280)

Sr. No.	Age (years)	Konkan region						Marathwada region					
		Beneficiary			Non-beneficiary			Beneficiary			Non-beneficiary		
		f	%	f	%	f	%	f	%	f	%	f	%
1.	Young (< 40)	11	15.71	12	17.14	23	16.43	18	25.71	16	22.86	34	24.29
2.	Middle age (40 to 59)	49	70.00	42	60.00	91	65.00	39	55.71	53	75.71	92	65.71
3.	Old (> 59)	10	14.29	16	22.86	26	18.57	13	18.58	01	1.43	14	10.00
Total		70	100	70	100	140	100	70	100	70	100	140	100

Mean= 49.50, S.d. = 9.29, f = frequency, % = per cent

Table 2: Distribution of respondents according to their level of education (n =280)

Sr. No.	Education (std)	Konkan region						Marathwada region					
		Beneficiary			Non-beneficiary			Beneficiary			Non-beneficiary		
		f	%	f	%	f	%	f	%	f	%	f	%
1.	Pre-primary (up to 4 th)	1	1.43	14	20.00	15	10.71	4	5.71	2	2.85	6	4.29
2.	Primary (5 th -7 th)	13	18.57	20	28.57	33	23.58	12	17.14	8	11.43	20	14.29
3.	Secondary (8 th -10 th)	39	55.72	24	34.29	63	45.00	38	54.29	30	42.86	68	48.57
4.	Higher secondary (11 th to 12 th)	12	17.14	10	14.28	22	15.71	7	10.00	10	14.29	17	12.14
5.	College (First year to final year)	5	7.14	0	0.00	5	3.58	7	10.00	20	28.57	27	19.28
6.	Post-graduate	0	0.00	2	2.86	2	1.43	2	2.86	0	0.00	2	1.43
Total		70	100	70	100	140	100	70	100	70	100	140	100

f = frequency, % = per cent

Table 3: Distribution of respondents according to their size of land holding (n =280)

Sr.No.	Land holding (ha)	Konkan region						Marathwada region					
		Beneficiary			Non-beneficiary			Beneficiary			Non-beneficiary		
		f	%		f	%		f	%		f	%	
1.	Marginal (Up to 1.00)	42	60.00	56	80.00	98	70.00	3	4.29	4	5.71	7	5.00
2.	Small (1.01 to 2.00)	19	27.14	10	14.28	29	20.71	19	27.14	14	20.00	33	23.57
3.	Semi-medium (2.01 to 4.00)	5	7.14	4	5.72	9	6.43	25	35.71	44	62.86	69	49.29
4.	Medium (4.01 to 10.00)	4	5.72	0	0.00	4	2.86	23	32.86	8	11.43	31	22.14
Total		70	100	70	100	140	100	70	100	70	100	140	100

f = frequency, % = per cent

Table 4: Distribution of respondents according to their annual income (n =280)

Sr. No.	Annual income (Rs.)	Konkan region						Marathwada region					
		Beneficiary			Non-beneficiary			Beneficiary			Non-beneficiary		
		f	%		f	%		f	%		f	%	
1.	Low (< 54953)	2	2.86	4	5.71	6	4.29	2	2.86	3	4.28	5	3.57
2.	Medium (54953 to 546909)	66	94.28	65	92.86	131	93.57	43	61.43	57	81.43	100	71.43
3.	High (> 546909)	2	2.86	1	1.43	3	2.14	25	35.71	10	14.29	35	25.00
Total		70	100	70	100	140	100	70	100	70	100	140	100

Mean = Rs.300931, S.d. = 245978, f = frequency, % = per cent

Table 5: Distribution of respondents according to their mass media exposure (n =280)

Sr. No.	Mass media exposure (score)	Konkan region						Marathwada region					
		Beneficiary			Non- beneficiary			Beneficiary			Non- beneficiary		
		f	%		f	%	Total	f	%		f	%	Total
1.	Low (<2.48)	4	5.71	23	32.86	27	19.29	2	2.86	20	28.57	22	15.71
2.	Medium (2.48 to 7.78)	36	51.43	43	61.42	79	56.42	49	70.00	50	71.43	99	70.72
3.	High (>7.78)	30	42.86	4	5.72	34	24.29	19	27.14	0	0.00	19	13.57
Total		70	100	70	100	140	100	70	100	70	100	140	100

Mean= 5.13, S.d. = 2.65, f = frequency, % = per cent

LOGISTIC MANAGEMENT OF HANDLOOM INDUSTRY

Rachana Goswami^{1*} and Ruby Jain²

¹Department of Home Science, Kanoria PG Mahila Mahavidyalaya, Jaipur

²Department of Home Science, University of Rajasthan, Jaipur

*Email: rachanagoswami82@gmail.com

ABSTRACT

The handloom industry plays an important role in the country's economy. It is one of the largest economic activities after agriculture. According to the Fourth All India Handloom Census(2019-20), the total number of households in India engaged in handloom activities (weaving and allied activities) is 31.45 lakhs. This tradition is prevalent till date and is developed by generation of artist and craftsmen who translate their imagination and visualization into wonderful creation of art. The leverage and development of the industry can only be acquired through diminishing the problems and issues arising in logistic management in this industry. Hence the research paper discusses the various logistic management issues such as Inventory management, transfer of information, the view of time, warehousing, packaging, distribution and transport management, role of information technology, buyer-supplier relationships in handloom industry.

The Handloom Industry in the state is operated through Rajasthan Rajya Bunkar Sahakari Samiti (RRBSS) and Rajasthan Handloom Development Corporation (RHDC). The respondent selected for this study included senior officials (50) of the two handloom government organizations working for the development of handloom weavers in Jaipur District. The data was collected through interview method, observation and secondary sources. The results depicted that handloom organizations were not making wise logistics management decisions. This paper further gives way forward which may support and enable to remove the industries' core issues for sickness starting from sourcing of raw materials to delivery of finished products.

Key words : Handloom, Logistics, Inventory management, Transfer of information

INTRODUCTION

Handloom industry is a traditional and a cottage industry in India. It provides employment to the large section of poor people. The technology of the loom has the advantage of being affordable and accessible to large numbers of people who have no other work option (Goswami & Jain, 2012). However, the role and significance of the industry to the national development is declining. In fact, the industry is facing lot of problems as regards to men, material,

methods, machines, money, marketing and management.

In Rajasthan for the development of handloom industry and weavers in cooperative fold Bunkar sahakari sangh is working as an apex organization in the state. It was established in 1957. The main objectives of Bunkar sangh was to provide raw material to purchase or receive for sale finished products of the member-societies and sell the same to the best, to arrange for the training of weavers (Samarika, 2001). Another government organization is

Rajasthan Handloom Development Corporation (RHDC) which was established in March 1984. The main objective was to promote aid and assist the growth and development of handloom industry. It works for marketing of handloom cloth in wholesale, retail or for commission. (Memorandum of association, RHDC, 2005). RHDC and RRBSS are state level organizations. Jaipur being the capital city the head offices of these organizations are situated here. It is the central place from where all the managerial decisions are done and implemented throughout the state for the development of Handloom industry. Logistic management is the coordinated set of techniques to plan and execute all steps in the global network used to acquire raw materials from vendors, transform them into finished goods, and deliver both goods & serviceomers. Logistic management helps in increase revenue, improve operating cost structure, reduce overall transportation costs, and improve customer service. In nutshell, logistics has a great potential for improving customer service and reducing costs. Therefore, the present study unfolds certain issues in logistic management of handloom industry and further a way forward is discussed.

METHODOLOGY

The present study was carried out in Jaipur district. Primary data from senior officials (50) attached to the two government organizations i.e. RRBSS (30) & RHDC (20)

was collected. The senior officials were administered with the semi structured interview schedule. Observation method was used to observe the products, exhibition and retail outlet scenario. Secondary data from government reports, newspaper articles was also collected.

LOGISTIC CHALLENGES IN INDUSTRY

There were certain key issues & challenges in logistic management of handloom industry such as inventory management, transfer of information, view of time, warehousing, packaging, role of information technology & buyer supplier relationship.

1. Inventory management : The term inventory refers to the goods or materials used by a firm for the purpose of production and sale. It also includes the items, which are used as supportive materials to facilitate production. The raw material used for handloom weaving is hank yarn. The demand is raised by the govt org. (customer) for certain products to the RRBSS (apex bodies). Then RRBSS purchases the yarn from different central organizations such as NHDC Luknow, Spinfed units (Ganaganagar, Gulabpura, and Hanumangarah) and National Textile Corporation. Payment of the raw material to the yarn providing organization is done in advance. The yarn is purchased in Kgs and on yarn count basis as required by the order. Then the RRBSS supplies the yarn to the cooperative societies as seen in fig 1. The order is given telephonically and by demand letter.

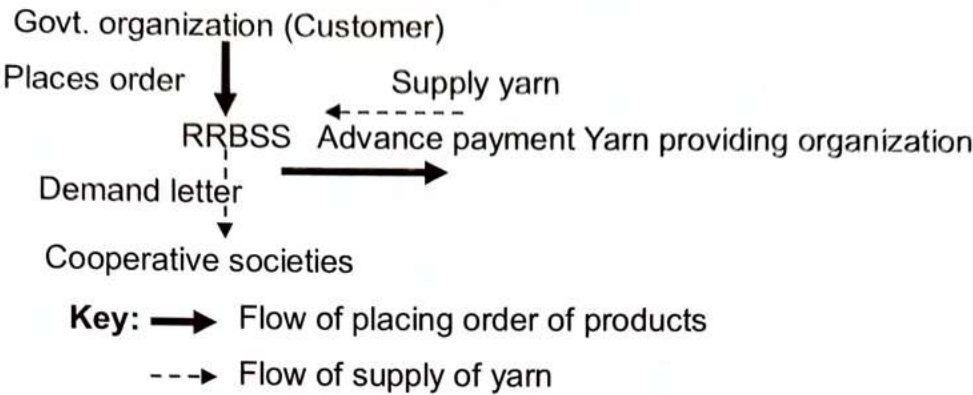


Fig 1: Flow of yarn in government based handloom organization

Views of Upper division clerk of production dept (lower management) as regard to problems faced in yarn procurement: *“No maintenance of buffer stock of yarn. As such, a time lag exists between when organizations place their orders and when the yarn is delivered, frequently upsetting the production cycle. Sometimes expenses have been incurred from the organization without the yarn having been received. This money was lost in corruption in the government structure.”* Observation of the assistant manager under marketing wing (RRBSS) was that the yarn purchase was not done in bulk instead it was done on the basis of order of production which led to losses. As the

organization had shortage of funds for procurement of yarn & above all they were placing the order for yarn from time to time, this increased the cost of the yarn and also the time required to supply the yarn. The bulk purchase would save money & time.

Moreover, the constraints faced by the organization in procuring yarn were quantified as seen in Table 1. They were time lag to reach the yarn from concern organization/yarn bank to RRBSS (66 percent), high priced yarn (66 percent), yarn of poor quality and inadequate quantity (17 percent respectively) and corruption (17 percent).

TABLE 1: Challenges Faced In Procuring Yarn by Staff of RRBSS & RHDC

S.No.		n=30	
	RRBSS	f	%
1	Time lag to reach the yarn from the concern yarn bank or yarn providing organization	20	66%
2	High priced yarn	20	66%
3	Poor quality of yarn	5	17%
4	Inadequate quantity of yarn	5	17%
5	Corruption	5	17%
	RHDC	n=20	
1	The shortage of funds	10	50%
2	Shortage infrastructure for storage of yarn	5	25%
3	Lack of accountability	5	25%

Source : Goswami & Jain (2012)

The reason for these constraints was that the spinning mills were not in the same city and transportation of yarn from one place to another consumes time, and most spinning mills were becoming dormant because of lack of proper financial assistance the other reason may be improper distribution of yarn. Even though new private spinning mills have come up, their focus was more on cone yarn (used in power looms) and exports. Twenty officials of RHDC were interviewed about the constraints faced in procuring yarn. Table 1 shows the responses, these were shortage of funds (10 respondents), shortage of infrastructure, storage of yarn (5 respondents) and lack of accountability (5 respondents).

The RHDC was providing the yarn to the weavers working in clusters. Probing into the situation it was revealed that after July 2007 RHDC stopped supplying the yarn to the individual weavers due to the financial crisis, loss and shortage of staff members. Not only the raw material inventory but the finished material inventory scenario showed the same. Sharma (2011, February 11) reported the scenario of the retail showrooms in article titled "How to get salary from tattered clothes" in *leading newspaper Danik Bhaskar*, p.9. It revealed that four showrooms, one at the head office i.e. Chomu house, Amer, M.I.road, Malviya nagar, Raja park have been closed. Showroom at Amer has heap of age old torn products. The officials in an interview revealed that "*The fabric has become so old that it got torned and no new supply is there*". Above all the compulsion was that the profit earned after selling the products will form their salary. In spite of improving the conditions of existing showrooms investment of lot of money has been done in purchasing shop in Rajasthali showroom at Ajmeri gate. Thus it can be concluded that there was stock piling as there

was lack of inventory management of yarn and finished products. This lead to the monetary losses of handloom organizations.

2. Transfer of information: The transfer of information is also the important work of logistics for smooth running of any organization. Project officer under Chief production officer (RRBSS) consult accounts dept that order has been placed for 100 bed sheets and reports the estimated price & amount of required raw material by checking the previous records. Then finance dept releases fund and further information about order is given to the yarn providing organization telephonically & releasing demand letter. After yarn reaches the head office of RRBSS there is no quality supervisor to check, the only primary requirement considered is the count of yarn. After yarn procurement the selection of cooperative societies is done for the production of certain products. For this also paper work is done manually. The organization had no such option of "One click information". The handloom organizations don't have flat organization structure which creates chaos & confusion. The flow of transfer of information was not effective. Handloom organizations were still using the traditional methods. This resulted in loss of information and increased lead times. There was no use of computers. If the concerned personnel were on leave the work cycle broke. It was revealed by chief marketing officer that organization was not using print & visual media, posters, and neon signs for promoting handloom products.

3. The view of time: It means the ability to respond to the dynamics of the global marketplace and must be quick. Raw materials and components must be ordered and arrive completely, accurately and quickly. At the same time orders must be filled with the same spirit. In the handloom industry the government department gave the order for

the production of specific goods required to the RRBSS/RHDC. The RRBSS/RHDC releases the demand letter of the order to the cooperative society and supplies the yarn to them. After production the cooperative society submits the bill increased by 10% to the apex organization along with the goods. The apex organization supplies the products & the bill to the government department. The government department releases the demand draft to the apex organization, the apex organization keeps the 10 percent of total amount with them and remaining gives to the society (fig.3). This process may take 15 days-3months. The deadlines are given by the govt.dept (customer) for the production but in handloom organization production personnel's are neither computer friendly nor are they motivated to work hard as there is no provision of any incentive. Sometimes there

was delayed payment by the government departments to the apex handloom organization. It sometimes took 6-12 months, which hindered further payments. Transportation was another problem, the organization didn't have adequate facility of transportation to supply the products on time.

4. Warehousing & Packaging: A warehouse is a commercial building for storage of goods. Warehouses are used by manufacturers, importers, exporters, wholesalers, transport businesses, customs, etc. It was observed that there was a square feet hall adjacent to one of the handloom organization (RRBSS) office, which had wooden & metal racks. It was common warehouse for raw material & finished product. The yarn was kept on floor in big boxes and the finished products was kept in the racks and on floor tied with a rope as seen in fig.2

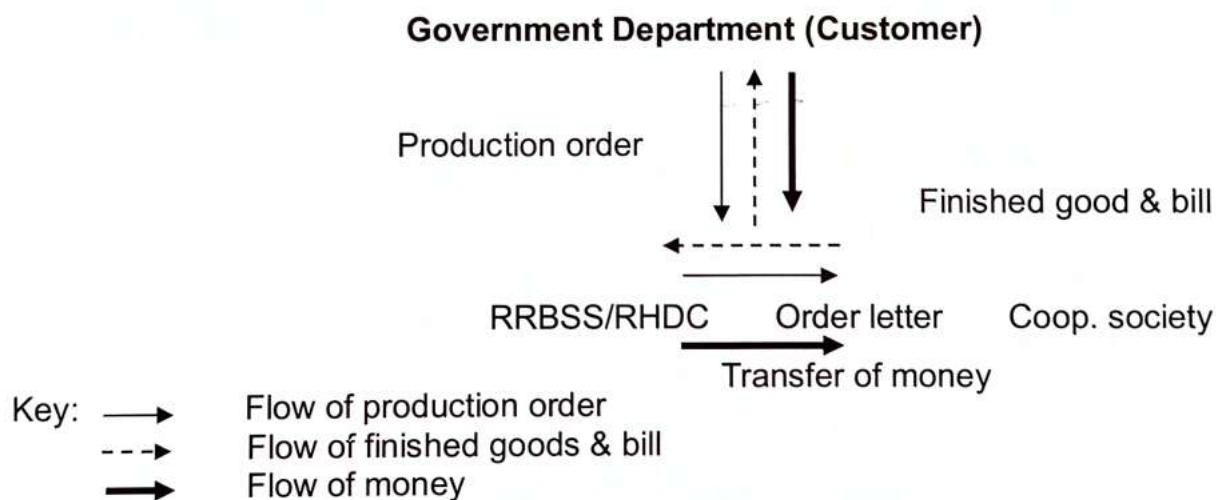


Fig 2: Flow of finished product & money in government based handloom organization

Today good package is regarded as an essential part of successful business practice. Since many potential customers first notice a new product after it has arrived on the shelves of a store, it is vital that the packaging provide consumers with the information they need and motivate them to make a purchase.

In the present study it was observed that the product lacked attractive packaging the customers were not attracted to actually purchase the item. The products didn't have any labeling regarding the use & care of the handloom product.

Perspectives of office superintendent (middle management) as regards to the

product woven: *"The most important element of good product is quality and packaging. The product should reach to big malls. If the presentation of the product is good then only it can be sold. The senior officials don't make an effort to check the quality of the product."*

Middle management officials (RRBSS) raised two issues that the quality & packaging of the handloom product needs to be improved but no quality assessment of yarns, woven fabric and dyeing was done. The senior officials were not fulfilling their respective roles. Though they know that quality assessment of yarns, woven fabric and dyeing should be done still no efforts to improve the quality were carried out.

5. Distribution and transport management

Transporting is required in the whole production procedures, from manufacturing to delivery to the final consumers and returns. Only a good coordination between each component would bring the benefits to a maximum. The transportation facility observed for raw material to be delivered to the co-operative societies and the finished goods to the warehouse and to retail outlets was often delayed.

It was observed by the researcher that there was improper handling of the raw material & finished product. The products were generally tied with the thick rope without being packed to protect against dust and dirt.

6. Role of information technology

The use of IT is considered as prerequisite for the effective control of today's logistic management. Through observation it was revealed that the physical structure of RRBSS office was presentable and only two computers were installed, whereas RHDC office had no computers, least maintained building with age old furniture. The organizations didn't had a website through which information can be generated.

7. Buyer - supplier relationships in handloom industry

Buyer-supplier relationships in the supply chain are one of the most important elements of supply chain integration. To enhance the value in competitive environment, the integration with customers and suppliers has become necessary. Several empirical studies conducted in China support that buyer-supplier relationships have a positive effect on a firm's financial performance (Liu and Wang 2000; Luo 1997; Yeung and Tung 1996)

Besides government departments the other channel where handloom products were supplied is through exhibitions and retail outlets. In the present study the salespersons at the showrooms were not efficient enough to influence the customer. There was lack of interest in the marketing personnel's of both the organizations.

Customers at the exhibition had the opinion that there was not much variety in their products and display was unappealing to the viewers. The products had least designing & innovativeness. There was absence of scientific market research, insufficient budget and improper planning of the promotional activities. Low sales in exhibitions and retail outlets depicted that products were not viable i.e. research on customer need identification was not done. This concludes that the organizations are not responding to market trends quickly.

WAY FORWARD

- The organizations must maintain up-to-date accounting records of the inventory.
- The obsolete stock should be cleared and then only further orders must be given.

- Yarn purchase should be done in bulk.
- Immediate installation of computers is necessary to make the system quick & centralized.
- Market research is a must to know exactly the customer demands. Marketing wing of both the organizations need to be strengthened so as to respond to the needs of the customers.
- The quality control staffs needs to be appointed who assess the counts, blends, strength and length of raw material. The quality assessment of dyed yarns should also be done for colour fastness.
- The product can be displayed with attractive & innovative packaging. It must attract attention, create consumer confidence and make a favorable overall impression.
- Handloom organizations should take expertise from design and product development department and coordinate their efforts.
- Electronic Data Interchange or EDI (in which the transmission of information between the members is done by electronic means) should be implemented. This will help in reducing the lag periods or lead times that are generated while orders are processed downstream in a supply chain.
- The differentiation in distribution channel can be done through online sales through website, marketing personnel's can be consulted, a tie up with boutique owners can be done to sell the handloom products.
- A regular buyer seller meet is required so that the weavers get a platform to market their products.

REFERENCES

- Fourth Handloom Census (2019-20) Office of The Development Commissioner for Handlooms, Ministry of Textiles, Government of India
- Goswami.R & Jain.R. (Dec, 2012). "Creating sustainability in Handloom Industry", edited volume on, International conference on Creating a sustainable Business: Managerial Implications and Challenges, organized by Jaipuria Institute of Management, Jaipur. ISBN:978-93-82563-51-8. Bloomsbury Publisher New Delhi. p.p.319-324
- Goswami .R & Jain.R. (Sept, 2011). "An Analytical Study of Managerial Issues of Handloom Industry in Jaipur District", *International Journal of Research in Commerce & Management. Haryana. ISSN:0976-2183*. 2(9), 94-97
- Goswami.R & Jain R. (August 2012) "Performance Evaluation of Rajasthan Handloom Development Corporation (RHDC) With Respect to Jaipur District." *Prabandhan: Indian Journal of Management, New Delhi. ISSN 0975-2854* 5(8), 22-27
- Jain, R., & Goswami, R. (2010, September). Livelihood through handloom weaving. *Research Analysis and Evaluation, International Research Journal for all subjects*, 1-3.
- Memorandum of association, Report of RHDC. (2005). Unpublished manuscript, Government printing office, 15-20.
- Samarika, (2001). Rajasthan Rajya Bunkar Sahakari Sangh (RRBSS). Report of state level weavers conference, 3-4.
- Yeung, Irene Y.M. and Rosalie L. Tung (1996), "Achieving Business Success in Confucian Societies: The Importance of Guanxi (Connections)," *Organizational Dynamics*, Autumn, 54-65.

COMPARISON OF SELECTION INDICES BASED ON PER CENT RELATIVE EFFICIENCY IN FINGER MILLET CROP

R. L. Ghetiya¹ and A. D. Kalola²

^{1&2} Department of Agricultural Statistics, B. A. College of Agriculture,
Anand Agricultural University, Anand- 388110 (Gujarat)
Email : radhikaghetiya98@gmail.com

ABSTRACT

The data on different biometrical characters of 40 genotypes of finger millet were collected from a P. G. student research work of AAU, Anand for present study. The experiment was carried out in randomised block design with three replications at the Genetics and Plant Breeding Farm, AAU, Anand during *kharif* 2020. Six distinct biometrical characteristics of forty genotypes of finger millet were used in the experiment: days to maturity, main ear length (cm), plant height (cm), test weight (g), productive tillers per plant and grain yield per plant (g). To investigate the crop improvement the selection index technique was used by assigning different weights to each biometric characters. Selection indices for individual characters, combinations of two characters, combinations of three characters, and so forth were computed. The combination that produced the highest relative efficiency was selected. Between yield and yield-attributing traits, the basic correlation coefficient, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated. Six biometric characters were used to calculate the selection indices, which were then built using all potential character combinations. Using the simple correlation coefficient [W_1], GCV [W_2] and PCV [W_3] as weights for each character, a total of 63 selection indices were created. Different indicators' predicted genetic advance and percent relative efficiency (PRE) were determined. The findings showed that, across all index combinations PRE with standard deviation as its weight was generally greater than the other weights. The selection index I_{2456} in GCV weight method was found the best.

Keywords : Finger millet, selection index, GCV, PCV and PRE

INTRODUCTION

Ragi or finger millet is one of the significant minor millets. According to Upadhyay *et al.* (2007), finger millet is produced on a global scale fourth after sorghum, pearl millet and foxtail millet, while in India it is the sixth largest produce after wheat, maize, sorghum, bajra, and rice (Chandra *et al.*, 2016). India is leading country in production

of ragi in the world with occupancy of 1.004 million ha, average production of 1.755 million tones and productivity of 1747 kg/ha in 2019-20 (Indiastatagri, 2020). In Gujarat, finger millet occupies an area of 11610 ha with an average production of 10010 tones and productivity of 862 kg/ha in 2019-20 (Indiastatagri, 2020).

The current study used six biometrical characteristics from 40 finger millet

RELATIVE EFFICIENCY IN FINGER MILLET CROP

genotypes to compare several selection indices based on different weights. The data was collected from the experiment conducted by the P.G. student during *kharif* 2020. The Genetics and Plant Breeding Farm, B. A. College of Agriculture, AAU, Anand was the site of the randomised block design experiment, which had 3 replications. Six of the 9 significant characters - main ear length (cm), plant height (cm), test weight (g), days to maturity, productive tillers per plant, and grain yield per plant (g) were used to create selection indices with various weights viz., simple correlation coefficient [W_1], Genotypic Coefficient of Variance [W_2] and Phenotypic Coefficient of Variance [W_3]. ANOVA, simple correlation, GCV, PCV, mean performance of genotypes and selection index technique utilising different weights was applied to the data on six characters.

MATERIALS AND METHODS

It is possible to compute the selection index for an individual character, a combination of two characters, a combination of three characters, and so on. The combination that has the highest relative efficiency is being selected. Using the following formulas, genetic advance and PRE were determined. The selection index for an individual character or set of characters that yields the highest PRE was selected. The expected genetic advance was calculated by following (Dabholkar, 1992)

$$GA = \frac{Z}{P} \left(\frac{\sum \sum a_i b_i G_{ij}}{\sqrt{\sum \sum b_i b_j P_{ij}}} \right)$$

where,

Z/P = Selection intensity i.e., 2.06 at 5% level of significance

G_{ij} = Genotypic variance and covariance of the component characters

P_{ij} = Phenotypic variance and covariance of the component characters

a_i = Equal weight assigned to i^{th} character

b_i = Coefficients of i^{th} character

b_j = Transpose of b_i

$i=j$ = 1, 2, 3, ..., p character

The gain of grain yield was used as the standard to compute each index's percent relative efficiency. It was computed as follows:

Relative Efficiency (%) =

$$\frac{\text{Genetic gain of selection index}}{\text{Genetic gain of grain yield}} \times 100$$

The selection score value, which was computed as follows, was used to assess the genotype's worth.

$$\text{Selection score (I)} = \sum_{i=1}^n b_i X_i$$

where,

n = 1, 2, ..., 6 characters

X_i = Value of i^{th} character

b_i = Coefficient of i^{th} character

Based on the greatest score value across all approaches, the top five genotypes were chosen, and the rank correlation between various ways was used to assess how similar or distinct the methods were.

Spearman rank correlation

Selection score (I) was calculated for all genotypes using all selection indices in all six methods. Method wise ranking was done on the basis of selection score to identify the

genotypes with their merit. The ranking of all genotypes in all six methods was subjected to spearman rank correlation analysis to find out degree of association between different methods (weights) employed in the study. Spearman rank correlation was worked out as under.

$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

where,

r_s = Spearman correlation coefficient.

d = Deviation square of ranks of genotypes by two different methods

n = Number of genotypes.

The test of significance of 'r' was done as under

$$t = \frac{r_s \sqrt{n-2}}{\sqrt{1-r^2}}$$

The t value was compared with table t at (n-2) degree of freedom at 5% and 1% level of significance.

Simple correlation coefficient [W_1]

Correlation coefficient was calculated between grain yield and different biometrical characters using Pearson's formula (Pearson, 1896).

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

where,

r = correlation coefficient

This value was used to assign weights in selection indices.

Genotypic coefficient of variation (GCV) [W_2]

Genotypic coefficient of variation was computed using the following formula given by Burton (1952).

$$GCV = \frac{\sqrt{\sigma_g^2}}{\bar{X}} \times 100$$

where,

GCV = Genotypic coefficient of variation

$\bar{X}$ = General mean of the character

σ_g^2 = Expected genetic variance

Phenotypic coefficient of variation (PCV) [W_3]

Phenotypic coefficient of variation was computed using the following formula given by Burton (1952).

$$PCV = \frac{\sqrt{\sigma_p^2}}{\bar{X}} \times 100$$

where,

PCV = Phenotypic coefficient of variation

$\bar{X}$ = General mean of the character

σ_p^2 = Expected phenotypic variance

RESULTS AND DISCUSSION

Mean, range and coefficient of variation

The genotypic variation for different characters was found to be significant. Table 1 displays the mean performance results. Genotype WN 594 had the highest grain yield per plant (32.73 g) and maximum number of productive tillers per plant (6.13), genotype KOPN 1230 had maximum test weight (3.07), genotype VL149 had the least number of days to maturity (93.00), the highest main ear length (11.39 cm) was found for genotype KMR 340 and the highest plant height (121.00 cm) was for genotype KOPN 1228.

Simple correlation coefficients

The simple correlation coefficient results (Table 2) showed that there was a positive

and significant correlation of grain yield per plant with number of productive tillers per plant (0.6541), test weight (0.4620), days to maturity (0.3723), main ear length (0.3292) and plant height (0.3193) (Keerthana *et al.* 2019, Lad *et al.* 2020). Additionally, productive tillers per plant and main ear length had significant and positive correlations with test weight (0.3317) and plant height (0.5257), respectively, as well as days to maturity (0.5693) and plant height (0.4901), respectively.

Genotypic and phenotypic coefficient of variation

PCV was found to be higher than GCV based on current research on GCV and PCV (Jyothsana *et al.* 2016, Anuradha and Patro, 2019, Abhilash *et al.* 2020, Shashibhushan *et al.* 2022). The small variation between GCV and PCV for each character (Table 3) indicates a reduced environmental impact. Grain yield per plant (20.92, 23.28%), productive tillers per plant (16.36, 19.33%) and main ear length (10.03, 11.38%) showed the highest variability of GCV and PCV, while days to maturity, test weight and plant height showed the lowest variability of GCV and PCV. Therefore, it is possible to increase grain yield in finger millet by utilising productive tillers per plant and main ear length.

Selection indices using different weights

All potential combinations of the six biometrical characters were taken into consideration while creating the selection indices. By assigning basic correlation coefficient (W_1), GCV (W_2) and PCV (W_3) as weights for each character, a total of 63 selection indices were created.

Expected genetic gain and relative efficiency (%) for individual character

The expected genetic advance and PRE of different indices were worked out (Table 4). In both single and combination characters, the genetic advance of grain yield (7.9927) with equal weight was taken into consideration as a base. In light of this, the efficiency was calculated for every selection index using various weights. For every weight approach (W_1 , W_2 , and W_3), a total of six selection indices were created, along with information on each one's genetic advance and percentage of relative efficiency. For W_1 , W_2 and W_3 , the corresponding PREs for the selection index of biometrical characters were 1.98 to 100.00, 7.74 to 2243.33 and 9.14 to 2328.00 percent.

Expected genetic gain and relative efficiency (%) for two characters

Using various weight algorithms, all feasible combinations of 2 characters were used to create the selection indices (W_1 to W_3). In all, 15 selection indices were created for each weight method, together with their genetic advance and percentage relative efficiency (Table 5). The single character genetic advance for grain yield (7.9927) with equal weight technique was taken as the starting point, and the effectiveness of all selection indices of all conceivable combinations of six characters for various weights was calculated. In the genotypic and phenotypic coefficient of variation weight techniques, as well as the simple correlation coefficient, the highest PRE was noted for the grain yield per plant and days to maturity combination (I_{14}). The lowest PRE was that of test weight and main ear length combination (I_{35}) in simple correlation coefficient, genotypic and phenotypic coefficient of variance weight methods.

Expected genetic gain and relative efficiency (%) for three characters

To create selection indices using each weight method, all possible combinations of 3 of the 6 biometrical traits were taken one at a time. A total of 20 selection indices with various character combinations were created (Table 6). For every weight technique, the selection indices were computed together with their projected genetic advance and percentage relative efficiency. The combination of test weight, days to maturity (I_{134}), and grain yield per plant showed the highest percentage relative efficiency among all feasible combinations in all weight techniques. On the other hand, across all weight techniques, the combination of productive tillers per plant, test weight, and main ear length (I_{235}) showed the lowest PRE.

Expected genetic gain and relative efficiency (%) for four characters

Total 15 different combinations of selection indices along with genetic advance and percent relative efficiency were constructed for each weight method using 4 biometrical characters (Table 7). The highest PRE was of index I_{1456} in phenotypic coefficient of variance as weight (5486.21%) and index I_{2456} in simple correlation coefficient (433.99%) and genotypic coefficient of variance (10931.39%) weight methods.

Expected genetic gain and relative efficiency (%) for five characters

To create the selection indices for each weight technique, every potential combination of 5 distinct characteristics, out of a total of six, was taken into account. There were 6 selection indices created for every weight method (Table 8). For every weight technique, the selection indices were computed together with their genetic

advance and PRE. Comparing various combinations of biometrical characters within each weight method, the highest PRE was found in the selection index (I_{12456}), which included days to maturity, main ear length, plant height, productive tillers per plant, and grain yield per plant across all weight methods. However, the selection index (I_{12345}), which includes test weight, days to maturity, main ear length, productive tillers per plant, and grain yield per plant, showed the lowest PRE among all the weight methods.

Expected genetic gain and relative efficiency (%) for six characters

Using various weights, combinations of the 6 biometrical features were utilised to create selection indices. The genetic advance and PRE of the selection indices were computed (Table 9). The per cent relative efficiencies were 215.52, 5069.78 and 5648.84 per cent for simple correlation coefficient, GCV and PCV weight methods, respectively.

Among all methods, the highest PRE was observed in GCV (10931.39%) followed by PCV (8960.31%) and simple correlation coefficient (433.99%) weight methods among all the combinations.

The highest percent relative efficiency was observed with index I_{2456} consisting of productive tillers per plant, days to maturity, main ear length and plant height with GCV (10931.39) and simple correlation coefficient (433.99) weight method and by index I_{12456} consisting of grain yield per plant, productive tillers per plant, days to maturity, main ear length and plant height in the PCV (8960.31) weight method. In order to obtain greater genetic gain, selection indices can be constructed using the GCV of the variables. Given its better relative efficiency, the selection index (I_{2456}) using the GCV weight

method which includes productive tillers per plant, days to maturity, main ear length, and plant height was thought to be more reliable.

For each genotype, the index score values were calculated using the three weight techniques, taking into account the highest PRE indicated by various character combinations (Table 10). The findings showed that, across all index combinations, PRE with GCV was generally greater than the other weights. There was agreement with all approaches as indicated by the positive and extremely significant rank correlation among the various methods for the selection score values. Overall, the results showed that the selection index with GCV had the highest PRE as well. The rank correlation (Table 11) between the PCV weight technique and the GCV weight method with simple correlation coefficient was positive and very significant ($r_s > 0.8$). As a result, the following index, which is based on GCV as weight is superior to all others.

$$I = 582.988X_2 + 11.104X_4 + 7.931X_5 + 3.533X_6$$

Where,

- X_2 = productive tillers per plant
 X_4 = days to maturity
 X_5 = main ear length (cm)
 X_6 = plant height (cm)

REFERENCES

- Abhilash, P. V.; Rani, S. B.; Suresh B. G. and Ram, B. J. (2020). Correlation and path analysis studies in finger millet for yield and yield contributing traits [*Eleusine coracana* (L.) Gaertn.]. *International Journal of Chemical Studies*, 8(6), 1696-1701. <https://doi.org/10.22271/chemi.2020.v8.i6x.11013>
- Anuradha, N. and Patro, T. S. S. K (2019). Studies on variability, heritability and genetic advance for quantitative characters in finger millet genotypes. *International Journal of Chemical Studies*, 7(3), 2021-2024.
- Burton, G. W. (1952). Quantitative inheritance in pearl millet (*Pennisetum glaucum*). *Agronomy Journal*, 43, 409-417.
- Chandra, D.; Chandra, S.; Pallavi and Sharma, A. K (2016). Review of finger millet [*Eleusine coracana* (L.) Gaertn.]: A power of health benefiting nutrients. *Food Science and Human Wellness*, 5, 149-155. <http://dx.doi.org/10.1016/j.fshw.2016.05.004>
- Dabholkar, A. R. (1992). *Elements of Biometrical Genetics*, New Delhi, India: Concept publishing company. <https://doi.org/10.20546/ijcmas.2020.909.081>
- Indiastatagri (2020). Statistical information. <https://www.indiastatagri.com/data/agriculture/ragi-finger-millet/data-year/all-years>. Accessed 6 Apr 2022.
- Jyothsana, S.; Patro, T. S. S. K.; Ashok, S.; Rani, Y. S. and Neerja, B. (2016). Studies on genetic parameters, character association and path analysis of yield and its components in finger millet [*Eleusine coracana* (L.) Gaertn.]. *International Journal of Theoretical & Applied Sciences*, 8(1), 25-30.
- Keerthana, K.; Chitra, S.; Subramanian, A. and Elangovan, M. (2019). Character association and path coefficient analysis in finger millet [*Eleusine coracana* (L.) Gaertn] genotypes under sodic condition. *The Pharma Innovation Journal*, 8(6), 556-559.
- Lad, D. B.; Mahalle, S. P. and Bade, B. A.

(2020). Association of characters and path coefficient analysis for yield and its components in finger millet [*Eleusine coracana* (L.) Gaertn.] genotypes. *Journal of Pharmacognosy and Phytochemistry*, 9(5), 599-602.

Pearson, K (1896). Contributions to the mathematical theory of evolution III. Regression, heredity and panmixia. *Proceedings of the Royal Society of London*. 59, 69-71.

Shashibhushan, D.; Kumar, C. V. S. and Kondi, R. K. R. (2022). Genetic parameters and association studies for yield and yield contributing traits in pearl millet cultivars. *Biological Forum – An International Journal*, 14(1), 416-421.

Upadhyay, H. D.; Gowda, C. L. L. and Reddy, V. G. (2007). Morphological diversity in finger millet germplasm introduced from Southern and Eastern Africa. *Journal of Semi-Arid Tropical Agricultural Research*, 3(1), 1-3.

Table 1: Mean performance of forty genotypes for yield and yield attributing characters of finger millet

Parameters	Grain Yield per Plant (g)	Productive Tillers per Plant	Test Weight (g)	Days to Maturity	Main Ear Length (cm)	Plant Height (cm)
Mean	20.63	3.49	2.67	111.11	9.17	93.78
Range	12.93- 32.73	2.27- 6.13	2.04- 3.07	93.00- 142.67	7.33- 11.39	77.67- 121.00
S. Em. $\pm$	1.22	0.21	0.11	1.35	0.29	3.38
C.D. at 5%	3.43	0.58	0.31	3.81	0.81	9.51
CV %	10.22	10.29	7.15	2.11	5.46	6.24

Table 2: Simple correlation coefficients between different characters of finger millet

Characters	GY	PT	TW	DM	MEL	PH
GY	1.0000	0.6541**	0.4620**	0.3723*	0.3292*	0.3193*
PT	-	1.0000	0.3317*	0.0564	0.0967	0.1707
TW	-	-	1.0000	0.2252	-0.0119	0.2956
DM	-	-	-	1.0000	0.5693**	0.4901**
MEL	-	-	-	-	1.0000	0.5257**
PH	-	-	-	-	-	1.0000

*, ** significant at 5 and 1 per cent level of significance, respectively

GY: Grain Yield per Plant, PT: Productive Tillers per Plant, TW: Test Weight, DM: Days to Maturity, MEL: Main Ear Length, PH: Plant Height

Table 3 : Genotypic and phenotypic coefficients of variation for different characters of finger millet

Characters	Coefficient of Variation (%)	
	Genotypic	Phenotypic
Grain yield per plant	20.92	23.28
Productive tillers per plant	16.36	19.33
Test weight	8.72	11.28
Days to maturity	8.97	9.22
Main ear length	10.03	11.38
Plant height	8.45	10.50

Table 4 : Selection indices, expected genetic advance and Per cent Relative Efficiency (PRE) for individual character by using different weight methods

Sr. No.	Equations	Genetic Advance	PRE
1	Simple Correlation Coefficient taken as Weights (W_1)		
I_1	$I=0.808X_1$	7.9927	100.00
I_2	$I=0.480X_2$	0.6629	8.29
I_3	$I=0.257X_3$	0.1586	1.98
I_4	$I=0.353X_4$	7.4420	93.11
I_5	$I=0.257X_5$	0.5521	6.91
I_6	$I=0.207X_6$	2.0600	25.77
2	Genotypic Coefficient of Variation (GCV) taken as Weights (W_2)		
I_1	$I=16.896X_1$	167.2079	2092.00
I_2	$I=0.017X_2$	0.6185	7.74
I_3	$I=4.844X_3$	2.9939	37.46
I_4	$I=8.500X_4$	179.3037	2243.33
I_5	$I=7.822X_5$	16.8219	210.46
I_6	$I=5.470X_6$	111.0003	1388.77

Sr. No.	Equations	Genetic Advance	PRE
3	Phenotypic coefficient of variation (PCV) taken as Weights (W_3)		
I_1	$I=18.802X_1$	186.0708	2328.00
I_2	$I=0.020X_2$	0.7308	9.14
I_3	$I=6.267X_3$	3.8728	48.45
I_4	$I=8.736X_4$	184.3010	2305.86
I_5	$I=8.874X_5$	19.0860	238.79
I_6	$I=6.803X_6$	138.0607	1727.33

Where, $I_1, I_2, I_3, I_4, I_5, I_6$ are selection indices and X_1 =Grain yield per Plant;
 X_2 = Productive Tillers per Plant; X_3 = Test Weight; X_4 = Days to Maturity; X_5 = Main Ear Length
and X_6 = Plant Height

Table 5 : Selection indices, expected genetic advance and Per cent Relative Efficiency (PRE) for possible combinations of two characters by using different weight methods

Sr. No.	Equations	Genetic Advance	PRE
1	Simple Correlation Coefficient taken as Weights (W_1)		
I_{12}	$I=0.774X_1+0.996X_2$	8.5445	106.90
I_{13}	$I=0.789X_1+1.212X_3$	8.1253	101.66
I_{14}	$I=0.804X_1+0.388X_4$	13.1960	165.10
I_{15}	$I=0.795X_1+0.533X_5$	8.2679	103.44
I_{16}	$I=0.844X_1+0.205X_6$	10.3637	129.66
I_{23}	$I=0.493X_2+0.346X_3$	0.7625	9.54
I_{24}	$I=0.382X_2+0.353X_4$	7.4987	93.82
I_{25}	$I=0.494X_2+0.270X_5$	0.9269	11.60
I_{26}	$I=0.950X_2+0.208X_6$	4.5293	56.67
I_{34}	$I=0.787X_3+0.352X_4$	7.5140	94.01
I_{35}	$I=0.192X_3+0.251X_5$	0.5558	6.95
I_{36}	$I=-0.765X_3+0.217X_6$	4.2597	53.29
I_{45}	$I=0.350X_4+0.395X_5$	7.8435	98.13
I_{46}	$I=0.408X_4+0.211X_6$	11.0025	137.66
I_{56}	$I=0.590X_5+0.191X_6$	4.6093	57.67

Sr. No.	Equations	Genetic Advance	PRE
2	Genotypic Coefficient of Variation (GCV) taken as Weights (W_2)		
I_{12}	$I=16.241X_1+22.561X_2$	180.9546	2263.99
I_{13}	$I=16.499X_1+24.889X_3$	169.7487	2123.79
I_{14}	$I=16.904X_1+9.230X_4$	296.1867	3705.70
I_{15}	$I=16.684X_1+13.531X_5$	175.5906	2196.88
I_{16}	$I=17.870X_1+5.398X_6$	233.7825	2924.94
I_{23}	$I=12.169X_2+7.173X_3$	18.4252	230.52
I_{24}	$I=9.651X_2+8.505X_4$	180.7489	2261.42
I_{25}	$I=12.429X_2+8.152X_5$	25.4043	317.84
I_{26}	$I=24.439X_2+5.499X_6$	119.3956	1493.80
I_{34}	$I=17.677X_3+8.464X_4$	180.6951	2260.74
I_{35}	$I=2.873X_3+7.715X_5$	16.7441	209.49
I_{36}	$I=-22.26X_3+5.755X_6$	112.5356	1407.97
I_{45}	$I=8.457X_4+10.978X_5$	191.5773	2396.89
I_{46}	$I=9.992X_4+5.501X_6$	274.2518	3431.26
I_{56}	$I=16.61X_5+5.06X_6$	123.5303	1545.53
3	Phenotypic Coefficient of Variation (PCV) taken as Weights (W_3)		
I_{12}	$I=18.096X_1+25.832X_2$	202.2980	2531.02
I_{13}	$I=18.377X_1+28.468X_3$	189.2857	2368.22
I_{14}	$I=18.760X_1+9.558X_4$	316.5475	3960.44
I_{15}	$I=18.570X_1+15.224X_5$	195.5861	2447.05
I_{16}	$I=20.019X_1+6.704X_6$	271.2821	3394.11
I_{23}	$I=14.430X_2+8.989X_3$	21.9893	275.12
I_{24}	$I=11.764X_2+8.742X_4$	186.1371	2328.83
I_{25}	$I=14.663X_2+9.266X_5$	29.4169	368.05
I_{26}	$I=29.658X_2+6.833X_6$	148.0066	1851.76
I_{34}	$I=19.414X_3+8.708X_4$	186.0618	2327.89
I_{35}	$I=4.032X_3+8.734X_5$	19.0271	238.06

Sr. No.	Equations	Genetic Advance	PRE
I ₃₆	$I = -27.436X_3 + 7.157X_6$	139.9936	1751.51
I ₄₅	$I = 8.710X_4 + 12.030X_5$	198.2548	2480.44
I ₄₆	$I = 10.653X_4 + 6.680X_6$	304.3131	3807.37
I ₅₆	$I = 19.821X_5 + 6.290X_6$	152.3545	1906.16

Table 6 : Selection indices, expected genetic advance and Per cent Relative Efficiency (PRE) for possible combinations of three characters by using different weight methods

Sr. No.	Equation	Genetic Advance	PRE
1	Simple Correlation Coefficient taken as Weights (W_1)		
I ₁₂₃	$I = 0.755X_1 + 0.988X_2 + 1.233X_3$	8.677	108.56
I ₁₂₄	$I = 0.784X_1 + 0.821X_2 + 0.390X_4$	13.544	169.46
I ₁₂₅	$I = 0.753X_1 + 1.063X_2 + 0.575X_5$	8.815	110.28
I ₁₂₆	$I = 0.762X_1 + 1.508X_2 + 0.214X_6$	10.937	136.83
I ₁₃₄	$I = -4.313X_1 + 229.839X_3 - 0.101X_4$	91.564	1145.59
I ₁₃₅	$I = 0.777X_1 + 1.191X_3 + 0.542X_5$	8.392	105.00
I ₁₃₆	$I = 0.856X_1 - 0.083X_3 + 0.206X_6$	10.464	130.92
I ₁₄₅	$I = 0.799X_1 + 0.380X_4 + 0.515X_5$	13.579	169.90
I ₁₄₆	$I = 1.030X_1 + 0.008X_4 + 0.351X_6$	14.108	176.51
I ₁₅₆	$I = 0.827X_1 + 0.888X_5 + 0.177X_6$	10.767	134.71
I ₂₃₄	$I = 0.327X_2 + 0.971X_3 + 0.351X_4$	7.582	94.86
I ₂₃₅	$I = 0.516X_2 + 0.268X_3 + 0.262X_5$	0.988	12.36
I ₂₃₆	$I = 1.209X_2 + 0.510X_3 + 0.002X_6$	1.886	23.60
I ₂₄₅	$I = 0.384X_2 + 0.349X_4 + 0.418X_5$	7.906	98.91
I ₂₄₆	$I = 0.794X_2 + 0.405X_4 + 0.214X_6$	11.142	139.40
I ₂₅₆	$I = 0.949X_2 + 0.572X_5 + 0.193X_6$	4.926	61.64
I ₃₄₅	$I = 0.722X_3 + 0.349X_4 + 0.386X_5$	7.908	98.94
I ₃₄₆	$I = -0.579X_3 + 0.411X_4 + 0.218X_6$	11.068	138.48
I ₃₅₆	$I = -0.697X_3 + 0.537X_5 + 0.203X_6$	4.660	58.30
I ₄₅₆	$I = 0.408X_4 + 0.367X_5 + 0.206X_6$	11.415	142.82

RELATIVE EFFICIENCY IN FINGER MILLET CROP

Sr. No.	Equation	Genetic Advance	PRE
2	Genotypic Coefficient of Variation (GCV) taken as Weights (W_2)		
I ₁₂₃	$I=15.843X_1+22.377X_2+25.552X_3$	183.493	2295.75
I ₁₂₄	$I=16.626X_1+17.871X_2+9.246X_4$	304.383	3808.25
I ₁₂₅	$I=15.866X_1+23.887X_2+14.402X_5$	189.072	2365.55
I ₁₂₆	$I=15.96X_1+36.022X_2+5.631X_6$	247.806	3100.39
I ₁₃₄	$I=-89.159X_1+4803.761X_3-2.274X_4$	1914.779	23956.50
I ₁₃₅	$I=16.312X_1+23.394X_3+13.722X_5$	177.893	2225.68
I ₁₃₆	$I=18.242X_1-9.738X_3+5.491X_6$	235.691	2948.81
I ₁₄₅	$I=16.811X_1+9.075X_4+13.416X_5$	308.025	3853.81
I ₁₄₆	$I=22.327X_1+0.154X_4+8.772X_6$	323.359	4045.66
I ₁₅₆	$I=17.491X_1+22.679X_5+4.741X_6$	246.098	3079.02
I ₂₃₄	$I=8.194X_2+22.274X_3+8.454X_4$	182.390	2281.95
I ₂₃₅	$I=12.884X_2+4.772X_3+8.007X_5$	26.370	329.92
I ₂₃₆	$I=30.928X_2+13.449X_3+0.056X_6$	48.322	604.57
I ₂₄₅	$I=9.774X_2+8.432X_4+11.556X_5$	193.181	2416.96
I ₂₄₆	$I=20.632X_2+9.922X_4+5.581X_6$	277.902	3476.93
I ₂₅₆	$I=24.480X_2+16.160X_5+5.112X_6$	131.437	1644.46
I ₃₄₅	$I=15.501X_3+8.439X_4+10.845X_5$	192.786	2412.01
I ₃₄₆	$I=-17.935X_3+10.05X_4+5.714X_6$	275.594	3448.06
I ₃₅₆	$I=-20.827X_3+15.227X_5+5.398X_6$	124.712	1560.32
I ₄₅₆	$I=10.018X_4+10.479X_5+5.385X_6$	286.868	3589.11
3	Phenotypic Coefficient of Variation (PCV) taken as Weights (W_3)		
I ₁₂₃	$I=17.667X_1+25.651X_2+29.297X_3$	205.512	2571.24
I ₁₂₄	$I=18.42X_1+21.248X_2+9.578X_4$	326.614	4086.39
I ₁₂₅	$I=17.683X_1+27.302X_2+16.191X_5$	211.487	2645.99
I ₁₂₆	$I=17.766X_1+42.527X_2+6.980X_6$	287.693	3599.43
I ₁₃₄	$I=-99.903X_1+5349.553X_3+-2.435X_4$	2131.672	26670.14
I ₁₃₅	$I=18.177X_1+26.715X_3+15.387X_5$	198.500	2483.51
I ₁₃₆	$I=20.540X_1-14.722X_3+6.843X_6$	273.760	3425.11

Sr. No.	Equation	Genetic Advance	PRE
I ₁₄₅	$I=18.667X_1+9.403X_4+14.771X_5$	329.873	4127.17
I ₁₄₆	$I=24.349X_1+0.646X_4+10.011X_6$	364.188	4556.48
I ₁₅₆	$I=19.563X_1+26.491X_5+5.925X_6$	285.535	3572.44
I ₂₃₄	$I=10.342X_2+24.485X_3+8.694X_4$	188.224	2354.93
I ₂₃₅	$I=15.241X_2+6.265X_3+9.078X_5$	30.722	384.38
I ₂₃₆	$I=37.771X_2+16.715X_3+0.070X_6$	59.210	740.80
I ₂₄₅	$I=11.929X_2+8.680X_4+12.700X_5$	200.283	2505.81
I ₂₄₆	$I=25.584X_2+10.568X_4+6.769X_6$	309.047	3866.60
I ₂₅₆	$I=29.660X_2+19.272X_5+6.347X_6$	161.750	2023.71
I ₃₄₅	$I=16.848X_3+8.706X_4+11.791X_5$	199.775	2499.46
I ₃₄₆	$I=-23.382X_3+10.728X_4+6.959X_6$	306.094	3829.65
I ₃₅₆	$I=-25.349X_3+18.113X_5+6.705X_6$	153.840	1924.75
I ₄₅₆	$I=10.682X_4+11.926X_5+6.547X_6$	318.632	3986.52

Table 7 : Selection indices, expected genetic advance and Per cent Relative Efficiency (PRE) for possible combinations of four characters by using different weight methods

Sr. No.	Equations	Genetic Advance	PRE
1	Simple Correlation Coefficient taken as Weights (W_1)		
I ₁₂₃₄	$I=0.757X_1+0.803X_2+1.645X_3+0.389X_4$	13.677	171.11
I ₁₂₃₅	$I=0.734X_1+1.057X_2+1.221X_3+0.584X_5$	8.939	111.84
I ₁₂₃₆	$I=1.479X_1-1.180X_2+12.359X_3-1.071X_6$	5.023	62.84
I ₁₂₄₅	$I=0.775X_1+0.849X_2+0.381X_4+0.539X_5$	13.925	174.22
I ₁₂₄₆	$I=0.714X_1+1.525X_2+0.455X_4+0.206X_6$	16.731	209.32
I ₁₂₅₆	$I=0.735X_1+1.600X_2+0.933X_5+0.185X_6$	11.333	141.80
I ₁₃₄₅	$I=0.771X_1+1.610X_3+0.377X_4+0.543X_5$	13.703	171.45
I ₁₃₄₆	$I=0.824X_1+1.369X_3+0.485X_4+0.081X_6$	16.061	200.94
I ₁₃₅₆	$I=0.831X_1+0.299X_3+0.882X_5+0.175X_6$	10.859	135.87
I ₁₄₅₆	$I=0.799X_1+0.442X_4+0.550X_5+0.188X_6$	16.760	209.69
I ₂₃₄₅	$I=0.336X_2+0.906X_3+0.347X_4+0.415X_5$	7.981	99.86

Sr. No.	Equations	Genetic Advance	PRE
I ₂₃₄₆	$I=0.917X_2-0.765X_3+0.408X_4+0.223X_6$	11.218	140.36
I ₂₃₅₆	$I=1.100X_2-1.008X_3+0.500X_5+0.209X_6$	5.008	62.66
I ₂₄₅₆	$I=23.132X_2+0.452X_4+0.269X_5+0.133X_6$	34.688	433.99
I ₃₄₅₆	$I=-0.649X_3+0.414X_4+0.293X_5+0.217X_6$	11.480	143.64
2	Genotypic Coefficient of Variation (GCV) taken as Weights (W ₂)		
I ₁₂₃₄	$I=16.025X_1+17.444X_2+35.735X_3+9.219X_4$	306.907	3839.83
I ₁₂₃₅	$I=15.482X_1+23.770X_2+24.250X_3+14.606X_5$	191.393	2394.59
I ₁₂₃₆	$I=16.420X_1+39.316X_2-19.462X_3+6.823X_6$	265.809	3325.63
I ₁₂₄₅	$I=16.459X_1+18.533X_2+9.072X_4+13.938X_5$	316.091	3954.73
I ₁₂₄₆	$I=14.809X_1+36.464X_2+10.975X_4+5.426X_6$	391.167	4894.04
I ₁₂₅₆	$I=15.361X_1+38.156X_2+23.716X_5+4.942X_6$	259.818	3250.67
I ₁₃₄₅	$I=16.201X_1+33.701X_3+9.023X_4+14.084X_5$	310.315	3882.47
I ₁₃₄₆	$I=17.824X_1+44.642X_3+12.335X_4+0.367X_6$	372.642	4662.26
I ₁₃₅₆	$I=17.740X_1-2.002X_3+22.038X_5+4.799X_6$	247.751	3099.71
I ₁₄₅₆	$I=16.805X_1+10.713X_4+14.256X_5+4.997X_6$	394.708	4938.34
I ₂₃₄₅	$I=8.557X_2+20.035X_3+8.390X_4+11.559X_5$	194.603	2434.75
I ₂₃₄₆	$I=23.786X_2-23.066X_3+9.978X_4+5.833X_6$	279.473	3496.59
I ₂₃₅₆	$I=28.337X_2-29.099X_3+14.262X_5+5.543X_6$	133.344	1668.32
I ₂₄₅₆	$I=582.988X_2+11.104X_4+7.931X_5+3.533X_6$	873.717	10931.39
I ₃₄₅₆	$I=-20.283X_3+10.154X_4+8.559X_5+5.688X_6$	288.178	3605.50
3	Phenotypic Coefficient of Variation (PCV) taken as weights (W ₃)		
I ₁₂₃₄	$I=17.782X_1+20.827X_2+39.634X_3+9.552X_4$	329.807	4126.34
I ₁₂₃₅	$I=17.274X_1+27.187X_2+27.76X_3+16.371X_5$	214.427	2682.77
I ₁₂₃₆	$I=18.322X_1+44.870X_2-21.771X_3+7.740X_6$	299.230	3743.77
I ₁₂₄₅	$I=18.245X_1+21.965X_2+9.400X_4+15.390X_5$	339.763	4250.90
I ₁₂₄₆	$I=16.223X_1+44.242X_2+11.769X_4+6.616X_6$	435.294	5446.12
I ₁₂₅₆	$I=17.048X_1+45.066X_2+27.716X_5+6.162X_6$	301.598	3773.40
I ₁₃₄₅	$I=18.034X_1+37.072X_3+9.355X_4+15.391X_5$	332.762	4163.31

Sr. No.	Equations	Genetic Advance	PRE
I ₁₃₄₆	$I=20.565X_1+80.408X_3+14.410X_4-2.783X_6$	410.273	5133.08
I ₁₃₅₆	$I=19.949X_1-5.583X_3+25.455X_5+6.034X_6$	287.655	3598.95
I ₁₄₅₆	$I=18.688X_1+11.456X_4+16.135X_5+6.117X_6$	438.498	5486.21
I ₂₃₄₅	$I=10.798X_2+21.823X_3+8.649X_4+12.603X_5$	202.080	2528.30
I ₂₃₄₆	$I=29.712X_2-30.339X_3+10.640X_4+7.100X_6$	311.173	3893.20
I ₂₃₅₆	$I=34.454X_2-35.694X_3+16.920X_5+6.880X_6$	164.150	2053.74
I ₂₄₅₆	$I=649.357X_2+12.021X_4+9.663X_5+4.536X_6$	974.397	12191.03
I ₃₄₅₆	$I=-26.204X_3+10.858X_4+9.445X_5+6.940X_6$	320.370	4008.27

Table 8 : Selection indices, expected genetic advance and Per cent Relative Efficiency (PRE) for possible combinations of five characters by using different weight methods

Sr. No.	Equations	Genetic Advance	PRE
1	Simple Correlation Coefficient taken as Weights (W_1)		
I ₁₂₃₄₅	$I=0.748X_1+0.834X_2+1.647X_3+0.378X_4+0.568X_5$	14.051	175.79
I ₁₂₃₄₆	$I=0.719X_1+1.534X_2+0.219X_3+0.457X_4+0.205X_6$	16.827	210.53
I ₁₂₃₅₆	$I=0.741X_1+1.605X_2+0.205X_3+0.921X_5+0.185X_6$	11.427	142.96
I ₁₂₄₅₆	$I=0.710X_1+1.545X_2+0.447X_4+0.570X_5+0.195X_6$	17.134	214.37
I ₁₃₄₅₆	$I=0.801X_1+0.422X_3+0.444X_4+0.545X_5+0.185X_6$	16.851	210.83
I ₂₃₄₅₆	$I=0.938X_2-0.858X_3+0.412X_4+0.274X_5+0.222X_6$	11.630	145.51
2	Genotypic Coefficient of Variation (GCV) taken as Weights (W_2)		
I ₁₂₃₄₅	$I=15.854X_1+18.181X_2+34.795X_3+9.013X_4+14.637X_5$	318.446	3984.20
I ₁₂₃₄₆	$I=13.689X_1+42.474X_2-47.257X_3+9.576X_4+10.317X_6$	403.198	5044.56
I ₁₂₃₅₆	$I=15.633X_1+38.412X_2-4.173X_3+22.938X_5+5.026X_6$	261.516	3271.92
I ₁₂₄₅₆	$I=14.733X_1+36.942X_2+10.841X_4+14.741X_5+5.172X_6$	403.537	5048.79
I ₁₃₄₅₆	$I=16.976X_1+0.870X_3+10.758X_4+13.640X_5+5.015X_6$	396.337	4958.71
I ₂₃₄₅₆	$I=24.454X_2-26.099X_3+10.103X_4+8.030X_5+5.829X_6$	292.078	3654.29

Sr. No.	Equations	Genetic Advance	PRE
3	Phenotypic Coefficient of Variation (PCV) taken as Weights (W_3)		
I_{12345}	$I=17.612X_1+21.623X_2+38.355X_3+9.346X_4+16.049X_5$	342.735	4288.08
I_{12346}	$I=16.535X_1+44.821X_2+-6.860X_3+11.791X_4+6.686X_6$	437.592	5474.88
I_{12356}	$I=17.453X_1+45.458X_2+-8.155X_3+26.522X_5+6.302X_6$	303.785	3800.77
I_{12456}	$I=16.136X_1+44.785X_2+11.616X_4+16.73X_5+6.327X_6$	716.174	8960.31
I_{13456}	$I=19.000X_1-3.253X_3+11.520X_4+15.015X_5+6.189X_6$	440.607	5512.59
I_{23456}	$I=30.506X_2+-34.026X_3+10.797X_4+8.728X_5+7.111X_6$	325.461	4071.96

Table 9 : Selection indices, expected genetic advance and Per cent Relative Efficiency (PRE) for combinations of all six characters by using different weight methods

Sr. No.	Equations	Genetic Advance	PRE
1	Simple Correlation Coefficient taken as Weights (W_1)		
I_{123456}	$I=0.713X_1+1.550X_2+0.325X_3+0.450X_4+0.558X_5+0.193X_6$	17.2263	215.52
2	Genotypic Coefficient of Variation (GCV) taken as Weights (W_2)		
I_{123456}	$I=14.923X_1+37.239X_2-1.370X_3+10.892X_4+13.965X_5+5.216X_6$	405.2140	5069.78
3	Phenotypic Coefficient of Variation (PCV) taken as Weights (W_3)		
I_{123456}	$I=16.460X_1+45.276X_2-6.035X_3+11.688X_4+15.414X_5+6.432X_6$	451.4970	5648.84

Table 10 : Top three ranking selection indices in different weight methods including finger millet grain yield per plant

Combinations	Rank	Simple Correlation (W_1)	GCV (W_2)	PCV (W_3)
Combinations of two characters	1	$I_{14}(165.10)$	$I_{14}(3705.70)$	$I_{14}(3960.44)$
	2	$I_{46}(137.66)$	$I_{46}(3431.26)$	$I_{46}(3807.37)$
	3	$I_{16}(129.66)$	$I_{16}(2924.94)$	$I_{16}(3394.11)$
Combinations of three characters	1	$I_{134}(1145.59)$	$I_{134}(23956.50)$	$I_{134}(26670.14)$
	2	$I_{146}(176.51)$	$I_{146}(4045.66)$	$I_{146}(4556.48)$
	3	$I_{145}(169.90)$	$I_{145}(3853.81)$	$I_{145}(4127.17)$

Combinations		Rank	Simple Correlation (W1)	GCV (W2)	PCV (W3)
Combinations of four characters		1	$I_{2456}(433.99)$	$I_{2456}(10931.39)$	$I_{1456}(5486.21)$
		2	$I_{1456}(209.69)$	$I_{1236}(4938.34)$	$I_{1246}(5446.12)$
		3	$I_{1246}(209.32)$	$I_{1246}(4894.04)$	$I_{1346}(5133.08)$
Combinations of five characters		1	$I_{12456}(214.37)$	$I_{12356}(109.53)$	$I_{12456}(8960.31)$
		2	$I_{13456}(210.83)$	$I_{12345}(108.01)$	$I_{13456}(5512.59)$
		3	$I_{12346}(210.53)$	$I_{12346}(4958.71)$	$I_{12346}(5474.88)$

Parenthesis value indicates Per cent Relative Efficiency (PRE)

Table 11 : Rank correlations between different weight methods based on the best selection index of respective weight methods including finger millet grain yield per plant

Weight	Correlation Wt.	GCV Wt.	PCV Wt.
Correlation Wt.	1.000	0.998**	0.788**
GCV Wt.	-	1.000	0.804**
PCV Wt.	-	-	1.000

** significant at 1 per cent level of significance, respectively; n = 40

DETERMINANTS OF PARENT'S ATTITUDE ON PRE-REQUISITE SKILLS OF CHILDREN WITH AUTISM

Seema Saikia^{1*} and Ramya Bhaskar²

^{1&2}Department of Human Development, Avinashilingam Institute of Home Science
and Higher Education for Women, Coimbatore

*Email : seemasaikia91@gmail.com

ABSTRACT

The study sample of 112 parents was taken through simple random sampling from assorted special schools of Coimbatore city of Tamilnadu to evaluate the attitude of parents on pre-requisite skills of the children with ASD and its determinants. An attitude scale and a socio-demographic questionnaire were administered to assess the attitude as well as personal and family backgrounds. The majority of the parents had a neutral attitude and 12.4% indicated an unfavorable attitude. The multiple linear regression analysis indicated that there is a significant relationship between the socio-demographic factors and the parents' attitudes with $F(7,104) = 3.654$ and $P = .001$. Family income ($\beta .250$, $t = 2.455$, $p = 0.016$), number of siblings of the child ($\beta -.254$, $t = -2.747$, $p = 0.007$), and area of residence ($\beta -.200$, $t = -2.134$, $p = 0.035$) were significant determinants of the parent's attitude towards pre-requisite skills of autistic children.

Keywords : Autism, Family Income, Parent Attitude, Pre-requisite skill

INTRODUCTION

Autism spectrum disorder (ASD) is a childhood developmental disorder characterized by social, behavioral, and communication difficulties (Centers for Disease Control and Prevention, 2022). The signs of ASD include loss of acquired speech, babbling or social skills, avoidance of eye contact, persistent preference for loneliness, difficulty understanding other people's feelings, delayed and impaired language development, repetition of words or phrases, struggle with minor changes in routines or surroundings, restricted interests and repetitive behaviors such as flapping, rocking and spinning (Autism Speaks, 2021). Minhas *et al.* (2015) deliberated

that, "individuals with autism have severely impaired communication resulting in poor social skills and isolation from community-based activities and interactions. ASD knows no barriers and impacts individuals across social and geographical boundaries and is termed as a lifelong disorder that affects the individual into adulthood". Arora, *et. al* (2021) stated that one in 125 children between 2-6 years age group and one in 80 among children in 6-9 years and the overall prevalence was estimated to be 1 in 89.

Rice (2009) states the gender-wise prevalence of ASD, that males were affected more (4.5 times) than females. Children with ASD may communicate out loud, nonverbally or a combination of both. It depends on how they get treatments and therapies. Lecavalier

et al (2006) identified that raising a child with the spectrum is certainly not an easy task for parents. The long-lasting nature of autism demands continuous care and this presents a huge challenge for parents. In addition, the behavioral problems and communication issues among autistic children make the challenges even more difficult and result in high levels of stress among parents. Zakaria and Tauhaid (2018) also stated that parents have to face problematic behaviors (energetic behavior, aggression, damage, and self-injury) causing never-ending emotional and physical effects on parents.

Bronfenbrenner (2005) defined parental attitude as the force characteristic related to a parent's temperament, motivation, and persistence in parenting an autistic child". It was substantiated by Picardi (2018) *et al.* who found that parents with autistic children had an increased subjective burden and negative attitude. They experience more persistent psychological distress and less social support. They also identified that mothers experienced a higher personal burden than fathers. The most positive and negative indicators of objective and subjective load were the symptom, severity, and social support".

Parent's attitudes on pre-requisite skills regarding autistic children are important considerations for the life of parents and children. According to Nathan Mahr (2023), pre-requisite skills represent the fundamental competencies essential for embarking on any potential career route. It involves developing abilities related to following instructions, completing tasks independently, and working well with others. Autistic children have a problem with social skills, communication skills, and appropriate social behavior which is very important in any vocation.

Many children with autism, even after success in home-based behavioral intervention programs, still do not develop skills that are fundamental to success such as responding to group instructions, following directions, asking for help when needed, understanding different kinds of authority, learning to maintain personal cleanliness/hygiene, making small decisions, self-awareness, self-advocacy, and safety skills (Michele R. *et.al* 2014). Here, pre-requisite skills gain the utmost importance. Because parents have to understand pre-requisite skills so that they can teach their children. It is important to start early for children with autism because if these prerequisites of the vocational training are not met then there will not be enough time to learn these skills and get access to the next level of vocational skills of getting a job, learning the job, and sustain the job. Parents of ASD children feel the pressure of seeing their children accepted in society, able to live without help, and take responsibility for their requirements. Given this backdrop, this study was conducted to assess the attitude of parents of children with ASD on pre-requisite skills with the consequent objectives.

OBJECTIVES

- To assess the attitude of parents on pre-requisite skills of children with ASD
- To find out the socio-demographic determinant of parents' attitudes on pre-requisite skills

METHODOLOGY

A simple random sampling technique was applied for choosing 112 parents of autistic children from assorted special schools in Coimbatore. The institute's human ethical clearance was obtained. A letter explaining

the need and objectives of the study was submitted to special school authorities and permission was taken to do the study. Parents who drop and pick their children from the special schools were approached to participate in the study and informed consent was taken from them after explaining the study's purpose. A self-structured questionnaire was used to collect the socio-demographic information of the subjects. A Likert scale (consisting of 35 items) was developed by the researcher and was used to assess the attitude towards pre-requisite skills. The items on the scale were related to the aspects of scheduling, attention, socialization, self-control, self-advocacy, and safety aspects. Each item had 5 responses indicating strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree with 1,2,3,4, and 5 ratings and vice versa for negative items.

The reliability of the scale was checked by using Cronbach's alpha reliability test which showed the good reliability (77). The levels of attitude were derived by averaging the total score indicating higher the score, favorable

the attitude. Frequency and percentages were calculated and multiple-linear regression analysis was applied to determine the relationship between the variables and identify the determinants of parents' attitudes.

RESULTS AND DISCUSSION

As per the objectives study results were presented under the following sections:

Section I : Results for socio-demographic profile of the respondents

Section II : Results regarding the attitude of respondents for pre-requisite skills

Section III : Results for association of variables and testing of significance

Section I : Results for socio-demographic profile of the respondents

This section details the findings about the socio-demographic profile of the respondents' sex, educational qualification, occupation, family income, number of siblings, family type, and area of living.

Table 1 : Socio-Demographic profile of the respondents

Variables	Details	n =112	%
Sex of Parent	Father	31	27.4
	Mother	81	72.6
Education Qualification	Higher Secondary	0	0
	UG	42	37.2
	PG	68	61.1
	Ph. D	2	1.8
Occupation	Govt. employed	15	29.5
	Private Sector	22	47.5
	Self Employed	3	16.4
	Home Maker	72	63.7
Family Income	Under2-5 Lakhs	16	14.2
	Under 5-10 Lakhs	87	77.9
	10 lakhs & above	9	8.0

Variables	Details	n =112	%
Number of Siblings	Single child	83	74.1
	1 Siblings	29	25.9
Family Type	Nuclear	86	77
	Joint	26	23
Area of living	Urban	93	83.2
	Semi-Urban	19	16.8
	Rural	0	0

Table 1 presents the socio-demographic profile of the respondents. It is evident from Table 1 that the majority of the parents who responded were mothers (72.6%) and the rest were fathers (27.4%). Most of the parents (61.1%) had postgraduate and graduate (37.2%) degrees. Parents were homemakers (63.7%), working in private (47.5%) as well as government sector (29.5%) and were self-employed (16.4%). It was noticed that 77.9% of respondents had family income between 5-10 lakhs, followed by 2-5 lakhs (14.2%) and above 10 lakhs (8.0%). The majority of the respondents had a single child

(74.1%) and 25.9% reported that the autistic child has one sibling. Further, the majority of respondents (77.0%) had nuclear families while 23% were living in joint families. The majority of the respondents were residing in urban (83.2%) and the rest (19.8%) were living in semi-urban areas. No respondent was living in a rural area.

Section II : Results regarding the attitude of respondents for pre-requisite skills

This section describes the findings about the attitude of respondents about pre-requisite skills.

Table - 2 Attitude of respondents on pre-requisite skills

Variable	Favorable	Attitudes Neither favorable or unfavorable i.e. Neutral	Unfavorable
Attitude	0	99 (87.6%)	14 (12.4%)

Table 2 shows the attitude of parents on pre-requisite skills. A higher percentage (87.6%) of respondents tend to have a neutral attitude which indicates that they have neither a favorable nor unfavorable attitude while 12.4% indicated an unfavorable attitude and no parents seemed to exhibit a favorable attitude. As per these results, it is seen that parents' attitudes were neither favorable nor unfavorable towards pre-requisite skills.

According to the study most of the parents with neutral attitudes might be confused in accepting or denying their willingness to

provide the training on prerequisite skills. This could be because of social pressure and also due to a lack of support from their family members. The parents of an autistic child have a negative mindset that ASD is not curable and it's a lifelong process. Thus, according to them providing training on pre-requisite skills may not influence their child's behavioral change. Therefore, they may not want to acknowledge that training on prerequisite skills will improve their day-to-day life. Lack of community support is also a major issue in this regard. A study carried out

by Griffith *et. al* (2010) revealed that parents of ASD children scored low on helpful perceptions because they lacked social support for their children. With this, parents of autistic children end up showing higher stress levels that might affect their attitudes.

Section III : Results for association of variables and testing of significance

This section details the findings drawn from the Multiple linear regression, testing of relevant assumptions on the sample of 112

respondents as independent variables were seven. The assumption of singularity was met and correlation (the independent variables did not have coefficient loadings with more than 0.8) was also met. The collinearity statistics were met with tolerance being less than 1 and VIF with less than 10. Extreme univariate outliers were identified during the initial screening and were modified after which the cook's distance was found to be .000 to .186.

Table 3 (a) : Relation between parent's attitude and socio-demographic factors

Variables	Attitude	Sex of Parent	Education Qualification	Parents Occupation	Family Income	Siblings of Child	Type of Family	Area of Living
Attitude	1							
Sex of Parent	-.162*	1						
Edu. Qualification	.019	-.080	1					
Parents Occupation	-.070	.738**	-.128	1				
Family Income	.249**	-.296**	.056	-.392**	1			
Siblings of Child	-	.047	.093	-.047	.079	1		
Type of Family	.231**						1	
Area of Residence	-.131	.009	.012	-.149	.254**	.206*		1
Mean	1.88	.067	-.056	.101	-.295**	-.213*	-.079	1
Std.Deviation	1.88	1.72	2.64	3.16	2.94	2.26	1.23	1.17
Number	.332	.449	.517	1.167	.470	.440	.424	.377
	112	112	112	112	112	112	112	112

Table 3 (a) explains the results of the correlation between the attitude of parents of autistic children and their socio-demographic factors. For this socio-demographic variables such as sex of parents, education, qualification, parent's occupation, number of siblings of child, type of family, and area of residence were the independent variables while parents' attitude was the dependent

variable. The attitude of respondents showed a significant negative association with the sex (-.162*), number of siblings of the child (-.231**), and area of residence (-.208*) while a significant positive association was seen for family income (.249**), The sex of the parent was significantly positively associated with occupation (.738**) and negatively with family income (-.296**). Occupation of

parents showed a negative association with family income (-.392**). Family income has a significant positive association with the type of family (.254**) and a negative with area of

residence (-.213*). Siblings of the child were positively associated with the type of family (.206*) and inversely with area of residence (-.213*).

Table 3 (b) : Summary of the model

Model	Model Summary			
	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.444 ^a	.197	.143	.298

1. Predictors: (Constant), Area of Residence, Education Qualification, Type of Family, Parent type, Siblings of Child, Family Income, Parents Occupation
2. Dependent Variable: Total attitudes

Table 3 (c): ANOVA results

Model		ANOVA				
		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2.268	7	.324	3.654	.001 ^b
	Residual	9.223	104	.089		
	Total	11.491	111			

1. Dependent Variable: Total attitudes
2. Predictors: (Constant), Area of Residence, Education Qualification, Type of Family, Parent type, Siblings of Child, Family Income, Parents Occupation

Coming to Tables 3 (b) and (c) represent the model summary and ANOVA respectively. Table 3(b) shows that the R-value is .444 indicating the relationship between the independent and dependent variable to be

positive with 19.7% of variance with R^2 being .197. Also, Table 3(c) reflects the highly significant relationship between the socio-demographic factors and the parents' attitude with $F(7, 104) = 3.654, P < .001$.

Model	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	2.167	.364		5.948	.000
Parent type	-.116	.095	-.162	-1.219	.225
Education Qualification	.015	.055	.024	.273	.786

Model	Coefficients			T	Sig.
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta		
Parents	.038	.038	.139	1.007	.316
Occupation					
Family Income	.171	.070	.250	2.455	.016
Siblings of Child	-.186	.068	-.254	-2.747	.007
Type of Family	-.103	.071	-.136	-1.446	.151
Area of Residence	-.171	.080	-.200	-2.134	.035
1. Dependent Variable: Total attitudes					

Further, the multiple linear regression analysis depicts that the family income ($\beta = .250$, $t = 2.455$, $P = 0.016$), number of siblings ($\beta = -.254$, $t = -2.747$, $P = 0.007$), and area of residence ($\beta = -.200$, $t = -2.134$, $P = 0.035$) are the significant variables that are determining the parents' attitude in the study. Hence, one unit change in family income will increase .250 score in parents' attitude on prerequisite skills of autistic children, while one unit change in the number of siblings decreases the parents' attitude by -.254 score, and one unit change in area of residence will decrease -200 score in parents' attitude. It could be understood that a higher family income shows a favorable parents' attitude based on the ordinal score of 1 to 4 where a higher score denotes higher income. Similarly, the lesser the siblings show the parents' attitude to be unfavorable with the ordinal score of 1 to 3 indicating higher the score higher the number of siblings. However, the area of living indicates that parents from urban areas show unfavorable attitudes based on the given nominal score of 1 and 2 for urban and semi-urban areas respectively.

Having an autistic child in a family marks a workload not as usual as it is for a normal child, especially for the care taker as well as the family members. Following this, they

have to make a huge amount of savings for their child's treatment and other expenditures. An unspoken condition exists that if the family has a good level of income, the family can afford the best care and treatment for the autistic child along with the other family expenditures. The study has come by the fact that economic wellbeing is important and it has a significant effect on the parent's attitude level. Wellness in the economic status indicates a favorable attitude towards pre-requisite skills and it can be considered as one of the predictors for the desirable attitude of parents of autistic children. According to Banach *et.al.* (2010), "Parents whose child is diagnosed with ASD experience difficulties and it changes the dynamics of the family in that everyday activities need to be modified and the child with ASD will need extra attention from the parents. Parents have to work more, and spend more for the child and family. Learning that the child is autistic can result in scattered emotions for the parents. Each family handles the vision of their child differently".

Quite often, it happens that parents of autistic children look for one more child of their own who is not autistic which gives them hope and support. The point of view which takes to opinion is that, if an autistic child has a sibling, then the sibling will be able to take care of the autistic child by playing with them,

accompanying them, assisting them, etc. In that way, the parents feel that the child will be less dependent on them as well as makes them feel secure. Therefore, the parents may have more chances of getting their own time or extra time to focus on other aspects and their careers. Consequently, an autistic child having siblings is considered to be a predictor of favorable parents' attitudes. McHale *et al.*, (2016) found that "Siblings are often the first playmates, the first role models and the first teacher's children will have. As such this unique relationship provides the opportunity for social, emotional, behavioral, and psychological development, all of which are particularly important for children with ASD who can face many challenges across these areas. The sibling relationship may provide many positives for the child with ASD".

Parents who are living in urban areas have unfavorable attitudes compared to semi-urban areas. It may be assumed that semi-urban families are more interested in learning new ideas to provide their children with a better life than families residing in urban areas. It is also assumed that parents from urban areas seem to be occupied with exploring other ways of giving the best to their children outside the home and also squeeze in time to focus on their day-to-day work. Thus, they may be not in a position to or cannot give much time to their child. In this study, parents residing in semi-urban areas seem to hold a positive attitude towards autistic children as they would want to give training or practices that they can at home. In a conservative society, social norms, societal demands, and expectations play a vital role in determining parents' choices, attitudes, and acceptance. The stress levels vary and pressure from society may not have as much impact on the parents residing in the semi-urban area as it does to parents in urban areas.

CONCLUSION

The study findings highlight the neutral attitude of parents indicating neither favorable nor unfavorable towards pre-requisite skills for autistic children with a considerable percentage of them reporting an unfavorable attitude as well. Socio-demographic factors such as family income, the number of siblings the autistic child has, and the areas of residence were found to be significant predictors of parents' attitudes towards pre-requisite skills. It is quite a task for a society like India that hosts varied cultures, traditions, languages, socioeconomic inequalities, and different education levels to understand Autism, and bringing about a change in their attitude towards pre-requisite skills is a challenge. In conclusion, the researcher deliberates on building a favorable attitude among parents by sensitizing them regarding the importance of training the children on pre-requisite skills and also, conducting an intervention programme to enhance positive mind set and mental health. These can give power to parents to steer beyond the existing socio-demographic conditions to have encouraging and resourceful parenting which can be more effective, helping them to enrich the social and emotional life of the ASD children and themselves. Owing to the limitation of a small sample size of the present study, it is recommended that research be carried out on a larger group for are presentation to infer the effects and impacts.

REFERENCE

- American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Washington, DC: Publisher.
- Arora, N. K., Nair, M. K. C., Gulati, S. (2018). Neurodevelopmental disorders in

- children aged 2–9 years: Population-based burden estimates across five regions in India. *PLoS Med.* 2018 Jul; 15(7): e100261.
- Autism Speaks (2021), <https://www.autismspeaks.org/science-news/autism-and-health-special-report-autism-speaks>
- Banach, M. and Couse, L. An interdisciplinary approach: Supporting families after diagnosis. Poster presented at the Council on Social Work Education. San Francisco, CA. October, 2010 [Google Scholar]
- Bronfenbrenner, U. (2005). Making human beings human: Bioecological perspectives on human development. Sage.
- Centers for Disease Control and Prevention. Prevalence of autism spectrum disorders among children aged 8 years-Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2010. *MMWR Surveill. Summ.* 2014;63:1–21. [PubMed] [Google Scholar]
- Griffith G. M., Hastings R. P., Nash S. and Hill C. (2010) Using matched groups to explore child behavior problems and maternal well-being in children with Down syndrome and autism. *Journal of Autism and Developmental Disorders* 40, 610–9
- Lecavalier, L., Leone, S., and Wiltz, J. (2006). The impact of behavior problems on caregiver stress in young people with autism spectrum disorders. *Journal of Intellectual Disability Research*, 50, 172–183.
- Michele R. Bishop, Carolyn Bredek, in Evidence-Based Treatment for Children with Autism, 2014. Doi, <https://www.sciencedirect.com/topics/psychology/prerequisite-skill#:~:text=Many%20children%20with%20ASD%2C%20even,skills%20to%20consider%20targeting%20include%3A&text=Responding%20to%20group%20instructions&text=Completing%20assignments%20independently>
- McHale S. M., Updegraff K. A., Feinberg M. E. (2016). Siblings of youth with autism spectrum disorders: Theoretical perspectives on sibling relationships and individual adjustment. *Journal of Autism & Developmental Disorders*, 46(2), 589–602. [PMC free article] [PubMed] [Google Scholar]
- Nathan Mahr, Explore pre-vocational skills. Learn the definition of pre-vocational skills, understand their different types, and discover various pre-vocational skills examples. Updated: 11/21/2023. Doi, <https://study.com/academy/lesson/what-are-pre-vocational-skills.html#:~:text=Pre%2Dvocational%20skills%20are%20sets,and%20working%20well%20with%20others.>
- Minhas, A., Vajaratkar, V., Divan, G., Hamdani, S. U., Leadbitter, K., Taylor, C., Aldred, C., Tariq, A., Tariq, M., Cardoza, P., Green, J., Patel, V., and Rahman, A. (2015). Parents perspectives on care of children with autistic spectrum disorder in South Asia - Views from Pakistan and India. *International Review of Psychiatry*, 27(3), 247–256.
- Picardi A, Gigantesco A, Tarolla E, Parental Burden and its Correlates in Families of Children with Autism Spectrum Disorder: A Multicentre Study with Two Comparison Groups. *Clin Prac Epidemiol Mental Health* 14, 143-176 (2018).
- Zakaria, S. M., and Tauhaid, N. S. M. (2018). Cabaran membekalkan anak-anak autisme daripada perspektif ibu (The challenges of nurturing autistic children from the mother's perspective). *Jurnal Psikologi Malaysia*, 32(1), 58-7

SCREENING OF PLANT GROWTH PROMOTING ATTRIBUTES AND EXTRACELLULAR HYDROLYTIC ENZYME PRODUCTION BY SOIL DWELLING FUNGI

Kishan Vachhani¹, Yogesh Paneliya¹, Yogesh Patel^{2*}, Gaurav Dave³

¹ Nature Bioscience, Raj industrial Zone, Gondal, Gujarat

² Department of Microbiology, College of Basic Science and Humanities, SDAU, Sardarkrushinagar, Gujarat

³ Department of Biochemistry, Pulses Research Station, SDAU, Sardarkrushinagar-385506

*Email : yrpmicro@gmail.com; yogeshpatel@sdau.edu.in

ABSTRACT

Plant growth promoting (PGP) activities are symbiotic relationship of plant and microorganisms where, microbes produce bioactive molecules which help in plant growth, and in return plant gives nutrition and habitat. In the present study, 25 fungal cultures were isolated from agricultural soil. The screening for PGP and extracellular enzyme production revealed two fungal cultures MA2 and TV1 as promising candidates. The fungal isolates were identified by morphological and cultural characteristics. The molecular level identification showed the isolate MA2 as *Aspergillus ochraceus* and TV1 as *Trichoderma yunnanensis*. The *in vitro* screening of PGP activity by both the fungal isolates demonstrated positive results for the production of siderophore, ammonia, indole acetic acid (IAA) and gibberellic acid. The isolates were found to be incapable of phosphate solubilization. The extracellular enzyme production by fungal isolates was carried out on solid media incorporated with specific substrates. The isolates displayed amylase, lipase, protease, cellulase and chitinase production capacity. Therefore, the fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* can be explored as potential candidates for the preparation of plant growth promoting and enzyme formulations for agriculture and industrial application.

Key words : Screening, plant growth promotion, *Aspergillus ochraceus*, *Trichoderma yunnanensis*, extracellular enzymes

INTRODUCTION

The microorganisms are considered as an integral part of agriculture and industry as the preparation of several economic products is possible due to diverse metabolic activities of the microorganisms. Fungi represent an important soil dwelling microorganisms owing to their dynamic growth requirements and excellent capacity to adopt with adverse

or unfavorable conditions. They produce array of extracellular enzymes which mediate breakdown and decomposition of complex molecules into simpler one, and thereby enhancing soil quality and fertility (Zifcakova et al., 2016). Based on their roles, soil fungi can be classified as biocontrol agents, ecosystem regulators, and decomposing and transforming agents (Frac et al., 2018). The interaction of fungi with plants can be

beneficial (mycorrhizal symbiosis) or harmful (fungal diseases). For nutrient acquisition, both symbiotic and most pathogenic fungi penetrate their host plants without breaking the cellular plasma membrane (Chanclud and Morel, 2016).

Successful plant growth is the result of favorable combination of several abiotic factors and microbial interactions. Rhizosphere, the region around the plant root is comparatively rich in nutrients; around 40% of plant photosynthesis products are released from the roots and accumulate in this region (Bais *et al.*, 2006). The rhizosphere is the site where large number of diverse groups of microorganisms show intense metabolic activity. Moreover, it provides an ideal habitat for the microbial populations exhibiting positive, neutral or detrimental effects on plant growth. Plant growth promoting fungi (PGPF) are a heterogenous group of nonpathogenic fungi (true fungi and oomycetes) that are associated with plant roots and provoke enhancement in plant growth or health (Bent, 2006). Mostly, the PGPF includes nonsymbiotic and saprotrophic free living fungi present in rhizosphere soil or on the plant root surface. Plant growth promoting and biocontrol activities of several members of genera *Aspergillus*, *Fusarium*, *Penicillium*, *Phoma* and *Trichoderma* are frequently reported (Brazhnikova *et al.*, 2021). Arbuscular mycorrhizal fungi (AMF) belonging to *Glomeromycotina* phylum have been considered as one of the most important components of the soil ecosystem, as they possess several beneficial characteristics for plant growth in abiotic and biotic stress conditions (Wagg *et al.*, 2019; Yu *et al.*, 2022). *Aspergillus* species among the rhizosphere organisms produce a variety of secondary metabolites which promote plant growth and protect against several soil borne plant pathogens (Akhtar and Siddiqui 2006).

Aspergillus fumigates (Pradhan and Sukla, 2006) and *Aspergillus* sp. (Rashid *et al.*, 2004) are known for their capability to solubilize insoluble phosphate and make it available to plants. Another candidate is the *Trichoderma* spp., which are free-living fungus commonly found in soil, rhizosphere and foliar environments. This fungus has an excellent plant growth promoting attributes as well as induction of systemic resistance in plants (Yedidia *et al.* 1999). Different species of *Trichoderma* are widely utilized as biocontrol agent in the agriculture. Apart from that, fungi are also known for the production of certain compounds having similarity with plant hormones, such as auxins, gibberellic acids, cytokinins, jasmonic acid, ethylene, salicylic acid and abscisic acid. The role of these hormones in overall plant growth and development as well as in triggering important plant signalling events during biotic and abiotic stresses is well documented (Chanclud and Morel, 2016). The extracellular enzymes produced by fungi have important role in nutrient acquisition by the plants and defence against plant pathogens.

Present study deals with the isolation and identification of soil dwelling fungi. The *in vitro* screening of plant growth promoting attributes as well as extracellular enzymes production by two fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* is included in this study.

MATERIALS AND METHODS

2.1 Collection of soil sample and isolation of fungal cultures

The soil samples were collected from agricultural farms (21°59'11.9"N 70°46'32.7"E) located in Gondal city, District Rajkot, Gujarat. All the soil samples were collected in sterile plastic bags and

transferred to the laboratory for further processing. The soil samples were serially diluted with sterile distilled water and plated on potato dextrose agar (PDA) plates with the help of sterile glass spreader. The plates were incubated at $28\pm 2^{\circ}\text{C}$ for 4-5 days. The growth of fungi was observed in terms of characteristics colony morphology. The pure cultures of fungi were transferred to PDA slants and stored at 4°C .

2.2 Identification of fungal isolates

The fungal isolates were identified by colony morphology, texture, color and reverse pigmentation. The microscopic analysis was done for the identification of mycelia type and spore arrangements. The molecular level identification was performed by 18S rRNA ITS gene sequencing from GeneXplore Diagnostics & Research Centre Pvt. Ltd., Ahmedabad, Gujarat.

2.3 Screening of plant growth promoting attributes of fungal isolates

2.3.1 Phosphate solubilization

Phosphate solubilization capacity of fungal isolates were screened on the Pikovskaya's medium containing (g/l): glucose, 10; yeast extract, 0.5; $\text{Ca}_3(\text{PO}_4)_2$, 5; $(\text{NH}_4)_2\text{SO}_4$, 0.5; KCl, 0.2; $\text{MgSO}_4\cdot 7\text{H}_2\text{O}$, 0.1; $\text{MnSO}_4\cdot \text{H}_2\text{O}$, 0.001; $\text{FeSO}_4\cdot 7\text{H}_2\text{O}$, 0.001; agar-agar, 15; pH, 7.0 ± 0.2 . The isolates were spot inoculated on the medium and incubate at $28\pm 2^{\circ}\text{C}$ for seven days. Clear zone around fungal growth indicated phosphate solubilization.

2.3.2 Siderophore production

Blue agar CAS (chrome azurol S) assay was carried out to test siderophore production as described by Schwyn and Neilands (1987). The basic principle of this test is that when a strong ligand L (siderophore) is added to a colored dye- Fe^{+3} complex, the color changes due to free dye release as the ligand- Fe^{+3} complex is formed. The fungal isolates were

spot inoculated on PDA plate containing CAS and FeCl_3 . The plates were incubated at $28\pm 2^{\circ}\text{C}$ for seven days. Orange halo around fungal growth indicated siderophore production.

2.3.3 Ammonia production:

The fungal isolates were inoculated into the test tubes containing 2% peptone water and incubate at $28\pm 2^{\circ}\text{C}$ for 3 days. After incubation, 0.5 ml Nessler's reagent was added into each tube. Development of brown to yellow color indicated positive test for ammonia production.

2.3.4 Indole acetic acid (IAA) production:

The potato dextrose broth supplemented with L-Tryptophan ($1\text{ }\mu\text{g/ml}$) was inoculated with fungal isolates and incubated at $28\pm 2^{\circ}\text{C}$ for three days. After incubation, the tubes were centrifuged at 10,000 rpm for 10 min. The clear supernatant (1 ml) was mixed with 2 ml of Salkowski's reagent and incubated for 15 min at room temperature. Development of pink color indicated IAA production by the isolates.

2.3.5 Gibberellic acid production:

The screening of gibberellic acid production was carried out using peptone-glucose Czepak's medium. The fungal isolates were inoculated into the medium and incubated at $28\pm 2^{\circ}\text{C}$ for seven days. The culture broth was centrifuged at 10,000 rpm for 10 min and clear supernatant was separated. The pH of the supernatant was adjusted to 2.5 using 1 M HCl and the extraction of gibberellic acid was done by adding equal volume of ethyl acetate to the culture supernatant. After 1 h, the aqueous phase was discarded and ethyl acetate layer was collected and evaporated at 65°C in rotary evaporator. The residues were dissolved in small volume of acetone and spotted on the TLC plate. The mobile phase used was isopropanol-ammonia-water (10:1:1). The plates were sprayed with

developing reagent containing 50 mg FeCl_3 and 3% H_2SO_4 in methanol, and incubate at 80°C for 10 min. the TLC plates were observed under UV light. Greenish fluorescence indicated the presence of gibberellic acid.

2.4 Screening of extracellular hydrolytic enzymes production

2.4.1 Amylase production:

The production of amylase by the fungal isolates was evaluated by streaking the isolates on nutrient agar plates containing 2% starch. All the plates were incubated at $28\pm 2^\circ\text{C}$ for five days. After the incubation, the plates were flooded with gram's iodine solution. The formation of clear zone around fungal growth indicated amylase production.

2.4.2 Cellulase production:

The fungal isolates were streaked on minimal agar medium containing 5% carboxy methyl cellulose (CMC). The plates were incubated at $28\pm 2^\circ\text{C}$ for five days. Growth of the isolates indicated hydrolysis of CMC by the production of cellulase.

2.4.3 Chitinase production:

The screening of fungal isolates for chitinase production was performed on the solid medium containing 2% chitin and 0.5% peptone. The fungal isolates were streaked on the medium and incubated at $28\pm 2^\circ\text{C}$ for five days. After incubation, the formation of clear zone around fungal growth indicated the production of chitinase.

2.4.4 Lipase production:

The lipase production capacity of the fungal isolates was checked on tributyrin agar plate. The fungal isolates were streaked on the plates and incubated at $28\pm 2^\circ\text{C}$ for five days. After incubation, the formation of clear zone around fungal growth indicated the production of lipase by the isolates.

2.4.5 Protease production:

The production of protease by the fungal

isolates was screened on solid medium containing 3% skimmed milk powder and 1% glucose. The isolates were inoculated on the plates and incubated at $28\pm 2^\circ\text{C}$ for five days. The formation of clear zone around fungal growth was indicated as positive result for protease production.

RESULTS AND DISCUSSION

3.1 Isolation and identification of fungal isolates:

The serial dilution of soil samples and standard plate method resulted into isolation of 25 fungal cultures. The growth of the isolates on PDA indicated formation of white mycelium during initial phase. The colored spores developed in later stage of fungal growth. The growth of the isolate MA2 was granular mycelial mat with brown colored pigmentation (Fig. 1A). The microscopic observation of the isolate MA2 revealed septate mycelia containing fungal nuclei. The fruiting body contained large spherical vesicle. The phialides were arranged on the vesicle in the circular pattern. The conidiospores were produced from the phialides in the form of long chains (Fig. 1B). The growth of the isolates TV1 was in the form of white mycelial mat on the PDA plate. The formation of conidiospores was evident in the form of loose and fluffy greenish colored growth with distinct concentric rings (Fig. 1A). Under microscope, the septate mycelium with lateral branches was observed. These branches were further divided at an angle of 90° to form secondary branches. These branches contained clusters of phialides. The phialides were enlarged in the middle and the tip containing conidiospores (Fig. 1B). The 18S rRNA sequence was used to carry out BLAST with

the database of NCBI GenBank. Based on maximum identity score, first fifteen sequences were selected and aligned using multiple sequence alignment software programs. The evolutionary history was inferred using the Neighbor-Joining method. The optimal tree with the sum of branch length = 1.19439419 (MA2) and 1.08478630 (TV1) is shown (Next to the branches). The evolutionary distances were computed using the p-distance method and are in the units of the number of base differences per site. The analysis involved 16 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 428 (MA2) and 485 (TV1) positions in the final dataset. Evolutionary analysis was conducted in MEGA7. Based on molecular data the isolates MA2 and TV1 were identified as *Aspergillus ochraceus* and *Trichoderma yunnanensis* respectively (Fig. 2).

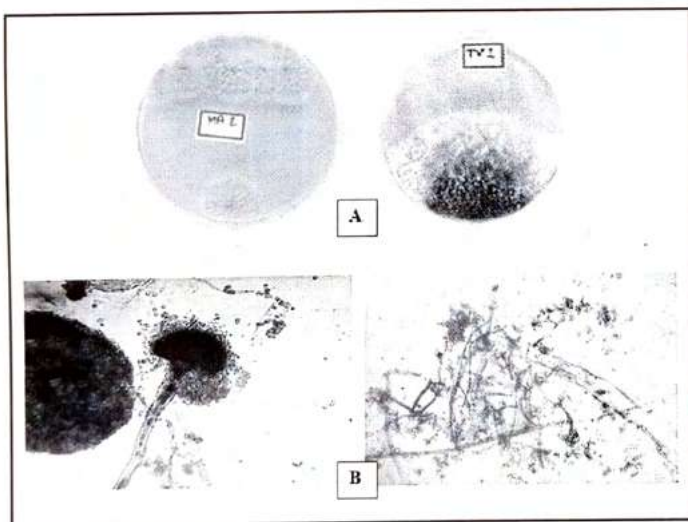


Figure 1: Growth and morphological characteristics of fungal isolates MA2 and TV1 on PDA medium (A), and typical characteristics of fungal isolates MA2 and TV1 under 40X objective of microscope (B)

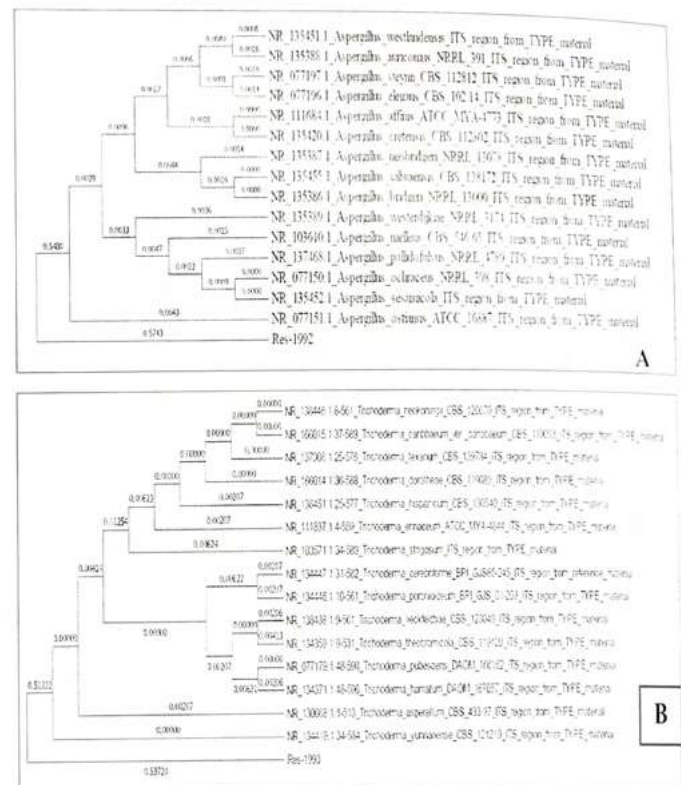


Figure 2: Phylogenetic analysis of ITS gene sequence displaying the place of fungal isolates MA2 (A) and TV1 (B) and its relationship among other species of related genera

3.2 Evaluation of plant growth promoting activities of fungal isolates

The isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* exhibited orange halo around their growth indicating siderophore production. However, the isolate *Aspergillus ochraceus* showed an excellent siderophore production capacity on CAS agar plate in terms of larger size halo (Fig. 3A). Siderophores are low molecular weight compounds produced from microorganisms and some plants. They offer an excellent iron chelating capacity; their production is the part of strategy to obtain iron from the environment containing low amount of available iron (Ferreira et al., 2019). The

biosurfactant producing fungus *Xylaria regalis* was able to produce siderophore which belonged to hydroxamate-type (Adnan et al., 2018). In another study plant growth promoting endophytic fungus *Aspergillus fumigatus* TS1 exhibited siderophore production on CAS agar plate (Bilal et al., 2018).

The screening of IAA production was carried out by mixing culture supernatants with Salkowski's reagent. Positive result was indicated by the formation of pink color. Both the fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* exhibited IAA production capacity (Fig. 3B). It is well known that IAA regulates several physiological processes in the plant such as cell growth, tissue differentiation and tactic response. Therefore, IAA production by our fungal isolates adds an advantage of promoting plant growth. The IAA production capacity was found in *Xylaria regalis* (Adnan et al., 2018), *Aspergillus flavus* CSH1 (Asaf et al., 2018) and *Aspergillus fumigatus* TS1 and *Fusarium proliferatum* BRL1 (Bilal et al., 2018).

The TLC plates observed under UV light exhibited greenish fluorescence in both the fungal isolates indicating gibberellic acid production capacity (Fig. 3C). Similar to IAA, gibberellic acid also has several developmental and regulatory roles in the plant such as germination of seed and development of seedling, growth of stem and leaf, floral initiation, and flower and fruit growth (Davies 2010; Pharis and King 1985). Moreover, it also helps in the plant root growth and root hair development, inhibition of floral bud differentiation, vegetative and reproductive bud dormancy as well as delay of senescence (Bottini and Luna 1993; Fulchieri et al. 1993; Reinoso et al. 2002;

Tanimoto 1987). Two endophytic fungi, *Aspergillus fumigatus* TS1 and *Fusarium proliferatum* BRL1 isolated from the roots of *Oxalis corniculata* exhibited gibberellic acid production capacity (Bilal et al., 2018). The fungal culture *Aspergillus niger* CSR3 isolated from *Cannabis sativa* exhibited multiple PGP traits like production of siderophores, indole acetic acid (IAA), gibberellins, and phosphate solubilization (Lubna et al., 2018).

The culture supernatants of both fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* reacted with Nessler's reagent and produced brownish yellow color indicating ammonia production. The production of ammonia is one of the important features of PGPR microorganisms for enhanced plant growth. In general, ammonia produced by such organisms serve as nitrogen source, which has enhancing effect on plant root and shoot elongation, and biomass production (Marquese et al., 2010).

The ability of fungal isolates to solubilize phosphate was evaluated on Pikovskaya's agar medium. In our study, none of the two fungal isolates showed phosphate solubilization as there was no evidence of clear zone around their growth. The organic acids produced by fungi are responsible for the solubilization of calcium phosphate and liberation of phosphate, which is further utilized for the fungal growth. Solubilization and mineralization are main microbial mechanisms of releasing phosphate from both organic and inorganic phosphate pool in the soil (Bhattacharya and Jha, 2012). The fungi belonging to genera *Aspergillus* and *Penicillium* are principle microorganisms to carryout phosphate solubilization (Nelofer et al., 2016). Pradhan and Sukla (2006) reported that *Aspergillus fumigatus* and

Penicillium sp. isolated from the rice field soil had good phosphate solubilization potential.

The rhizospheric fungi are least explored for their PGP potential as compared to rhizobacteria. Moreover, these fungi have no stringent host specificity, and therefore it provides an added advantage of selection and preparation of fungal inoculants for diverse crops. Therefore, our study was focused on isolation of free-living rhizospheric fungi and *in vitro* screening for their PGP potential. The role of soil fungi is not limited to PGP activity; they play vital role in nutrient mineralization, biogeochemical cycling of the elements, decomposition of vast variety of complex organic materials into humus, and thereby improvement of soil fertility and productivity. Organic acids produced by number of fungi are responsible for mineral mobilization, and thus accelerates mineral uptake process by plant roots (Imran et al., 2021).

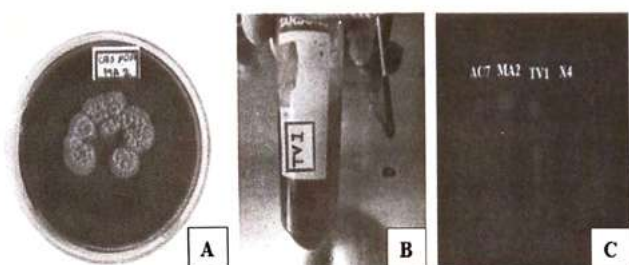


Figure 3: Plant growth promoting activities by fungal isolates: Orange halo around the growth of MA2 (*Aspergillus ochraceus*) indicating siderophore production (A), isolate TV1 (*Trichoderma yunnanensis*) showing positive result for indole acetic acid (IAA) production (B) greenish fluorescence under UV light showing positive result for gibberellic acid production by both the fungal isolates (C)

3.3 Screening of extracellular hydrolytic enzymes production by fungal isolates

The production of amylase enzyme was indicated by formation of clear zone around fungal growth as a result of hydrolysis of starch. The amylase enzyme production capacity was observed with both the fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* (Fig. 4A). Fungal amylase is responsible for hydrolysis of starch into sugars, which can be taken up by fungi for their growth. In accordance to our findings, *Aspergillus fumigates* isolated from soil in Eastern Nigeria showed amylase production on solid media (Nwagu and Okolo 2011).

The growth and formation of clear halo on tributyrin agar plate was the indication of lipase enzyme production. In our study, the fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* produced lipase enzyme on solid media (Fig. 4B and 4C). Many researchers have documented lipase production capacity of fungal isolates. For instance, Takó et al., (2012) screened 35 fungal isolates for lipase production, and all the fungal isolates were found positive. Similarly, a strain of *Trichoderma harzianum* IDM14D isolated from soil in Turkey was found positive for extracellular lipase production (Ülker et al. 2011).

The growth of both the fungal isolates was evident on the CMC agar plate. The cellulase enzyme produced by the fungal isolates hydrolyzes CMC, and such hydrolyzed products can further utilized for fungal growth. The fungal cellulase has an important role in the nature as well as in the

industry, as it degrades complex insoluble cellulose into simple sugars. For instance, in the process of bioconversion of lignocellulose into simple sugars, *Trichoderma reesei* finds its potential owing to production and secretion of large quantities of cellulase-rich secretome (Berrin et al., 2014). Reddy et al., (2014) screened 23 fungal isolates for cellulase production; nine fungal isolates displayed positive results for cellulase production.

The screening of extracellular chitinase production showed positive results with both the fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis*. The chitinase production was indicated by the formation of clear zone around fungal growth due to hydrolysis of chitin. The production of chitinase has protective role, as it acts and hydrolyses cell wall of plant pathogenic fungi (Castillo et al. 2016, Suman et al. 2016). Our results are in accordance with previous study, wherein seven fungal isolates isolated from Egyptian soil were positive for chitinase production (Sherief et al. 1991).

production by TV1 (*Trichoderma yunnanensis*); lipase (C) and cellulase (D) production by MA2 (*Aspergillus ochraceus*)

The extracellular production of protease was indicated by the formation of clear zone on skimmed milk agar plate. In our study, both the fungal isolates were found to be positive for extracellular protease production. Protease enzyme mediates proteolysis, the breakdown of larger proteins into smaller polypeptides and single amino acid residues. Such amino acids are further utilized for the synthesis of new protein products. Similar to our findings, Sharma et al., (2015) carried out screening of five fungal isolates for protease production on gelatin agar and skimmed milk agar; three isolates among five showed positive result for protease production. In another study, *Panicillium bilaiae* Pb14, *Panicillium bilaiae* C11, *Talaromyces pinophilus* T14, *Aspergillus* sp. D1 and *Beauveria bassiana* T7 displayed production of different extracellular enzymes like amylase, protease and lipase (Brazhnikova et al., 2021).

Numerous industrial as well as biotechnological applications, directly or indirectly are linked with fungal extracellular enzymes. The extracellular enzymes of fungal origin have potential role in the decomposition and degradation of numerous organic residues in the soil and formation of humus. The degraded metabolites released in the soil serve as source of nutrients for other organisms as well as for plants (Frąc et al. 2018; Wösten 2019). Therefore, fungal isolates having capacity to produce large array of extracellular enzymes are quite promising candidate for enhancing soil fertility and thereby agricultural crop yield (Imran et al., 2021). In our study, soil dwelling

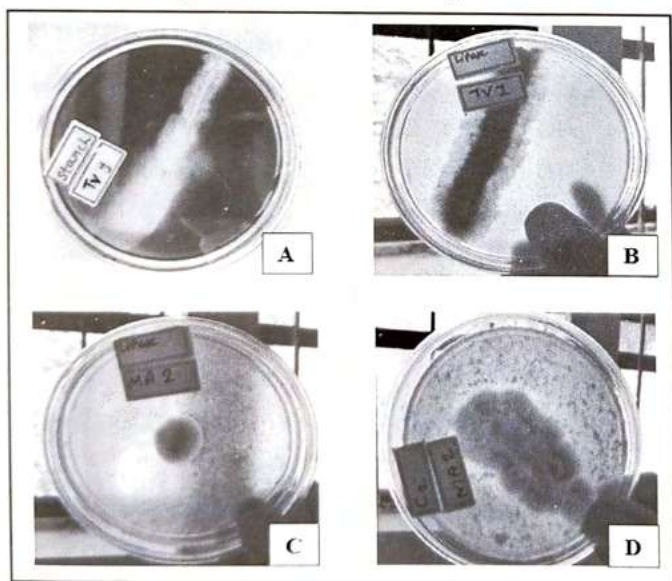


Figure 4: Screening of fungal isolates for extracellular enzyme production: Positive results of amylase (A) and lipase (B)

fungus isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* possess both PGP as well as extracellular enzyme production capacity, which ultimately help in the improvement of soil fertility and productivity.

CONCLUSION

In the present study, two fungal strains were isolated from agricultural soil and tested for plant growth promoting activities and extracellular hydrolytic enzymes production capacity. The isolates demonstrated positive results for the production of siderophore, ammonia, indole acetic acid (IAA) and gibberellic acid. The fungal isolates also produced extracellular hydrolytic enzymes, mainly amylase, lipase, protease, chitinase and cellulase. Therefore, the fungal isolates *Aspergillus ochraceus* and *Trichoderma yunnanensis* hold potential as plant growth promoting fungi as well as source of extracellular enzymes, and can be explored for fungal bioinoculant formation.

REFERENCES

- Adnan, M., Alshammari, E., Ashraf, S. A., Patel, K., Lad, K., & Patel, M. (2018). Physiological and molecular characterization of biosurfactant producing endophytic fungi *Xylaria regalis* from the cones of *Thuja plicata* as a potent plant growth promoter with its potential application. *BioMed Research International*, 2018.
- Akhtar, M. S., & Siddiqui, Z. A. (2006). Effects of phosphate solubilizing microorganisms on the growth and root-rot disease complex of chickpea. *Mycology Phytopathology*, 40(3), 246-254.
- Asaf, S., Hamayun, M., Khan, A. L., Waqas, M., Khan, M. A., Jan, R., Lee, I.J., & Hussain, A. (2018). Salt tolerance of *Glycine max*. L induced by endophytic fungus *Aspergillus flavus* CSH1, via regulating its endogenous hormones and antioxidative system. *Plant Physiology and Biochemistry*, 128, 13-23.
- Bais, H. P., Weir, T. L., Perry, L. G., Gilroy, S., & Vivanco, J. M. (2006). The role of root exudates in rhizosphere interactions with plants and other organisms. *Annual Review of Plant Biology*, 57, 233-266.
- Bent, E. (2006). Induced systemic resistance mediated by plant growth-promoting rhizobacteria (PGPR) and fungi (PGPF). In *Multigenic and Induced Systemic Resistance in Plants* (pp. 225-258). Springer, Boston, MA.
- Berrin, J. G., Herpoel-Gimbert, I., Ferreira, N. L., Margeot, A., & Heiss-Blanquet, S. (2014). Use of cellulases from *Trichoderma reesei* in the twenty-first century—part II: optimization of cellulolytic cocktails for saccharification of lignocellulosic feedstocks. In *Biotechnology and Biology of Trichoderma* (pp. 263-280). Elsevier.
- Bhattacharyya, P. N., & Jha, D. K. (2012). Plant growth-promoting rhizobacteria (PGPR): emergence in agriculture. *World Journal of Microbiology and Biotechnology*, 28(4), 1327-1350.
- Bilal, L., Asaf, S., Hamayun, M., Gul, H., Iqbal, A., Ullah, I., Lee, I.J., & Hussain,

- A. (2018). Plant growth promoting endophytic fungi *Aspergillus fumigatus* TS1 and *Fusarium proliferatum* BRL1 produce gibberellins and regulates plant endogenous hormones. *Symbiosis*, 76(2), 117-127.
- Bottini R, & Luna, V, (1993). Bud dormancy in deciduous fruit trees. *Current Topics in Plant Physiology*, 1:147–159.
- Brazhnikova, Y., Ignatova, L., Omirbekova, A., Mukasheva, T., Kistaubayeva, A., Savitskaya, I., Egamberdieva, D., Usmanova, A., & Batlutskaya, I. (2021). Effect of plant growth promotion fungi on agricultural crops. In *BIO Web of Conferences* (Vol. 40, p. 01004). EDP Sciences.
- Castillo, B. M., Dunn, M. F., Navarro, K. G., Meléndez, F. H., Ortiz, M. H., Guevara, S. E., & Palacios, G. H. (2016). Antifungal performance of extracellular chitinases and culture supernatants of *Streptomyces galilaeus* CFFSUR-B12 against *Mycosphaerella fijiensis* Morelet. *World Journal of Microbiology and Biotechnology*, 32(3), 1-12.
- Chanclud, E., & Morel, J. B. (2016). Plant hormones: a fungal point of view. *Molecular Plant Pathology*, 17(8), 1289-1297.
- Davies, P. J. (2010). The Plant Hormones: Their Nature, Occurrence, and Functions. In: *Plant Hormones*. Davies PJ (ed) Springer, Dordrecht, pp 1–15.
- Ferreira, C. M., Vilas-Boas, Â., Sousa, C. A., Soares, H. M., & Soares, E. V. (2019). Comparison of five bacterial strains producing siderophores with ability to chelate iron under alkaline conditions. *AMB Express*, 9(1), 1-12.
- Fraç, M., Hannula, S. E., Bełka, M., & Jędryczka, M. (2018). Fungal biodiversity and their role in soil health. *Frontiers in Microbiology*, 9, 707.
- Fulchieri, M., Lucangeli, C., & Bottini, R. (1993). Inoculation with *Azospirillum lipoferum* affects growth and gibberellin status of corn seedling roots. *Plant and Cell Physiology*, 34(8), 1305-1309.
- Imran, M., Abulreesh, H. H., Monjed, M. K., Elbanna, K., & Ahmad, I. (2021). Multifarious functional traits of free-living rhizospheric fungi, with special reference to *Aspergillus* spp. isolated from North Indian soil, and their inoculation effect on plant growth. *Annals of Microbiology*, 71(1), 1-17.
- Lubna, Asaf, S., Hamayun, M., Gul, H., Lee, I. J., & Hussain, A. (2018). *Aspergillus niger* CSR3 regulates plant endogenous hormones and secondary metabolites by producing gibberellins and indoleacetic acid. *Journal of Plant Interactions*, 13(1), 100-111.
- Marques, A. P., Pires, C., Moreira, H., Rangel, A. O., & Castro, P. M. (2010). Assessment of the plant growth promotion abilities of six bacterial isolates using *Zea mays* as indicator plant. *Soil Biology and Biochemistry*, 42(8), 1229-1235.
- Nelofer, R., Syed, Q., Nadeem, M., Bashir, F., Mazhar, S., & Hassan, A. (2016). Isolation of phosphorus-solubilizing fungus from soil to supplement biofertilizer. *Arabian Journal for Science and Engineering*, 41(6), 2131-2138.
- Nwagu, T. N., & Okolo, B. N. (2011). Growth profile and amylolytic activity of a

- thermophilic fungus *Aspergillus fumigatus* isolated from soil. *Asian Journal of Biotechnology*, 3(1), 46-57.
- Pharis, R. P., & King, R. W. (1985). Gibberellins and reproductive development in seed plants. *Annual Review of Plant Physiology*, 36(1), 517-568.
- Pradhan, N., & Sukla, L. B. (2006). Solubilization of inorganic phosphates by fungi isolated from agriculture soil. *African Journal of Biotechnology*, 5(10).
- Rashid, M., Khalil, S., Ayub, N., Alam, S., & Latif, F. (2004). Organic acids production and phosphate solubilization by phosphate solubilizing microorganisms (PSM) under in vitro conditions. *Pakistan Journal of Biological Sciences*, 7(2), 187-196.
- Reddy, P. L. N., Babu, B. S., Radhaiah, A., & Sreeramulu, A. (2014). Screening, identification and isolation of cellulolytic fungi from soils of Chittoor district, India. *International Journal of Current Microbiology and Applied Sciences*, 3(7), 761-771.
- Reinoso, H., Luna, V., Dauría, C., Pharis, R. P., & Bottini, R. (2002). Dormancy in peach (*Prunus persica*) flower buds. VI. Effects of gibberellins and an acylcyclohexanedione (trinexapac-ethyl) on bud morphogenesis in field experiments with orchard trees and on cuttings. *Canadian Journal of Botany*, 80(6), 664-674.
- Schwyn, B., & Neilands, J. B. (1987). Universal chemical assay for the detection and determination of siderophores. *Analytical Biochemistry*, 160(1), 47-56.
- Sharma, A. K., Sharma, V., Saxena, J., Yadav, B., Alam, A., & Prakash, A. (2015). Isolation and screening of extracellular protease enzyme from bacterial and fungal isolates of soil. *International Journal of Scientific Research in Environmental Sciences*, 3(9), 0334-0340.
- Sherief, A. A., El-Sawah, M. M. A., El-Naby, A., & Mohamed, A. (1991). Some properties of chitinase produced by a potent *Aspergillus carneus* strain. *Applied Microbiology and Biotechnology*, 35(2), 228-230.
- Suman, A., Yadav, A. N., & Verma, P. (2016). Endophytic microbes in crops: diversity and beneficial impact for sustainable agriculture. In *Microbial Inoculants in Sustainable Agricultural Productivity* (pp. 117-143). Springer, New Delhi.
- Takó, M., Kotogán, A., Németh, B., Radulov, I., Niță, L. D., Tăraș, D., Dicu, D., Tóth, B., Papp, T., & Vágvolgyi, C. (2012). Extracellular lipase production of zygomycetes fungi isolated from soil. *Review on Agriculture and Rural Development*, 1(1), 62-66.
- Tanimoto, E. (1987). Gibberellin-dependent root elongation in *Lactuca sativa*: recovery from growth retardant-suppressed elongation with thickening by low concentration of GA3. *Plant and Cell Physiology*, 28(6), 963-973.
- Ülker, S., Özel, A., Colak, A., & Karaoğlu, Ş. A. (2011). Isolation, production, and characterization of an extracellular lipase from *Trichoderma harzianum* isolated from soil. *Turkish Journal of Biology*, 35(5), 543-550.
- Wagg, C., Schlaeppi, K., Banerjee, S., Kuramae, E. E., & van der Heijden, M. G. (2019). Fungal-bacterial diversity

- and microbiome complexity predict ecosystem functioning. *Nature Communications*, 10(1), 1-10.
- Wösten, H. A. (2019). Filamentous fungi for the production of enzymes, chemicals and materials. *Current Opinion in Biotechnology*, 59, 65-70.
- Yedidia, I., Benhamou, N., & Chet, I. (1999). Induction of defense responses in cucumber plants (*Cucumis sativus* L.) by the biocontrol agent *Trichoderma harzianum*. *Applied and Environmental Microbiology*, 65(3), 1061-1070.
- Yu, L., Zhang, H., Zhang, W., Liu, K., Liu, M., & Shao, X. (2022). Cooperation between arbuscular mycorrhizal fungi and plant growth-promoting bacteria and their effects on plant growth and soil quality. *PeerJ*, 10, e13080.
- Žifčáková, L., Větrovský, T., Howe, A., & Baldrian, P. (2016). Microbial activity in forest soil reflects the changes in ecosystem properties between summer and winter. *Environmental Microbiology*, 18(1), 288-301.

GUIDELINES TO AUTHORS

The Gujarat Agricultural Universities Research Journal is published quarterly basis. The following types of manuscripts are considered for publication on meeting the standard of the journal.

- 1.1 ARTICLES ON ORIGINAL RESEARCH COMPLETED, not exceeding 4000 words (upto 15 typed pages, including references, tables, etc.) should be exclusive for the journal. They should present a connected picture of the investigation and should not be split into parts. A complete information of Ph.D. thesis should preferably be given in one article
- 1.2 SHORT RESEARCH NOTES, not more than 1300 words (total 05 typed pages), which deal with (i) research results that are completed but do not warrant comprehensive treatment, (ii) descriptions of new material or improved techniques or equipment, with supporting data, and (iii) a part of thesis or study. Such notes require no headed sections.
- 1.3 CRITICAL RESEARCH REVIEW ARTICLES, showing lacunae in research and suggesting possible lines of future work. These are mostly invited from eminent scientists.
- 1.4 The research article or note submitted for publication should have a direct bearing on agricultural production or open up new grounds for productive research. Articles on agricultural engineering, agricultural economics and home science are also considered. Basic type of articles and notes relating to investigation in a narrow-specialized branch of a discipline may not form an appropriate material for this journal, nor do the articles of theoretical nature, or those of local importance, repetitive, based on old data, with no positive significance.
- 1.5. Author should note:
 - (a) period (years) of conducting the experiment must be indicated, (b) article should preferably be submitted soon after completion of experiment. (c) articles on genetics and plant breeding and on plant crops should be based on data of minimum two years. (d) contribution involving a former or present student must clarify that it is not based on complete M.Sc. thesis, or complete or a part of the Ph.D. thesis, indicating its year of submission and (e) Article Certificate must be signed by all the authors and must contain subscription numbers of authors.

- 2.1 TITLE should be short, specific and informative. It should be phrased to identify the content of the article and include the nature of the study and the technical approach, essential for key word indexing and information retrieval.
- 2.2 ASHORT TITLE not exceeding 35 letters should also be provided for running headlines.
- 2.3 BY-LINE should contain, in addition to the names and initials of the authors, the place (organization) where research was conducted. Change of address should be given as a footnote and correspondence address separately.
- 3.1 ABSTRACT, written, in complete sentences, should not have more than 150 words. It should contain a very brief account of the materials, methods, results, discussion and conclusion, so that the reader need not refer to the article except for details. It should not have references to literature, illustrations and tables.
- 4.1 INTRODUCTION parts should be brief and limited to the statement of the problem or the aim and scope of the experiment. The review of recent literature should be pertinent to the problem. Keywords of the article should be given in the beginning.
- 4.2 Relevant details should be given of MATERIALS AND METHODS including experimental design and the techniques used. Where the methods are well known, citation of the standard work is sufficient. Mean results with the relevant standard errors should be presented rather than detailed data. The statistical methods used should be clearly indicated.
- 4.3 RESULTS AND DISCUSSION should be combined, to avoid repetition.
- 4.4 The results should be supported by brief but adequate tables or graphic or pictorial materials wherever necessary. Self-explanatory tables should be typed on separate sheets, with appropriate titles.
- 4.5 The tables should fit in the normal lay-out of the A-4 page only. All weights and measurement must be in SI (metric) unit. Tables and illustrations (upto 20% of text) should not reproduce the same data.
- 4.6 The discussion should relate to the limitations or advantages of the author's experiment in comparison with the work of others. All recent relevant literature should be discussed critically.

- 4.7 Line-drawings should be clearly drawn (8.5 or 17 cm width) in black waterproof ink on smooth, tough paper. Minor points of style should be noted carefully. Photographs should be large, unmounted, glossy prints of good quality. They should be clear and relevant to the subject. Colour photographs may be sent for better identification or differentiation of different parts of the object. Line-drawings and photographs should have legends (typed). Original artwork should accompany 02 copies. Repetition in graphic and tabular matter should be avoided.
5. For citing REFERENCES, are cent issue of the journal should be consulted, ensuring that the names and dates in the text and at the end correspond. Each citation should have the names of the authors, initials, year of publication, full title of the article, name of the journal (without abbreviation), volume, preferably the issue (within parentheses), and complete page- range (not merely the first page). Complete name of publisher and place of publication of books should be given. For proceedings or other publications complete details should be given.
6. All articles are sent to referees for scrutiny, and authors should meet criticism by improving the article, indicating the modifications made (in separate sheet, 02 copies).
7. Articles should be TYPEWRITTEN, and double spaced throughout (including by-line, abstract, references and tables) on white, durable A-4 size paper with a 4 cm margin at the top, bottom and left. Articles should be sent in duplicate after checking typographical errors.