



**Advances in  
Agricultural, Animal  
and Fisheries Sciences**

# **Advances in Agricultural, Animal and Fisheries Sciences**

**Editors**

Devi Dayal  
Shamsudheen Mangalassery

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## PREFACE

Science encompasses a systematic study of the structure and behavior of the natural and physical world through observations and experimentation. There is a close interrelationship between science and technology. Technology is basically a skill, art or ability used in the development of products. Scientific knowledge is used to develop technology and this technology again used to develop science. Both science and technology are evolved with human civilization, as a result of our desire to acquire knowledge, solutions to the questions raised in our mind and to satisfy our quest for better standards of living. In every respect we are connected with science and technology in our day today life. The science and Technology has solution for almost all the problems.

This has been possible through dissemination and sharing of knowledge and inventions made in one part of the world to other part. Faster dissemination is important to save recourses and time of scientists. This facilitates development of newer scientific knowledge and advanced technology in a faster pace without having to work on those areas that already explored.

The dissemination of scientific knowledge occurs through publications in the form of journal articles, books etc. In this compilation, some important developments in the diverse fields of agricultural, anima and fisheries sciences are compiled in the form of a book. The editors are thankful to all the authors for timely submission of their chapters and prompt corrections to the suggestions of reviewers and editors. We hope that this publication will be very useful to the students, scientists, academicians, researchers, and other stakeholders.

Devidayal  
S. Mangalassery

## **ABOUT THE EDITORS**

### **Dr. Devi Dayal**

Dr. Devi Dayal is former Head, ICAR- Central Arid Zone Research Institute, Regional Station, Gujarat. He started Agricultural Research Service in January 1984 and has worked in different capacities in technology development and dissemination related to groundnut and other dryland crops for about 36 years in different institutes such as Directorate of Groundnut Research, Junagadh. He was instrumental in developing paired row planting pattern and in-situ moisture conservation technologies for groundnut and other dryland crops. During his career, he mobilised external funding from different agencies such as PPV&FRA, NATP, NAIP and NASF for various research activities and handled collaborative projects with international CGIAR institutions like ICRISAT, Hyderabad & ICARDA, Jordan. He conducted many national seminars in the capacity of organising secretary. He has edited 15 books and published more than 100 research papers in journals of national and international repute. He has also contributed to several book chapters to books and proceedings of the symposia apart from many technical bulletins and training manuals. He has received many awards including Fellow 2015 by the Indian Society of Oil Seeds Research and Gold Medal and Distinguished Plant Scientist Award-2013 by the Academy of Plant Sciences. He serves as member of Editorial Board for Indian Journal of Oil Seeds Research and Advances in Plant Sciences. He acts as external examiner for post-graduate and doctoral students for several universities Junagadh Agricultural University, Junagadh and MPKV, Rahuri, TNAU, Coimbatore and Osmania University, Hyderabad.

### **Dr. Shamsudheen Mangalassery**

Dr. Shamsudheen Mangalassery Has joined ICAR as scientist in the year 2007 at Central Arid Zone Research Institute, Jodhpur and presently working as Senior Scientist at ICAR-Directorate of Cashew Research, Puttur. His main research interest are arid soil and ecosystem management. He is actively engaged in research in the area of soil carbon sequestration, different tillage practices, soil biology and abiotic stress tolerance. His previous research includes research on

organic farming in spices in tropical humid environment. He completed M.Sc. (Agri.) Soil Science and Agricultural Chemistry from University of Agricultural Sciences, Dharwad in 2003 and Ph.D. from the University of Nottingham, United Kingdom in 2013. He has published 37 research papers in journals of national and international repute, 3 books, and contributed to 28 book chapters and has 52 conference proceedings/abstracts to his credit apart from 28 extension folders, 9 technical bulletins and 4 training manuals and several other publications/compilations. He has received different awards including International Research Excellence Scholarship from the University of Nottingham and International Fellowship by the Indian Council of Agricultural Research, ICAR JRF for post graduate studies. He also bestows with the Laming award of the University of Nottingham and also Travel grant from the University. He has received 3 best research paper awards, 3 best poster, one best oral presentation award and distinguished scientist award. He has developed 16 software/mobile apps and has 4 copy rights and involved in development of three cashew varieties. He has organised one national review meeting and 4 trainings. He is currently a member of International Soil Tillage and Research Organisation and serves as reviewer of different national and international journals. He has brought external grants from different organisations such as NASF, ISRO, RKVY amounting to more than Rs. 4 Crores. He was instrumental in developing advanced laboratory facilities at CAZRI, Regional Research Station, Bhuj, Gujarat and ICAR-DCR, Puttur. He has developed one state of art cashew museum at DCR, Puttur. He has visited countries such as UK and Italy.





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<b>Milk born hazards and technique of harvesting clean and hygienic milk</b>	<b>Chapter 1</b>
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## **ABSTRACT**

Milk supplies all the essential nutrients for growth and maintenance of mammals. Immunoglobulins present in milk protect newborns from a variety of disorders. Consumers all throughout the world have developed a taste for high-quality products and prefer them. Milk is a perishable product; it must be produced and handled in a sanitary manner from the farm to the consumer's table. Milk and milk-derived products can contain a wide range of microorganisms and are potential sources of food-borne diseases. Food-borne pathogens in milk may be consequence of direct contact with contaminated sources in the dairy farm environment, as well as discharge from an affected animal's udder. One of the most significant aspects of improving the quality of milk is to produce it in a clean environment. Animal hygiene, milking hygiene, equipment hygiene, and processing hygiene are the four key characteristics of clean milk production. Lack of information about clean milk production, use of unclean equipments and lack of potable water for cleaning purposes are some of the factors which contribute to the poor hygienic quality of raw milk. Farmers must be properly educated on the necessity of clean milk production from the perspectives of health, marketing, and animal health. The need for clean milk production is crucial in order to compete in national and international markets.

**Keywords:** Clean milk production, Hazards, Milk contamination, Milk borne pathogens

## **Introduction**

Milk is soul food for progeny of mammals which is produced from their mammary glands. It contains all the necessary elements in a balanced form for growth and sustaining the human and animal body. Immuno-globulins present in milk protects the newly born from different diseases. Also, due to its various properties, it can be easily converted into different milk products and used as an ingredient for other food items. For microorganisms like bacteria to proliferate, milk serves as a brilliant medium especially in humid conditions. Microorganisms deteriorate the quality of milk and hence rejected by the consumers. Visible dirt like hair and larger pieces of soil and dung can be easily removed by filtering the milk immediately after milking, but it does not remove the very fine dirt particles or the invisible bacteria. As the price of milk often depends on its quality; good hygiene standards are of the supreme importance for the milk and its product's quality, as well as for the producer. The processor requires high-quality milk for processing and consumer demands a safe and wholesome product. The handling of milk robustly influences the quality of the finished product. Milking, transportation, storage, and processing strongly determine milk quality and hygiene. Thus, the dairy farmer must follow the improved management practices such as good housing, feeding, milking and health care activities for clean and hygienic milk production.

## **What is clean and hygienic milk?**

- Milk derived from the udder of healthy animals
- Milk with pleasant creamy smell and good taste
- Free from off flavour
- Collected in clean dry utensils
- Containing no more foreign material like dust, debris, hair, manure etc.
- Containing a smaller number of bacteria and no harmful pathogens
- Standard composition and acidity
- Antibiotics and chemical residues free

## **Milk Hygiene and Public Health**

**Hygiene:** It is defined as the practice of cleanliness to maintain health or practice and principles of protection, promotion and maintenance of health by preventing the disease.

**Milk Hygiene:** It is defined as the production of wholesome milk and milk products obtained from healthy milch animals for human consumption which are free from any type of contamination.

**Ideal definition of milk:** Milk is defined as the whole, fresh, clean lacteal secretion obtained by the complete milking of one or more healthy milch animals, excluding that obtained within 15 days before or 5 days after calving or such periods as may be necessary to render the milk practically colostrum free and containing the minimum prescribed percentages of milk fat and milk solids not fat.

**Chemical composition of milk of different species**

Species	Water	Fat	Protein	Lactose	Ash
Buffalo	84.2	6.6	3.9	5.2	0.8
Cow	86.6	4.6	3.4	4.9	0.7
Sheep	79.4	8.6	6.7	4.3	1.0
Goat	86.5	4.5	3.5	4.7	0.8
Human	87.7	3.6	1.8	6.8	0.1

Source: De (1980).

**Antimicrobial systems in milk**

Raw milk contains various types of inhibitory substances which help in protecting udder infection, providing passive immunity to new-borne and preserving milk in natural condition. Levels and presence of inhibitory substances in milk varies depending upon the species (maximum activity in human milk), difference in milking and even vary between quarters.

Two groups of substances are present in milk:

**I. Inherent compounds** comprising of naturally occurring substances

**II. Non-inherent compounds** secreted into milk from other sources

**Germicidal period:** In normal raw milk bacterial growth is either inhibited or reduced for some period of time, called germicidal period.

- Shorter in higher temperature and longer in lower temperature
- Variation also contributed by species difference and quarter difference
- By heating up the milk at temperature of 60 – 80 °C for 30 minutes, this germicidal property gets destroyed.

## **I. Inherent naturally occurring substances in milk**

### **A. Specific factors**

**1) Immunoglobulin:** Protect newborns against specific infections. In animals (cow, buffaloes) most immunoglobulins are transferred through colostrum post-nataly during the period when gastrointestinal tract of the offspring is permeable to intact molecules. Immunoglobulin A (IgA) and immunoglobulin G (IgG) are mostly present. IgA is synthesized in udder and secreted into the milk while IgG is passed into the milk from blood stream.

#### **Functions of IgA:**

- Neutralizes toxins and viruses
- Inhibits bacterial adhesion to mucosal surface
- Suppresses bacterial growth
- Aid in phagocytosis

**2) Complement:** The complement system via its bactericidal and phagocytic functions provides innate immunity against microorganisms. Small quantity of several components (nine) has been detected in milk which is associated with antibacterial properties of milk. The milk obtained from healthy glands of dairy cows contains small amount of complement. A slight inhibition of the bactericidal/hemolytic activities, of the deposition of C1q on bacteria, and of the phagocytic activity of C5a makes milk a rather anti-inflammatory fluid.

**3) Viable leucocytes (Macrophages):** Total cell count of milk from uninfected udder is 1 – 5 lakh cells/ml. About 80 percent of the cells in colostrum are macrophages that are associated with phagocytosis *i.e.* engulfing and subsequent killing of bacteria many of which are pathogenic in nature.

**4) Bifidus factor:** This is a nitrogen containing oligosaccharide found mainly in human milk, responsible for dominance of a bacterium *Bifidobacterium bifidus* (gram-positive, non-motile, often branched anaerobic bacteria) in infant gut imparting three main beneficial effects.

- Production of lactic acid and acetic acid causing inhibition of enteropathogenic strains of *E. coli*, *Shigella* spp., etc.
- Acidic pH of stool is necessary for absorption of Ca, Fe, and P
- Synthesis of vitamin B complex

## **B. Nonspecific factors**

**1) Lactanins:** The concentration of lactanin fractions viz lactanin 1 (L<sub>1</sub>) and lactanin 2 (L<sub>2</sub>) in milk varies. The bovine colostrum is rich in L<sub>1</sub> and normal milk contains higher quantities of L<sub>2</sub> fraction. A third fraction L<sub>3</sub> has also been noticed in raw milk. There is a partial inactivation of L<sub>1</sub> at 60 °C per 30 minutes. On heating raw milk to 70 °C per 20 minutes at pH 7.0, L<sub>1</sub> is completely destroyed leaving behind L<sub>2</sub> fraction in relatively higher concentration. It is proved that these two compounds L<sub>1</sub> and L<sub>2</sub>, when interact are more bactericidal than either one alone. Lactanin is mostly active against *Streptococcus pyogenes*. The ability of these microbes to grow in udder is due to the fact that lactanin has little activity under anaerobic conditions prevailing there.

**2) Lysozyme:** Human milk contains high concentration of lysozymes 30 mg/100 ml while bovine milk contains almost 3000 time less amount than human milk (0.01 mg/100 ml). Lysozyme causes hydrolysis of  $\beta - 1, 4$  glycosidic linkage of peptidoglycan of cell wall. It is effective against *Escherichia coli*. In association with ascorbate and peroxide, both of which are present in low concentrations in milk, it causes lysis of some species of *Salmonellae*. Heating up of cow milk at 75°C for 15 minutes destroys 25 percent of the activity of this enzyme.

**3) Xanthin Oxidase:** It is an enzyme which is linked with the fat globule membrane of bovine milk. It is composed by iron & molybdenum *met al* ions with the protein molecule. It indirectly inhibits the bacterial activity by producing hydrogen peroxide which itself a bactericidal molecule.

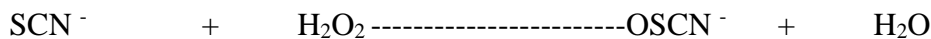
**4) N-Acetyl  $\beta$ -D-glucosamidase (NAGase):** It is also a lysosomal enzyme which is secreted in great amount in mammary glands. It shows bactericidal effects on the bacteria or pathogens such as *Pseudomonas*, *Staphylococcus* etc.

**5) Lactoferrin:** This is an iron binding glycoprotein. Lactoferrin binds to iron making it unavailable to the microorganisms which require iron for their growth and survival. Its concentration is markedly increased in the secretion of un-milked (protect dry udder from *E.coli*) and infected animals. Its quantity is higher in human milk than cow and buffalo milk. Antibacterial spectrum includes *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Vibrio cholerae*, *Clostridium tyrobutyricum*, *B. subtilis*, *E. coli*, etc.

**6) Lactoperoxidase:** An enzyme that is identical with L<sub>2</sub> fraction of lactanins. Absent in human milk, but present in cow milk @ 30  $\mu$ g/ml. The enzyme acts on the substrate thiocyanate in the

presence of H<sub>2</sub>O<sub>2</sub> and forms compounds with antimicrobial activity through a system called “Lactoperoxidase –thiocyanate – hydrogen peroxide system” or ‘LP system’.

*Lactoperoxidase*



(Thiocyanate ion) + (Hydrogen Peroxide) -----Hypothiocyanate ions (Antibacterial compound)

- LP system is bacteriostatic for gram positive bacteria (e.g. *Streptococci*) and bactericidal for gram negative bacteria (e.g. *E. coli*, *Salmonella Typhimurium*, *Klebsiella aerogenes*)
- LP system cause temporary preservation of raw milk throughout the collection & transportation to the processing plant, especially in developing countries where refrigeration facilities are limited
- No heat treatment is required therefore, sometimes called ‘cold sterilization’
- Thiocyanates and H<sub>2</sub>O<sub>2</sub> are added from external sources in balanced proportions
- Recommended level of additions as per International Dairy Federation (1988) within 3 hours of production, Thiocyanate @ 14 mg / l., Sodium percarbonate (as source of H<sub>2</sub>O<sub>2</sub>) @ 30 mg / l. Extended shelf life to 7-8 hrs.

**7) Vitamin binding proteins:** These proteins bind to vitamins thereby depriving the bacteria of these essential vitamins. Mainly bind vitamin B12 and folates.

**8) Fatty acids:** Milk contains free fatty acids released by action of lipase on milk fat or by microbial action. Bacteria require fatty acids. But high concentrations are inhibitory to bacterial growth. Mainly gram-positive bacteria are found more susceptible.

**9) Antimicrobial peptides (AMPs):** Fermented dairy products such as yogurt, cheese, and sour milk contains a wide variety of naturally formed bioactive peptides which helps in boosting natural immune protection by lessening the risk of chronic diseases.

**II. Non-inherent antimicrobial substances in milk:** Antibiotics, sanitizers and chemicals are the non-inherent antimicrobial compounds found in milk.

**Two principles of hygienic milk production**

- Avoid the contamination of milk
- Reduce the growth of microorganisms

**Characteristics of hygienic and quality milk**

- Milk is a white fluid having low viscosity
- Milk is slightly sweet in taste

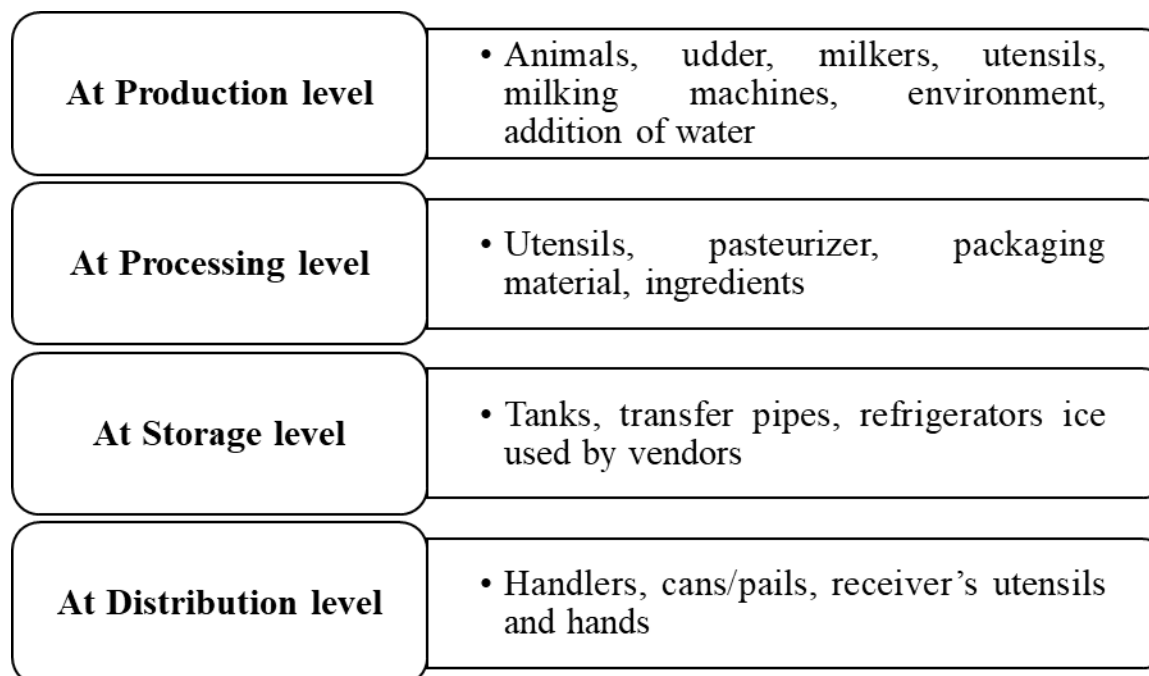
- It is a yellowish-white liquid and have a pleasant smell
- Only a very few bacteria are found in the milk obtained from a healthy udder
- Natural inhibitory system protects the milk from bacterial growth during the initial 2-3 hours
- The fresh raw milk should contain less than 50,000 bacteria per ml when it reaches the dairy processing unit
- Only mastitis free and healthy animals can produce hygienic or clean milk
- Diseased cows may secrete the pathogenic bacteria in the milk which further can affect the health of the consumers
- Contaminated and dirty equipment allow microorganisms to grow rapidly

**Why clean milk?**

- Clean raw milk enhances the keeping quality or shelf life
- Clean milk facilitates the production of high-quality dairy products
- Clean milk protects the wellbeing and health of the consumers
- Clean milk fetches high price for the producers

**Key sources of milk contamination**

Milk can be contaminated at production, processing, storage and distribution. The responsibility lies not only with milk producers but every person involved in milk handling at various stages to protect milk from contamination by implementing various control measures. The potential contamination sources are:



### **Milk borne hazards and their control**

Milk borne illnesses come under the broad category of food borne illness and there are three main types of foodborne illnesses:

- A. Food infection:** Refers to the ingestion/intake of viable pathogens with food leading to lodgement & establishment of pathogens in consumer's organs.
- B. Food intoxications:** Ingestion/intake of already produced toxins by microorganisms in the food causes poisoning syndromes in the consumers
- C. Toxi-infection:** A certain groups of organisms capable of infecting intestines by producing toxins in situ, to bring about poisoning symptoms, when ingested with the food

### **A. Milk borne infections**

<b>Disease and Causative agents</b>	<b>Sources of contamination to milk and milk products</b>	<b>Prevention and control</b>
<b>Anthrax</b> <i>Bacillus anthracis</i>	Infected animal (discharge and secretion of animal, rarely from blood to milk), contaminated environment	<ul style="list-style-type: none"> <li>• Proper disposal of carcasses by deep burial with lime disinfection or total incineration of unopened carcasses.</li> <li>• Disinfection of animal</li> </ul>



		<p>products</p> <ul style="list-style-type: none"> <li>• Wool and hair</li> <li>• Dust control in factories &amp; plants</li> <li>• Vaccination of animals and high-risk group persons.</li> <li>• Medical care and management of cases</li> </ul>
<p><b>Brucellosis</b> <i>Brucella abortus</i> <i>Brucella suis</i> <i>Brucella melitensis</i> (<i>Brucella melitensis</i> is most virulent for humans)</p>	<p>Infected animal (secreted in milk through infected udder), contaminated environment, personnel handling of milk and animals (accidental)</p>	<ul style="list-style-type: none"> <li>• Pasteurization of milk</li> <li>• Vaccination of animals and high-risk persons</li> <li>• Eradication by test and segregate or test and slaughter policy</li> <li>• Health education.</li> </ul>
<p><b>Listeriosis</b> <i>Listeria monocytogenes</i> (Organisms can nurture in the temperature range of 1– 45 °C)</p>	<p>Infected animals through infected udder, handlers, faecal contamination, contaminated refrigerators, and dishcloths</p>	<ul style="list-style-type: none"> <li>• Avoidance of reservoirs by pregnant women or immune-deficient persons</li> <li>• Good environmental hygiene</li> <li>• Pasteurization of milk</li> <li>• Immunization</li> </ul>
<p><b>Tuberculosis</b> <i>Mycobacterium tuberculosis</i> <i>M. bovis</i> <i>M. avium</i></p>	<p>Infected animals and humans, contaminated feed, water and Environment. Also, from bird droppings</p>	<ul style="list-style-type: none"> <li>• Early diagnosis and treatment</li> <li>• Test and slaughter of positive animals</li> <li>• Pasteurization of milk</li> <li>• Keeping infected persons away from cattle</li> </ul>
<p><b>Q fever</b> <i>Coxiella burnetii</i></p>	<p>Infected animal, contaminated environment</p>	<ul style="list-style-type: none"> <li>• Pasteurization of milk</li> <li>• Health education</li> </ul>

<p><b>Campylobacteriosis</b> <i>Campylobacter jejuni</i></p>	<p>Faecal contamination, polluted water, infected animals and human</p>	<ul style="list-style-type: none"> <li>• Personal hygiene</li> <li>• Clean milk handling</li> <li>• Effective pasteurization</li> <li>• Proper treatment of water supply</li> </ul>
<p><b>Vibriosis</b> <i>Vibrio parahaemolyticus</i></p>	<p>Contaminated water supply, cross contamination in kitchen</p>	<ul style="list-style-type: none"> <li>• Avoid contamination of water supply (especially marine water)</li> <li>• Personal hygiene to prevent crosscontamination.</li> </ul>
<p><b>Yersinia infection</b> <i>Yersinia enterocolitica</i> <i>Y. pseudotuberculosis</i></p>	<p>Faecal contamination, infected animals, milk handlers, contaminated water</p>	<ul style="list-style-type: none"> <li>• Prevent water from contamination</li> <li>• Avoid faecal contamination</li> <li>• Avoid handling of products by infected personnel</li> </ul>
<p><b>Salmonellosis</b> <i>S. Typhi</i> <i>S. Paratyphi</i> (causes paratyphoid in humans)</p>	<p>Water, persons in carrier state, infected animals</p>	<ul style="list-style-type: none"> <li>• Adequate treatment of water supply</li> <li>• Hygienic production (prevent handlers who are infected or in carrier state), storage &amp; processing of milk and milk products</li> <li>• Pasteurization of milk</li> <li>• Fly control</li> </ul>
<p><b>Shigellosis</b> <i>Shigella dysenteriae</i> <i>S. flexneri</i></p>	<p>Contaminated water, utensils, milk handlers (carriers), flies</p>	<ul style="list-style-type: none"> <li>• Strict personal and environmental hygiene</li> <li>• Proper treatment of water supply and waste disposal</li> <li>• Education and supervision of milk handlers</li> </ul>

		<ul style="list-style-type: none"> <li>• Fly control</li> </ul>
<p><b><i>Streptococcus pyogenes</i></b> (causes septic soar throat and scarlet fever), Group D <i>Streptococcus</i> (causes food poisoning; predominantly of faecal origin)</p>	<p>Faecal contamination, human carriers, infected animals, contaminated milking machines</p>	<ul style="list-style-type: none"> <li>• Personal hygiene</li> <li>• Pasteurization</li> </ul>
<p><b><i>Diphtheria</i></b> <i>Corynaebacterium diphtheriae</i></p>	<p>Respiratory tract of human beings, infected animals (mastitis cases), contaminated dairy environment</p>	<ul style="list-style-type: none"> <li>• Adequate heat treatment</li> <li>• Personal hygiene (avoid sneezing and coughing during milking)</li> </ul>
<p><b><i>Tick borne encephalitis</i></b> <i>Flavi virus</i></p>	<p>Infected animals, contaminated environment (Goat &amp; sheep milk)</p>	<ul style="list-style-type: none"> <li>• Pasteurization of milk</li> <li>• Immunization of milch animals</li> </ul>
<p><b><i>Hepatitis</i></b> <i>Hepatitis A virus</i></p>	<p>Infected milk handlers, Contaminated water supply</p>	<ul style="list-style-type: none"> <li>• Pasteurization</li> <li>• Health education</li> </ul>
<p><b><i>Foot and mouth disease</i></b> <i>Aphthovirus</i></p>	<p>Infected animals, contaminated materials</p>	<ul style="list-style-type: none"> <li>• Pasteurization of milk</li> <li>• Disinfection of premises, equipments and vehicles</li> </ul>

**B. Milk borne intoxications**

Disease and Causative agents	Sources of contamination to milk and milk products	Prevention and control
<p><b><i>Clostridium botulinum</i></b></p> <ul style="list-style-type: none"> <li>• Most severe of all food poisoning</li> <li>• Organisms are heat resistant</li> <li>• Organisms produce eight</li> </ul>	<p>Contaminated soil and water</p>	<ul style="list-style-type: none"> <li>• Adequate heating at 100 °C for 10 – 20 minutes</li> <li>• Hygienic measures during production</li> <li>• Rapid chilling</li> </ul>

<p>types of (A, B, C1, C2, D, E, F and G) neurotoxins, one of the most potent toxins in nature</p>	
<p><b><i>Vibrio cholerae</i></b></p>	<p>Contaminated water supply, personal carriers and infected persons, adulteration of milk with contaminated water</p> <ul style="list-style-type: none"> <li>• Pasteurization of milk and milk products</li> <li>• Water treatment</li> <li>• Preventing infected and carrier personnel from handling milk</li> </ul>
<p><b><i>Escherichia coli</i></b></p> <ul style="list-style-type: none"> <li>• LT is destroyed by heating at 65°C for 30 minutes but ST is not destroyed in this condition</li> <li>• <i>E. coli</i> poisoning is associated with many types of products especially ice cream, kulfi, dried milk, cheese</li> </ul>	<p>Faecal contamination, milk handlers, infected animals, contaminated environment</p> <ul style="list-style-type: none"> <li>• Avoid water contamination and ensure proper treatment of water</li> <li>• Good personal hygiene and environmental hygiene</li> </ul>
<p><b><i>Staphylococcus aureus</i></b></p> <ul style="list-style-type: none"> <li>• Organisms produce at least 8 types of enterotoxins – A, B, C1, C2, C3, D, E and F</li> <li>• Enterotoxins are heat stable and can withstand boiling for 10 minutes</li> </ul>	<p>Human handlers (since the organism is normally present in nasal tract, skin wounds, pimples and boils), milch animals (harbouring this organism in udder)</p> <ul style="list-style-type: none"> <li>• Adequate heating of milk immediately to avoid toxin production</li> <li>• Adequate cooling immediately after heat processing</li> <li>• Health education and application of personal hygiene in milk and milk products handling</li> </ul>

**C. Milk borne Toxi-infections**

<b>Disease and Causative agents</b>	<b>Sources of contamination to milk and milk products</b>	<b>Prevention and control</b>
<p><b><i>Bacillus cereus poisoning</i></b></p> <ul style="list-style-type: none"> <li>• Toxins are responsible for the syndrome</li> <li>• Toxins include haemolysin, lecithinase, and enterotoxins (diarrhoeal and emetic)</li> </ul>	<p>Infected animals (teat, skin), contaminated utensils and cans, equipments and soil</p>	<ul style="list-style-type: none"> <li>• Prompt cooling of milk and milk products</li> <li>• Environmental hygiene to prevent aerial contamination by spores</li> <li>• Hygienic production and processing</li> </ul>
<p><b><i>Clostridium perfringens</i></b></p> <ul style="list-style-type: none"> <li>• Anaerobic spore formers</li> <li>• Poisoning occurs through canned milk products.</li> <li>• Enterotoxins liberated during sporulation of bacteria are responsible for disease</li> <li>• Five types of toxins are produced – A, B, C, D and E</li> </ul>	<p>Contaminated water, faecal environment</p>	<ul style="list-style-type: none"> <li>• Proper heat treatment of milk</li> <li>• Prompt cooling following pasteurization</li> </ul>

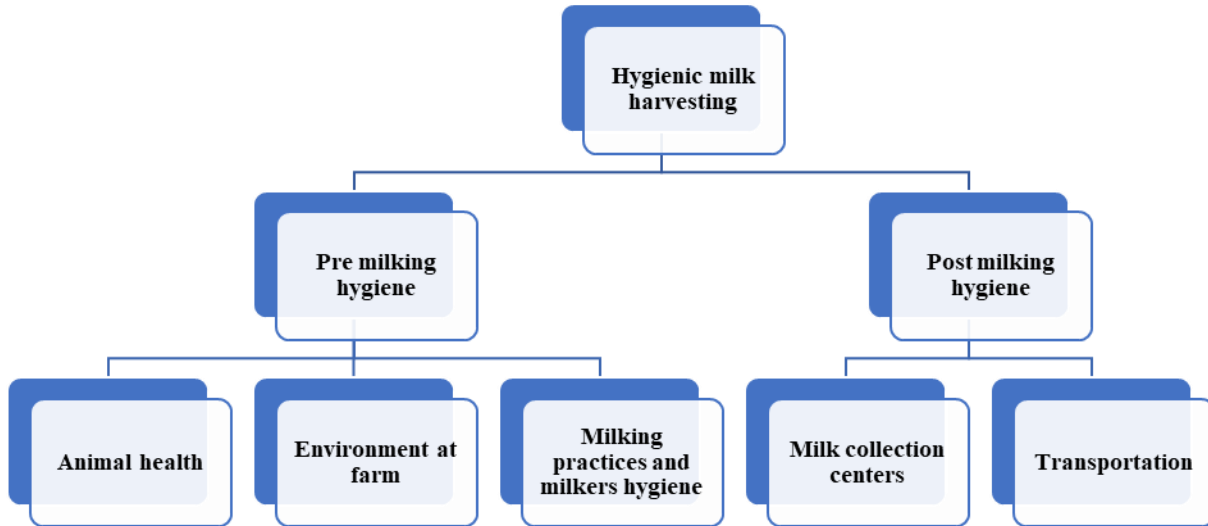
**Chemical contaminants residues in milk**

<b>Source(s)</b>	<b>Residue</b>
<b>Farm animal</b>	<ul style="list-style-type: none"> <li>• Veterinary medicines/drugs e.g. hormones, antibiotics, antiparasiticides, etc.</li> <li>• Feed additives e.g. antioxidants, trace elements</li> </ul>
<b>Environment</b>	<ul style="list-style-type: none"> <li>• Soil minerals e.g. Cadmium, Lead</li> <li>• Agrochemicals e.g. growth promoters, pesticides</li> <li>• Environmental organics e.g. Radionuclides, Mycotoxins</li> </ul>

	<ul style="list-style-type: none"><li>• Emissions e.g. Fumes, dusts, aerosols</li></ul>
<b>Milking and processing</b>	<ul style="list-style-type: none"><li>• Hygiene formulations e.g. Insecticides, cleaning &amp; disinfecting agents</li><li>• Surfaces e.g. Plasticizers, <i>met als</i></li><li>• Microbial products e.g. Bacterial enzymes, Mycotoxins</li></ul>

### **Hygienic milk harvesting**

Milk is the prime output of any dairy farm and serves as a source of nutrition as well as income for the farmer. Hence, to get better benefits from the farm, the dairy farmer must make sure that milk produced in hygienic way. The milk provides excellent environment for microbial growth and can be easily exposed to microorganisms during production, handing, transporting and marketing. Sustaining high-quality hygiene is vital to prevent contamination due to harmful pathogens resulting from unhygienic milking procedures, milk contact surfaces, handlers, equipments, packaging conditions. To reduce the risk of contamination, following points needs to be considered for the production of clean milk and milk products.



### **Pre milking hygiene**

#### **Animal health:**

The milking animal should be healthy. Animal having any infection of genital tract with discharge, udder infection, enteritis with diarrhoea & fever, the milk from such animals must not be used by the humans for consumption. Milk of cows positive for TB or *Brucella* must not be used for human consumption. Animal must not be administered with unauthorized substances or products, if administered then prescribed withdrawal period should be observed.

#### **Animal Cleanliness:**

The animal should be kept clean. Regular grooming & washing should be followed to avoid milk contamination.



#### **Animal housing:**

Stables must be clean, dust free, dry, and well ventilated. Passage ways should be free from dung and slurry accumulations. Milking place should be washed at least one hour before milking. It should be protected from flies, mosquitoes, rats, birds etc.

#### **Milking practices:**

The cow must be soil, dirt and manure free. Udders, teats, and adjacent parts should be washed with clean water before milking. Washing of udder before milking facilitates the release of oxytocin hormone which acts on the milk secretory cells, and thus stimulates the milk let-down. Milk must be examined for physical or chemical or organoleptic abnormalities and abnormal milk must be rejected.

**Feed & water supply:**

Feed and weed flavor deteriorate the milk quality. So, the feeds with off flavor should not be fed to the animal. Potable water or clean water should be provided to the animals. The potable water is also required in sufficient amount for udder & teat washing, hand washing, and for cleaning the equipments.

**Pests, Vermin & Other Animals:**

Measures must be taken to prevent contamination by controlling birds and rodents on the premises. Activities like removal of needless vegetation from premises, storage of feed in closed containers and removing remaining feed from mangers immediately after every milking should be followed. Milk storage areas must be protected from vermin. Cats, dogs and birds including poultry, should not be allowed inside the premises.

**Utensils/equipments:**

Equipments should be kept clean, free from any dent and smooth surfaced. Narrow mouthed utensils should be used to prevent air borne infection. Both inner and outer surfaces of the milk utensils must be properly cleaned directly after each milking to reduce the risk of contamination thereby providing safe and wholesome product to the consumer.

**Milker's hygiene:**

Milkers and milk handlers must not be suffering from any disease condition and their hands should be free from cuts. They must wash their hands with soap and water before milking. Wrong milking practice like incomplete milking should be avoided by the milker's because leftover milk cause multiplication of organisms.



**Post milking hygiene**

**Milk collection centers:**



Milk should be collected as soon as possible specifically within two hours of milking. Any delay in the transport to milk collection or processing centers reduces the shelf life of the final products. Proper cooling of milk is essential to ensure good quality because cooling inhibits bacterial growth and prolongs nonspecific inhibitory effects of milk.



### **Transportation of milk:**

Being an extremely perishable product; transporters must make certain about the speedy transport, careful handling and high levels of hygiene of milk. This will reduce the losses due to spoilage & spillage, prevent contamination by pathogens, and also ensure the profits. Aluminium and stainless-steel containers are ideal to use. Containers made up of copper should not be used for milk as copper oxidizes the butterfat, resulting in off-flavors.

### **Dairy plant hygiene:**

The prerequisite for hygienic and quality milk production is the cleaning of contact surfaces as contact surfaces of milk and milk products contribute to about 60% of the total contamination.

Hygiene of dairy plant comprises of three segments in general:

- ❖ Processing hygiene
- ❖ Equipment hygiene
- ❖ Personnel hygiene

### **Processing hygiene and equipment hygiene**

- Insufficient knowledge regarding machineries & equipment handling is one of the major reasons responsible for microbial contamination in milk and other milk products. This can be prevented by imparting appropriate training and regular monitoring of the equipments
- Not following the cleaning & sanitization standards can result into harmful substances contamination. So, the equipments should be cleaned and sterilized thoroughly after the milk processing
- Industry-approved non-corrosive, safe detergents and disinfectants should be used only judiciously
- Optimal drainage system should be there in the processing area and abundant water supply should be made available for effective cleaning
- Floor should be sloped and impervious. Regular cleaning of the floor should be practiced for optimum hygiene
- Plant workers should wear PPE including face masks, safety boots, hair caps and gloves

### **Personnel Hygiene**

- Persons should wash their hands with disinfectant before and after leaving the milk processing or production unit. Finger nails should be trimmed and kept clean
- Any cut must be covered by a band-aid
- Workers in dairy plant must wear hygienic clothing to prevent contamination of the product
- Wearing hand gloves is compulsory when handling the dairy products. Feet should be covered with high-quality, disposable shoe caps

### **Dairy waste water hygiene**

- Insufficient measures to manage dairy waste water are the primary cause of unhygienic work conditions and contaminations
- To maintain proper hygiene, methods like aerobic treatment, biological filtration and activated sludge must be followed for treating dairy waste water

## **Conclusions**

For clean milk production the milking animals need to be healthy and milk should be harvested and stored under hygienic/clean conditions. Well maintained, clean, sterile and non-corrosive utensils should be used to collect & store milk. Infected or diseased animals must be isolated and milk from such animals must not be used for consumption. All the personnel's involved in milk production and processing must be trained in health risks, and milk hygienic practices. Clean water must be made available in the milking area in sufficient amount for activities like washing of udders and teats, equipments, utensils, hands, floors during and after milking. Proper records must be maintained on disease conditions, feed and fodder supplies and veterinary drugs to ensure safe and wholesome product for the consumers.

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<b>Nutrigenomics tools to address the emerging issues in marine fish larviculture</b>	<b>Chapter</b> 2
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## **ABSTRACT**

It is of note that the capture fisheries are under stress for many targeted species. To reduce the pressure on the wild, research on mariculture had been practicing for decades. Even though technologies for captive breeding are standardized, the growth and survival of the larvae of candidate marine fish species are still not up to the mark. It is necessary to focus and encourage new approaches to standardize the hatchery protocol for enhanced production and sustainable management towards future demands. The major concern facing the marine fish hatchery is the delivery of nutritionally enriched feeds to the larvae. Inadequate nutrition is one of the major reasons for early mortality, weaning mortality, cannibalism, inadequate growth, lowered immunity etc. In India, nutrigenomics research is an up-and-coming field, especially the transcriptomics approach that can be applied to understand the gene expression profile of the larvae and juveniles with respect to nutritional interventions. By means of RNA sequencing (RNA-seq) technology, a clear understanding of the growth, development, metabolism, immune function, stress, adaptation and differential gene expression is possible. In addition, the specific effects of selected nutrients on targeted genes can be studied to alter the diet composition accordingly for improving the growth, condition and survival of candidate species of marine fish larvae. This novel approach has the potential to unravel valuable information required to address

the issues in marine fish larval nutrition and for the development of species and life-stage specific micro-feeds for sustainable larviculture.

**Keywords:** Larviculture, Mariculture, mRNA, Nutrigenomics, Transcriptomics

## **Introduction**

Globally aquaculture is one of the fast-growing and demanding sectors through which a nation's food crises are secured nutritionally. Due to the tremendously increasing demand for seafood and declining trend in capture fisheries, an innovative and sustainable hatchery technology is required to operate the industries (FAO, 2018). One of the major problems in marine aquaculture operations is sudden mortality, especially during the early larval and weaning stages (Dessen, 2020). This could be due to more than one factor, but the most important concern is the nutritional imbalance which leads to disease outbreaks (bacterial, fungal, virus), cannibalism, etc (Shefat and Karim, 2018). Even though marine aquaculture is a growing industry, the problems in the hatcheries at their early stages are tricky and it is a challenging task to overcome. Advancement in research towards nutrient delivery through suitable feed may increase marine fish production (Roques *et al.*, 2020). Researchers have been trying to solve the issues in various approaches based on nutrition as a solution (Liang *et al.*, 2001; Hixon, 2014). To achieve this, basic knowledge about the growth and development process with the advancement in research like nutrigenomics is needed to enhance sustainable production (Hakim *et al.*, 2018).

Nutrigenomics especially in marine organisms is the advanced and emerging technology used in aquaculture research to overcome the problems faced by aqua-farming sector. It involves the study of the effects of diets and their constituent ingredients on gene expression through metabolism. There are many 'omics' tools that can be applied in marine fish research which includes transcriptomics, proteomics, and metabolomics. The nutrients for an organism have been identified as important elements which modifies the gene expression, normal metabolism and affect the health (Corthésy-Theulaz *et al.*, 2005; Heras *et al.*, 2020). Considerable reduction in early weaning mortality of marine larvae via making dietary recommendations based on its genome could be considered as a breakthrough in the larval rearing sector. In India, nutrigenomics research is an up-and-coming field, especially the transcriptomics approach that can be applied to understand the gene expression profile of the larvae and juveniles due to nutritional interventions.

### **Application of Nutrigenomics in aquaculture**

The scientific approach plays an important role in the growing aquaculture industry. Nutrigenomics tools which are an emerging field, especially in marine fish species involve transcriptomics, proteomics and metabolomics, each with specific applications (Mutch *et al.*, 2005). The technique is applied in marine research to sort out the issues involved in the hatchery phase with respect to the deficiency in nutrition. The applications of nutrigenomics can be used to study the marine fish' response to the nutrients, and diet development according to the nutrient acceptance, understanding cell response to the provided nutrients, deliver sustainable hatchery protocol, pointing out the metabolism according to the environmental factor, identifying the various nutrient requirement of an organ and tissue of an organism, metabolic changes of candidate species (Hakim *et al.*, 2018). Most of the tropical marine fish larvae depend on the live feed to grow starting from day one to more than a month. Even though researchers are working towards micro-diets for the early-stage larvae, most marine fish hatcheries still rely on live feed (rotifers, *Artemia* sp. and copepods). This is mostly due to the knowledge gap in the nutritional requirement of the marine fish larvae species (Hamre *et al.*, 2013). Application of nutrigenomics tools in aquaculture has the potential to crack these issues.

### **Transcriptomics**

Transcriptomics is the study of whole RNA transcripts at a specific point of time. It describes a clear understanding of the growth, development, metabolism, immune function, stress, adaptation and differential gene expression with the help of whole transcriptome shotgun sequencing or RNA sequencing (RNA-seq) technology (Leduc *et al.*, 2018; Chandhini and Kumar, 2019). The previous studies of transcriptome analysis were done with economically important aquaculture species which including, *Lates calcarifer*, *Macrobrachium rosenbergii*, *Epinephelus coioides*, *Ctenopharyngodon idella*, *Oreochromis niloticus*, *Fenneropenaeus chinensis*, *Eriocheir sinensis*, and *Crassostrea virginica* (Chandhini and Kumar, 2019). Effect of specific nutrients in fish larval metabolism and survival could be revealed with the help of transcriptomic analysis (Panserat and Kaushik, 2010). There are studies which established the early developmental transcriptome profiles of marine larvae and identified candidate nutritional markers in the development of digestive system and organogenesis (Hilerio-Ruiz *et al.*, 2021; Martínez-Burguete *et al.*, 2021).

### **Proteomics**

Fish plays a pivotal role in providing animal protein in the human diet. Proteomics is the study of proteomes, which is a set of proteins produced in an organism. This tool is used to investigate the expression of the proteins, amount of protein produced, degraded and stabilized, modification of ways, and its interactions with one another (Nissa *et al.*, 2021). The proteins responsible for metabolic pathways are important tools in the aquaculture industry that is used to study nutrition, health, environmental quality (pollutants, toxins and temperature fluctuations) and safety (Tomenek, 2011; Nissa *et al.*, 2021). The modern technology applied is the high throughput proteomics and metaproteomics which are necessary for aquaculture research to achieve a high standard of quality food production and environmental sustainability (Rodrigues *et al.*, 2017). Proteomics helps researchers to find out the scientific reasons behind the altered cellular and/or tissue level phenomena as the effect of nutritional factors. The technique reveals communications involved in complex intracellular signalling pathways by which the cell maintains its fates as proliferation, migration, recognition and differentiation (Tian, 2014). Thus, specific biological queries could be addressed with the application of various types of proteomic approaches and technologies in larval nutrition.

### **Metabolomics**

Among the progressive technology, metabolomics is important which allows us to understand the effects of feed on fish metabolism. Metabolomics is the study of the set of life-sustaining non-targeted chemical reactions of metabolites in cells, biofluids and tissues of an organism and how this changes the physiological disturbance (Wishart, 2019). The metabolome is the final most product of gene transcription and its changes are relative to transcriptomic and the proteomic changes (Horgan and Kenny, 2011). It is a useful methodology which helps to understand the complex molecular interactions in biological systems (Hall *et al.*, 2002). Application of metabolomic studies based on muscle lipid profiling can even identify the origin of the fish stock (Melis *et al.*, 2014). Gil-Solsona *et al.* (2019) identified nutritional deficiency markers in gilthead sea bream. Application of this technology will aid in the development of species-specific metabolic network maps with differential expression of metabolites in fish fed with special or targeted nutrients.

A combination of transcriptomics, proteomics and metabolomics approaches will enhance the quality and survival of marine larviculture by improved feed formulation, disease management etc. The path ahead appears full of hope as the development of proteomic and transcriptomic database of different species become available leading to emergence of new hatchery management strategies, and also helps researchers to characterise and design larval fish feeds based on molecular level expression of the nutrients in order to get desired nutritional quality, growth and health of fish.

### **Nutrigenomics studies initiated at ICAR- Central Marine Fisheries Research Institute**

To address the issues in larval nutrition, a proper understanding of the nutritional requirements (stage and species-wise) *viz.*, protein, carbohydrates, fatty acids, peptides, vitamins, and minerals is necessary. By keeping this in focus, the Central Marine Fisheries Research Institute initiated a project entitled ‘Dr. E. G. Silas Centre of Excellence and Innovations in Marine Fish Microbiome and Nutrigenomics’ (Dr. EGS-CoEI), supported by the Department of Biotechnology, Government of India (<http://210.212.232.215/egscei/index.php>). Under this project, the economically important marine species such as Cobia (*Rachycentron canadum*), Silver pompano (*Trachinotus blochii*) and Orange spotted Grouper (*Epinephelus coioides*) were selected. The Dr. EGS-CoEI is the first of its kind in India, dedicated to address the poor larval growth and survival rates of commercially important mariculture finfish species of the country.

### **Standardization of sampling, processing and storage of Cobia (*R. canadum*) larvae**

As an initial step towards RNA-seq, marine fish larvae (*R. canadum*) of different life stages were collected, preserved and analysed to evaluate the RNA quantity and quality. The larval samples were freshly collected from the Marine Fish Hatchery at Mandapam Regional Centre of the Central Marine Fisheries Research Institute, Tamil Nadu and (Fig. 1 a, b).





Fig. .1 (a) Larval sampling at the Marine fish hatchery at ICAR- CMFRI, Mandapam;

(b) Collection of cobia larvae

The larval samples were processed in five different methods for transcriptomics analysis on different trials (Fig. 3) as follows: Trial 1– the fresh/ live larval sample was collected and directly stored at - 20 °C, Trial 2– the fresh larval sample was collected in a vial, 5 volumes of Trizol added and stored in - 20 °C, Trial 3– the fresh larval sample was collected in a vial, 5 volumes of RNAlater added and stored at - 20 °C, Trial 4– the fresh larval sample was collected in a vial, 5 volumes of RNAlater added, kept at 4 °C for 12 hours and stored at - 20 °C, Trial 5– the fresh larval sample was collected in cryovials, 5 times of RNAlater added, kept at 4 °C for 12 hours and stored in Liquid Nitrogen (LN2).

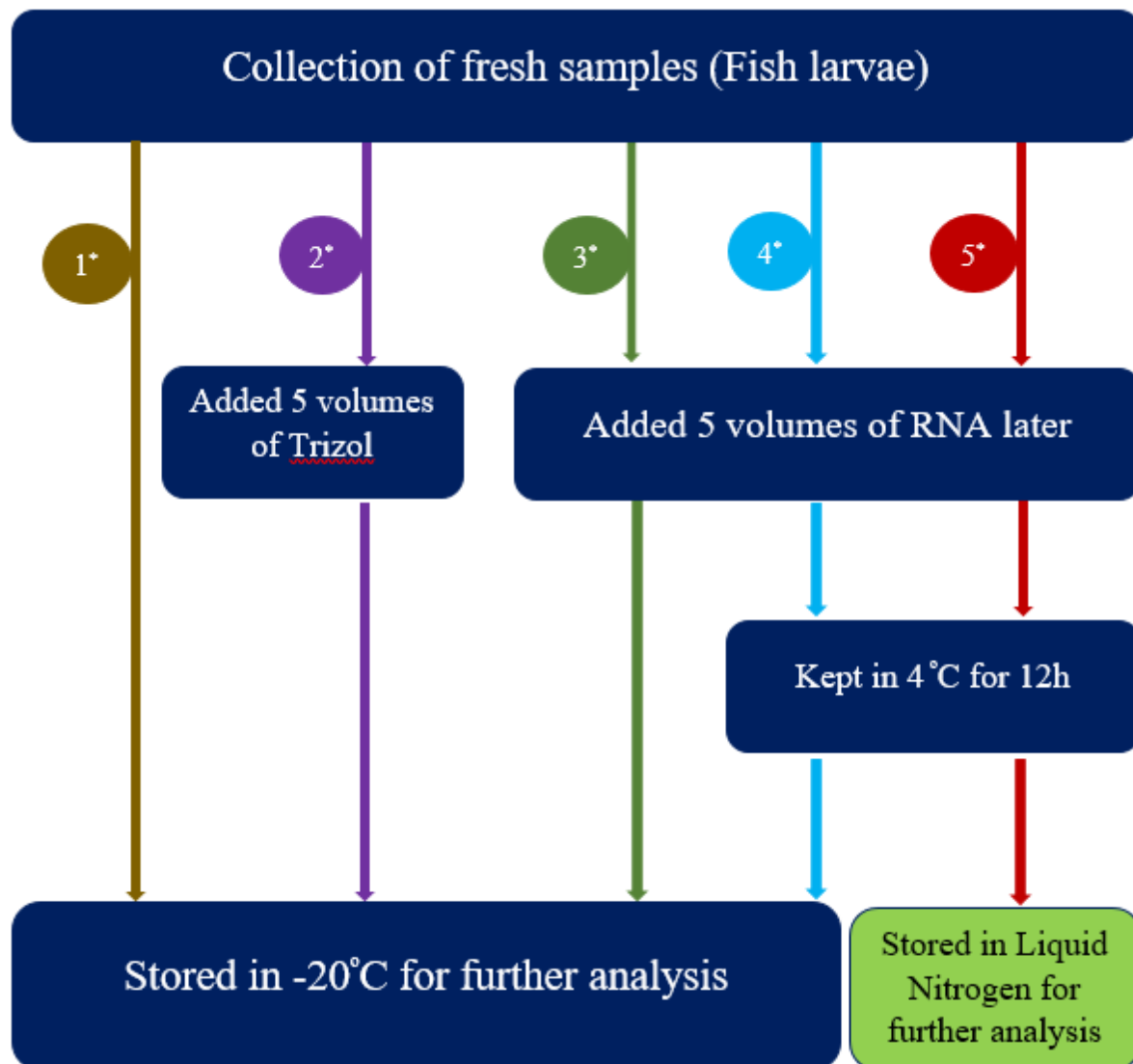


Fig. 3. Pictorial representation of sample collection and analysis methods used for the study

*\*Different methods employed*

## Results

Among the different methods used, the Trial 5, in which the samples were collected and treated with RNA later and incubated at 4 °C for 12h and finally stored in liquid nitrogen, maintained superior RNA quality and found suitable for further processing for transcriptomic analysis as compared to other methods.

### **Conclusion and future prospects**

Nutrigenomics is the most appropriate tool to understand the effects of nutrients on the growth and metabolism in marine fish larvae and to decipher the major reasons resulting in early mortality *viz.*, weaning mortality, cannibalism, inadequate growth, lowered immunity etc. By using the RNA-seq technology, a clear understanding of the growth, development, metabolism, immune function, stress, adaptation and differential gene expression is possible. In addition, the cues leading to early mortality in the different weaning periods can be predicted and also envisage the contribution of the genotype responsible for mortality. The specific effects of selected nutrients on targeted genes can be studied to alter the diet composition accordingly for improving the growth, condition and survival of candidate species of marine fish larvae. This novel approach has the potential to unravel valuable information required to address the issues in marine fish larval nutrition and for the development of species and life-stage specific micro-feeds for sustainable larviculture.

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<b>Assessment of evidences of fishing gear losses from selected areas of Indian waters</b>	<b>Chapter 3</b>
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#### **ABSTRACT**

Fishing gears may be lost into the seas because of rough climatic conditions, damages of the gear, entanglement with bottom obstructions or dragged away by other fishing vessels or ships etc. These lost gears designated as abandoned, lost or otherwise discarded fishing gears (ALDFG) contributes to species mortality by continuing to entangle and kill fishes and other endangered/threatened species such as turtles, birds and mammals, a phenomenon referred to as ghost fishing. Passive gears like traps, gillnets may catch fish for several months or even years after they are lost. Locating ALDFG will be helpful to understand the fate and transport of lost fishing gear and to remove them from marine waters, thus eliminating its harmful impacts to species and habitats. Present study was undertaken for evidences of fishing gear losses and ghost fishing from selected areas of Indian waters. Underwater investigation by scuba diving were conducted at Enayam, Tamil Nadu & Vizhinjam coast of Kerala. About 33kg lost gears were recovered by scanning an area of 700m<sup>2</sup> seabottom at Enayam. Six types of lost gears were retrieved in which Nylon monofilament gillnet panels (47.3%) were the predominant gear types followed by pieces of trawl codends, parts of long lines, ropes, traps, and squid jigs. Retrieved traps contained Molluscs, Arthropods, Echinoderms, Annelids and Cnidarians, Poriferans at various degrees of decomposition. From Vizhinjam coast of Kerala, gillnet webbings and ropes

were recovered. This baseline information will be useful to understand the scale and distribution of ALDFG and identification of the hotspot areas of gear losses.

**Keywords:** Fishing gear loss, Indian coast

### **Introduction**

Fishing gears may be lost into the seas because of rough climatic conditions, damages of the gear, entanglement with bottom obstructions like wrecks and reefs or dragged away by other fishing vessels or ships etc. Sometimes fishermen intentionally leave the nets due to some gear conflicts or due to lack of disposal facilities for old/ damaged nets. Fishing gears that are lost in waters designated as (ALDFG) abandoned, lost or otherwise discarded fishing gears have the potential to continue fishing whereby ALDFG entangles or entraps animals (Gilman, 2015). The fishing gear loss and other fishing related debris adds to marine pollution to nearly 10 percent and its impact on marine organisms is very severe (Macfadyen *et al.*, 2009). The ecological impacts related to ALDFG are well known from marine systems and is getting worsen over the years due to the large-scale global fishing operations and introduction of highly durable fishing gears made of synthetic materials (Macfadyen *et al.*, 2009; Gilman *et al.*, 2016). Approximately, 100, 000 marine mammals die annually from entanglement or ingestion of fishing related marine debris (Laist, 1997). Moreover, these ALDFGs are hazardous to sensitive ecosystems like corals and leads to habitat degradation and interferes navigation and shipping activities.

Ghost fishing is another long-lasting effect of ALDFG defined as “the ability of fishing gear to continue fishing after all control of that gear is lost by the fisherman” and contributes to species mortality by continuing to entangle and kill target organisms and non-target species such as turtles, birds and mammals (Stelfox *et al.*, 2016). Most common type of fishing gears causing ghost fishing are passive gears like gillnets and traps. Locating ALDFG will be helpful to understand the fate and transport of lost fishing gear and to remove them from marine waters, thus eliminating its harmful impacts to species and habitats. Worldwide number of programs specifically aimed at the removal of ALDFG have successfully removed them from, onshore and at sea, thereby reducing the potential for ghost fishing (Bech, 1995; Humborstad *et al.*, 2003). Currently, the information about the geographical distribution of ALDFG from Indian waters are limited (FAO, 2017; Thomas *et al.*, 2020). Hence the present study was undertaken for evidences of ALDFG, gear types, their catch composition/condition through underwater investigations from selected areas of Indian waters.

## Methodology

Fishing gear retrieval was carried out at selected locations in Enayam N 08<sup>o</sup> 12.886' N, 77<sup>o</sup> 10.701 E) in Tamil Nadu and Vizhinjam (8<sup>o</sup> 21.259'N, 77<sup>o</sup> 10.701'E) in Kerala during January to March 2019. The location was identified with the help of fishers in the particular location and area of reef/ rocky patch where the ALDFGs were usually present. Retrieval was carried out at a depth range of 20-30 m with the help of scuba divers. Different types of knives and shears were used for the retrieval of old fishing gear. Transects were set in the selected locations in each of the following diving locations and the details of retrieved gear also recorded. After photographic documentation, the details of retrieved gears were documented. Retrieved gear samples identified based on its mesh size, twine diameter, twist and construction. Organisms associated with retrieved gears were identified and quantified.

## Results and discussion

From Enayam, about 33kg of lost gears were recovered by scanning an area of 700m<sup>2</sup> sea bottom. A total of 16 diving observations were carried out. Six types of ALDFG (Fig 1) were recovered with nylon monofilament gillnet panels (47.3%) as the predominant gear types (Fig 1 & 2). These panels were having eight mesh sizes 35, 45, 46, 50, 52, 60, 105 and 115mm. The recovered gears include monofilament netting panels (65.4 m<sup>2</sup>), pieces of trawl codends (2.8 m<sup>2</sup>), parts of long lines (17.1m), PP ropes (13.4m), traps (3nos), and squid jigs (3nos). From Vizhinjam coast of Kerala, gillnet webbings and ropes were recovered. Gajanur and Jaafar, 2022 while reviewing ALDFG studies worldwide, reported that monofilament fishing nets and lines accounted for the majority of ALDFGs.

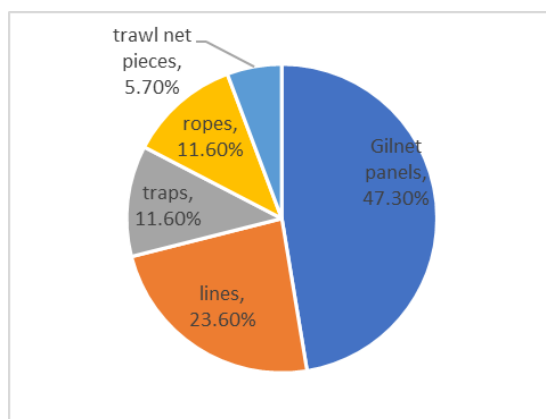


Fig. 1. Relative abundance (based on numbers) of retrieved fishing gears





Fig.2. Retrieved gillnet panel and trap

Retrieved traps contained Molluscs, Arthropods, Echinoderms, Annelids and Cnidarians and Poriferans at various degrees of decomposition. Of the total gears retrieved 49% contained organisms. Retrieved traps contained the largest number of animals followed by gillnets. Majority of the organisms were found in Mollusca followed by Echinodermata. The details of retrieved gears/gear parts are given in the table 1. One eighty individual organisms were recorded. Most abundant species recorded were bivalve *Perna indica* (47.2%). All the organisms were found dead on retrieval. Several researchers have reported the impacts due to lost fishing gear. Bilkovic *et al*, 2014 reported that 28-38 % of retrieved blue crab traps were actively ghost fishing in the Virginia waters of Chesapeake Bay.

Table 1. Organisms in retrieved gears

Phylum	Class/species	number
Mollusca	Bivalvia ( <i>Perna indica</i> )	85
	Gastropoda ( <i>Cypraea</i> sp)	38
Echinodermata	Asteroidea ( <i>Stichastrella</i> sp)	15
	Other Echinoderms	15
Arthropoda	Malacostraca ( <i>Atergatopsis</i> sp)	4
	Pycnogonida	15
Annelida	Polychaeta	5
Porifera	Demospongiae ( <i>Callyspongia</i> sp)	Small fragments
Cnidaria	Anthozoa ( <i>Gorgonia</i> sp)	Small fragments

Chances of entanglement and trapping of individuals in derelict nets are influenced by several factors. For example, the re-baiting phenomenon is one whereby initially trapped organism in derelict nets attract other predators and scavengers which in turn also get entangled in the net (Breen, 1990). Over the period, with the declining structural integrity of ALDFG, their impact on the environment may be at a declining rate (Erzini *et al*, 1997). Further, the declining impact of ALDFGs may also be as a result of organism's adaptability, by using ALDFGs for their shelter or refuge due to the structural integrity of ALDFGs (Angiolillo and Fortibuoni, 2020). However, systematic studies are needed over larger for determining the efficacy of ALDFGs as active trapping devices.

### **Conclusion**

The findings from the present study provides a baseline information on the amount of ALDFG and data for identifying hot spot areas of gear losses in future retrieval studies. Dive cleanups and coastal cleanups programmes are also being carried around the globe with active participation of various stakeholders to protect marine areas. Such retrieval studies also reduce the impact of ALDFG on marine environment and further ghost fishing possibilities. Measures such as incorporation of biodegradable netting panel / twines in fishing gears, fishing gear marking, increasing the awareness among the stakeholders towards proper disposal of damaged gear will also help to lessen the impact of ALDFG.

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<b>Knowledge regarding stubble burning practices with special reference to happy seeder farm technology- A sociological study</b>	<b>Chapter</b> 4
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## **ABSTRACT**

When the rice is harvested, straw and stubble is left behind, and with no cost-effective and environment friendly way to clear the fields in time to sow wheat for the winter season, farmers resort to burning the crop. Keeping in mind the advantages of Happy Seeder and to check the knowledge level of the farmers regarding Happy Seeder along with factors affecting the knowledge level, a study was carried out among 80 Happy Seeder adopter farmers in rural areas of Fatehabad district. Analysis of data clearly revealed that maximum number of the respondents (42.50%) had medium level of knowledge regarding Happy Seeder. Rest 40.00% and 17.50% respondents had high and low level of knowledge respectively regarding Happy Seeder farm technology. The factors associated with level of knowledge of the respondents revealed that age, education, size of land holding, mass media exposure, socio-economic status and annual family income were found significantly associated. Caste was found non-significantly associated with

knowledge level of the respondents. Data on knowledge aspects before operation revealed that overwhelming majority of the farmers had knowledge about uniform distribution of loose residues across the field (85.00%). More than 3/4<sup>th</sup> of the respondents had full knowledge regarding laser leveling (75.00%) and operation of Happy Seeder after sufficient evaporation of moisture from residues (77.50%).

**Key words:** Happy Seeder, technology, knowledge, Socio-economic factors, crop residue

### **Introduction**

Paddy is one of the main vegetation of Haryana. The growing constraints of labour and time have brought about the adoption of mechanized farming in tremendously in-depth rice system. In Haryana, by and large the paddy and wheat vegetation are harvested with the aid of using combines. The general amount of straw generated in Haryana, Punjab and UP states became 28.4 million tonnes in 2020. Burning is the regular and simplest approach of crop residue control alternative because it interferes with tillage and seeding operations for the subsequent crop. Presently, a large amount of the whole rice straw produced yearly is being burnt in 3-4 weeks during October-November because of lack of knowledge of the farmers (Singh *et al.*, 2010). The gaseous emissions from burning of rice straw analyzed 70% CO<sub>2</sub>, 7% CO, 0.66% CH<sub>4</sub> and 2.09% N<sub>2</sub>O. Substantial lack of plant nutrients (in particular N and S) and organic carbon takes place for the duration of burning of crop residues, which has crucial implications for soil health (Singh *et al.*, 2005). Different strategies for crop residue control i.e., mulching, soil incorporation etc. straw, clover, leaves, corn cob and sawdust like crop residue and different plant waste are broadly and significantly used as mulch due to the fact they are reasonably-priced and frequently easily available. It lets in water to go into with inside the soil easily, whilst keep an ok level. The mulching with those substances assists lowering the loss because of evaporation and extended the water content material with inside the soil. Mulching is a superb and powerful manner to enhance the retention of water and to growth the nutrient content material of the soil. The use of crop residue and different plant waste as mulch can improve the microbial interest with inside the soil and will increase the quantity of worms. It similarly consequences into the discount of weed boom with inside the discipline. Reduction in evaporation, moisture retention, and prevention of soil erosion, manipulate over weeds and addition of vitamins to the soil is a number of the gain of the mulching. Similarly, it has a few demerits as because of the heavy mulching over a length of a few years can end result into the build-up of soil over the crown

vicinity of the plants. Different straw control equipment available, like that Super Seeders, Rotavator, Mulcher, disc harrow and zero tillage seed drill. But Super Seeders is a completely unique method for sowing wheat in integrates harvested paddy discipline. The Happy Seeder is a tractor set up enforce that mixes a ZT seeder with a straw control unit. The latter incorporates of serrated rotating flails connected to a roller that shreds and easy the residues in the front of the tyne openers after which deposits the residue across the seeded row as mulch. This is carried out in a single easy operation of direct-drilling with inside the presence of status in addition to free floor residues. The residue left at the floor as mulch enables lessen evaporation losses, suppresses weed growth, buffers soil moisture and temperature, and allows a greater green uptake of water and vitamins *via* way of means of plant roots (Sidhu *et al*, 2015; Singh *et al*, 2015). The use of the Happy Seeder additionally reduces labour necessities for crop established order *via* way of means of as tons as 80%, irrigation wishes *via* way of means of 20–25%, and herbicide use *via* way of means of as tons as 50% (Saunders *et al*, 2012). It in addition reduces gas use and improves productivity, mainly below climatic strain conditions (Aryal *et al*, 2016; Saunders *et al*, 2012; Sidhu *et al*, 2007). A study was undertaken on Happy Seeder for wheat crop under rice wheat the cropping system in Allahabad region. In this study the performance of the Happy Seeder was evaluated with conventional method and the results showed its effectiveness over the sowing technique. The cost of operating per hectare by Happy Seeder was observed Rs. 2098.65 and cost of operation per hectare by seed drill + tillage operations was Rs. 3106.38. (Singh *et al*, 2017). Therefore, cost of operational with Happy Seeder was economical as compared to seed drill by Rs. 1008.38 per hectare and Happy Seeder is unique technique for sowing wheat in combine harvested paddy field. It controls the weeds also. Therefore keeping in mind, the benefits of Happy Seeder and to know the knowledge level of the Happy Seeder adopter farmers along with socio-economic factors affecting knowledge level, a study was carried out with following objectives:

- To know the knowledge level of the Happy Seeder adopter farmers.
- To delineate the socio-economic factors associated with knowledge level.

## **Methodology**

The study was carried out in Fatehabad district of Haryana state. From this district, three blocks namely Bhuna, Ratia and Fatehabad were selected purposively as maximum no. of farmers had

adopted Happy Seeder farm technology in that area. Four villages from Bhuna block, three villages from Ratia block and two villages from Fatehabad block were undertaken. On the whole, a total of 80 Happy Seeder adopter farmers were interacted with the help of well-structured interview schedule. Data were analyzed and tabulated to draw the inferences as per objectives of the study.

### **Contextual matrix of the respondents**

Results revealed that 41.25% of the respondents hailed from 35-50 years of age group. Rest 31.25% and 27.50% respondents were above 50 years of age and up to 35 years respectively.

It was found that almost 2/3<sup>rd</sup> of the respondents (63.75%) belonged to General castes and 20.00% respondents belonged to backward classes, while 16.25% respondents hailed from scheduled castes. Regarding level of education of the respondents data revealed that 29.38% of the respondents were educated up to secondary and senior secondary level, while rest of the respondents were educated up to middle level (27.50%), graduation and above (23.75%) and illiterate (19.37%). It was found that 37.50% of the respondent's families had nil subsidiary occupation, while 30.00% were in business and services and rest 32.50% were engaged in small scale enterprise.

Regarding land holding, maximum number of the respondents (41.25%) had marginal size of land holding i.e. up to 1 ha. followed by small size of land holding (26.85%) i.e. between 1-2 ha. Rest 16.87% and 15.00% had semi-medium and medium size of land holding respectively. Analysis depicted that more than half of the respondents (57.50%) belonged to nuclear family. On the other hand, 42.50% of the respondents were from joint families. It was found that near one-fourth (26.87%) of the respondents had family income > 300000 Rs per annum, while 40.63% of the respondents had annual family income between Rs.1,50,000 to Rs.3,00,000 and rest 32.50% had between Rs 750000-150000 per annum. More than half of the respondents (51.25%) had no social participation, while 35.00% had medium and 13.75% had low level of social participation. Analysis clearly revealed that maximum number of the respondents (48.75%) had medium level of exposure to mass-media followed by low (26.25%) and high (25.00%) level of exposure to mass media. More than half (51.25%) of the respondents had medium level of socio-economic status. Rest 26.25% and 22.50% respondents had low and high level of socio-economic status, respectively.

### **Knowledge Level of the respondents**

Analysis of data (Fig.1) clearly revealed that maximum number of the respondents (42.50%) had medium level of knowledge regarding Happy Seeder. Rest 40.00% and 17.50% respondents had high and low level of knowledge respectively regarding Happy Seeder technology.

Table 1. Knowledge level of respondents regarding Happy Seeder Adopters (n=80)

S. No.	Knowledge level	Frequency	Percentage
1.	Low	14	17.50
2.	Medium	34	42.50
3.	High	32	40.00

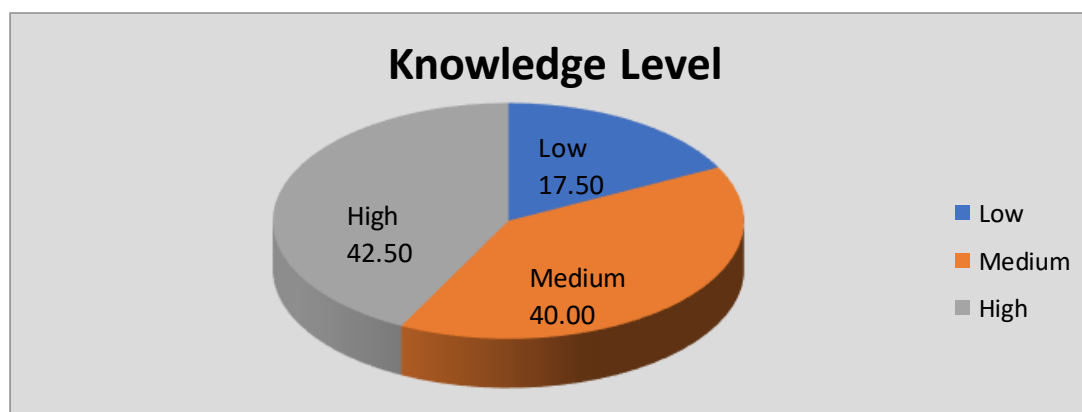


Fig. 1. Knowledge Level of the respondents

### **Knowledge statements regarding Happy Seeder**

Data on knowledge aspects before operation revealed (Table 2) that overwhelming majority of the farmers had knowledge about uniformly distribution of loose residues across the field (85.00%). More than 3/4<sup>th</sup> of the respondents had fully knowledge regarding laser leveling (75.00%) and operation of Happy Seeder after sufficient evaporation of moisture from residues (77.50%). While 30.00% and 56.25% respondents had no knowledge of optimal soil moisture content and about the height of cutter bar of combine harvester respectively. Near about 2/3<sup>rd</sup> of the respondents had no knowledge about choking of machine; condition of the seeder and



adjustments of machine and about proper row spacing and seed quantity i.e., 62.50% and 57.5% respectively.

Data on knowledge during the operation showed that more than half of the respondents had fully knowledge about use of double clutch tractor to operate the machine (55.00%). While maximum number of the respondents had no knowledge about adjustment as top link of the machine (48.75%) use of recommended seed and fertilizer rate to calibrating the planter, (43.75%) raising of Happy Seeder, while turning on headland (56.25%) and engaging the PTO gear of the tractor (62.50%). It was found that 56.25 percent of the respondents had fully knowledge about the cleaning and washing of all the parts of machine properly after the operation and 55.00% had partial knowledge of the same. The results of the evaluation suggested that the Happy Seeder technology is more profitable than conventional cultivation or direct drilling after burning and it is viable for farmers from a financial perspective (Singh et. al., 2008).

Table 2. Knowledge Statements regarding Happy Seeder (n=80)

Sl. No.	Knowledge Aspects before operation	Fully Knowledge (3)	Partial Knowledge (2)	No Knowledge (1)
1.	Uniformly distribute the loose residues over the anchored residues across the field so that the residues load becomes uniform across the field	68(85.00)	8(10.00)	4(5.00)
2.	Preferably the fields should be laser leveled for direct drilling of crops so as to ensure uniformity in soil moisture across the field.	60(75.00)	12(15.00)	8(10.00)
3.	During the early morning hours, the moist residues (due to dew and high surface soil moisture etc) tend to clog the planter. Therefore, Happy Seeder may be operated after sufficient evaporation of moisture from residues.	62(77.50)	10(12.50)	8(10.00)
4.	Optimal soil moisture content should be ensured at the time of sowing so as to have uniform crop establishment.	40(50.00)	16(20.00)	24(30.00)

5.	The height of cutter bar of combine harvester during harvesting of crops (rice for example) should be such that after harvesting 50% of total straw remain anchored and rest 50% as loose residues .	25(31.25)	10(12.50)	45(56.25)
6.	Check the condition of the seeder and make any adjustments or repairs necessary. In particular, the fasteners, blade bolts and welds before operating.	12 (15.00)	22(27.50)	46(57.50)
7.	Select the proper row spacing, seed quantity, and depth according to the field and crop. (For e.g., the optimum depth of seeding should be between 3.5 to 5.0 cm)	09(11.25)	21(26.25)	50(62.50)
<b>Knowledge aspects during the operation</b>				
1.	Use double clutch tractor to operate the machine in field. 60-65 hp tractors are sufficient to operate 9-to-12-time Happy Seeder.	44(55.00)	21(26.25)	15 (18.75)
2.	Adjust top link of the machine to keep machine straight while operating in field	11(13.75)	30(37.50)	39(48.75)
3.	Use recommended seed and fertilizer rate through calibrating the planter.	21(26.25)	24(30.00)	35(43.75)
4.	Raise Happy Seeder while turning on headland without disengaging PTO gear.	15(18.75)	20(25.00)	45(56.25)
5.	Ensure optimal depth of planting through adjustment of depth control wheels.	13(16.25)	20(25.00)	47(58.75)
6.	Engage the PTO gear of tractor, set the tractor engine to 1800-2000 RPM and operate the tractor in 1st low or 2nd low gear depending on the residues load in the field.	10(12.50)	20(25.00)	50(62.50)

	Statements after operation	Fully	Partial	No
		Knowledge (3)	Knowledge (2)	Knowledge (1)
1.	After the operation all parts of machine-like seed box, fertilizer box, metering mechanism, seed tubes, furrow openers, window drum, ground wheel etc should be cleaned and washed properly.	45(56.25)	25(31.25)	10(12.50)
2.	Planter should be stored properly.	15(18.75)	44(55.00)	21(26.25)

Figures in Parentheses indicate percentage.

### **Association between socio-economic variables and knowledge level of Happy Seeder adopters**

The factors associated with level of knowledge of the respondents are shown in Table (3). Age was found significantly associated with knowledge level. More than fifty percent of the respondents (55.56%) of middle age group had medium knowledge level, while in old age 38.89% had it high with chi-square value 12.61. Education was also found significantly associated with knowledge level; illiterate respondents (66.67%) had low level of knowledge, while respondents educated up to senior secondary (55.56%) and graduation & above had high level of knowledge followed by medium level of knowledge 57.77% and 34.62% respectively. Sizes of land holding and annual family income were found significantly associated. Respondents having income between Rs. 75000-150000 had low knowledge (50.00%), while families with income between Rs.1,50,000-3,00,000 had medium (62.20%) and above Rs.3,00,000 had high level of knowledge (77.80%). Mass media exposure and socio economic status were found significantly associated with knowledge level. Respondents with nil social participation had medium level of knowledge (37.50%), while with medium level social participation respondents had high level (57.89%) of knowledge. Respondents with high socio economic status had high level of knowledge (47.37%) and low economic status respondents had low (45.00%) level of knowledge. Caste was found non-significantly associated with knowledge level of the respondents. Kathpalia *et al.* 2020 found in a study conducted in rural areas of Kaithal district of Haryana state that education was found significantly associated with education

level; illiterate respondents (36.36%) had low level of knowledge while respondents educated up to senior secondary (41.17%) and graduation & above (50%) had medium level of knowledge followed by high level of knowledge 29.41% and 25% respectively. Size of land holding and annual family income was found significantly associated. The factors by which the rate of adoption of HST was affected included attributes of HST and extension activities conducted to disseminate the HST technology among the farmers. The attributes of the technology viz. Relative advantage, Compatibility, complexity, trialability and observability were studied. Other factors such as availability of happy seeder, availability of high-power tractor and extension activities attended by the farmers, were also studied (Singh *et al.* 2021).

Table 3. Association between socio-economic variables and knowledge level of happy seeder adopters (n= 80)

Socio-economic variables	Knowledge level			
	Low	Medium	High	Total
<b>Age</b>				
up to 35 yrs.	1(3.80)	8(30.80)	17(65.40)	26(32.50)
36-50 yrs.	8(22.22)	20(55.56)	8(22.22)	36(45.00)
above 50 yrs.	5(27.78)	6(33.33)	7(38.89)	18(22.50)
Total	<b>14(17.5)</b>	<b>34(42.5)</b>	<b>32(40.0)</b>	<b>80</b>
<b><math>\chi^2</math> Cal= 12.61*</b>				
<b>Caste</b>				
General Castes	3(5.00)	28(46.67)	29(48.33)	60(75.00)
Backward Class	6(50.00)	5(41.67)	1(8.33)	12(15.00)
Scheduled Castes	5(62.50)	1(12.50)	2(25.00)	8(10.00)
<b><math>\chi^2</math> Cal= 28.29</b>				
<b>Level of Education</b>				
Illiterate	8(66.67)	3(25.00)	1(8.33)	12(15.00)
Up to middle	3(20.00)	9(60.00)	3(20.00)	15(18.75)
Secondary and Senior secondary	1(3.70)	15(55.56)	11(40.74)	27(33.75)
Graduation and above	2(7.69)	7(26.92)	17(65.39)	26(32.50)
<b><math>\chi^2</math> Cal=31.04 *</b>				
<b>Size of land holdings</b>				

Marginal (up to 1 ha)	4(22.22)	7(38.89)	7(38.89)	18(22.50)
Small (1-2 ha)	3(14.29)	11(52.38)	7(33.33)	21(26.25)
Semi-medium (2-4 ha)	4(21.05)	7(36.84)	8(42.11)	19(23.75)
Medium (4-10 ha)	3(13.64)	9(40.91)	10(45.45)	22(27.50)
<b><math>\chi^2</math> Cal= 22.68*</b>				
<b>Annual family income</b>				
Between Rs.75,000 - 1,50,000/-	8(50.00)	7(43.75)	1(6.25)	16(20.00)
Between Rs.1,50,001 - 3,00,000/-	4(10.80)	23(62.20)	10(27.00)	37(46.25)
Above Rs. 3,00,000/-	2(7.40)	4(14.80)	21(77.80)	27(33.75)
<b><math>\chi^2</math> Cal= 36.86*</b>				
<b>Mass media exposure</b>				
Low (up to 9)	9(56.25)	4(25.00)	3(18.75)	16(20.00)
Medium (10-17)	3(7.30)	22(53.70)	16(39.00)	41(51.25)
High (above 17)	2(8.70)	8(34.80)	13(56.50)	23(28.75)
<b><math>\chi^2</math> Cal= 23.23*</b>				
<b>Social organization Participation</b>				
No membership	11(34.37)	12(37.50)	9 (28.13)	32(40.00)
Membership of one organization	1(3.45)	16(55.17)	12(41.38)	29(36.25)
More than one organization	2(10.53)	6(31.58)	11(57.89)	19(23.75)
<b>Membership</b>				
<b><math>\chi^2</math> Cal= 10.94*</b>				
<b>Socio-economic Status</b>				
Low (12-18)	9(45.00)	4(20.00)	7(35.00)	20(25.00)
Medium (19-24)	3(7.30)	22(53.70)	16(39.00)	41(51.25)
High (25-31)	2(10.52)	8(42.11)	9(47.37)	19(23.75)
<b><math>\chi^2</math> Cal= 15.57*</b>				

Figures in parentheses indicate percentage

\*Significant at 5% level of significance

## **Conclusions**

It is concluded that most maximum number of the respondents (42.50%) had medium level of knowledge regarding Happy Seeder farm technology. Rest 40.00% and 17.50% respondents had high and low level of knowledge respectively concerning Happy Seeder. Happy seeder is the most efficient method to reduce the cost of production and manages the combine harvested paddy straw and ultimately improves the soil productivity. Therefore, it's advisable to undertake the Happy Seeder for sowing wheat in the combine harvested fields for in-situ management of paddy straw and also for better profit.

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<b>Ginger cultivation in Mizoram: Status, constraints, sustainable approaches and prospects</b>	<b>Chapter</b> 5
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## **ABSTRACT**

Ginger is an important cash crop of India including Mizoram. It plays a vital role in the livelihood security and income of Mizo farmers. The high suitability of agro-climatic conditions for ginger cultivation in Mizoram is attributed to their special characteristics like aroma, pungency, less crude fibre, distinctive taste and high gingerol content. However, there are certain constraints such as traditional Jhum farming, unavailability of quality planting materials, high production cost, lack of proper marketing channel, post-harvest losses etc., that result in lower production. Though, scientific interventions like providing need base farmers training of good agricultural practices for ginger cultivation; timely availability of high yielding quality planting material like Bold Nadia and Bhaise; soil solarization and pre-planting rhizome treatment; crop rotation and adoption of intercropping with other crops; timely pests and diseases management etc., would result in doubling the production of ginger as compared to production under

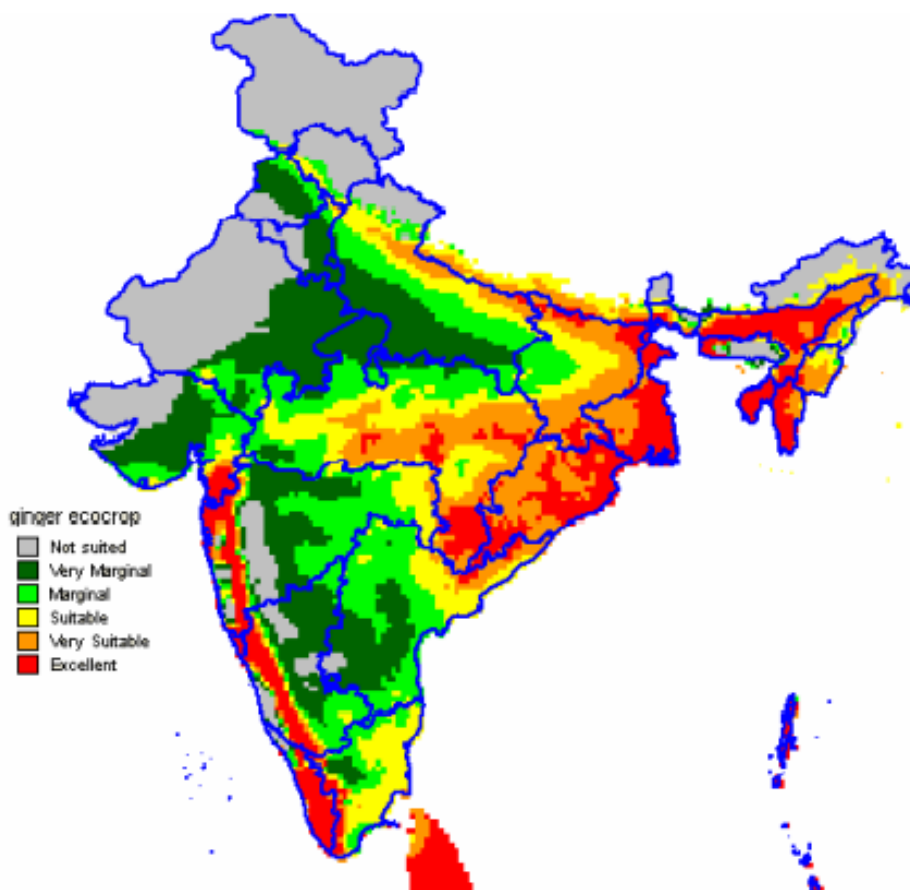
conventional methods. At the same time, Mizoram received GI tag for “Mizo Ginger” has been attracting the attention and interest of buyers globally. Therefore, there is an urgent need to focus on its production through government support with scientific backup, so that farmers can improve its production and productivity.

**Keywords:** Ginger, Mizoram, agro-climatic, quality and GI

## **Introduction**

The terrain of Mizoram is bestowed with a suitable climate for growing wide varieties of vegetables and a large variety of spices such as chilli, ginger, turmeric, tejpat, cinnamon, coriander, fennel, ajwain, dill, fenugreek and garlic. Among different spices, ginger (*Zingiber officinale*), family Zingiberaceae; is the major cash crop being cultivated especially in jhum lands supporting the livelihood and income of many ginger growers of the state. The use of geographic information system (GIS) to assess land suitability for ginger cultivation identified four states in India such as Mizoram, West Bengal, Orissa and Kerala as most suitable for its cultivation (Parthasarathy *et al.*, 2008). The whole state of Mizoram has excellent suitability for ginger (Fig 1; Utpala *et al.*, 2006) and is known for growing ginger with its low fibre content. Apart from fibre, some special characteristics like aroma, pungency, high gingerol content and distinctive taste have been reported in ginger grown in Mizoram. These unique and special characteristics of indigenous gingers are attributed to the agro-climatic conditions prevailing in Mizoram. High oleoresin and higher oil recovery were obtained from ginger cultivated in higher elevation (Ngachan and Deka, 2008). The higher oil recovery (1.6-2.5 per cent versus 1.5-2.0 per cent) and oleoresin content (5.9-8.56 per cent versus 5-8 per cent) have been recorded in Mizoram ginger as compared to other parts of India (Spice Board, 2007).





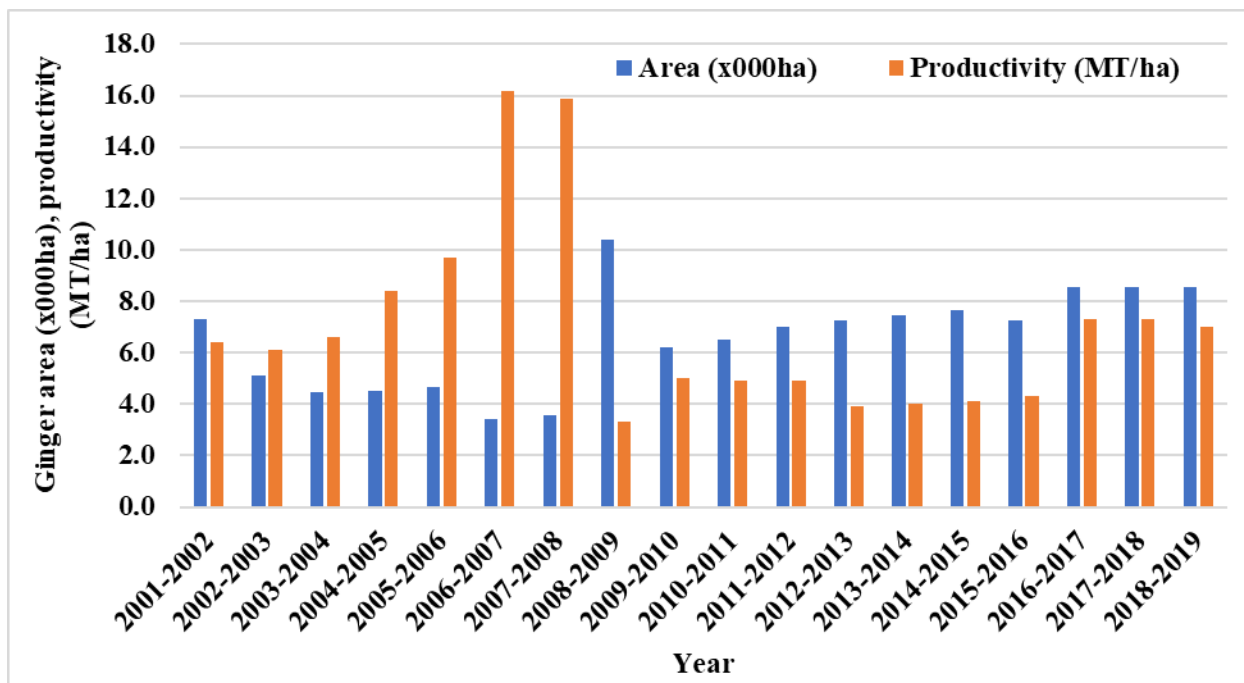
**Fig. 1.** Ginger site suitability map for India (Utpala *et al*, 2006)

Ginger requires a warm, humid climate with heavy rainfall of 1500-3000 mm per year or plenty of irrigation for its cultivation. It may be cultivated at altitudes ranging up to 1500 metres from above sea level. It grows well in clay loam or sandy loam soil with adequate humus content and good drainage. Partially shaded fields are ideal for ginger. It is an excellent crop for intercropping. The planting season in Mizoram starts after the celebration of ‘Chapchar Kut’ festival during April-May month that coincides with onset of monsoon. The best time for planting ginger is the first fortnight of April. The stored seed rhizomes for planting should be sorted with large, shiny; disease-free, spots, marks, bud or eye injury should be selected for planting. The seed rhizomes can be planted as a whole or cut the rhizome into pieces bearing 2-4 sprouts per cutting. Harvesting of rhizomes is done from the 6<sup>th</sup> month onwards after sowing for green ginger and 8<sup>th</sup> – 9<sup>th</sup> month for dry ginger when the leaves turn yellow and gradually dry up. The rhizomes harvested can be eaten as raw or in processed form. It can be used as spice and

medicine for over many years. It exhibits some promising health benefits and medicinal properties. It has been used to treat various problems like vomiting, cold symptoms, pain, etc. It has been shown to have anti-inflammatory, anti-tumor, anti-apoptotic, anti-pyretic, anti-tumourigenic, anti-platelet, anti-hyperglycaemic, anti-diabetic, anti-clotting, antioxidant, cardiogenic, cytotoxic and analgesic properties (Shahrajabian *et al.*, 2019).

### **Status of ginger in India and Mizoram**

Ginger occupies an area of 0.17 million hectares in India with a production of 1.84 million tonnes having productivity of 10.72 t/ha (FAOSTAT, 2020). The state of Assam is leading in ginger production followed by Maharashtra and West Bengal while Mizoram stood 7<sup>th</sup> position in ginger production (NHB, 2017-2018). The productivity of ginger in Mizoram (2018-19) is 7.03 MT/ha which is one of the highest in India (Economic Survey, 2019-2020). The trend in production of ginger in Mizoram for eighteen years is shown in Fig 2. The indigenous ginger cultivars such as Thinglaidum, Thingpuidum, Thingaria, Thingpui and Jugijan were reported to dominate the ginger cultivars of the state (Rahman *et al.*, 2008). ‘Thinglaidum’ dominates in area having small in size, extremely pungent, less fibre with blackish ring and mainly used in the processing of dried ginger which has varied industrial uses. ‘Thingpui’ cultivar occupied second in an area having bold, light-yellow rhizome with less pungency that is used for table and domestic purposes. Mizoram got the geographical indication (GI) tag for these two ginger cultivars, collectively called “Mizo Ginger” (Fig 3). The interest among farmers for ginger cultivation grows as climate, soil and other ecological factors favour quality production of ginger. In Mizoram, there is a good scope to improve the yield per unit area and hence the overall production of ginger. Farmers produce black ginger, a variety of ginger with bluish-black rhizomes, for both commercial and self-consumption, and it receives a premium price in the market for its therapeutic and medicinal properties.



Source: Economic Survey (2019-2020)

Fig. 2. The trend in area and productivity of ginger in Mizoram (2001-2019)

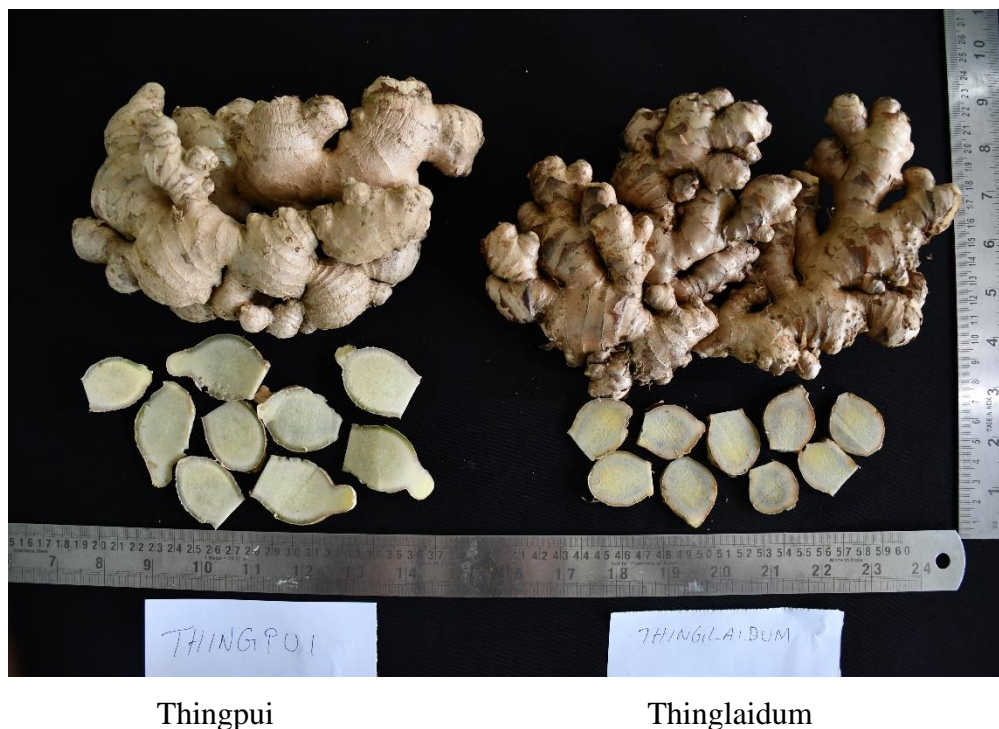


Fig. 3. Thingpui and Thinglaidum ginger cultivars collectively called “Mizo Ginger”

### **Constraints in ginger cultivation**

**Traditional Jhum Farming:** Despite the fact that ginger output in Mizoram has improved, there is always room for increasing productivity. The practice of growing ginger on steep slopes under jhum cultivation in rainfed conditions without following proper agronomic package for its cultivation leads to reduction in yield. In the first and second years of cultivation, virgin soils under the jhum method provide greater yields, however, after a gap of 3-5 years, low ginger yield (5-8 t/ha) was obtained (Jha and Deka, 2012). Earlier, due to low population pressure, jhum lands got sufficient time (10-15 years) for regeneration of forests, however, the cycle of cultivation has shortened (3-5 years) due to population pressure (Yadav *et al.*, 2004). The regeneration of biomass in jhum land takes time and is insufficient for good cropping thus reducing yield of the crop.

**Land tenure system:** In Mizoram, the land is owned by the community and not individuals. The village council president leases a particular hill to a family for cultivation for 3-5 years. As a result, farmers could not undertake adequate management practices resulting in lower production.

**Quality planting material:** Non-availability of quality planting material concurrence with serious seed-borne diseases has attributed to low productivity. Some serious seed-borne diseases are soft rot (*Pythium sp.*, *Rhizoctonia sp.* and *Sclerotium rolfsii*), bacterial wilt (*Ralstonia solanacearum*) and dry rot (*Fusarium oxysporum*). Rhizome rot incited by *Pythium aphanidermatum* is highly destructive in all the ginger-growing areas of Mizoram (Singh *et al.*, 2018). Ginger stem borer (*Dichochrosis punctiferalis*) and shoot borer weevil (*Prodiotes halmaticus*) cause crop damage between 30-40 percent during July-September (Jha and Deka, 2012).

**Fertilizer availability:** The use of chemical fertilizers is very less among the farmers as they are unable to purchase the fertilizer either due to unavailability in village markets, limited availability in cities, and its high costs. The total consumption of fertilizer in terms of nutrients (NPK) is 31.97 kg/ha in Mizoram which is far below the national average of 133.44 kg/ha (Anonymous, 2020).

**Resource-poor farmer:** Most of the farmers are small and marginal with smaller landholdings that make them unable to grow ginger on a commercial scale. Moreover, lack of storage facilities on-farm results in loss of harvested produce. Non-existence of a proper marketing channel force

the hardworking farmers to sell their produce at throw-away prices. Besides, lack of awareness on post-harvest technologies among farmers and skilled trainers leads to lower-income. The absence of an adequate number of post-harvest processing units to absorb marketable surplus (which is nearly 70 per cent) forces the cultivators to sell the produce as fresh only (Jha and Deka, 2012). During handling and transport, the post-harvest loss of ginger in the North-eastern region is estimated to be around 10.5 per cent (Deka *et. al.*, 2004).

**Financial support:** The lack of financial aid for the cultivation of ginger from the government to purchase quality seeds and other inputs is also a concern for farmers. As cultivation of ginger requires lots of planting material (1.5-2.0 t/ha) with a large capital requirement, many poor farmers do not afford it. At the same time, they are afraid to take risks to invest in the crop due to an unorganized market.

#### **Sustainable approaches for ginger cultivation in Mizoram**

- The right to land ownership should be given to farmers to stop jhum cultivation and judicious management of land. This will help in the transformation of Jhum land to a settled form of cultivation in the form of terraces (Fig 4).



Jhum land



Permanent terrace land

Fig. 4. Transforming Jhum land to permanent terrace land

- The availability of high-yielding quality planting material, free from diseases and pests will contribute to enhancing the productivity of ginger. In Mizoram, apart from local cultivars, research at ICAR Kolasib found that Bold Nadia is performing best with a yield of 12-15 t/ha. Apart from this, some other varieties are Bhaise, PGS 121, PGS 95, PGS 102 and Gurubathani are suitable varieties for this region.



- There is a need for the establishment of seed agencies to supply certified seed rhizome in Mizoram.
- Soil solarization is very effective for the control of rhizome rot under organic cultivation. This was done by using a transparent polythene sheet of 100-micron thickness to cover the irrigated soil immediately by burying the edges of the polythene in the soil. Solarization should be conducted for six weeks (April to May) when the temperature increases by approximately 4-10°C which is enough to kill the soil pathogens, insects and weed seeds (Fig 5).



Fig. 5. Soil solarization under terrace farming to control soil-borne ginger diseases

- Crop rotation is an important practice to break reproduction cycles of pathogens and insects. It also improves the physical condition of the soil that ultimately helps in the growth and development of the crop. In the North-eastern region, ginger is mainly rotated with french bean or soybeans, which also give additional income to the farmers. The cycle of rotation varied for 2-4 years and crops such as mustard, potato and paddy are also used in rotation. Apart from crop rotation, cultivation of ginger under intercropping system results in a synergistic effect leading to increased productivity, higher yield per unit area per unit time as compared to sole cultivation. The finding shows that ginger performed better under an intercropping system with taro, legumes crops, sweet corn, papaya, banana etc. (Fig 6).



Fig. 6. Compatible ginger base intercropping system

- Integrated disease management of rhizome rot using hot water treatment, bio-fungicide and chemical has been found effective. Hot water treatment at 47 °C for 30 min, soil application of bio-fungicide (*Trichoderma harzianum* at 2.5 kg/50 kg FYM/ha) followed by three time drenching of copper oxychloride (0.3 per cent) in combination was found most effective in limiting the incidence of soft rot (19.29 per cent) on ginger besides having their significant response in improving the growth and yield (41.90 q/ha) (Singh *et al.*, 2018). Bio-organic/botanical extracts proved to be effective for control of rhizome rot of ginger. *Trichoderma harzianum*, *T. viride*, *Metarhizium anisopliae*, *Azadirachta indica* and *Agave Americana* were found to be promising in reducing mycelial growth of *Pythium aphanidermatum*, the main causal organism of ginger rhizome rot (Sharma, 1998; Hossain *et al.*, 2021). Soaking of ginger rhizomes in *Boerhaavia diffusa* root extract (10 per cent) overnight and 3 foliar sprays of the same at weekly intervals starting just after apparent symptom was found quite effective in the management of the disease (Pandey *et al.*, 2010). Extracts of *Polyalthia longifolia*, *Parmotrema tinctorum*, *Flavoparmelia caperata*, *Jacaranda mimosifolia*, *Moringa olifera*, and *Terminalia arjuna* were also found to be effective in controlling the disease (Dileep *et al.*, 2013; Praveen

and Sharma, 2014; Shivanna and Garampalli, 2015). Cow urine extract of *Elaeagnus kologa* caused high inhibition of *Pythium aphanidermatum* (Rakesh *et al.*, 2013).

- For effective control of shoot borer in ginger, application of chlorantraniliprole + spinosad @ 0.5 ml/L (alternatively) at fortnightly intervals was found very effective that resulted in good ginger growth, higher yield attributes and ultimately higher fresh rhizome yield (18.0 t/ha).
- Farmers / Farmers Association / NGOs / Field labourers should be trained to develop technical skills in farm management and agronomic practices of ginger cultivation. Training in processed products and marketing is also important for strengthening the income of farmers and reducing wastage. Marketing of Ginger produced in the state is taken up in collaboration with Mizoram Agriculture Marketing Solution (MAMSoL) and Mizoram Farmers' Society (MIFAS). Ginger produced by farmers are purchased and sold through these Agencies with interest free loan provided from Ginger Marketing Scheme.
- The establishment of processing units in the region is needed to absorb the market surplus and produce value-added products that have longer shelf life.
- The harvest of mother rhizome in off-season fetch higher price in market thus providing supplemental income to farmers. The traditional practice of mother rhizome removal called '*mau* extraction'. In this practice, higher seed rate (2-2.5 t/ha) against normal rate (1.5 t/ha) is required and planted in the month of March-April. By the end of May or June, *i.e.* when ginger crop gives 3-4 leaves or attains 60 days age, the mother rhizomes are removed, leaving the sprouted piece of rhizome in the soil and well-decomposed farmyard manure is applied after 15 days of *mau* extraction (Rahman *et al.*, 2009).
- Quality ginger production following GAP (Good Agricultural Practices) should be followed to boost sale of ginger inside and outside of Mizoram. Organic ginger fetches high prices in market and international trade. More focus on organic production of ginger and proper marketing channel can boost the economy of the state.

### **Prospects of ginger cultivation**

The northeastern region is the ginger hub of India as the climate and the land composition for the cultivation of ginger are most favourable in this region. Quality ginger produced in Mizoram can be processed to get quality products such as dry ginger, ginger oil, oleoresin, ginger powder etc. Adoption of scientific methods of cultivation like use high yielding varieties like Bold Nadia,



Bhaise etc. with proper soil solarization, pest and disease management and adoption of proper crop rotation can improve crop yield and ultimately farmers' income. Other technologies for value-addition like encapsulated ginger, preserved ginger, crystallized ginger, salted ginger, etc. can be adopted to improve income and avoid post-harvest losses. The establishment of processing industries and adequate training for skill enhancement are also very necessary for the grower to make them efficient, and to compete with the global market. The role of government is also very necessary in terms of financial support to expand the production and market. The storage facility is another vital component for the preservation of fresh ginger. Low cost of production technologies through the use of farm mechanization, use of bioagents and biofertilizers along with *in situ* compost, vermicompost and manure production unit is crucial to achieving cheaper production cost of ginger. The rich diversity of ginger germplasms that are available in the state needs to be conserved and register to get GI for better marketing and export while preventing unauthorized use of registered GI.

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<b>An empirical study on consumer practice and usage of plastic bags</b>	<b>Chapter</b> 6
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#### **ABSTRACT**

A plastic material is any of a wide range of synthetic or semi-synthetic organic solids that are flexible. Plastics are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, but many are partially natural. Plastics are inexpensive, lightweight, strong, durable, corrosion-resistant materials, with high thermal and electrical insulation properties. The study was executed to know the current practices of plastic bags and usage among the housewives of urban areas of Dharwad city. The sample of 200 households were selected for data collection on usage and practices of plastic bags through questionnaire. Results of the study indicated that majority of the respondents are having graduation and PUC level of education and belongs to 30-55 years of age. Cent percent of the respondents using plastic container for storage and purchase of material. Plastic bags are available free of cost and low price are the reasons for usage. The respondents are followed good practice for usage of plastic bags. Now a day's most of the respondents are facing problems while marketing are non-availability of plastic bags due to plastic ban effect in India. They opined that paper bags are available to carry the purchased materials while shopping and said that paper bags are costlier than plastic bags.

**Key words:** Plastic bags, Practice, Usage, Type of material

## **Introduction**

Plastic bags are considered as one of the most extensively used shopping bags all over the world. Each year, an estimated 500 billion to one trillion bags are consumed worldwide. Plastic bags were first introduced in 1977's in America (Williamson, 2003) and gained an increasing popularity amongst consumers and retailers. It is because of their lightweight, easy availability, sturdiness and low-price. Until today most of the consumers use it regularly and wastefully as they get it free from the retail outlets (Ruban, 2012). There are two types of plastic bags used in the retail sector they are high-density polyethylene (HDPE) and low-density polyethylene (LDPE). The HDPE are thin, light and usually non-branded. They are commonly used for packing products of higher quality products.

Used plastic carry bags are virtually found everywhere including in the streets, along the roads and pathways, dumpsites, drainages, ditches, open fields, roof tops, hanging from trees and overhead cables, floating on ponds, among others. This poses a threat to the quality of the environment. Improper disposal causes soil degradation and suffocate livestock or block their digestive tract when mistakenly eaten leading to death because they are impermeable to water. The life span of a plastic bag is anywhere from 15 to 1,000 years to be broken down and reintroduced into the environment and they began to litter beaches, parks, and even our oceans. The Environment impacts of plastic bags are devastating. About 1 percent of all trash in landfills is from plastics bags. Plastic bag does not biodegrade and it is expensive to recycle. (Jones 2008 and Jackson 2009.)

Considering the hazardous effects associated with production and use of polythene, In January 2002, the Government declared a ban on the production and use of polythene carrier bags of less than 30 microns with effect from September 2007 (Xie *et al*, 2006). The objectives of the study were, therefore, to determine households' awareness regarding ban and management of plastic bags. Hence, the present investigation was therefore, initiated to study the awareness regarding ban on plastic and management practices among homemakers of Dharwad city.

## **Material and Methods**

The study was conducted during the year 2015-18 in Dharwad city of Dharwad district, Karnataka state. The sample of 200 households from five areas of Dharwad city were selected randomly to know the current practices of plastic bags and usage among the housewives of urban areas of Dharwad city. The self-structured questionnaire was used as a research tool to collect the

required information regarding demographic characteristics of the households, current practices and usage pattern of plastic bags in households of Dharwad city. Data was coded, categorised, tabulated by using descriptive statistics (Frequencies, and Percentages) to assess households' awareness on the ban on plastic.

### **Result and Discussion**

The perusal data at Table 1 indicates demographic profile of the selected respondents like age, education, size of family, occupation of head of the family and annual income of the family. The age of the respondents was grouped into three categories less than 30 years (younger) and 30-55 years (middle) and above 55 years (old). Higher percentage (63.50%) of the respondents ranged between 30-55 years while 24 per cent of the samples were in the age group of more than 55 years and remaining 12.50 per cent in the age group of less than 30 years.

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Regarding education, majority of the respondents were graduates (31.50%) followed by 24 per cent of the respondents completed pre-university education. While 19.50 per cent of the respondents were completed SSLC. Majority (62.00%) of the selected families belongs to medium family size of 3-6 members followed by 36.50 per cent belongs to large family having more than 6 members and remaining 1.50 percent belongs to small family size having less than three members.

Eighty-nine per cent of the spouses of the respondents were self-employed followed by service in government/state government servants (6.00%). Only five percent of the respondent's was working in private sector.

Annual income of the family is an important factor influencing the standard of living. According to the findings 53.50 per cent of the selected families fall in low income (less than Rs.2, 57,484/-) group followed by 34.00 percent in high income (more than Rs. Rs. 3, 93,876/-) group. Only 12.50 per cent were in medium income (Rs. 2, 57,484 - Rs. 3, 93,876) group. In a study conducted by Synthia and Kabir (2014) reported that, the majority (35.00%) of the respondents was homemakers belongs to the age group of 41-50 years and had a education up to undergraduate level. They have household income of less than Rs.80,000 per month.

Table 1. Demographic profile of the selected respondents (N=200)

Sl.No.	Particulars	Categories	Frequency	Percentage
1	Age	Younger age (Less than 30)	25	12.50
		Middle age (30-55)	127	63.50
		Old age (More than 55)	48	24.00
2	Education	Profession	4	2.00
		Post-graduation	13	6.50
		Graduation	63	31.50
		PUC	48	24.00
		SSLC	39	19.50
		High school pass but not 10th class pass	33	16.50
3	Family Size	Small (Less than 3)	3	1.50
		Medium (3-6)	124	62.00
		Large (More than 6)	73	36.50
4	Occupation of head of the family	Service in central/state Govt	12	6.00
		Service in private sector	10	5.00
		Self-employed (eg, shops, Rehdies or petty business)	178	89.00
5	Annual income	High income (More than Rs. 3,93,876)	68	34.00
		Middle income (Rs. 2,57,485-3,93,875)	25	12.50
		Low income (Less than Rs. 2,57,484)	107	53.50

Usage pattern of packaging materials after consuming the product by the respondents were depicted in Table 2. The usage of packaging material for the products consists of paper and paper products, glass bottles, *met als* and plastics.

From the Table 2 it was found that, majority (85%) of the respondents sell their paper and paper products followed by reuse by nine per cent and dispose (6.00%). With regard to usage of glass

bottle, majority (44%) of the respondents are reuse followed by dispose (47.50%) and 8.50 per cent of respondents sell the bottles to the door-to-door collector. More than 50 per cent of the respondents dispose the packaging *met als* followed by reuse (28%) and sell to the door-to-door collector (10.50%). About 71 per cent of the respondents reuse the plastic packaging followed by selling (22%) and dispose (7%).

Majority (85%) of the respondents sells paper and paper products while 44.00 per cent of the respondents reuse glass bottles. About 71 per cent of the respondents reuse the plastic packaging followed by selling (22%) and disposing (7%). These results are supported by Negussie and Mustefa (2017) found that, 40.00 per cent of the residents used plastic bottles among the plastic products. About 35.80 per cent and 30.10 per cent of residents believed that lack of alternatives and low cost are the reasons to prefer usage of plastic packaging.

Table 2. Usage pattern of packaging materials after consuming the product (N=200)

Sl. No	Packaging material	Reuse		
		Reuse	Recycle/sale	Dispose
1	Paper and paper products (Newspaper, Magazine, papers, JunkMail/ Brochures, Corrugated box)	18.00 (9.00)	170.00 (85.00)	12.00 (6.00)
2	Glass bottles (jam &jelly, pickles, amul milk, oil bottles <i>etc.</i> )	88.00 (44.00)	17.00 (8.50)	95.00 (47.50)
3	<i>Met als</i> (Tin & Aluminium can & box, Tin cans)	56.00 (28.00)	21.00 (10.50)	123.00 (61.50)
4	Plastics (Water Bottles, soft drinks bottles, Containers & boxes, Bags)	142.00 (71.00)	44.00 (22.00)	14.00 (7.00)

(Note : Figures in parentheses indicate percentage)

Table 3 discloses the type of packaging materials generally used in the households as expressed by selected respondents. It can be observed that, cent per cent of households were used plastic bottles, bags/sacks, and container followed by cotton bags (96%) and paper bags about 88 per cent. More than 50 per cent were used cardboard box (60.50%), glass bottles (60.50), and tins and cans by 76 per cent. Regarding available packaging material in the households, it was found that cent per cent of households are used bottles, bags/sacks, and container made up of plastic

material. It is because of plastics are used in an enormous and expanding range of products and 42 per cent of India's consumption was used in packaging due to their relatively low cost, ease of manufacture, versatility and imperviousness to water reported by Vigneshwaran and Arunkumar (2010).

Table 3. Types of packaging materials generally used by the consumer in the household storage (N=200)

Sl. No.	Packaging materials	In the households	
		Frequency	Percentage
1	Paper bags	176	88.00
2	Plastic wrapper and film	67	33.50
3	Foil/Foil paper	46	23.00
4	Plastics bottles	200	100.00
5	Tins and Cans	152	76.00
6	Glass bottles and jars	121	60.50
7	Gunny bag/sacks	58	29.00
8	Plastic bags and sacks	200	100.00
9	Card board box	121	60.50
9	Cartons boxes (Milk, juice)	58	29.00
10	Cardboard box with plastic film and laminated	15	7.50
11	Plastic containers	200	100.00
12	Cotton bags	192	96.00

(Note: Multiple reposes possible)

Re-use of plastic bags by the respondents was indicated in Table 4. It is clearly indicated that, more than 40 per cent of the respondents always used to carry things/materials (52.00%) followed by used for shopping (41.50%) and to storage of materials at home (41.00%). About 37.50 per cent of the respondents were always used plastic bags for waste collection followed by 36 per cent of the respondents using plastic bags as bin liner in kitchen and bathroom and 33.50 per cent used for disposing of trash. Always plastic bags were used for packed lunches (21.50) and as a dishwashing scrub by 14 per cent. Sharma and Kanwar, (2007) revealed that, the use of



the alternative shopping bags faces some challenges regarding materials, especially the paper bags are not waterproof and tear easily. The others are bulk and therefore not convenient to carry. For instance, it might be difficult for one to carry a basket to the workplace, for shopping on their way back home etc.

Some times more than 50 per cent of the respondents using plastic bag to store food in freezer (73.50) followed by used for shopping (57.50%), used for dusting and cleaning (58%) and used for waste collection (54.50%). Forty-eight per cent of the respondents said that, sometimes-plastic bags has been used for carry things or materials followed by used for disposing trash (46%), and to store the things at home (45.50%).

Sixty-four percentage of respondents never using plastic bags as dishwashing scrub followed by for packed lunches (48.50%). More than 20.00 per cent of the respondents never used plastic bags as a bin liner in kitchen and bath –room. About 25.50 per cent never used for dust cleaning and disposing of trash (20.50%). Less percentage of respondents never used plastic bags for storage of things at home(13.50%) followed by storage of food in the freezer (8.00%), never used for shopping (3.00%) and never used for waste collection (8.00%).

Table 4. Re-use of plastic bags by the respondents (N=200)

Practices followed	Usage of plastic bag		
	Always	Sometimes	Never
Storage of food in freezer	37 (18.50)	147 (73.50)	16 (8.00)
Used for shopping	83 (41.50)	115 (57.50)	6 (3.00)
To carrying things/ materials	104 (52.00)	96 (48.00)	0 (0.00)
As a dishwashing scrub	28 (14.00)	45 (22.50)	127 (63.50)
For dusting and cleaning	33 (16.50)	116 (58.00)	51 (25.50)
Used for waste collection	75 (37.50)	109 (54.50)	16 (8.00)
As a bin liner in kitchen, and bathroom	72 (36.00)	65 (32.50)	63 (31.50)
To store things at home	82 (41.00)	91 (45.50)	27 (13.50)
Used for packed lunches	43 (21.50)	60 (30.00)	97 (48.50)
Used for disposing trash	67 (33.50)	92 (46.00)	41 (20.50)

The study carried out by the UK's WRAP (2005) reported that, several different reuses that consumers give to plastic bags are described, such as bin liners, for pet's excrements, garden refuse, reuse for supermarket or other shopping, to store things at home, for packed lunches, to carry other things at home, and to keep bottles and cans in for recycling among others. In such study the most common use among the respondents was as a bin liner in kitchen (53%)

Usage practices of plastic bags by the respondents were categorized into three groups based on the usage practice score and percentage distribution of respondents were presented in Table 5. From this table it was found that 55.50 percent of the respondents are fall under very good practices of plastic bag usage followed by good practice (37.00 %) and fair practice of plastic bag usage was 7.50 per cent.

An examination of Table 5 illustrates the association between the demographic variables on usage practices of plastic bags. In case of age majority of them belonged to very good practice (52.90%) followed by 41.20 per cent had good practice and only 5.90 per cent had fair practice of usage of plastic bags in the age category of less than 30 years. Where as in the age group of 30-55years the trend was the same followed in the age group of more than 55 years. Over all 55.00 per cent of the respondents had very good practice of plastic bag usage followed by good (37.00%), and fair (7.50%) plastic usage. There was significant association was found between the age and usage of plastic bags.

In case of education majority of them belonged to very good practice (59.25%) followed by 33.33 per cent had good practice and only 7.40 per cent had fair practice of usage of plastic bags in the post-graduation category. Where as in the graduation category the trend was the same followed in the PUC, graduation and SSLC. Overall, 55.50 per cent of the respondents had very good practice of plastic bag usage followed by good practice (37.00%), and fair (7.50%) plastic usage. There was significant association was found between the education and usage of plastic bags.

In the category of occupation maximum percentage of respondents belonged to very good practice (66.70%) followed by 25.00 per cent had good practice and only 8.30 per cent had fair practice of usage of plastic bags was observed with respondents working in central/state gov't/ category. Whereas the respondents working in private sector category the trend was the same followed in the self- employed. Over all 55.50 per cent of the respondents had very good

practice of plastic bag usage followed by good (37.00%), and fair (7.50%) plastic usage. There was significant association was found between the occupation and usage of plastic bags.

In the case of socioeconomic status maximum percentage of respondents belonged to very good practice (62.10%) followed by 34.50 per cent had good practice and only 3.40 per cent had fair practice of usage of plastic bags was observed with high socio-economic status. category. Whereas the respondents in upper middle socio-economic the trend was the same followed in the poor middle class of socio-economic status. Overall 55.50 per cent of the respondents had very good practice of plastic bag usage followed by good (37.00%), and fair (7.50%) plastic usage. There was significant association was found between the occupation and usage of plastic bags.

Table 5. Association between the demographic variables on usage practices of plastic bags (N= 200)

Variables	Category	Practice			Modified $\chi^2$
		Fair	Good	Very Good	
Age	<30	1 (5.90)	7 (41.20)	9 (52.90)	2.72*
	30-55	12 (9.0)	52 (39.10)	69 (51.90)	
	>55	2 (4.00)	15 (30.00)	33 (66.00)	
	<b>Total</b>	15 (7.50)	74 (37.00)	111 (55.50)	
Education	Post-graduation	2 (7.40)	9 (33.33)	16 (59.25)	9.21*
	Graduation	3 (4.54)	25 (37.87)	38 (57.57)	
	PUC	5 (8.77)	25 (43.85)	27 (47.36)	
	SSLC	5 (10.00)	15 (30.00)	30 (60.00)	
	<b>Total</b>	15 (7.50)	74 (37.00)	111 (55.50)	
Occupation	Service in central/state Govt	1 (8.30)	3 (25.00)	8 (66.70)	2.07*
	Service in private sector	0 (0.00)	5 (50.00)	5 (50.00)	
	Self employed	14 (7.90)	66 (37.10)	98 (55.10)	
	<b>Total</b>	15 (7.50)	74 (37.00)	111 (55.50)	
SES	High	1 (3.40)	10 (34.50)	18 (62.10)	3.51*

Upper middle	12 (8.30)	56 (38.60)	77 (53.10)
Poor middle	2 (7.70)	8 (30.80)	16 (61.50)
<b>Total</b>	15 (7.50)	74 (37.00)	111 (55.50)

(Note : Figures in parentheses indicate percentage.), \*Significant at 5 % level

Table 6 shows disposing method of plastic bags. Sixty-seven percentage of respondents always hand over to the waste collectors followed by putting in the community bin (25%) and disposing at garbage corners on the road by 13 percent. Few respondents were always throwing away on the road and 1.50 percentages of respondents burning the plastic bags.

Some- times more than 50 percent of respondents were disposing plastic bags at disposing at garbage corners on the road followed by community bin. Some- times plastic bags were handed over to the waste collectors by 24.50 percent followed by burning (32%) and throw on the road.

Table 6. Method of disposing for plastic bag (N=200)

<b>Method of disposing</b>	<b>Always</b>	<b>Sometimes</b>	<b>Never</b>
1. Throw away on the road	3 (1.50)	33 (16.50)	164 (82.00)
2. Disposing at garbage corners on the road	26 (13.00)	107 (53.50)	67 (33.50)
3. Community bins	50 (25.00)	137 (68.50)	13 (6.50)
4. Hand over to the waste collectors	134 (67.00)	49 (24.50)	17 (8.50)
5. Burning	3 (1.50)	64 (32.00)	133 (66.50)

(Note : Figures in parentheses indicate percentage)

Eighty two percent of respondents said that plastic bags never throw away on the road followed by burning (66.50%), disposing at garbage corners on the road (33.50%), hand over to the waste collectors (8.50%), and community bin (6.50%). Nitin Joseph *et al*(2013) revealed in their study

that, 1.20 percent of participants were littering the plastic bags in open areas after usage and 78.80 percent were dispose plastic bags in bins.

Ayalonet *al* (2009), and Synthia, and Kabir(2014)in their study said that, 25 percent of the bags brought from the store are thrown into the trash immediately after the first use, 52 percent are used as trash bags, and 23 percent are reused for packing other products in or outside the homes. The empty plastic bags are widely reused for many domestic purposes, ranging from storage of food in freezer to using as a dishwashing scrub.

### **Conclusion**

In the selected households, cent per cent of available packaging materials were plastic bottles, plastic bag or sacks and plastic containers as packaging material for purchase and storage consumer goods. With regard to usage pattern of packaging materials, most of the respondents sell their paper items and re-use plastics, glass and *met als*.Majority of the respondent's always reused plastic bags to carry material and have good practice of plastic bag usage (55.50 %) and disposing methods (46.50 %). There is significant association between demographic variables and usage and disposing method of plastic bag. Regarding management of plastic bags, majority of the respondents are practicing very good method of usage of plastic bags and disposing method. Majority of the respondents never burn plastic bags. Hence, they preferred substitutes included durable woven bag cloth bags, paper bags and paperbags.

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<b>Nutri-cereal pearl millet: A promising climate smart crop for food and nutrition security</b>	<b>Chapter</b> 7
<p>Asha Kawatra, Veenu Sangwan and Saroj Dahiya</p> <p><i>Department of Foods and Nutrition, IC College of Home Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana), India</i></p>	

#### **ABSTRACT**

International Year of Millets will be celebrated in 2023 to highlight the importance of locally available, cost effective and resilient millets. Governments through various projects have been advocating the nutritional importance of millets especially pearl millet and that is why the nomenclature of coarse cereals has been notified as Nutri Cereals. The Centre of Excellence established in the Department of Foods and Nutrition, CCS HAU, Hisar is working for upscaling and value addition of pearl millet. The pearl millet grey, white and biofortified varieties were used for development of different types of traditional, baked, extruded, sugar free, gluten free products, instant food mixes, weaning foods, snacks, etc. It is the need of the hour to emphasise among people to increase the utilisation of the climate smart crops especially pearl millet. In this modern era in urban areas people are very much inclined to consume the pearl millet products and hence there is a promising scope for setting up small- and large-scale food businesses based on pearl millet products.

**Key words:** Pearl millet, value addition, processing, nutrition, entrepreneurship

## **Introduction**

Pearl millet (*Bajra*) is a nutritionally equivalent crop to main food grains and possesses appreciable amount of protein, energy, vitamins, minerals, fibre, phytochemicals and micronutrients, and hence also known as "nutri-cereal". It is a better source of nutrients particularly protein and fat than other millets. It is climate tolerant and cultivated mostly in Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Haryana, Karnataka, Andhra Pradesh, Tamil Nadu and Madhya Pradesh. Nutritional composition of pearl millet exhibits 12.5 to 14.4, 5.6 to 7.8, 0.5-4.0 and 1.53-2.00 percent protein, crude fat, crude fibre and ash, respectively. It is considered as "underprivileged man's grain," and needs revamp for its excellent nutritional and functional values. Pearl millet confers a number of health benefits like prevention of constipation, obesity, diabetes, hypertension, inflammation, cancer and coronary heart disease (Ambati and Sucharitha, 2019). It being gluten free can be well utilized by celiac disease patients. Biofortified pearl millet can play vital role in deterrence of anemia. Pearl millet's dietary fibre aids in dwindling bad lipoprotein and thus has positive effect on prevention of heart diseases. Government of India is extensively promoting the utilization of coarse cereals through various development and awareness programmes. The emphasis is to popularise and convince the masses to increase the utilisation of the climate smart crops especially pearl millet for ensuring nutritional security and improvement in nutritional status of vulnerable sections of society. As a result of concerted efforts of Government of India, the United Nations has declared the International Year of Millets-2023.

## **Pearl Millet Processing Techniques and Equipments for production of value-added pearl millet products**

There are a number of constraints like mouth feel, appearance, handling, shelf life etc. in utilisation of pearl millet, compared to wheat and rice. These constraints can be overcome by devising processing methods for improving its nutritional and keeping quality and also through development and promotion of different types of value added products. The processing techniques like pearling and milling; blanching; parboiling; malting; soaking; sprouting/germination; fermentation; roasting, etc. improve the nutritional availability of pearl millet by lowering the level of antinutrients (phytic acid and tannin contents) and making complex nutrients readily available for digestion by human system (Bajaj *et al*, 2021, Iswarya and Narayanan, 2016).



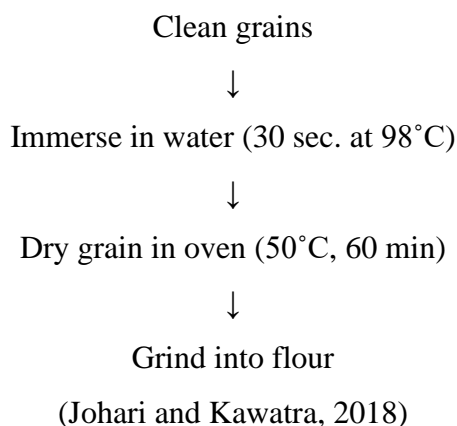
## **Common processing techniques**

**Pearling and milling-** It is done to separate the seed coat and make the grain utilizable.

## **Blanching and Parboiling**

### **Blanching**

Blanching may be done by the method described below:-



Blanching and parboiling are excellent processing methods for inhibiting breakdown processes in the grain matrix and thereby extending the stability of pearl millet flour to more than three months. The blanched and parboiled pearl millet are subjected to drying in the Solar Tunnel Dryer.

**Malting** is successfully used in pearl millet grains to improve the nutritive value of grains. Malted pearl millet is a store house of active hydrolytic enzymes. The Malted flour can be utilized to prepare weaning and infant foods and milk- based beverages.

**Preparation of pearl millet malt-** Malting involves following steps:

**Soaking** - To facilitate rehydration and sprouting, the grains were soaked in excess water, in a germinating dish and kept in an incubator for 6 hours (25°C-30°C). The mouth of the dish was covered with a muslin cloth using rubber band. The unimbibed water was drained off without removing the cloth.

**Aeration-** For enhancement of enzyme activity, aeration was done by removing the cloth. The grains were rotated occasionally by glass rod. Grains were again immersed with fresh 0.1 per cent formaldehyde solution for 16 hours and the mouth of dish was kept covered. After 16 hours of steeping, water was drained off, cloth was removed and the sample was air rested for 2 hours.

**Sprouting-** Grains were again sprayed with 25 ml of 0.1 per cent formaldehyde solution and allowed to germinate in an incubator at 25 °C for a period of 48 hours.

**Kilning-** The germinated grains were dried at 50°C and grains having a distinct malt odour can be used to make malted flour.

### **Dry heat treatments**

Effectively impede the lipase and minimizes breakdown of nutrients in pearl millet during storage. Thus improve the shelf life of pearl millet flour.

### **Popping**

Popping is done to prepare ready-to-eat crunchy, porous, and precooked foods with superior shelf life.

### **Acid treatment**

Lightens the grey colour and thus improve its acceptability and amplify *in vitro* protein and starch digestibility.

Table 1. Primary processing equipments

<b>Sr. No.</b>	<b>Name of the Equipment</b>	<b>Approx. Cost (Rs.)</b>
1.	Three-in-one destoner-cum-grader-cleaner	200,000
2.	Dehuller/ Pulvariser/ Pearling machine	200,000
3.	Parboiling Unit for pearl millet	200,000
4.	Blancher with attachment	100,000
5.	Hot air tray drier	125000
6	Solar Tunnel Drier	150000

## **SECONDARY PROCESSING EQUIPMENTS**

- Flour mill
- Oven
- Proofer
- Rotary rack oven
- Dough Mixer
- Noodle making machine
- Pasta Making machine
- Sealing and Packaging machine

- Vacuum Packaging Machine
- Extruder for Ready to Eat Snacks

The skill of developing millet products can be adopted as an entrepreneurial activity by potential entrepreneurs and Self Help Groups. The setting up of the production units based on pearl millet products can serve as a regular source of income for potential entrepreneurs. Centre of Excellence on Processing and Value Addition of Pearl millet for Nutritional Security was set up in the Department of Foods & Nutrition, IC COHS, CCSHAU, Hisar, funded by Ministry of Agriculture and Farmers Welfare has applied primary and secondary processing techniques for increasing the nutritive value and extend the shelf life of pearl millet. The value-added products of pearl millet like shelf stable flour, cake, biscuits of various types, *laddoo*, *sev*, nutritious crispies, multi grain puffs, weaning foods etc. developed in Centre are ready for commercialization (Kawatra *et al*, 2017; Zuberi and Sangwan, 2020).

Table 2. Pearl millet-based value-added products ready for commercialisation and their specialty









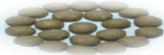



Sl. No	Product	Class*	Unique character	Shelf Life	Whether Technology Commercialized (Yes/No)
<b>1. Pearl Millet Bakery and Confectionery</b>					
	Cakes	RTE	High energy	3 days	Ready for commercialisation
	Biscuits/Melting moments	RTE	High energy, high protein	3 months	Yes
	Bread	RTE	Fibre rich	3 days	Ready for commercialisation
	Bun	RTE	Fibre rich	3 days	Ready for commercialisation
	<i>Kulcha</i>	RTE	Fibre rich	3 days	Ready for commercialisation
	Gluten free biscuits	RTE	Suitable for celiac patients	3 months	Ready for commercialisation


Sugar free biscuits	RTE	Suitable for diabetics and weight control	3 months	Ready for commercialisation
<b>2. Pearl Millet Traditional Products</b>				
<i>Ladoo</i>	RTE	Protein, energy and dietary fibre rich	3 months	Yes
<i>Sev</i>	RTE	Protein, energy and dietary fibre rich	3 months	Yes
<i>Matar</i>	RTE	Protein, energy and dietary fibre rich	3 months	Ready for commercialisation
<i>Shakarpara</i>	RTE	Protein, energy and dietary fibre rich	3 months	Ready for commercialisation
<i>Suhali</i>	RTE	Protein, energy and dietary fibre rich	3 months	Ready for commercialisation
<i>Mathri</i>	RTE	Protein, energy and dietary fibre rich	3 months	Ready for commercialisation
<i>Idli</i>	RTE	Protein, energy and dietary fibre rich	To be consumed fresh	Ready for commercialisation
<i>Dhokla</i>	RTE	Protein, energy and dietary fibre rich	To be consumed fresh	Ready for commercialisation
<b>Pearl Millet Extruded Products</b>				
Noodles	RTC	Nutritious	3 months	Ready for commercialisation
Vermicelli	RTC	Nutritious	3 months	Ready for

					commercialisation
Pasta	RTC	Nutritious	3 months	Ready for	commercialisation
Crispies	RTE	Nutritious	3 months	Ready for	commercialisation
Puffs	RTE	Nutritious	3 months	Ready for	commercialisation
<b>Convenience mixes</b>					
<i>Halwa mix</i>	RTC	Protein and energy rich	3 months	Ready for	commercialisation
<i>Ladoo mix</i>	RTC	Protein and energy rich	3 months	Ready for	commercialisation
<i>Dhokla mix</i>	RTC	Protein and energy rich	3 months	Ready for	commercialisation
<i>Idli mix</i>	RTC	Protein and energy rich	3 months	Ready for	commercialisation
<i>Upma mix</i>	RTC	Protein and energy rich	3 months	Ready for	commercialisation
<i>Kheer mix</i>	RTC	Protein and energy rich	3 months	Ready for	commercialisation
<i>Khichri mix</i>	RTC	Protein and energy rich	3 months	Ready for	commercialisation
Popped mixtures	RTE	Nutritious	3 months	Ready for	commercialisation
Pearl Millet Shelf stable flour	RTC	Good source of protein and energy	3 months	Ready for	commercialisation
Pearl Millet Grits	RTC	Good source of protein and energy	3 months	Ready for	commercialisation

\*RTE – Ready-to-Eat Food Products; RTC – Ready-to-Cook Food Products

Table 3. Glimpses of products developed by COE, Hisar

<p><b>Peanut Biscuits</b></p> 	<p><b>Kaju Biscuits</b></p> 	<p><b>Coconut Biscuits</b></p> 
<p><b>Chocolate-Peanut Biscuits</b></p> 	<p><b>Salty Biscuits</b></p> 	<p><b>Sesame Biscuits</b></p> 
<p><b>Cake</b></p> 	<p><b>Vegetable Rolls</b></p> 	<p><b>Soft Rolls</b></p> 
<p><b>Pearl Millet Doughnuts</b></p> 	<p><b>Pearl Millet Dinner Rolls</b></p> 	<p><b>Pizza Base</b></p> 
<p><b>Kulcha</b></p> 	<p><b>Ladoo</b></p> 	<p><b>Sev</b></p> 
<p><b>Crispy</b></p> 	<p><b>Puff</b></p> 	<p><b>Pasta</b></p> 

<p style="text-align: center;"><b>Vermicelli</b></p> 	<p style="text-align: center;"><b>Pearl millet flour</b></p> 	<p style="text-align: center;"><b>Carrot twigs powder Biscuits</b></p> 
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### ***LADOO***

**Ingredients:** Pearl millet four, Chickpea flour, Desi *Khand*, Sesame seeds, Groundnut kernel, Ghee.

**Method-** Roasted groundnut, removed husk and grind coarsely. Roasted sesame seeds slightly in a separate pan and grind coarsely. Sieved pearl millet flour and chickpea flour separately and roasted separately. After roasting mix the flours and add ghee. Add roasted groundnut and sesame seeds. After cooling of flour mixture add to it desi *khand*, mix properly and make *laddoos*.

### ***NAMKEEN SEV***

**Ingredients:** Pearl millet four, Chickpea flour , Salt, Red Chilli powder, Clove powder, Hydrogenated fat

**Method-** Sieved pearl millet and chickpea flour and added all other ingredients. Make soft dough using water. Make thin *sevs* of the dough using *sev* machine directly in hot oil. Fry and break into small *sevs*. For value addition spinach and amaranths leave puree can be added while kneading the flour.

### ***MATAR***

**Ingredients:** Pearl millet four, Refined flour, Ghee, *Ajwain*, Salt, Hydrogenated fat

**Method-** Sieved pearl millet flour and add all ingredients. Knead into a tight dough using water. Roll dough into thin sheets, cut into shape of *matar* and deep fry till golden brown.

### **MELTING MOMENT**

**Ingredients:** *Maida*, *Bajra*, Ghee, Sugar, Baking powder, Ammonia, Vanilla essence, *Meetha* soda, Milk, Corn flakes

**Method-** Creamed sugar and ghee till light & fluffy. Sieved *maida*, *bajra* flour, baking powder and *meetha* soda. Add flour this flour mixture to creamed sugar and ghee. Added vanilla essence and form into dough using milk. Crushed cornflakes and keep in baking tray. Made small balls of dough, rolled in cornflakes and kept in baking tray. Baked biscuits in the oven at 150°C, till brown.

### **CHOCOLATE CAKE**

**Ingredients:** Pearl millet flour, Refined flour, Sugar, Butter, Coco powder, Baking powder, Sodium bicarbonate, Milk powder, Vanilla essence, Eggs

**Method-** Sieved pearl millet and refined flour with baking powder, sodium bicarbonate and coco powder. Creamed butter and sugar (powder) till light and fluffy. Beat the eggs and add gradually to the above mixture. Added flours and mixed gently. Poured batter in ground tin and baked at 170° for 15-20 min. or till done.

Pearl millet-based products have good entrepreneurial potential and production of such products both at household and large-scale level would help initiate the production units aimed at raising the income level of housewives and farmers as well. Value added products like *sev* and *ladoo* can be prepared easily with small initial investment and by using locally available utensils. However for setting up enterprise unit based on cake, biscuits, shelf stable flour, multigrain puffs and nutritious crispies specialized equipments will be required. Industrial linkages for development and commercialization of these food products and shelf stable flour will secure market for millet especially pearl millet.

It is recommended that there is urgent need to promote setting up entrepreneurial unit based on pearl millet which will raise the economic condition of *bajra* growing farmers as well as the nutritional status of the community. In India, alternative uses of pearl millet could provide significant prospects for poverty reduction and food security. This chapter includes important information for entrepreneurs, scientists, students and general public and contains information on processing techniques of Pearl Millet, methods for preparation of various value added products and different types of machineries required for establishment of entrepreneurial unit. These



technologies will be useful to establish small scale enterprise of Pearl Millet and Value Added products for income generation and for achieving food and nutrition security. This is a step towards self-resilience.

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<b>Perceived impact of mass media on agricultural production among farmers – A sociological analysis</b>	<b>Chapter 8</b>
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## **ABSTRACT**

In a country like India, where literacy is low, choosing the right communication medium is critical. With the majority of the Indian people working in agriculture, television might be an effective means of disseminating farm information and technical know-how. Through media, farmers may easily understand processes, technologies, and teaching. Any media meant for a bigger audience is referred to as mass media. Media is a vehicle or means of communication that disseminates information from the source to the target public. Therefore, the present research was conducted in Haryana state. Hisar II and Adampur block were selected from Hisar district. The sample of 120 respondents was selected through systemic random sampling techniques. Data were collected through interview Schedule and analyzed with suitable descriptive statistical techniques. Analysis clearly revealed that more than half of respondents (54.00 %) had medium level of awareness. Forty-five per cent respondents had utilized mass media sometimes for gathering information and about fifty-two per cent respondents were also having medium level

of impact of mass media on agricultural production. Most effective source and young and middle age respondents used mobile and internet for gaining information about agriculture production. Majority of respondents used internet for getting agricultural information. Socio economic factor age, education, annual family income, Land holding, subsidiary occupation and ICT sources, socio economic status were found significantly associated with knowledge about mass media regarding knowledge. Thus, we conclude that there is need to create more awareness about use of mass media for agriculture through some trainings. Hence it was also found that education and knowledge of farmers regarding mass media will also help in more productivity. Creating social media channels on YouTube, Telegram and groups on Whatsapp and Facebook by University level and KVKs at district level that provide farmers with up-to-date information about new and improved seeds, irrigation, crop protection etc. so that farmers can make better use of research conducted by different departments of the university.

**Key words:** Impact of mass media on agricultural production, Knowledge, Utilization, Socio-economic factor

## **Introduction**

Agriculture plays a vital role in India's economy. 54.6% of the total workforce is engaged in agricultural and allied sector activities (Census 2011) and accounts for 17.8% of the country's Gross Value Added (GVA) for the year 2019-20 (at current prices). As per 4th Advance Estimates for 2019-20, total food grain production in the country is estimated at 296.65 million tonnes. The production during 2019-20 is also higher by 26.87 million tonnes than the previous five years' (2014-15 to 2018-19) average production of food grain. The Contribution of agriculture sector in India economy is much higher than world's average 6.4 percent (Ministry of statistic and programme implementation, 2018). Haryana contributed near 3.63 percent in India's GDP in 2018-2019 (India Brand Equity Foundation, 2019). Any media meant for a bigger audience is referred to as mass media. Media is a vehicle or means of communication that disseminates information from the source to the target public. There are many different types of mass media, ranging from early pictorial representations through mass manufacturing of newspapers, fancy videos on television, and high-tech media combining the Internet and computers. As the primary source of information, entertainment, marketing, advertising media,

and motivation for everyone and everywhere on the planet, you will learn about the various types of mass media and how they influence people through this site.

Radio and television have been hailed as the most effective means of disseminating scientific knowledge to the general public. In a country like India, where literacy is low, choosing the right communication medium is critical. In this regard, television and radio are important because they quickly disseminate current agricultural techniques to both educated and uneducated farmers in rural areas. Currently, there are roughly 50 of these radio units scattered over the country. With the majority of the Indian people working in agriculture, television might be an effective means of disseminating farm information and technical know-how. Through media, farmers may easily understand processes, technologies, and teaching. The shifting global demands on agricultural productivity for sustainability and food security necessitate constant technical innovation and timely sharing of that information. The farmer's ability to use new agricultural technologies is largely dependent on successful communication via social media, to which they are frequently exposed, either directly or indirectly. People's behaviour can be affected to a large extent by the media, which can spontaneously modify their beliefs by delivering pertinent information. Second, through influence, it can have a significant impact on people's behaviour without relying on their information. Information and communication technology (ICT) has become increasingly important telephones, cell phones, the internet, and other communication devices are used as a means for obtaining and disseminating information. With access to price information, weather information, and production information, as well as the newest agricultural technology, government initiatives, and demand information, knowledge technology is a major phrase in the agriculture sector. The only method to get timely information to farmers is through the media, and the spectrum of media available is vast. In a short amount of time, mass media communicate current agricultural knowledge to educated and uneducated farmers alike, especially in rural areas. Radio and television have been hailed as the most effective media for disseminating scientific knowledge to the public. Farmers can readily learn technology, operation, and teaching thanks to television. Newspapers and farm magazines play an important role in agricultural information dissemination among farmers. By leveraging the print media, the mass media plays a significant part in boosting the country's literacy rate, which offers fresh promises and potential. Using the media to effectively communicate new agricultural research findings and technologies to rural farmers is a viable technique for enhancing agricultural output. Increased use of

agricultural inputs, technological progress, and technical efficiency are three major factors that lead to agriculture expansion. In a low-literacy country like India, picking the correct communication medium is crucial. Television and radio are crucial in this aspect since they provide immediate feedback. It aims to boost agricultural productivity by improving sustainable development, communication diffusion, education, healthy pleasure, and the distribution of vital information. Newspapers and agricultural magazines are the most common means of conveying news and information. Newspapers serve as a source of entertainment and education in addition to providing agricultural information. ICTs have been utilized in conjunction with mobile phones, the internet, radio, computers, and television. Radio technology has a significant impact on social, economic, and basic information dissemination in remote areas of developing countries. Furthermore, growers in certain countries do not have access to energy, according to reports, while other cultures frequently rely on new technologies. Newspapers are periodic publications that include news, editorial viewpoints, analytical essays, adverts, special reports, photos, and comics. Newspapers can also give consistent and prominent coverage on specific themes, and they play a vital role in motivating the public to change attitudes, develop awareness, improve knowledge and skills, and learn about a variety of topics, including agriculture. As a result, newspapers serve a critical role in distributing development information, especially information on agricultural production. New technologies, such as television, enable many stakeholders to exchange the most up-to-date information on a variety of concerns, and growers have benefited greatly from this latest technology and obtained essential agricultural expertise. Growers can use the internet to learn about new products and gain fresh market information. Akhter (2021) conclude in their study that different communication sources are playing an integral role in disseminating agriculture-based information for betterment of the agriculture sector. However, this review found out that interpersonal communication channels in different shapes, i.e. neighboring farmers, friends, field staff of agriculture department and opinion leaders were most reliable amongst farmers for seeking agriculture related information and adoption of innovations. The most essential role of mobile phones in developing countries is that producers utilize them to receive the most up-to-date information from numerous market sources, while others contact agricultural cooperation professionals for fresh knowledge on fertilizers, pesticides, and insecticides in their farms. The computer is used extensively all across the world, particularly in marketing, agriculture, and rural areas. The internet-connected

computer disseminates crucial information about agricultural processes to the farmer. People kept their information private before the invention of computers, but in the present era, everyone wants to share their information and spread data to farmers in remote areas. Computers are now available in almost every field, but there is a shortage of technical staff in agriculture extension. Agriculture extension workers in rural areas are unable to persuade farmers with accurate facts about agriculture. In today's world, a computer is required for recording data in the agriculture and rural development sectors.

Mass media channels bring variety and provide farmers with holistic knowledge about general development in rural areas, not just about agriculture. It increases their social, economic, political, and cultural awareness, allowing people to make better decisions and stay informed and connected. The mass media can also be used by rural residents to affect the growth of their community and the flow of investment into infrastructure development. Farmers can sell their products directly to consumers using mass media technologies through forums like community supported agriculture. Farmers can also communicate with extension agents through the media, and experts to receive real-time solutions to their problems. Using the media, many progressive farmers are able to sell their products directly to retailers and consumers. . . Bite *et al*(2017) also mentioned in his study that nowadays with internet and social media applications in it. Farmers are making use of social media for innovative practices, sharing information etc. the most popular social media in agricultural marketing is Facebook, YouTube, WhatsApp, Twitter and LinkedIn. He also said that social media is becoming powerful tool and connects millions of people globally. Farmers are using social media because it has ability to connect with farmers, agribusiness, agri experts over a geographical distance. Up to certain extent social media in agricultural marketing provides solutions to the agricultural marketing problems.

Keeping in view the above facts, a study on Farmer 'Impact of Mass media on agricultural production among farmers – A Sociological Study' will be undertaken with following specific objectives: -

- To know the perceived impact of mass media on Agriculture Production .
- To find the constraints faced by the respondents in obtaining information from media sources.

## **Materials and methods**

The present study was conducted in Haryana state. One district viz. Hisar were selected randomly as they are present in two different zones of Haryana. Further two blocks were selected randomly. Hisar II and Adampur block were selected from Hisar district. Two Villages were selected from each of the two blocks randomly. In Hisar II, Rawalwas and Hindwan were selected while Sadalpur and Khermpur were selected from Adampur block. Thirty respondents from each selected village i.e. Rawalwas, Hindwan, sadalpur and khermpur were selected. So, on the whole 120 respondents were taken as a sample for present study. A semi structured interview schedule was prepared keeping in view the both types of variables independent and dependent. The personal interview method was used for collecting data. Keeping in views the objective of the study the scholar visited all the selected villages and interacted with village functionaries and farmers before data collection. All the items prepared were designed in schedule form and schedule so prepared was pretested. . The schedule was divided into two parts. The first part of the schedule was about personal and socio-economic profile of the respondents and the second part of the schedule dealt with the respondent's Knowledge of mass media, mass media utilization, impact of mass media along with constraints. The data was collected personally with the help of an interview schedule consisting of measuring devices of dependent and independent variables and the respondents' data. The main statistical techniques used were percentages, averages and chi-square.

## **Results and discussion**

### **Contextual matrix of the respondents**

The maximum number of respondents (45.80 %) belonged to 35 years of age group followed by (42.50%) who belonged to 36 to 50 years of age group and 11.70 per cent of the respondents belonged to 50 years of age group. Data revealed that overwhelming of the respondents (95.80%) were male and female respondents were only 04.20 per cent. Similar findings were reported by Bite *et al*(2017) that their data shows that major respondents are from the gender male i.e. 91 % and female respondents are 9 %. While interviewing with farmers it is found that male farmers are getting more time to use social media as compared to female farmers Distribution of caste among respondents showed that overwhelming of the respondents (85.00%) belonged to general caste and the rest 10.80 and 04.20 per cent respondents were from backward and scheduled castes. As far as family size is concerned, majority of the respondents (52.50%) had medium

family size *i.e.* between 5-8 members and (45.80%) respondents were belonged to small family size (45.80%) *i.e.* up to 4 members, respectively. However, only 01.70 per cent had large family size *i.e.* more than 8 members. Analysis clearly revealed that 42.50 per cent of the respondents earned income up to Rs.1,00,000/- followed by nearly one-fourth of the respondents (24.20%) earned up to Rs.1,00,001-200000 and 17.50 per cent of the respondents earned income Rs. 2,00,001-300000. The maximum number of the respondents (45.00%) had marginal and semi-medium size of land holding followed by 30 per cent respondents had small size of land holding and 21.70 per cent respondents had medium size of land holding. Only 03.30 percent had large size of land holding. Only 35.00 per cent of the respondents were labourers followed by 33.30 of the respondents who were not engaged in any occupation. Remaining 15.80 and 09.20 per cent were engaged in service and independent profession respectively. The data revealed that half of the respondents (50.83%) hailed from medium level of socio-economic status and near about than two-fifth of respondents (39.67%) had low level socio-economic status followed by 10.00 per cent of the respondents had high level of socio-economic status. Most of the of respondents (92.50%) were not member of any organization. Only 02.50 respondents were member of one organization and 01.70 per cent of the respondents of more than one organization. The data showed that 35.00 per cent respondents had participation in two extension activities followed by 29.20 per cent respondents participated in three activities. Only around 17.50 per cent respondents participated in four or more extension activities while the remaining 04.20 per cent respondents had no participation in extension activities. The present study revealed that all respondents (100%) had mobile phone followed by 91.70 and 88.30 per cent had internet and television as ICT sources respectively. Further, maximum number of the respondents (43.30%) had radio. Majority of the respondents (56.70%) had high level of ICT Sources followed by 37.50 per cent had medium level of ICT sources. Only a few respondents 05.80 per cent had low level of ICT sources. Ayoade, A.R (2010) concluded that farmers rely more on radio and television as a source of information through the mass media, according to most of the respondents, implying that most of the respondents listened to radio and television programmes, implying that agricultural programmes on radio and television have an impact on farm families. Memon *et al* (2014) also revealed in his study that overwhelming majority (80.23%) of the respondents were male farmers while proportion of females was only 19.77 percent.



Table 1. Contextual matrix of the respondents

Sl. No	Independent variables	Frequency	Percentage
<b>1.</b>	<b>Age</b>		
	Young (upto 35)	55	45.80
	Middle (36 to 50)	51	42.50
	Old (above 50)	14	11.70
<b>2</b>	<b>Gender</b>		
	Male	115	95.80
	Female	5	04.20
<b>3</b>	<b>Caste</b>		
	General	102	85.00
	Backward	5	04.20
	Schedule	13	10.80
<b>4.</b>	<b>Education</b>		
	Illiterate	10	08.30
	Primary	13	10.80
	Middle	15	12.50
	High School	21	17.50
	Intermediate	32	26.70
	Graduate/Post Graduate	29	24.20
<b>5</b>	<b>Family Type</b>		
	Nuclear	59	49.20
	Joint	61	50.80
<b>6</b>	<b>Family Size</b>		
	Small (upto 4 members)	55	45.80
	Medium (5-8 members)	63	52.50
	Large (more than 8 members)	2	01.70
<b>7</b>	<b>Annual Family Income</b>		
	Up to Rs. 100000	51	42.50
	Rs 100001-200000	29	24.20
	Rs 200001-300000	21	17.50

	<b>Rs 300001-400000</b>	7	05.80
	<b>More than Rs 400000</b>	12	10.00
<b>8</b>	<b>Land Holding</b>		
	<b>Marginal (upto 1 ha)</b>	27	22.50
	<b>Small (1-2 ha)</b>	36	30.00
	<b>Semi-medium (2-4 ha)</b>	27	22.50
	<b>Medium (4-10 ha)</b>	26	21.70
	<b>Large (above 10 ha)</b>	4	03.30
<b>9</b>	<b>Subsidiary Occupation</b>		
	<b>None</b>	40	33.30
	<b>Labourer</b>	42	35.00
	<b>Business</b>	3	02.50
	<b>Independent Profession</b>	11	09.20
	<b>Dairy</b>	5	04.20
	<b>Service</b>	19	15.80
<b>13</b>	<b>Socio-economic Status</b>		
	<b>Low (09-13)</b>	47	39.67
	<b>Medium (14-19)</b>	61	50.83
	<b>High (20-26)</b>	12	10.00

### **Perceived impact of mass media on agricultural production**

The results in Table 2 indicated that about 58.34 per cent of the respondents had medium impact of mass media followed by one-fourth of the respondents (25.83%) had low impact and 15.83 per cent of the respondents had high impact of mass media on land preparation in agricultural production. However, near about three-fifth of the respondents (58.34%) had high impact followed by one-fourth of the respondents (25.83%) had low impact of mass media and only 15.83 per cent of the respondents had high impact of mass media on seed and sowing in agriculture production .Out of the total, half (50.83%) of respondents had medium impact whereas two-fifth of the respondents (40.00%) had low impact of mass media followed by 09.17 per cent of the respondents had high impact of fertilizer management of mass media on agricultural production . However, more than half of the respondents (51.67%) had medium

impact of mass media and two-fifth of the respondents (40.00%) had low impact followed by 08.33 per cent of the respondents had high impact of mass media on Irrigation management in agricultural production. Near about half of the respondents (48.33%) had low impact of mass media and 44.17 per cent of the respondents had medium impact of mass media followed by 07.50 per cent of the respondents had high impact on plant protection measures in agricultural production. Out of 120 respondents, near about half 48.34 per cent of the respondent had low impact of mass media on harvesting and threshing. About 43.33 per cent of the respondents had medium impact of mass media on harvesting and threshing. However, only 06.67 per cent of the respondents had high impact on marketing of produce. Near about half of the respondents had low impact of mass media on marketing of produce. Bite *et al*(2017) reported in their study that data shows that most of the respondents are using social media for information seeking followed by Solution of problem. From the interview of the respondent, it is found that farmers are seeking information on YouTube videos, because they could visualize the thing.

Table 2. Distribution of respondent according to impact of mass media on agricultural production

Sl. No.	Sources	Impact of Mass Media on agricultural production		
		High	Medium	Low
1	Land preparation	19(15.83)	70(58.34)	31(25.83)
2	Seed and sowing	19(15.83)	79(58.34)	31(25.83)
3	Fertilizer management	11(09.17)	61(50.83)	48(40.00)
4	Irrigation management	10(08.33)	62(51.67)	48(40.00)
5	Plant protection measures	09(07.50)	53(44.17)	58(48.33)
6	Harvesting and threshing	10(08.33)	52(43.33)	58(48.34)
7	Marketing of produce	08(06.67)	54(45.00)	58(48.33)

(Figures in the parenthesis denote percentage)

### **Overall impact of mass media on agricultural production**

The data of overall impact were calculated by summing all scores of 08 sources for each respondent and categorised in three different categories. Results in Table 4.19 indicated that out of total, near about three-fifth of respondents (51.66%) had medium impact of mass media followed by 30.83 per cent of the respondents had high impact of mass media. Only 17.50 per

cent of respondents had low impact of mass media on agricultural production. Memon *et al* (2014) mentioned in his study that majority (70.93%) of the respondents considered the information receiving through mass media is highly relevant in solving agriculture problems; while about one fourth (25.58%) of the respondents indicated that the information receiving through mass media is moderately relevant in solving agriculture problems. Shaikh *et al* (2020) reported in their study that all farmers receive the substantial information regarding weather change (67.2%), market price (56.7%), rotation of water from irrigation department (49.4%), seasonal cropping (62.8%), cultivation techniques (55.6%) and disaster preventions alerts (46.1%).

Table 3. Overall distribution of respondent according to impact of mass media for agricultural production

Sl. No.	Impact of mass media for agricultural production	Frequency	Percentage
1	Low (07-10)	21	17.50
2	Medium (11-14)	62	51.66
3	High (15-18)	37	30.83
4	Total	120	100.00

#### **Socio-economic factors associated with impact of mass media on agricultural production**

It was found that 51.70 per cent of the respondents had medium impact of mass media followed by low (30.80%) and high (17.50%). Age of the respondents found highly significantly associated with impact of mass media. Analysis further revealed that near about three-fifth of the respondents (57.10%) who belong to above 50 years of age group had medium impact of mass media. On the other hand, majority of the respondents (54.50%) who were from young age up to 35 years of age had medium impact of mass media on agricultural production followed by 47.10 per cent had medium impact.

Gender of the respondents not found significantly associated with impact of mass media analysis clearly reveal that near about three-fifth of the male respondents (60.00%) who had low impact of mass media followed by 53.00 per cent female respondent who had medium impact of mass media.

Caste of the respondents found significantly associated with impact of mass media on agricultural production. Overwhelming of the respondents (100.00%), who belonged to backward caste, had medium impact of mass media followed by half of the respondents (50.00%), who belonged to general caste had medium impact of mass media. Contrary to that, maximum number of the respondents (46.20%), who belonged to scheduled caste, had medium impact of mass media.

Highly significant association found between level of education of the respondents and impact of mass media. Analysis clearly revealed that near about three-fifth of the respondents (58.60%), who were educated up to graduation and post-graduation, had low impact of mass media. On the other hand, more than half of the respondents (51.47%), who were educated up to middle and up to intermediate, had medium impact of mass media followed by 47.82 per cent low impact of mass media.

Type of family found significantly associated with impact of mass media. Further analysis revealed that majority of the respondents (52.50%), who belonged to joint family, had medium impact of mass media. Contrary to that, more than half of the respondents (51.50%) who belonged to nuclear family, had medium impact of mass media.

Size of family found significantly associated with impact of mass media on agricultural production. It was clear from the field of the study that majority of the respondents (54.00%), who hailed from medium size of family *i.e.* 5 to 8 members, had medium impact of mass media. Contrary to that, half of the respondents (50.00%), who hailed from large size of family *i.e.* up to 5-8 members, had low impact of mass media.

Table 4. Socio-economic factors associated with impact of mass media on agricultural production

Socio-economic variables	Impact of mass media on agricultural production			
	Low	Medium	High	Total
<b>Age</b>				
<b>Young (upto 35)</b>	13(23.60)	30(54.50)	12(21.80)	55(45.80)
<b>Middle (36 to 50)</b>	21(41.20)	24(47.10)	06(11.80)	51(42.50)
<b>Old (above 50)</b>	03(21.40)	08(57.10)	03(21.40)	14(11.70)

<b>Total</b>	37(30.80)	51(51.70)	21(17.50)	120(100.00)	$\chi^2=05.14^*$
<b>Gender</b>					
<b>Male</b>	34(29.60)	61(53.00)	20(22.60)	115(95.80)	$\chi^2=02.47^*$
<b>Female</b>	03(60.00)	01(20.00)	01(20.00)	05(04.20)	
<b>Caste</b>					
<b>General Caste</b>	33(32.40)	51(50.00)	18(17.60)	102(85.00)	$\chi^2=05.11^*$
<b>Backward Class</b>	-	05(100.00)	-	05(04.20)	
<b>Scheduled Caste</b>	04(30.80)	06(46.20)	03(23.10)	13(10.80)	
<b>Education</b>					
<b>Illiterate &amp; Primary</b>	11(47.82)	10(43.47)	02(08.69)	23(19.16)	$\chi^2=24.92^{**}$
<b>Middle &amp; up to intermediate</b>	23(33.82)	35(51.47)	10(14.70)	68(56.66)	
<b>Graduation &amp; Post-Graduation</b>	03(10.30)	17(58.60)	9(31.00)	29(24.20)	
<b>Family type</b>					
<b>Nuclear</b>	25(31.20)	41(51.20)	14(17.50)	80(66.66)	$\chi^2=1.65^*$
<b>Joint</b>	12(30.00)	21(52.50)	7(17.50)	40(33.33)	
<b>Family size</b>					
<b>Small (up to 04 members)</b>	19(34.50)	27(49.10)	09(16.40)	55(45.80)	$\chi^2=1.40^*$
<b>Medium (05 to 08 members)</b>	17(27.00)	34(54.00)	12(19.00)	63(52.50)	
<b>Large (more than 8 members)</b>	01(50.00)	01(50.00)	-	02(01.70)	
<b>Annual family income (Rs.)</b>					
<b>Up to 100000</b>	14(27.50)	31(60.80)	6(11.80)	51(42.50)	$\chi^2=07.69^*$
<b>100001-200000</b>	10(34.50)	14(48.30)	05(17.20)	29(24.20)	
<b>200001-300000</b>	07(33.30)	10(47.60)	04(19.00)	21(17.50)	
<b>Above 300000</b>	06(31.57)	07(36.86)	06(31.57)	19(15.83)	

<b>Land holding</b>				
<b>Marginal (up to 1 ha)</b>	10(37.00)	11(40.70)	06(22.22)	27(22.50)
<b>Small (1-2 ha)</b>	10(27.80)	23(63.90)	03(08.30)	36(30.00)
<b>Semi-medium (2-4 ha)</b>	11(40.70)	15(55.60)	01(03.70)	27(22.50)
<b>Medium and Large (4 and above 10 ha)</b>	06(20.00)	13(43.33)	11(36.66)	30(25)
				<b><math>\chi^2=17.00^{**}</math></b>
<b>Subsidiary occupation</b>				
<b>None</b>	09(22.50)	25(62.50)	06(15.00)	40(33.30)
<b>Labourer</b>	17(40.50)	20(47.60)	05(11.90)	42(35.00)
<b>Business</b>	1(33.33)	02(66.70)	-	03(100.00)
<b>Independent profession</b>	04(36.40)	04(36.40)	03(27.30)	11(09.20)
<b>Dairy</b>	02(40.00)	03(60.00)	-	05(04.20)
<b>Service</b>	04(21.10)	08(42.10)	07(36.80)	19(15.80)
				<b><math>\chi^2=12.03^{**}</math></b>
<b>Social participation</b>				
<b>Not member of any organization</b>	34(30.60)	57(51.40)	20(18.00)	111(92.50)
<b>Member of one or more than one organization</b>	02(40.00)	02(40.00)	01(20.00)	5(04.16)
<b>Office bearer and Public leader</b>	01(25.00)	03(75.00)	-	4(03.33)
				<b><math>\chi^2=05.41^*</math></b>
<b>Extension contacts</b>				
<b>Low (08-10)</b>	16(32.70)	25(51.00)	08(16.30)	49(40.80)
<b>Medium (11-13)</b>	19(31.70)	31(51.70)	10(16.70)	60(50.00)
<b>High (14-16)</b>	02(18.20)	06(54.50)	03(27.30)	11(09.20)
				<b><math>\chi^2=01.32^*</math></b>
<b>Extension activities</b>				
<b>Less than two activities</b>	10(45.50)	07(31.80)	05(22.70)	22(18.30)
<b>Two activities</b>	16(38.10)	24(57.10)	02(04.80)	42(35.00)
<b>More than two activities</b>	11(19.60)	31(55.40)	14(25.00)	56(46.7)
				<b><math>\chi^2=12.62^{**}</math></b>
<b>ICT sources</b>				

<b>Low (Less than two)</b>	05(71.40)	01(14.30)	1(14.30)	7(05.80)
<b>Medium (Two)</b>	18(40.00)	21(46.70)	06(13.30)	45(37.50)
<b>High (More than two)</b>	14(20.60)	40(58.80)	14(20.60)	68(56.70)
				$\chi^2=10.92^*$
<b>Socio-economic status</b>				
<b>Low (09-13)</b>	17(36.20)	26(55.30)	04(08.50)	47(39.20)
<b>Medium (14-19)</b>	18(29.50)	32(52.50)	11(18.00)	61(50.80)
<b>High (20-26)</b>	2(16.70)	04(33.30)	06(50.00)	12(10.00)
				$\chi^2=11.58^{**}$

(Figure in parenthesis denote percentage.)

\*Significant at 5% level; \*\*Highly significant at 1% level

Annual income of the respondents found significantly associated with impact of mass media on agricultural production. The data revealed that three-fifth of the respondents (60.70%), who earned annual income *i.e.* up to Rs.1,00,000 had low impact of mass media. Contrary to that 48.30 per cent of the respondents, who earned annual income above Rs. 1,00,001-2,00,001, had medium impact and 47.20 per cent had medium impact of mass media.

Highly significant association found between size of land holding and impact of mass media on agricultural production. It was clear from the data of the respondents (63.90%) had medium impact *i.e.* small size of land holding followed by 55.60 per cent had semi-medium size of land holding had medium impact of mass media. Contrary to that, 43.33 per cent respondents, who had medium and large size of land holding medium impact of mass media.

Subsidiary occupation of the respondents found high significantly associated with impact of mass media on agricultural production. On the other hand, 66.70 per cent of the respondents engaged in business, medium impact of mass media on agricultural production. It was clear from the data that three-fifth of the respondents (60.00%), engaged in dairy as subsidiary occupation, medium impact of mass media on agricultural production.

Highly significant association found between social participation and impact of mass media on agricultural production. Three-fourth of the respondents (75.00%), who had medium impact of mass media. Contrary to that, more than half of the respondents (51.40%), who were not member of any organizations had medium impact of mass media on agricultural production.



Extension contacts found significantly associated with impact of mass media on agricultural production. Analysis clearly revealed that majority of the respondents (54.50%), who had high extension contact had medium impact of mass media on agricultural production, 51.70 per cent of the respondent had medium contacts who had medium impact of mass media on agricultural production. Contrary to that, 32.70 per cent of the respondents who had low extension contacts had low impact of mass media on agricultural production.

Extension activities found highly significant associated with impact of mass media on agricultural production. Analysis revealed that revealed majority of the respondents (57.10%), who involved in two activities had medium impact of mass media, 55.40 per cent of the respondents involved in more than two activities had low impact of mass media followed by 45.50 per cent of the respondents involves in less than two activities had low impact of mass media on agricultural production.

ICT Sources found significant associated with impact of mass media on agricultural production. Analysis revealed that 71.40 per cent of the respondents, who had low impact of ICT source followed by 58.80 per cent and 46.70 per cent of the respondents with medium impact of mass media on agricultural production.

Socio-economic status found highly significant associated with impact of mass media on agricultural production. It was clear from the field of the study that majority of respondents (55.30%), who had low socio-economic status, medium impact of mass media. Contrary to that, 52.50 of the respondents, who had medium socio-economic status, medium impact of mass media on agricultural production. Ali (2011) reported in his study that adoption of media information is significantly higher among those farmers who are having better irrigation facilities. Vegetable growers with irrigation facility of their own are about twice more likely to adopt media-based information in vegetable cultivation as compared to those growers who depends on rental irrigation facilities.

Shuwa *et al* (2014) revealed in her study that the availability of various farm information has impacted greatly on their production output and income because it has open up opportunities for them to trace where and how to acquire new technology and market information.

### **Constraints**

It was evident that near about half of the respondents (48.33%) had no problem in obtaining information from the media sources. However, 41.67 per cent of the respondents faced constraint

of high cost of purchasing and maintaining media sources followed by power failure which was 40.00 per cent and poor signal, language barriers and inability to respond immediately to source of 05.00, 04.16 and 0.83 per cent respectively were the least significant constraints faced by the respondents in the use of mass media. The possible reason could be that, since many mass media are one way communication, if any doubt arises, it is very difficult for the farmers to get clarification. The some of the technologies were exposed to the technology for the first time, so farmers don't readily accept the message or technology through mass media. Memon *et al* (2014) also reported that regarding major obstacles in receiving information, 31.40 percent respondents reported power failure, followed by high cost (24.42%), and poor signals (12.79%). Shaikh *et al* (2020) also confirmed in their study that sampled farmers follow traditional method of seed fertilization, plant protection and irrigation method due to lack of resources. Although, they also have insufficient information related to the procedure of higher agricultural production. Ndaghu *et al*(2012) also concluded that power failure, lack of signals and high cost of television gadgets and maintenance are the major challenges experienced by farmers in sourcing and accessing agricultural production information from the mass media.

### **Conclusions**

Forty five per cent respondents had utilized mass media sometimes for gathering information and about fifty two per cent respondents had medium level of impact of mass media on agricultural production. Socio economic factor age, education , annual family income ,Land holding , subsidiary occupation and ICT sources , socio economic status were found significantly associated with knowledge about mass media regarding knowledge.

Socio economic factor age, education , family type, family size , annual family income ,Land holding , subsidiary occupation and ICT sources , socio economic status were found significantly associated with utilization of mass media. Socio economic factor education, Land holding, subsidiary occupation and extension activities, socio economic status were found significantly associated with impact of mass media. Ali (2011) concluded in his study that with rising demand in high value agricultural products coupled with rapid increase in organised retailing of fresh produce, vegetable cultivation has increasingly become an information-dependent sector requiring a wide range of scientific and technical information for effective decision-making at the farm level.

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<b>Iron deficiency anaemia: status and underlying risk factors among rural populations of Rajsamand district of Rajasthan, India</b>	<b>Chapter</b> 9
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## **ABSTRACT**

Iron deficiency, and specifically iron deficiency anaemia, remains one of the most severe and important nutritional deficiencies in the world today. The study aims to determine the status and underlying risk factors of anaemia in rural populations of Railmagra block of Rajsamand district of Rajasthan (India) in 2016-17 and a total of 128 subjects of variable age group and gender of 30 families participated in this research. The general information, socio-economic profile and blood samples of all subjects was collected and subjected to haemoglobin estimation excluding children below three years of age and pregnant and lactating mothers. The study group comprised two types of families *i.e* 4 and 5 family size. All members of 30 families were found to be anaemic particularly children and females. Anaemia was widely prevalent in all ages and gender. All three categories of anaemia- mild, moderate and severe were present in the family members. But, moderate anaemia was most commonly present. Anaemia was present irrespective of family size. Majority of adult family members and family heads were illiterate or had poor

educational status. Maximum subjects were vegetarian and took two meals a day. There were no toilet facilities inside the house in almost all selected households and subjects go for defecation in the open ground. The drainage system was open in study area and garbage was disposed in open in maximum cases. Maximum households used to keep their animals inside the houses. Subjects had poor personal hygiene habits. Maximum 70.00 per cent families belonged to agriculture caste and were landless or having less land. Majority of the selected families belonged to middle class having low socio-economic status. The main possible reasons behind the wide prevalence of anaemia in the study group were- vegetarian diet, low educational and socio economic status, poor personal hygiene and environmental sanitation practices which need immediate attention at village level.

**Key words-** Anaemia, iron, haemoglobin, status, risk factors and rural

### **Introduction**

Even after seventy years of independence, India has still to battle many nutritional deficiencies. While discussing many nutritional problems- Iron Deficiency Anaemia is a serious and widespread public health concern in both developing and developed countries. It affects 20-50% of the world's population (Saloojee and Pettifor, 2001). Micronutrient deficiency especially the iron deficiency is the bane of our lives, affecting all strata of society. Unfortunately, the women during pregnancy, adolescence and children are under this curse particularly in developing countries like India. Iron deficiency anaemia is the world's second leading cause of disability and thus one of the most serious global public health problems. Iron deficiency is the most common cause of anaemia. It remains as a major nutritional problem among all age and sex in India. According to National Family Health Survey-3 and UNICEF report, anaemia is a serious public health problem affecting all segments of the population (50-70%) especially infants and young children, adolescent boys and girls, women of child bearing age and pregnant women. This is observed despite of the fact that from decades nutritional interventions are running in country but nutritional problems are pervasive. Anaemia is defined as a disorder of the blood, when insufficient iron is absorbed. The most common form of anaemia is hypochromic type. Among all micronutrients, iron deficiency holds greatest share towards burden of diseases (WHO, 2008). Anaemia is a major public health problem affecting 1.62 billion people globally (McLean *et al*, 2009 and Balarajan *et al*, 2011). The prevalence of anaemia is estimated at 9% in

countries with high development rate in contrast to countries with low development, where the prevalence is 43% (McLean *et al*, 2009 and Balarajan *et al*, 2011).

### **Materials and methods**

The present investigation was conducted during the year 2016-17 to study the status and underlying risk factors of iron deficiency anaemia in rural population of Kuraj village of Railmagra block of Rajsamand district of Rajasthan, India. The investigator selected 30 families to judge anaemia status and other associated risk factors causing iron deficiency based on maximum number of anaemic members in the family alongwith support and co operation ensured by the family. The study was planned and implemented on 30 anaemic families consisting 128 anaemic members of all age group and gender excluding children below 3 years and pregnant and lactating mothers. A proforma was developed to collect general family details from all the members of 30 households selected by direct interview method. This included information about age, sex and educational status of each family member. The haemoglobin level of the subjects was considered as the sole parameter to identify anaemic members in the families for studying anaemia status. The family members were persuaded by investigator for conducting the blood testing and a verbal consent was taken from them for taking blood sample for haemoglobin estimation. Haemoglobin was measured by Sahli's method using the Sahli's hemometer (Wintrobe, 1975). WHO classification for considering the Indians as normal or anaemic was used to decide the presence of anaemia in the family members as given in Table1.

A structured interview tool was developed to collect required data related to subject's food habits, practices related to environmental sanitation and personal hygiene. Revised Udai Pareek and Trivedi socio-economic status scale for rurals by Gururaj *et al* (2015) was used for gathering SES information to categorize socioeconomic status of the selected 30 anaemic families.

Table 1. Optimum haemoglobin concentration for different age and gender groups

<b>Group</b>	<b>Haemoglobin g/l</b>
Children 0.5-5 y	>110
Children aged 5-11 y	>115
Children aged 12-13 y	>120
Men	>130
Non-pregnant women	>120

(Source: WHO, 2001)

## Results & discussion

As discussed earlier the target group for the study was 30 anaemic families having 128 members. Table 2 showed the distribution of 30 families based on total number of family members. Amongst 30 families who were selected for study, only two types of families were present. 73.30 per cent were four member families and 26.70 per cent were five member families. The status of iron deficiency anaemia has been discussed in terms of prevalence of anaemia in the study group:

Table 2. Percentage distributions of 30 intervention families based on total number of family members

S.No.	Family size	Intervention families (n=30)
1.	4 members	22 (73.30)
2.	5 members	8 (26.70)

() Figures in parenthesis are percentage of families

### *Prevalence of anaemia*

Based on the haemoglobin level of all the 128 anaemic members of 30 intervention families the following findings have been derived. Among 128 members of 30 families, all were found to be anaemic on the basis of haemoglobin estimation as all the subjects had Hb level less than normal. Data in Table 3 revealed that mean hemoglobin level was ranging between 7.88 g per cent among children 5 to 11 years to 9.16 g per cent among adult male members. Maximum difference of 33.00 per cent from normal Hb level was seen in the children of 12-14 years which was similar to adult females i.e. 32.83 per cent. This was followed by divergence of 31.48 per cent from normal Hb level in children of 5-11 years and 30.38 per cent in boys of 15-17 years. Similar type of observations was seen in study done by Verma *et al* (2013) and Lamba *et al* (2014).

Table 3. Hb level of 128 members of 30 families by their age

Age Group	N	Normal (g/dl)	Hb Mean Hb $\pm$ SD	SEm	% Deviation from normal
Children (<5 years)	4	11.00	7.98 $\pm$ 0.17	0.09	27.45
Children (5-11 years)	19	11.50	7.88 $\pm$ 0.68	0.16	31.48

Children (12-14 years)	10	12.00	8.04±0.56	0.18	33.00
Boys (15-17 years)	4	13.00	9.05±0.44	0.22	30.38
Girls (15-17 years)	3	12.00	8.60±0.53	0.31	28.33
Adult male	42	13.00	9.16±1.02	0.16	29.54
Adult female	46	12.00	8.06±1.05	0.15	32.83

All three categories of anaemia were present in the family members. 69.53 per cent were moderately anaemic, 28.13 per cent were severely anaemic, and very few 2.34 per cent were mildly anaemic in the selected families. Moderate anaemia was most commonly present (Table 4). All 30 intervention families had four or five anaemic members. Table 5 depicted that among selected 30 families, 22 families had family size four with all members anaemic. And 8 families had five members and all were anaemic. This showed that anaemia was present irrespective of family size and the families selected for intervention had all anaemic members.

Table 4. Percentage distribution of 128 members of 30 intervention families by category of anaemia

Anaemia category	Frequency (%)
Mild	3 (2.34)
Moderate	89 (69.53)
Severe	36 (28.13)

Table 5. Distribution of selected families by number of anaemic members in different family size

Family size	No. of families	No. of anaemic members	
		4	5
4	22	22 (100.00)	0
5	8	0	8 (100.00)
Total	30	22	8
<b>No. of families based on anaemic members in different family size</b>			

() Figures in parenthesis are percentage of families



The results pertaining to category of anaemia of 128 members revealed maximum were moderately anaemic (69.53%) followed by severely anaemic (28.13%) and very few mildly anaemic (2.34%) as depicted in Table 6. Adult females were most severely anaemic followed by children of 5-11 years and 12-14 years and then adult males. It can be inferred that anaemia was widely prevalent in all ages and gender. The most commonly prevalent category of anaemia in the study group was moderate to severe anaemia. The results were in conformity with reports of NNMB (2006) and NFHS-3.

Table 6. Distribution of members by grades of anaemia (n=30 families 128 members)

Age Group	N	Anaemia Category			Over all anaemic
		Mild	Moderate	Severe	
Children (<5 years)	4	-	4	0	4
			(100.00)		(100.00)
Children (5-11 years)	19	-	9	10	19
			(47.37)	(52.63)	(100.00)
Children (12-14 years)	10	-	7	3	10
			(70.00)	(30.00)	(100.00)
Boys (15-17 years)	4	-	4	0	4
			(100.00)		(100.00)
Girls (15-17 years)	3	-	3	0	3
			(100.00)		(100.00)
Adult male	42	2	36	4	42
		(4.76)	(85.71)	(9.53)	(100.00)
Adult female	46	1	26	19	46
		(2.17)	(56.53)	(41.30)	(100.00)
Total	128	3	89	36	128
		(2.34)	(69.53)	(28.13)	(100.00)

( ) Figures in parenthesis are percentage of members with in age groups

Majority of the selected families belonged to middle class. About seventy per cent members were moderately anaemic and twenty to thirty per cent were severely anaemic in middle class

(Table 7). Mahmood *et al* (2012) also reported that low socio-economic class had a direct relationship with presence of iron deficiency anaemia among populations.

Table 7. Distribution of members based on socio economic class and category of anaemia (n=30 families 128 members)

Sl. No.	Category	No. of families	Anaemia category			Overall anaemic members
			Mild	Moderate	Severe	
1.	Lower class	5	0	14 (60.90)	9 (39.10)	23 (100.00)
2.	Lower middle class	14	0	42 (71.20)	17 (28.80)	59 (100.00)
3.	Middle class	8	3 (9.10)	23 (69.70)	7 (21.20)	33 (100.00)
4.	Upper middle class	3	0	10 (76.90)	3 (23.10)	13 (100.00)

( ) Figures in parenthesis are percentage of members with in class

#### ***Underlying risk factors of anaemia***

Data was collected from all the 128 anaemic members of 30 families regarding general information *i.e.* age, gender, educational level. Table 8 depicted the agewise distribution of 128 members in 30 families. The distribution of members varies in different age groups. According to the distribution of subjects based on age group it was found that there were 35.94 per cent adult females, 32.81 per cent adult males and 31.25 per cent children of different age groups. Regarding distribution of subjects based on gender, it was equal *i.e.* 50.00 per cent males and 50.00 per cent females (Table 8). Out of total 128 family members, 40 subjects were children. Table 8 depicted the categorization of 88 adult family members of 30 families on the basis of educational level. It showed that 57.95 per cent members were illiterate. Very few were primary educated (10.23%) and middle educated (13.64%). Majority of adult family members were illiterate or had poor educational status. Similarly Table 8 depicted the classification of heads of 30 families on the basis of educational level. It showed that highest ratio was of illiterate *i.e.* 53.30 per cent followed by 26.70 per cent middle educated. These results are in close conformity with the findings of Premalatha *et al* (2012), Yerpude and Jogdanad (2013) and Abbasi *et al* (2013) who also reported that illiteracy and poor educational status are the risk factors for iron deficiency anaemia.

Table 8. Percentage distribution of 30 families by background information

<b>Age wise distribution of 128 members</b>	
<b>Age Group</b>	<b>No. of members (%)</b>
Children ( 4-6 yrs)	8 (6.25)
Children (7-9 yrs)	10 (7.81)
Children ( 10-12 yrs)	10 (7.81)
Children (13-15 yrs)	7 (5.47)
Children (16-17 yrs)	5 (3.91)
Adult male	42 (32.81)
Adult female	(35.94)
<b>Gender</b>	
<b>Gender</b>	<b>No. of members (%)</b>
Male	64 (50.00)
Female	64 (50.00)
<b>Educational level of 88 adult anaemic members of 30 families</b>	
<b>Educational level</b>	<b>Frequency (%)</b>
Illiterate	51 (57.95)
Primary	9 (10.23)
Middle	12 (13.64)
Secondary	5 (5.68)
Senior Secondary	6 (6.82)
Graduate and above	(5.68)
<b>Educational level of head of 30 families</b>	
<b>Educational level</b>	<b>Frequency (%)</b>
Illiterate	16 (53.30)
Primary	4 (13.30)
Middle	8 (26.70)
Secondary	(6.70)

- **Food eating habits:** Majority subjects (86.72%) were vegetarian and a small percentage of 12.50 per cent were non-vegetarian.

- **Taking non-vegetarian foods:** The non-vegetarian subjects (13.28%) were taking flesh foods and eggs only once a month. This reflected that there was more intake of non-haem iron from predominantly vegetarian diet in the study group.
- **Dietary pattern:** In relation to the frequency of meals taken, highest percentage of subjects (70.30%) were having two meal dietary pattern followed by 23.40 per cent taking three meals. Yerpude and Jogdand (2013) also reported that habit of taking meal was a significant socio-demographic determinant of iron deficiency anaemia.
- **Suffering from chronic disease:** Only 14.84 percent subjects were having some type of chronic illness like tuberculosis, gynaecological problem and arthritis. Rest 85.16 per cent subjects were free from any chronic disease which can become a cause of profuse bleeding leading to anaemia.
- **Toilet facilities:** It was observed that 74.20 per cent were having no toilet facility inside the house. Only 18.80 per cent had improved toilet facility inside the house and 7.00 percent had flush in the house. It was seen that 64.10 per cent subjects were going for defecation in the open ground around house and 11.70 per cent were going in open ground around the village. This clearly indicated that majority of the households had no toilets in the houses and subjects were going in open for defecation which could be the cause of various communicable diseases and infections.
- **Drainage:** More than sixty per cent of the drainage system was open in the study area which can be the major reason of mosquito and houseflies breeding.
- **Garbage disposal:** In respect of garbage disposal majority of the subjects (98.44%) were dumping household and farm waste in the open giving refuge to houseflies for multiplying and spreading infections.
- **Keeping of animals:** 67.20 per cent subjects reported keeping of animals inside their houses directly creating unhygienic conditions inside the house.
- **Washing hands before having food:** 99.20 per cent subjects used to wash hands before having food.
- **Washing hands after using toilet:** 99.20 per cent subjects were in the habit of always washing hands after using toilet.

- **Use soap for washing hands:** 47.66 per cent subjects used to wash hands with soap always followed by 42.97 per cent never used soap for washing hands and only 9.37 per cent used soap sometimes.
- **Brushing teeth daily:** 94.50 per cent subjects didn't used to brush teeth daily.
- **Drinking clean water:** All the subjects were drinking clean water.

There was no complaint about loss of appetite, nausea, blood in stools or vomiting and observed worms or its eggs in stools which revealed that the subjects were free from worm or helminthic infestation. So, it can be concluded that maximum subjects were vegetarian and the only few subjects who were non-vegetarian were having non-vegetarian foods once a month. Majority subjects used to take meals two times a day. Majority of the subjects were not suffering from any chronic disease and not having any complaints of worm infestation. There were no toilet facilities inside the house in almost all selected households and subjects go for defecation in the open ground. The drainage system was open in study area and garbage was disposed in open in maximum cases. Maximum households used to keep their animals inside the houses. Regarding discussing personal hygiene of subjects, almost all the subjects were washing hands always but only half of the subjects were using soap. Almost all subjects brush their teeth daily. The water used for drinking was from a clean source and stored at households properly. The high prevalence of anaemia in study group can be attributed to food habits, improper environmental sanitation and personal hygiene habits in the households (Table 9). Similar results were reported by Stevens *et al* (2013) and Manna and Ghosh (2014).

Table 9. Percentage distribution of 30 families by general information  
(Food habits, environmental sanitation and personal hygiene habits)

<b>Alternates</b>		<b>Frequency (%)</b>
<b>Food eating habits</b>		
	Vegetarian	111 (86.72)
	Non Vegetarian	16 (12.50)
	Ovatarian	1 (0.78)
<b>Taking non-vegetarian foods</b>		
	Non-consuming	111 (86.72)
	Daily	0 (0.00)

<b>Alternates</b>		<b>Frequency (%)</b>
	On alternate days	0 (0.00)
	Once a week	0 (0.00)
	One a fortnight	0 (0.00)
	Once a month	17 (13.28)
	Occasionally	0 (0.00)
<b>Dietary pattern</b>		
	1 meal	7 (5.50)
	2 meals	90 (70.30)
	3 meals	30 (23.40)
	4 meals	0 (0.00)
	More than 4 meals	1 (0.80)
<b>Suffering from chronic disease</b>		
	No	109 (85.16)
	Yes	19 (14.84)
<b>Toilet facilities (Inside house)</b>		
	No	95 (74.20)
	Flush	9 (7.00)
	Improved	24 (18.80)
<b>Toilet facilities (Outside house)</b>		
	No	31 (24.20)
	Open ground around house	82 (64.10)
	Open ground around village	15 (11.70)
<b>Drainage</b>		
	Open	83 (64.80)
	Closed	45 (35.20)
<b>Garbage disposal</b>		
	Open	126 (98.44)
	Pits	2 (1.56)
<b>Keeping of animals</b>		
	Inside house	86 (67.20)

<b>Alternates</b>		<b>Frequency (%)</b>
	Outside house	42 (32.80)
<b>Washing hands before having food</b>		
	Never	0 (0.00)
	Sometimes	1 (0.80)
	Frequently	0 (0.00)
	Always	127 (99.20)
<b>Washing hands after using toilet</b>		
	Never	1 (0.80)
	Sometimes	0 (0.00)
	Frequently	0 (0.00)
	Always	127 (99.20)
<b>Use soap for washing hands</b>		
	Never	55 (42.97)
	Sometimes	12 (9.37)
	Frequently	0 (0.00)
	Always	61 (47.66)
<b>Brushing teeth daily</b>		
	Never	121 (94.50)
	Sometimes	1 (0.80)
	Frequently	0 (0.00)
	Always	6 (4.70)
<b>Drinking clean water</b>		
	Never	0 (0.00)
	Sometimes	0 (0.00)
	Frequently	0 (0.00)
	Always	128 (100.00)
<b>Loss of appetite, nausea, blood in stools or vomiting</b>		
	No	128 (100.00)
	Yes	0 (0.00)
<b>Worms or its eggs in stools</b>		

<b>Alternates</b>		<b>Frequency (%)</b>
No		128 (100.00)
Yes		0 (0.00)

***Socio-economic profile***

Data was collected from heads of 30 families pertaining to parameters determining socio-economic class and suitably classified as suggested by revised Udai Pareek socio economic status scale (rural) 2015 as enumerated below:

Maximum 70.00 per cent families belonged to agriculture caste and 20.00 per cent belonged to lower caste. Only three families were from prestige caste as given in Table 10. Further Table 10 demonstrated about land holding owned by the screened families and revealed that 43.33 per cent of screened families were landless followed by families having land holding of 1-5 acres (23.33%) which was at par with families having less than 1 acre (20.00%) and families having 5-10 acres land were 13.34 per cent respectively. Maximum families were landless or having less land. Regarding type of family, all the 30 families had up to five member family size (Table 10). Yerpude and Jogdand (2013) also reported that type of family was a significant socio-demographic determinant. Socio-economic class has a profound effect on the quality and quantity of dietary intake along with habits of personal hygiene and environmental sanitation. As socio economic class is an indicative of purchasing power and standard of living which are hidden reasons for various nutritional deficiencies. While studying the socio-economic class of 30 families, it was found that 46.67 per cent families belong to lower middle class followed by middle class (26.67%) and lower class (16.66%) as given in Table 10. Similar results were seen in a study done by Bhatnagar and Paliwal (2009) who reported prevalence of anameia was higher in low socio-economic status people. Only three families were from upper middle class.

Table 10. Percentage distribution of 30 families by socio-economic profile

<b>Category</b>	<b>Frequency (%)</b>
<b>1. Caste of 30 families</b>	
Lower caste	6 (20.00)
Agriculture caste	21 (70.00)
Prestige caste	(10.00)



<b>2. Land holding owned by 30 families</b>	
No land	13 (43.33)
Less than 1 acre	6 (20.00)
1-5 acre	7 (23.33)
5-10 acre	(13.34)
<b>3. Type of family</b>	
Size upto 5	(100.00)
<b>4. Socio-economic class</b>	
Lower class	5 (16.66)
Lower middle class	14 (46.67)
Middle class	8 (26.67)
Upper middle class	3 (10.00)

### **Conclusion**

A high prevalence of anaemia was observed in subjects of all ages, stages and sex in rural areas and poses a major health problem in rural populations. The commonest form of anaemia present was of moderate type. The most vulnerable were women and children. The educational level was found to be low and the family size has no direct correlation with the presence of anaemia. The high prevalence of anaemia in study group can be attributed to vegetarian diet, improper environmental sanitation and personal hygiene habits in the households, low socio economic status and poverty. Efforts are needed at individual as well as community level to improve health and nutritional status of the whole family as the problem of iron deficiency and iron deficiency anaemia is prevalent irrespective of age, stage and sex. Nutrition education is to be emphasized to focus on the improvement of dietary habits and quantity and quality of the diet. Alongwith it, issues of education, hygiene and sanitation, living standard are also to be taken care of while attending the widespread problem of iron deficiency anaemia.

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## Nature and extent of adoption and knowledge of farmers regarding Happy Seeder

Chapter

10

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### ABSTRACT

Wheat is major cropping system in North West India with cropping intensity of nearly 200 %. The huge quantity of paddy straw after the combine harvesting of paddy is to be managed in 15-20 days to plant next succeeding wheat crop. Keeping in mind this short window of time, farmers prefer to burn rice residue after combine harvesting of crop because residues interfere with tillage and seeding operations for the next crop. According to a report by the Ministry of Agriculture & Farmers welfare (2018), total paddy straw produced in Haryana and Punjab together is 28.10 million tonnes (2018 estimates) out of which 11.3 million tonnes was burnt in the fields.. Though a number of machines are available for straw management, Happy Seeder is one of the unique techniques which is used for sowing wheat in standing stubbles of crop residue. The study was conducted in two agro-climate zones of Haryana namely dry zone and wet zone. Two districts i.e. Kaithal and Fatehabad were randomly selected from both the zones. From each of two selected districts, one block was i.e. Pundri from Kaithal & Ratia from Fatehabad were randomly selected for the purpose of the study. After the selection of blocks, a cluster of villages were randomly selected for the purpose of the study. 30 adopters and 30 non-adopters respondents were selected from each block on the whole 120 respondents were selected for the purpose of the study. The analysis clearly revealed that majority of the respondents i.e. 51.66% lie at medium level of adoption level

followed by 20.0% at low and 28.33% at high level. With regard to education 33.3% of the respondents had education up to secondary school & above category, 30.0% of the respondents had education up to primary school, 17.5% of the respondents had education upto middle school, and 19.2% of the respondents were illiterate. With regards to the caste, majority of the respondents belonged to the general caste i.e. 75.2% where as 12.5% of the respondents were from backward class and 11.3% of the respondents were from scheduled caste respectively. that majority of the respondents were having medium level of knowledge, 16.7% of the respondents were having low level of knowledge whereas 40.0% of the respondents belonged to high level of knowledge.

**Key words:** Happy Seeder, nature, extent, technique

### **Introduction**

According to a report by the Ministry of Agriculture & Farmers welfare (2018), total paddy straw produced in Haryana and Punjab together is 28.10 million tonnes (2018 estimates) out of which 11.3 million tonnes was burnt in the fields. 59.79% of the straw was managed through incorporation in the soil and other measures. In Haryana 16.9% of the straw was burnt while in Punjab it was 49.47%. Haryana accounted for 11.85% of the straw while Punjab accounts for 88.15% of the straw burnt in these two States. Large scale burning is confined to Fatehabad, Sirsa, Kaithal, Karnal and Kurukshetra in Haryana. Haryana is among the top ten producers of food grains and stands at sixth place with a total production of 16.38 million tonnes from an area of 4.47 million Hectares. Of total food grains produced in the state, contribution of wheat and rice was 11.3 and 4.15 million tonnes respectively. Haryana is the 4th largest producer of wheat in the country with approximately 12 per cent of total wheat production. The state stands at 10th place in total rice production (Ministry of Agriculture & Farmers welfare). It is also a major food grain consumed in Haryana and exported out of the state. An acre of paddy field produces around 2.5 tonnes of stubble which, on burning, releases 7.5 kg of particulate matter, 150 kg of carbon monoxide, 3,650 kg of carbon dioxide, 498 kg of ash and 5 kg of sulphur dioxide. These gases and aerosols consisting of carbonaceous matter contribute to global climate change. For sowing wheat on-time the burning of rice residue decreases the soil fertility and is harmful for human beings, animals and environment (The Hindu Business line, 2018). On other hand, burning of paddy stubbles leads to the loss of precious nutrients, as nearly 25% nitrogen and phosphorus, 50% sulphur and 75% potassium. It is estimated that burning of 1 tonne of stubble or paddy straw accounts for loss of 5.5 kg N, 2.3 kg P, 25 kg K and 1.2 kg S, besides organic carbon. Husk

has high productive value. Rice husk is unusually high in ash, which contain 92-95% silica, highly porous and light in weight, with a very high surface area. Its absorbent and insulating properties are useful in many industrial applications, such as acting as strengthening agent in building materials. Heat generated by burning paddy straw kills useful microbes in the soil leading to loss of soil nutrients & poor soil health. Husk is also produced as fuel for processing paddy, production through direct combustion or gasification. Hundreds of farmers in several villages of Haryana are restless and worried because the state government, they say, is not lending them an ear over the issue of crop burning and paddy straw disposal so they generally burn paddy straw before wheat sowing as the cheap and easy option for residue management as spreading, removal and incorporation of paddy straw in the field are labor-intensive and expensive tasks. Burning of agricultural field residue (stalks and stubble) during wheat and rice harvesting periods in the Indo-Gangetic plains is an important source of atmospheric pollution in this region. But a simple solution exists. With the invention of Turbo Happy Seeder (THS), farmers need not burn the crop residues for sowing of next crop. The THS has a provision of direct drilling of seed and fertilizers at desired seed and fertilizer rates, depth and spacing in one go. Thus, by deploying the Happy Seeder, straw could be easily managed without burning and its retention enhances the soil productivity. Thus, Happy Seeder Technology promotes minimal disturbance of the soil by tillage (zero tillage), balanced application of chemical inputs (only as required for improved soil quality and healthy crop and animal production), and careful management of residues and wastes. This reduces land and water pollution and soil erosion, reduces long-term dependency on external inputs, enhances environmental management, improves water quality and water use efficiency, and reduces emissions of greenhouse gases. The Happy Seeder is a tractor mounted machine that cuts and lifts rice straw, sows wheat into the bare soil, and deposits the straw over the sown area as mulch. It therefore allows farmers to sow wheat immediately after their rice harvest without the need to burn any rice residue for land preparation. The wheat crop with Happy Seeder can be sown in standing stubbles of rice which avoids the preparatory tillage of the field and the crop can be sown 7-10 days earlier as compared to conventional method of sowing. For Sowing wheat on time the burning of Rice residue decreases the soil fertility and is harmful for human beings, Animals and environment. So, this technology is eco-friendly. With the burning of rice residue gases produced creates very harmful situations for our environment. The Happy Seeder offers the means of drilling wheat into rice stubble without burning rice residue, eliminates air pollution and loss of nutrients due to burning, at the same time it increases the yield (Sidhu *et al* 2007). The advantages of

Happy Seeder are that the possibility of sowing wheat crop just after rice harvesting i.e. option for long duration wheat and rice varieties, Possibility of sowing wheat in the residual moisture i.e. saves one irrigation, Timely sowing wheat even after long duration basmati rice varieties, Crop residue as much helps in moisture and temperature conservation, Environment friendly technology to check air pollution & Improved soil health. Gupta (2019) conducted a study in Punjab and revealed that Happy Seeder could not only save up to 1200/ acre in sowing of wheat but also facilitate the timely sowing of wheat without any residue burning. She also explained the constraints for adoption of Happy Seeder that were high cost of machine, no standard rent & low manufacturing in the state.

The study will prove beneficial for the farmers that crop burning is not the best method to remove stubble and has negative implications for the food system & soil fertility. For one, the nutrients present in the stubble are wasted in burning and farmers have to spend on chemical fertilizers to increase soil productivity. Burning rice residues leads to the ground temperature rising and the soil drying up necessitating additional water for irrigation and at last livestock is impacted by crop burning. Moreover, heavy smog slowly drifts in and hangs in through the winter, sending particulate matter (PM) levels soaring to a hazardous degree and results in respiratory problems. Comprehensive evaluation study is imperative to get the feedback from the farmers about the Happy Seeder technique. Such type of study will reveal the attitude, knowledge and level of adoption of Happy Seeder technique by the farmers. It will explore the impact of this innovation on the farming community along with the constraints. Empirical evidences in this regard will also facilitate the extension workers, policy makers, administrators to disseminate the information about this technological innovation to the farmers at large scale. Speedy adoption of this innovation will boost the eco-friendly farming', restore the ecological imbalance, raise the soil productivity and save water. Empirical evidence regarding its impact and case studies of successful farmers will encourage other farmers for opting for Happy Seeder technology. Guru *et al* (2017) concluded the recent developments in machinery (Happy Seeder) allowing zero-till sowing of wheat with rice residue as surface mulch, while maintaining yield, reduced tillage costs and time savings, avoids the need for burning.

Keeping these points in mind the present study has been planned with the following specific objectives:

- To assess the nature, extent of adoption and knowledge of farmers regarding Happy Seeder.

## **Materials and methods**

The study was conducted in two agro-climate zones of Haryana namely dry zone and wet zone. Two districts i.e., Kaithal and Fatehabad were randomly selected from both the zones. From each of two selected districts, one block was i.e., Pundri from Kaithal & Ratia from Fatehabad were randomly selected for the purpose of the study. 30 adopters and 30 non-adopters respondents were selected from each block on the whole 120 respondents were selected for the purpose of the study. The data was collected by interview method from the respondents to gather information on dependent and independent variables. The collected data were coded, tabulated, analyzed and interpreted according to the objectives of the present study with the help of appropriate statistical techniques. The descriptive statistical tools such as frequency, %age, chi-square, weighted mean and total weighted score were calculated to draw the inference. The data was tabulated, classified and analyzed by application of suitable statistical tools to work out association of the dependent and independent variables so as to draw meaningful inferences of the study. Frequency, %age, chi-square and many more can be calculated on the same platform.

## **Results and discussion**

### **Contextual matrix of the respondents**

It is clear from the table 1 that 52.5% of the respondents belonged to 25-50 years of age group followed by 25.0% of the respondents who belonged to up to 25 years age group and 21.5% of the respondents who belonged to above 50 years of age group. With regard to education 33.3% of the respondents had education up to secondary school & above category, 30.0% of the respondents had education up to primary school, 17.5% of the respondents had education upto middle school, and 19.2% of the respondents were illiterate. With regards to the caste, majority of the respondents belonged to the general caste i.e. 75.2% where as 12.5% of the respondents were from backward class and 11.3% of the respondents were from scheduled caste respectively. With regard to family type 51.6% of the respondents belonged to joint family where as 48.4% of the respondents were having nuclear family. With regard to family size 42.5% of the respondents had 5-8 members, whereas 38.3% of the respondents had up to 4 members and 19.2% of the respondents had above 8 members. Regarding size of land holding, it was found that 30.8% of the respondents were small farmers with land between 1-2 ha, 25.8% of the respondents were marginal farmers with less than 1 ha of land, 20.0% of the respondents were having 2-4 ha of land and fell under the category of semi-medium farmers and 23.0% of the respondents were medium farmers with 4-10 ha of land holding. Data revealed that 40.8% of the respondents were having no



subsidiary occupation, 20.0% of the respondents were involved in services & 39.2% of the respondents had small scale enterprises. Data regarding annual income clearly shows that 40.0% of the respondents were earning (up to Rs.1,50,000), 39.2 % of the respondents were earning Rs. 1,50,001 – 3,00,000 and 20.8% of the respondents were earning above Rs. 3,00,001. Regarding socio-economic status 17.5% of the respondents were having low socio-economic status and 40.0% were having medium whereas maximum number 42.5% of the respondents belonged to higher socio-economic status. Regarding mass media exposure, 44.2% of the respondents were at medium level of mass-media exposure whereas 40.8% of the respondents had low level of mass media exposure and 15.0% of the respondents had high level of mass media exposure. It was clearly found that 48.3% of the respondents were member of one organization. 26.2% and 15.5% of the respondents were not member of any organization and more than one organization. Data revealed that 50.0% of the respondents were having low extension contact and 12.5% accepted that they were having medium extension contacts.

Table 1. Contextual matrix of the respondents

<b>Sl. No.</b>	<b>Variables</b>	<b>Adopters (n=60)</b>	<b>Non adopters (n=60)</b>	<b>Total (n=120)</b>
1.	<b>Age</b>			
	Up to 25yrs of age group	27(45.0)	4(6.6)	31(25.0)
	Between 25 to 50 yrs of age group	18(30.0)	45(75.0)	63(52.5)
	Above 50 yrs of age group	15(25.0)	11(18.4)	26(21.5)
2.	<b>Education</b>			
	Illiterate	11(18.3)	12(20.0)	23(19.2)
	Primary School	13(21.7)	23(38.3)	36(30.0)
	Middle School	13(21.7)	8(13.3)	21(17.5)
	Secondary School & above	23(38.3)	17(28.4)	40(33.3)
3.	<b>Caste</b>			
	Scheduled	10(16.7)	4(6.6)	14(11.3)
	Backward	11(18.3)	4(6.6)	15(12.5)
	General	39(65.0)	52(86.8)	91(75.2)
4.	<b>Family Type</b>			
	Nuclear	31(51.7)	27(45.4)	58(48.4)
	Joint	29(48.3)	33(96.6)	62(51.6)

<b>5. Family Size</b>			
Upto 4 members	30(50.0)	21(35.0)	46(38.3)
Between 5 to 8 members	16(26.7)	30(50.0)	51(42.5)
Above 8 members	14(23.3)	9(15.0)	23(19.2)
<b>6. Size of landholding</b>			
Marginal (<1 ha)	19(31.7)	12(20.0)	31(25.8)
Small (1-2 ha)	18(30.0)	19(31.6)	37(30.8)
Semi medium (2-4 ha)	12(20.0)	12(20.0)	24(20.0)
Medium (4-10 ha)	11(18.3)	17(28.4)	28(23.0)
<b>7. Occupation</b>			
Nil	16(26.7)	33(55.0)	49(40.8)
Service	16(26.7)	8(13.4)	24(20.0)
Small scale enterprise	28(46.6)	19(31.6)	47(39.2)
<b>8. Annual Income</b>			
Up to 1,50,000	29(48.3)	19(31.6)	48(40.0)
Between 1,50,001-3,00,000	16(26.7)	31(51.6)	47(39.2)
Above 3,00,001	15(25.0)	10(16.8)	25(20.8)
<b>9. Socio-economic Status</b>			
Low (4-6)	9(15.0)	12(20.00)	21(17.5)
Medium (7-9)	22(36.7)	26(43.33)	48(40.0)
High (10-12)	29(48.3)	22(36.67)	51(42.5)
<b>10. Mass media exposure</b>			
Low (4-6)	23(38.3)	26(43.4)	49(40.8)
Medium(7-9)	22(36.7)	31(51.6)	53(44.2)
High(above 10)	15(25.0)	3(5.0)	18(15.0)
<b>11. Social Participation</b>			
Not member of any organization	31(51.7)	12(20.0)	43(26.2)
Member of 1 organization	16(26.7)	42(70.0)	58(48.3)
More than 1 organization	13(21.6)	6(10.0)	19(15.5)
<b>12. Extension Contacts</b>			
Nil (1)	35(58.3)	10(16.6)	45(37.5)
low (2-3)	15(25.0)	45(75.0)	60(50.0)
Medium (above 3)	10(16.7)	5(8.4)	15(12.5)

**Knowledge level of adopters regarding Happy Seeder**

Regarding the statement to ensure uniformity in soil the field should be laser leveled for direct drilling of crops 60.8% of the respondents had knowledge about it whereas 39.2% had no knowledge about it. With regard to the statement happy seeder should be operated after sufficient evaporation of moisture from residues 63.3% of the respondents had knowledge about it followed by 36.7% who had no knowledge. Regarding the statements Diversification of farming should be done in order to change/ raise the level of crop production and living standard of farmers and Don't sow crop with Happy Seeder where paddy residues are infested with pests 66.7% of the respondents had knowledge about it whereas 33.3% of them knew nothing about it. Regarding the statement Use double clutch tractor for sowing operation with Happy Seeder 68.3% of the respondents had knowledge followed by 31.7% who had no knowledge. With regard to statements Ensure the condition of Happy Seeder before operating particularly, the fasteners, blade bolts and welds, ensure optimal soil moisture content at time of sowing so as to have uniform crop establishment & don't irrigate the field before sowing of wheat with happy seeder 67.5% of the respondents had knowledge whereas 32.5 had no knowledge. With regards to statement Using combine harvester before Happy Seeder led to ease of using Happy Seeder 65% of respondents had knowledge about it whereas 35% had no knowledge. Ngwira *et al* (2014) in Malawi on extent of adoption of conservation agriculture practice among the farmers. They found out that membership to NGOs and farmer groups, operational land holding, extension efforts by the extension agents and linkage between the farmer and extension agencies have positive effect on extent and rate of adoption of conservation agriculture practice. Singh and Chahal (2009) conducted a study in Punjab and described the extent of adoption as the number of improved practices adopted by the selected wheat growers. They studied extent of adoption in terms of area covered by the farmers under HST out of their total operational land holding.

Table 2. knowledge level of adopters regarding Happy Seeder (n=120)

<b>Sl. No.</b>	<b>STATEMENTS</b>	<b>YES (2)</b>	<b>NO (1)</b>
1.	To ensure uniformity in soil the fields should be laser levelled for direct drilling of crops	73(60.8)	47(39.2)
2.	Happy Seeder should be operated after sufficient evaporation of moisture from residues.	76(63.3)	44(36.7)

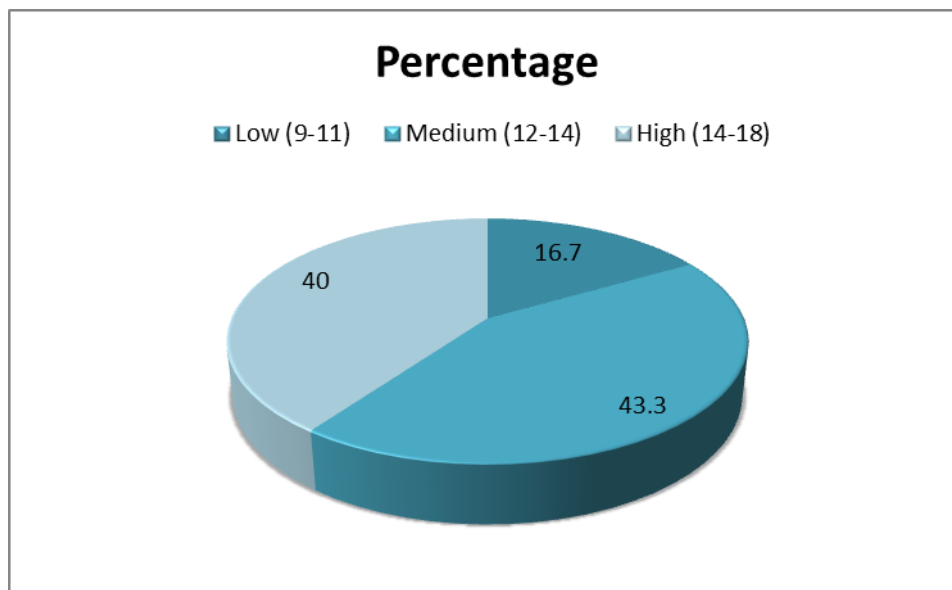
3.	Diversification of farming should be done in order to change/ raise the level of crop production and living standard of farmers	80(66.7)	40(33.3)
4.	Use double clutch tractor for sowing operation with Happy Seeder	82(68.3)	38(31.7)
5.	Ensure the condition of Happy Seeder before operating particularly, the fasteners, blade bolts and welds	81(67.5)	39(32.5)
6.	Ensure optimal soil moisture content at time of sowing so as to have uniform crop establishment	81(67.5)	39(32.5)
7.	Don't irrigate the fields before sowing of wheat with Happy Seeder	81(67.5)	39(32.5)
8.	Don't sow crop with Happy Seeder where paddy residues are infested with pests	80(66.7)	40(33.3)
9.	Using combine harvester before Happy Seeder led to ease of using Happy Seeder	78(65.0)	42(35.0)

### **Level of knowledge of Happy Seeder adopters**

In Table 3 or in Fig.1 it can be clearly seen that majority of the respondents were having medium level of knowledge, 16.7% of the respondents were having low level of knowledge whereas 40.0% of the respondents belonged to high level of knowledge. Singh (2020) conducted a study in five Agro-Climate zones of Punjab and found that major constraints in the adoption of HST are non-uniformity in rent and design of the machine, high initial cost, requirement of high power tractor, management of moisture. Agronomic practices such as seed rate, fertilizer doze and methods of application, weed management, irrigation etc. need to be validated through research for Happy Seeder sown wheat as compared to traditional method of wheat cultivation. Awareness and motivation among the farmers regarding environmental pollution and Happy Seeder technology should be increased as they are taking maximum time to reach interest stage from awareness stage.

Table 3. Level of knowledge of Happy Seeder adopters (N=60)

Sl. No.	Knowledge level	Frequency	Percentage
1.	Low (9-11)	10	(16.7)
2.	Medium (12-14)	26	(43.3)
3.	High (14-18)	24	(40.0)

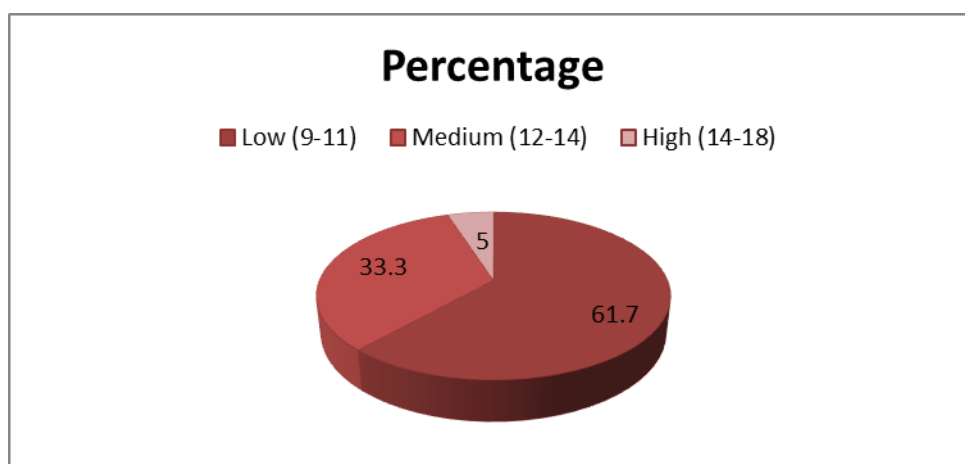


**Fig. 1. Level of knowledge of Happy Seeder non-adopters**

In Table 4 or in Fig.2 it can be clearly seen that majority of the respondents 61.7% were having low level of knowledge, 33.3% were having medium level of knowledge whereas only 5% of them belonged to high level of knowledge.

Table 4. Level of knowledge of Happy Seeder non-adopters (N=60)

Sl. No.	Knowledge level	Frequency	Percentage
1.	Low (9-11)	37	(61.7)
2.	Medium (12-14)	20	(33.3)
3.	High (14-18)	3	(5.00)



**Fig. 2. Nature and extent of adopters regarding Happy Seeder**

All the respondents were using Happy Seeder on wheat crop & most of them were using Happy Seeder on 33-66% of their land comes under medium category

Table 5. Nature & extent of adoption regarding Happy Seeder (n=60)

<b>WHEAT- 60 (100%)</b>		
<b>Low</b> (up to 33%)	<b>Medium</b> (33-66%)	<b>High</b> (Above 66%)
9(17.1)	28(46.6)	23(38.3)

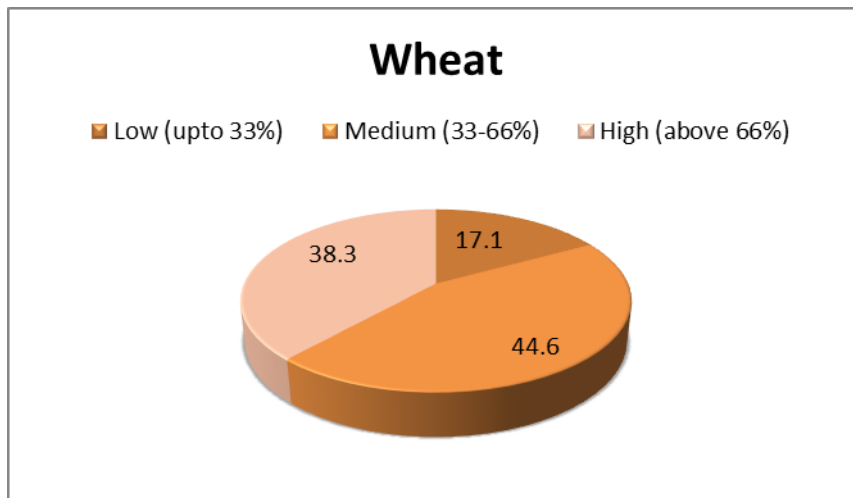


Fig. 3. Adoption level of respondents towards Happy Seeder

In Table 6 it is clearly revealed that majority of the respondents i.e. 51.66% lie at medium level of adoption level followed by 20.0% at low and 28.33% at high level. Manan & Sharma (2017) conducted a survey in district Kapurthala, Punjab and reported that the method of sowing in wheat, shift in area under rotavator and Happy Seeder was observed from seed cum fertilizer drill, as compared to last year. Overall, farmers preferred new varieties and technologies. With the ease in technology, the adoption level increased as in case of zero till seed drill and broadcasting methods of wheat sowing.

Table 6. Level of adoption of respondents towards Happy Seeder (n=60)

<b>Sl. No.</b>	<b>Adoption level</b>	<b>Frequency</b>	<b>Percentage</b>
1.	Low (Up to 3)	12	(20.0)
2.	Medium (4-6)	31	(51.6)
3.	High (above 6)	17	(28.4)

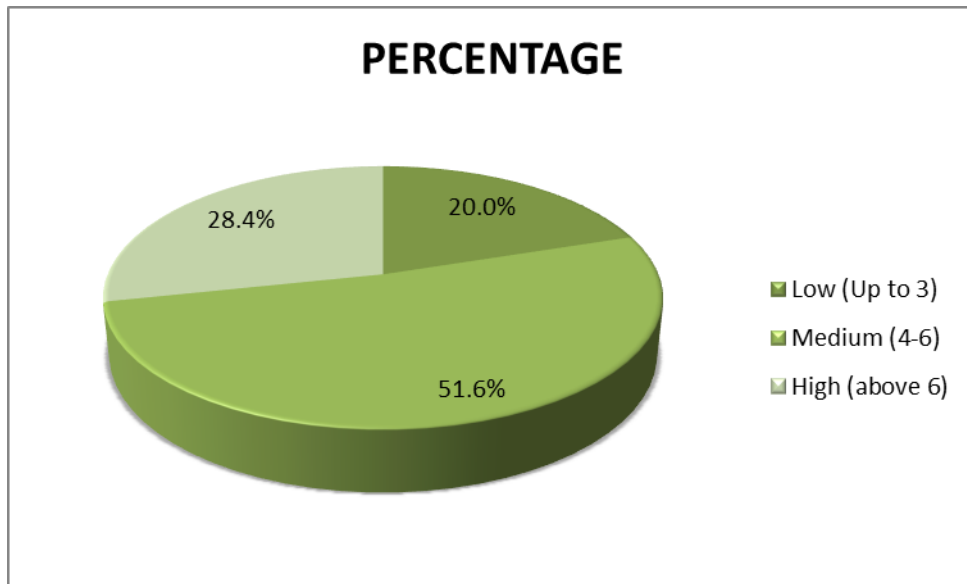


Fig. 4. Level of adoption of respondents towards happy seeder

### **Conclusions**

It was concluded that majority of the farmers had joint family, belonged to general caste and were married. Most of the respondents belonged to medium level of mass media exposure and have low extension contacts. Adopters falls in medium category of knowledge level whereas non- adopters have low knowledge about Happy Seeder which clearly indicates that adopters have more knowledge about Happy Seeder than non-adopters. Majority of adopters agreed to the fact that Happy Seeder is a profitable technology and should be adopted by all the farmers whereas non adopters were not adopting it because they have better technologies & they don't find it beneficial at all. *Singh J. & Singh M. (2020) concluded that sowing wheat crop with Happy Seeder in previous crop residues gave similar or slightly higher grain yield than wheat sown with normal drill after burning previous paddy residue. This method reduced cost of machinery operations for wheat crop establishment by reducing time taken for field operations, reduced weed control and labor cost. It avoids the need for burning and terrible air pollution due to burning. Retention of paddy residue in field added nutrients to the field along with organic matter.*

### **Constraints**

Educational constraints Lack of extension contact and Lack of adequate training programme & literature.

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<b>Role of plant growth regulators in flower crops</b>	<b>Chapter</b>
	11
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## **ABSTRACT**

Plant growth regulators play a critical role in the integration of developmental processes. Environmental variables frequently cause inductive effects in plants by causing changes in hormone metabolism and distribution. They also control the expression of a plant's innate genetic potential. Phytohormones have been shown to control genetic expression at both the transcriptional and translational levels. Their exogenous application aids in the improvement of a variety of economically significant and market-desirable floral crop qualities. Plant growth regulators as part of their cultural practises, commercial growers of ornamental plants and flower crops use. Plant growth regulators' efficacy is influenced by a number of factors, one of which is the mode of application. In determining the efficacy of plant growth regulators, because PGRs can be useful if plants absorb them adequately. Furthermore, creation of a method to focus on the elements that can influence a plant's response to plant growth regulators will aid in increasing the efficiency of PGRs. And avoid phytotoxicity which can maximize their productivity.

**Keywords:** plant growth regulators, flowers, growth regulation, metabolism

## **Introduction**

Since the start of history, flowers have been associated with mankind. They represent love, beauty, and serenity. In our nation, Flowers have been grown and used since the beginning of

time. Flowers have become an important element of our daily lives. Its use has increased as a result of changing lifestyles, particularly for religious and social purposes. This has led to a better knowledge of the economic value of flowers, as well as their aesthetic appeal. Globally, The production of floricultural crops is practised in more than 140 countries. Approximately 309 thousand hectares of floriculture land were under cultivation in India in 2017-18. In 2017-18, India produced 1,806 million tonnes of loose flowers and 704 million stems of cut flowers. During 2015-16, the country exported 25105.21 million tonnes of floriculture goods to the world, worth Rs. 479.42 crores. The United States, the Netherlands, Germany, the United Kingdom, the United Arab Emirates, Japan, and Canada are the top export destinations (APEDA 2017). Plant growth regulators, or phytohormones, are chemical substances produced naturally in higher plants that regulate growth or other physiological functions at a distance from their source and are only active in trace amounts. Auxins, gibberellins, cytokinins, ethylene, growth retardants, and growth inhibitors are examples of plant growth regulators. Auxins were the first hormones found in plants, followed by gibberellins and cytokinins.

**Factors Affecting PGR Efficiency:** The effects of PGRs in plants are dependent on a number of elements that all play a part in achieving the desired results. The method of application, the time of application, the concentration of PGRs, the plant species, and the environmental circumstances in which the plants are produced are all elements to consider (Grzesik, 1989). The frequency with which PGRs are used is also thought to have an impact on their efficacy, although some plants respond well to a single spray, most plants require numerous applications to achieve effective results. (Carey *et al*, 2007). Other auxiliary elements could include the chemical characteristics of the PGRs solution, particularly the pH, which is important for PGR absorption by plants. We analyse the various techniques of application and their potential advantages over one another.

**Application Methods:** In the literature, different techniques of applying PGRs to plants have been recorded, the most common of which is foliar application (Sajjad *et al*, 2014), drenching (Matsumoto, 2006), pre-plant sowing (Currey and Lopez, 2010), seed priming (Pill and Gunter, 2001), pasting (Saniewski *et al*, 2010), capillary string (Carswell *et al*, 1996) and injection (de Vries and Dubois, 1988). Foliar spray, drenching, and pre-planting are the most often used methods for ornamental plants. Early application of PGRs, such as dipping before planting and substrate drenching during planting time, is beneficial in achieving desired

effects and also supports the efficient use of these compounds, according to studies. (Ranwala *et al*, 2005). Due to differences in their modes of absorption by plants, the effects of PGRs vary depending on how they are applied, Some chemicals are taken just through the root, leaves, or stem, while others are absorbed by all of the above organs, giving you the option to use them in either way, Anthymidol is absorbed by the roots, stems, and leaves, but B-Nine is only absorbed through foliar sprays, but Bonzi and sumagic are absorbed through the stem and root zone. (Latimer, 2009). The most prevalent methods utilised by commercial producers are foliar spraying and soil drenching. (Lee and Rho, 2000) In the event of foliar sprays, larger concentrations of PGRs are utilised. The presence of large concentrations of some PGRs can be harmful to plants, resulting in stunted development.(Cox and Keever, 1988) In addition, the input cost rises. Foliar application for pest management might be more successful if done at the proper time of growth. It requires knowledge about the phenology of the target plant as well as certain features. The plant's response to foliar spray is also influenced by absorption rate, which is influenced by environmental factors such as temperature and humidity. Plants are said to absorb more PGRs when the temperature is somewhat higher, the humidity is higher, and the drying period is longer.

Soil drenching is a good method, and PGRs are used in smaller amounts, but residual PGR effects persist in pots, which can harm the plant. Drenching have advantage over foliar sprays in that it ensures treatment homogeneity by delivering the same amount of PGRs to each plant and allowing absorption via the root zone. This approach is appropriate for PGRs that absorb well through the root medium. (Sanderson *et al*, 1988). Substrate drenching involves more labour than other approaches; as a result, it may not be cost effective if labour is highly compensated in that area.

Although pre-plant soaking of plant material in PGRs has been reported to be an effective method, their use on a commercial scale is relatively uncommon (Sajjad *et al*, 2015). Over other approaches, this method has the advantages of saving time and effort, as well as correct dose, although disposal of residual solutions can be difficult (Larson *et al*, 1987), as some PGRs including paclobutrazol, uniconazole, ancymidol etc. When disposed of in an open environment, it can be hazardous to the environment. This issue can be rectified by using the previously utilised solutions as a substrate drench at a later date. (Krug, 2004). The concentration of PGRs and the duration of dipping plant material in the solution are the two most essential elements that impact the success of this approach. (Ranwala *et al*, 2002). Application of PGRs in lower doses supports their usage on a large scale cheaply, and low

doses are effective if the dipping time is increased, as longer dipping time may improve chemical absorption, which can speed up effectiveness.

**Auxins:** Auxins increase stem elongation while inhibiting lateral bud development. (maintains apical dominance). The stem, buds, and root tips all produce them. Example: Indole Acetic Acid (IAA). Auxin is a plant hormone that promotes cell elongation and is produced in the stem tip. Auxin travels to the darker side of the plant, causing cells on that side to grow larger than those on the lighter side. Phototropism is the curving of the plant stem tip toward the light as a result of this. Auxins are widely known for initiating and stimulating stem cutting roots. (Hartmann *et al*, 2002), a quick-dip in a concentrated solution as a base. Auxins are commonly employed in commercial plant propagation to boost rooting percentage, speed root initiation, increase the number and quality of roots, and promote root uniformity. IBA is the most often used auxin for commercial rooting. (Karimi *et al*, 2012). Indole-3-butyric acid (IBA) and naphthalene acetic acid are two synthesised materials (NAA), For rooting, they were even more effective than naturally occurring or synthesised IAA, and they were frequently utilised in tissue culture produced micro cuttings rooted. IBA and NAA (alone and in combination) have both been shown to be effective in establishing roots in cuttings. When these two hormones are combined in differing amounts, they are said to have a synergistic impact.

### **Plant Propagation**

In flower crops, there are three kinds of propagation: asexual or vegetative methods, sexual (via seed), and micro-propagation (through tissue culture). Vegetative propagation methods such as stem and leaf cuttings, bulbs, corms, and tubers are used to propagate the majority of ornamental plants.

**A) Vegetative Propagation:** In Rose, chrysanthemum, carnation, gerbera. Auxins (IBA, NAA and IAA) are mostly used for rooting of the cuttings. IBA is the most popular and widely used auxin for rooting. (Indole Butyric acid) followed by NAA and IAA. Auxin combinations containing two or more auxins are more efficient (synergistic effect).

### **There are 3 Methods of Auxins Application for Inducing Rooting**

1. Long-term soak therapy at low dosages for 24 hours (25- 100 ppm)
2. Depending on the nature of the cuttings, whether they are soft or hard wood, the quick dip procedure involves dipping the basal region of the cuttings in greater concentrations of 1000-10000 ppm for 5 seconds to 2 minutes.
3. Dip the damp basal section of the cuttings in auxin-tainted tale (500-12000 ppm)

The success of rooting is determined by a number of external and internal criteria, such as the best time to plant, the best time to plant, and the best time to plant. Photoperiod, Light, Temperature, Aeration, Humidity, nutrient status of the cutting and endogenous auxins level in the cutting for e.g. For bougainvillea, For propagation, hard wood cuttings are employed, with 1000-3000 ppm IBA in a fast dip procedure being the best. At 1000 ppm of NAA, the proportion of roots increases and the time it takes for rotting decreases.

**B) Seed Propagation:** Marigolds, antirrhinums, pansies, coreopsis, gaillardia, larkspur, petunia, phlox, Verbena, sweet alyssum, candytuft, sweet sultan, lupine, and other seasonal flowers. Germination percentage, seedling vigour, and final population stand are all improved when seeds are treated with lower concentrations of gibberellic acid etc in many seed propagated seasonal flowers.

**C) Micro-Propagation:** Orchids, Carnation, and Gerbera, Anthurium. Cytokinins and auxins are widely used as supplements for induction of shoots and roots, respectively in the tissue cultured plantlets

Susaj *et al* (2003) Germination percentage, seedling vigour, and final population stand all improve when seeds are treated with lower concentrations of gibberellic acid (50 and 47 roots) and the longest roots at the end of vegetation (31 and 28 cm) were recorded by using IBA 1000 ppm. However, utilising IBA 500 ppm resulted in the strongest roots and healthiest seedlings. Krishnamurthy *et al* (2017) observed that significant effect on all sprouting and growth parameters. At 1500 ppm of IBA, maximum bud sprouting (78.8%), days to sprout (6), number of leaves / plant (10), and chlorophyll index (39.3 mg/g) in rose cuttings were measured. The optimum level of IBA was discovered to be between 1000 and 1500 ppm, but NAA had no such impact on these, IBA was superior to NAA for its strong synergistic effect on all growth parameters.

**Gibberellins:** Increased inter-node extension, leaf growth, plant diameter, number of flowers, induce flowering, and enhanced apical dominance are the most notable impacts of GA3 on shoot growth. GA3 simulates light in its effects on leaf expansion and some forms of dormancy. Increased shoot growth is induced in most photoperiod-sensitive plants, particularly in the form of long-day photoperiod, GA3 has a similar effect. It also has stimulant effect on germination (Shohani *et al*, 2014). Gibberellins are plant growth regulators that influence a variety of developmental events including as stem elongation, germination, dormancy breaking, flowering, sex expression, enzyme induction, and leaf and fruit senescence. In chrysanthemum and other flowering plants, GA3 spraying resulted in

increased plant height, spread, and the number of leaves and branches (Lal & Mishra, 1986; Sujatha *et al*, 2002; Kumar *et al*, 2003; Rana *et al*, 2005).

Gibberellins cause many beautiful plants to blossom early and increase the quantity of flowers. In Chrysanthemum, spraying GA3 produced early flowering, increased flower size, fresh weight, and dried weight (Nagarjuna *et al*, 1988); (Koriesh *et al*, 1989). Gibberellic acid has been proven to help marigold plants grow faster and produce more flowers (Girwani *et al*, 1990). GA3 has been found to control plant development via regulating cell division and cell expansion. Spraying of GA3 gave maximum number of flowers per plant, flower weight and flower yield (Kumar *et al*, 2003), In anthurium, foliar application of GA3 increases stalk length and spathe length (Dhaduk *et al*, 2007). Whereas, (Devadanam *et al* 2007) The minimum number of days required for spike emergence has been observed. maximum spike length after GA3 foliar spray. In marigold and tuberose, decreased GA3 concentrations reduce the number of days to 50% flowering and increase the number of leaves, spike girth, spike length, rachis length, floret length, and floret diameter (Panwar *et al*, 2006; Devadanam *et al*, 2007).

### **Seed Set and Yield**

In many seasonal flowers, such as pansy, petunia, phlox, and cineraria, GA3 at lower concentrations (5-10 ppm) promotes fruit set and seed output. Seed treatment (by soaking) with IBA 5 ppm or GA3 5-10 ppm for 12-24 hours significantly improved seed output in balsam plants compared to control plants. This improves the germination percentage. In gladiolus, tuberose, and other plants, spraying Kinetics (BA 100 ppm) and GA3 (100 or 200 ppm) once or twice as foliar sprays boosts corm and bulb yield.

### **Plant Height Control**

In gladiolus, tuberose, and other plants, foliar sprays of Kinetics (BA 100 ppm) and GA3 (100 or 200 ppm) boost corm and bulb yield. The majority of the retardants have a very specific activity. A specific retardant may only dwarf a specific plant species while being ineffective for others. A perfect growth retardant would be one that is uniformly effective, non-phytotoxic, and extends the postharvest period. Life without any lingering negative consequences. For greenhouse flower production, a variety of growth retardants are offered commercially. Chlormequat chloride (CCC) (commercially known as Cycocel) is one of many plant growth regulators recommended for height control in poinsettias, azaleas, geraniums, and hibiscus. The chemical can be applied directly to the substrate or sprayed

onto the plant (1,000 to 3,000 mg/litre), However, for efficacy, a number of applications are required. Furthermore, chlorotic spots on the expanding leaves are a probable side effect, and large quantities might induce necrotic spots on the plant. Another plant growth regulator for height control, paclobutrazol (marketed as Cultar), can be effective when added to the substrate at concentrations of 2 to 90 mg/litre Wanderley *et al* (2014) studied that chlormequat chloride (CCC) had no effect on the growth of *A. graminifolia* at the concentrations used whereas paclobutrazol was effective in reducing the height of *Arundina graminifolia* plants at a concentration of 5 mg/litre. However, paclobutrazol dosages of 10 and 20 mg/litre were poisonous to the plants and killed the fresh shoots Sable *et al*, (2015) reported that lowest plant height was observed in treatment CCC 750 ppm spray. In CCC 250 ppm/plant as foliar spray, the minimum number of leaves per plant (10.8) and leaf area (64.8 cm<sup>2</sup>) were reported Wasker *et al*, (2015) studied that lowest plant height was observed in treatment CCC 750 ppm spray. CCC 250 ppm per plant as foliar spray resulted in the lowest number of leaves per plant and the largest leaf area in gladiolus.

### **Dormancy Breaking**

The chemicals like ethylene chlorohydrins or Ethereal, Ethephon, Thiourea, Hydrogen cyanamide (Dor-break or Dormex) Gladiolus corms and cormels are utilised to break their dormancy. Gladiolus dormancy is broken by soaking in 1000 ppm ethereal for 24 hours.

Preventing sprouting is also necessary in some situations, such as while shipping or storing bulbous materials, in order to prevent mortality caused by sprouting. Propyl gallate, MH, SADH, and other PGRs can be employed to extend the dormancy period.

Baskaran *et al* (2014) Early corm sprouting, spike emergence, maximum duration, and propagation coefficient value were measured in GA3 500 ppm Nomita *et al*, (2013) GA3 at 200 ppm stimulates early sprouting of shoots, according to the findings (16.77 days), produced maximum number of leaves (9.06) per plant, maximum spike length (92.66 Page | 10 cm) and rachis length (72.25 cm). The ethylene rereleasing chemical (CEPA2-chloro ethyl phosphoric acid) encourages dormant gladiolus corms to germinate (Ginzburg, 1974). And according to Denny and Miller (1934) and Denny *et al*, (1938) reported that five gladiolus cultivars sprouted faster after being exposed to 3-5 ml of 40% ethylene chlorohydrin per litre of air space in a closed container for 3-5 days. However, room temperature was found to be effective for early sprouting when ethephon 1000 ppm was applied. (Bhalla and Singh, 2000). Another statement reported by Umrao *et al*, (2006) where 500 ppm ethrel produced considerably more sprouts per corm than the lower, higher, and control levels.

**Cytokinins:** The first endogenous cytokinin discovered was zeatin, which was extracted from maize kernels. Kinetin, benzyladenine, and ethoxymethyladenine are synthetic cytokinins. Cell divisions, elongation and enlargement, stimulation of blooming, apical dominance-overcoming, delay senescence, tissue culture morphogenesis, breaking dormancy, and improving nitrogen metabolism are some of the key actions of cytokinin in plants.

### **Extension of Cut Flower Life**

Adding Kinetics, Ethylene inhibitors (MCPI), and HQ chemicals to the vase water can dramatically extend the vase life of cut flowers. Gibberellin helps in delaying senescence. It promotes the opening of immature buds in gladiolus. Gladiolus outer bracts control alpha-amylase synthesis Saeed *et al*, (2013) According to the study, using GA3 at a concentration of 25–50 mg/litre improves the vase life and quality of gladiolus cut flowers the most. Cytokinins are vital in delaying the onset of senescence. With age, the amount of cytokinins in the body declines. Tuberose senescence is delayed by using BAP in a holding solution, while Anthurium vase life is increased by using BA in a dip treatment. A rich supply of sugar, electrolytes, and growth regulators like auxin, gibberellins, and cytokinin, mature coconut water is regarded a rich source of sugar, electrolytes, and growth regulators like auxin, gibberellins, and cytokinin (Mamaril *et al*, 1986) Agampodi and Jayawardena, 2007 When treated with 50 percent Coconut water and 0.23 percent NaOCl, the Anthurium cut flower variety Wild Pink had the longest vase life (21 days). Coconut water has been used to successfully extend Gerbera's post-harvest life (Nair *et al*, 2000)

**Ethylene:** Senescence is induced in many flowers by a hydrocarbon gas known as a ripening hormone. Ethylene has a number of key effects, including carnation *pet als* sleeping, Poinsettia epinasty, and *pet als* or complete blooms falling off. Rose bud opening inhibition or promotion Celikel *et al*, 2002 studied the effect of 1-MCP and promalin on oriental lily and observed that 1- MCP have a vital function in reducing ethylene-induced post-harvest damage of buds and flowers.

**Apical Dominance/Enhancing Lateral Branching:** To overcome apical dominance, pinch or stop the primary shoot, allowing the formation of lateral shoots, such as carnations and chrysanthemums. PGRs such as MH (600 or 1000 ppm), ethephon, benzyl adenine, and others induce branching (lateral shoots) in the same way as pinching does. TIBA 25 ppm produces more branches than pinching in marigold.

**Regulation of Flowering:** Growth regulators can be used to speed up or slow down flowering, as well as to induce uniform blossoming in a variety of flower crops. Growth



regulator foliar sprays can also help with seed set. PGRs can thus be employed to improve, expedite, or postpone flowering in a variety of floral crops. GA3 - 5-25 ppm induces anthurium to blossom early. GA3 - 10 ppm applied 140 days after planting boosts blossom count and size. In dahlias, GA3 - 100 or 200 ppm caused early flowering. Auxins (NAA or IAA) at larger concentrations (>100 ppm) delay flowering in general. At the early bud stage, GA3-100 & 150 ppm or 2, 4-D (1 ppm) and or IAA (150 ppm) improves flower growth and weight.

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<b>Improving the harvest index in early generation selection in F<sub>3</sub> population in chickpea (<i>Cicer arietinum</i> L.)</b>	<b>Chapter</b> 12
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#### **ABSTRACT**

This investigation was undertaken to study the genetics of seed related attributes in chickpea (*Cicer arietinum* L.) in F<sub>3</sub> progenies of eighteen different crosses were sown with 8 rows per cross were hand sown with 4.0-meter row length and spacing of 50 cm x 20 cm during *Rabi* 2020-2021 at Pulses Research Farm, CCSHSU, Hisar, Haryana. Observations were recorded at physiology maturity on five randomly selected plants from each 18 F<sub>3</sub> progenies for high numbers of pods/plant, seed index, seed yield per plant (g per plant), Total biomass yield per plant and harvest index. The F<sub>3</sub> cross combination namely (H 12-55 x CSJ 8962) x CSJ 8962 and H 12-55 x GNG 1958 recorded the highest harvest index i.e., 62.0 % followed by H 13-09 x *reticulatum* 237) x H 13-09 GNG 1581 (60.0 %). From two years data studied in early generation selection may be considered useful because it recorded high seed yield in cross (H12-55 x CSG 8962) x CSG 8962 i.e., 4125 kg/ha and 1799 kg/ha in F<sub>2</sub>, F<sub>3</sub> progenies during 2019 and 2020 respectively. F<sub>3</sub> progenies were selected for high pod number, seed yield /plant and high harvest index. Selection response through harvest index effective for improvement of seed yield ranged from 36 % to 62.0 % in all the 18 F<sub>3</sub> populations. Improvement in yield via route through selection was obtained when the response was measured through the harvest index. Selection of harvest index in early generation for improvement of yield was effective when the response was measured

in different years in F<sub>2</sub>, F<sub>3</sub> progenies because high yielding genotypes may be lost by delay selection. Early generation selecting for high pod number, early maturity, more seed yield and high harvest index were important trait for the genetic improvement of seed yield.

**Key words:** Chickpea, Early generation, F<sub>3</sub> population, Harvest Index

### **Introduction**

The dry matter production potential of chickpea is about 6 tonne/ha, and even a conservative harvest index of 50–60 % suggests that up to 4.0 to 4.5 t/ha of seed yield should be harvested compared to the world average of only 1014 kg/ha of this crop. The ideal route to realize higher yield in chickpea is to convert a greater amount of accumulated dry matter into seed yield. This approach to increasing yield has fascinated chickpea scientists, but little progress has been made in improving the harvest index on a consistent basis. Seed yield predict by many crop models for the estimation of number of seeds per unit area, number of plants per unit area, and the rate and duration of seed filling (Ritchie *et al.*, 1998). In some other crop models, seed yield accumulation is calculated as the product of total biomass accumulation and harvest index (HI), and harvest index is assumed to increase linearly as a function of time after beginning of seed growth with a constant rate (dHI/dt) (Sinclair, 1986). Chickpea is self-pollinated legume crop with 17-24 % protein, 41-50.8 % carbohydrates and high percentage of the mineral nutrients and is the most important pulse crop for human consumption (Jodha and Subbarao, 1987, Maiti, 2001). Chickpea crop require very less water requirement as compare to cereals i.e., 10<sup>th</sup> part of Wheat and Rice. It grows very well on conserved soil moisture makes them “resilient” to changing climate conditions, as heterozygosity in the population appears to confer resistance to environmental change (Schierenbeck, K.A 2016). As observed by Bishop, *et al.*, 2016 heterogeneity in plant populations accelerates opportunities for the selection of more stress-tolerant genotypes and thereby provides resilience to the crop as well as the ecosystem. Globally chickpea is second most important crop grown in an area of 14.60 million ha with an annual production of 14.8 million tons and an average productivity of 1014 kg ha<sup>-1</sup>, which is much less than estimated potential of 6.0 tons/ha under optimum growing conditions. In India, chickpea is grown annually in an area of 9.54 million ha with an annual 9.07 million tons production and 951.4 kg ha<sup>-1</sup> productivity. In Haryana, area under chickpea was 42000 hectares with a total production of 48000 tonnes and an average productivity of 1117 kg per hectares during 2019-20 (Anonymous 2020). In sustainable agriculture system, this crop has low production cost, wide climate

adaptation, crop rotation suitability and atmospheric nitrogen fixation ability. Yield potential of chickpea is low due to many reasons that make this crop less competitive with those grown other crop during winter season. Yield is a complex character; its expression depends on the functioning and interaction of many physiological component processes, especially the limiting components that vary with variety. Varieties differ extensively in the physiological processes, determining crop yield. Physiological components are complex characters; they result from the interaction of many component processes and environmental influence on the individual processes or the genes controlling them (Wallance *et al*,1972). Development of varieties largely depends on the amount of genetic diversity present in the base population of the material. An attempt has been made in the paper for study of the degree of genetic variation observed in the F<sub>3</sub> population on the basis of new eighteen chickpea crosses and their further consideration in the subsequent year for breeding programme.

### **Materials and Methods**

Experiment was conducted at Pulses Research Area, Department of Genetics and Plant Breeding, during *Rabi* 2019-20 (F<sub>2</sub> progenies) and 2020-2021 (F<sub>3</sub> progenies) is located at latitude of 29°10'N and longitude of 75°46' E of CCS Haryana Agricultural University, Hisar, The experimental material consisted of 18 progenies with 75 rows of each F<sub>2</sub> population were planted and 8 row of 4 m length of each F<sub>3</sub> progenies with spacing of 50 x 20 cm. The data for quantitative traits *viz.*, Total biomass yield, 100-seed weight and seed yield (kg per plot) was recorded on plot basis on 18 F<sub>2</sub> progenies. Eighteen crosses involving thirteen chickpea female and fourteen male genotypes were made in 2017-2018. The F<sub>1</sub> generations were raised in *Rabi* 2018-2019 to obtain the F<sub>2</sub> seeds. The F<sub>2</sub> populations along with their parents were field grown at Pulses Research area CCS, Haryana Agricultural University, Hisar during *Rabi*-2019-2020. Seventy-five rows of each F<sub>2</sub> and single row of each parent were grown with the spacing of 45 x 10. The data were recorded on randomly selected 75 plants from each F<sub>2</sub> and 5 plants from each parent per replication. The F<sub>3</sub> populations of 18 progenies were grown at Pulses Research Area CCS, Haryana Agricultural University, Hisar during *Rabi*-2020-2021. Eight rows of each F<sub>3</sub> progenies were grown with the spacing of 45 x 10. The data were recorded on plot basis for the trait *viz.* Total biomass yield, no of pods per plant, seed yield per plot, 100 seed weight (seed index).

**Results and discussion**

The quantitative character namely total biomass yield per plot, seed yield per plot, 100 seed weight and harvest index of eighteen crosses are presented in Table 1 and Figure 1. It is observed that harvest index ranged from 41.80 to 56.8. %, whereas 56.8 % highest harvest index was recorded in the cross combination (H 12-55 x CSJ 8962) x CSJ 8962 and H 13-09 x *reticulatum* 237 followed by 54.80 % in the cross H 12-55 x GNG 1958 during the 2019-20 in F<sub>2</sub> progenies. However lowest harvest index was recorded 41.8 % by the cross viz. H 14-01 x GL 12003 and H 14-22 x PBG 5. It can also be seen from the Table 1 that the all the 18 F<sub>2</sub> progenies showed a fairly wide range of variation for Total biomass yield, number of pods per plant, 100 seed weight (g) and seed yield means these characters are supposed to have a large influence on harvest index. Monpara and Kalariya (2009) reported significant changes in harvest index due to differences in maturity time of bread wheat cultivars.

Table 1. Mean values of F<sub>2</sub> and F<sub>3</sub> generations for total biomass yield, seed yield and harvest index during 2019-2020

Sl. No.	Cross-combination	Total biomass yield (kg/hectare)	Number of pods/plant	Seed yield (kg/hectare)	100 seed weight (g)	Harvest Index (%)
1	GNG 1581 x HC 5	6563	88	2875	16.8	43.8
2	H 08-18 x JG 12	4638	60	2500	17.6	53.9
3	H 12-29 x GNG 2171	4894	51	2500	17.4	51.1
4	H 12-55 x GNG 1958	4325	49	2375	24.0	54.9
5	H 12-63 x GNG 1581	5288	38	2375	16.7	44.9
6	H 13-01 x GNG 1581	6025	51	2875	17.5	47.7
7	H 13-02 x PBG -7	5013	43	2500	16.0	49.9
8	H 13-03 x PBG 7	5775	58	2625	15.9	45.5
9	H 13-09 x JG 14	5075	40	2125	19.2	41.9
10	H 14-01 x GL 12003	5388	43	2250	14.7	41.8
11	H 14-22 x JG 24	5981	63	2750	20.2	46.0
12	H 14-22 x PBG 5	6275	73	2625	17.6	41.8
13	H 12-55 x CSJ 8962) x CSJ 8962	7256	178	4125	14.8	56.8

	CSJ 8962					
14	H 12-63 x ICC 37	4650	85	2250	18.2	48.4
15	H 13-01 x ICC 37	4488	95	2375	16.4	52.9
16	H 13-09 x <i>reticulatum</i> ) x H 13- 09	3963	70	2250	16.5	56.8
17	Virat x CSJ -741	5438	58	2875	16.1	52.9
18	H 13-12 x <i>judaicum</i>	4343	43	2250	17.8	51.8
	HC 5 (Check)	5445	78	2458	16.7	45.1
	GNG 1581 (Check )	5098	65	65	2039	40.1

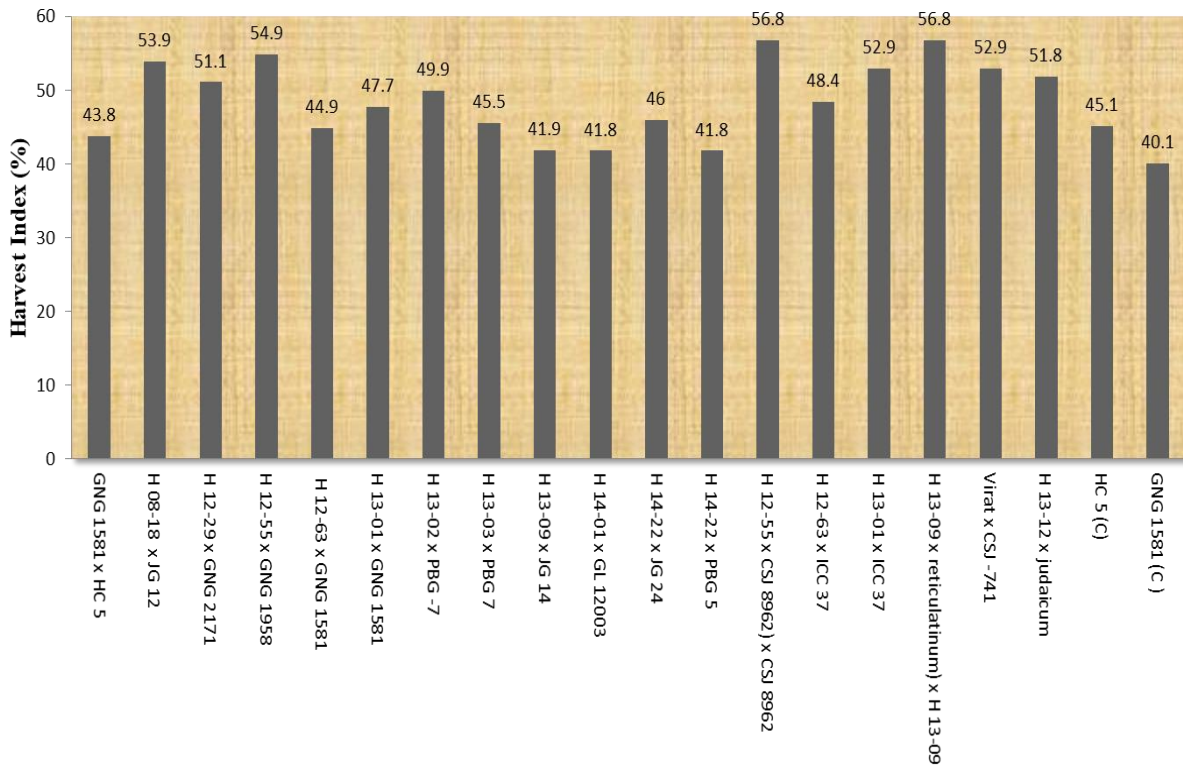


Fig. 1. Comparison of cross combination on the basis of harvest index in F<sub>2</sub> progeny during 201-20

The mean values of cross combination ranged from 39.7 to 62.0 % in the F<sub>3</sub> generation (Table 2 and Figure 2). In F<sub>3</sub> progenies highest harvest index was recorded 62.0 % by the cross-combination in (H13-09 x *reticulatum* 237) x H 13-09 and H 12-55 x GNG 1958 followed by 59.9 % in (H 12-55 x CSJ8962) x CSJ 8962. However the lowest harvest index was reported 39.70 % in GNG 1581 x HC 5 followed by 44.90 in H 13-09 x JG 14. This suggests that genes involved in the inheritance of harvest index may vary in their



nature and are expressed differently in different genetic backgrounds. Further, it was observed that the magnitude of variation among the F<sub>2</sub> and F<sub>3</sub> segregates of a cross was not proportionate to the degree of diversity of the parents involved in a particular cross. Thus, results indicate that parents involved in cross combination with varying level of harvest index behaved differently in releasing variability for harvest index.

Table 2. Mean values of F<sub>3</sub> generations for total biomass yield, seed yield and harvest index during 2020-2021

Sl. No	Cross-combination	Total biomass yield (kg/hectare)	Numbers of pods/plant	Seed yield (kg/hectare)	100 seed weight (g)	Harvest Index (%)
1	GNG 1581 x HC 5	4450	58	1103	20.1	39.7
2	H 08-18 x JG 12	2710	40	969	18.2	57.2
3	H 12-29 x GNG 2171	3675	51	1281	18.3	55.8
4	H 12-55 x GNG 1958	2860	69	1109	24.8	62.0
5	H 12-63 x GNG 1581	3450	48	1034	19.5	47.9
6	H 13-01 x GNG 1581	3860	71	1325	18.9	54.9
7	H 13-02 x PBG -7	3725	63	1113	17.9	47.8
8	H 13-03 x PBG 7	3645	48	1028	18.8	45.1
9	H 13-09 x JG 14	3450	49	969	21.1	44.9
10	H 14-01 x GL 12003	3830	47	1088	18.8	45.4
11	H 14-22 x JG 24	3385	53	1097	26.4	51.8
12	H 14-22 x PBG 5	3520	36	1013	20.4	46.0
13	H 12-55 x CSJ 8962) x CSJ 8962	4805	93	1799	15.1	59.9
14	H 12-63 x ICC 37	3420	42	969	20.9	45.3
15	H 13-01 x ICC 37	3320	45	1069	20.9	51.5
16	H 13-09 x <i>reticulatum</i> ) x H 13-09	2670	60	1034	18.9	62.0
17	Virat x CSJ -741	3750	58	1113	20.8	47.5
18	H 13-12 x <i>judaicum</i>	2875	53	1047	19.6	58.3

<b>HC 5 (Check)</b>	3350	52	959	15.4	45.8
<b>GNG 1581 (Check)</b>	3645	47	1028	16.1	45.1

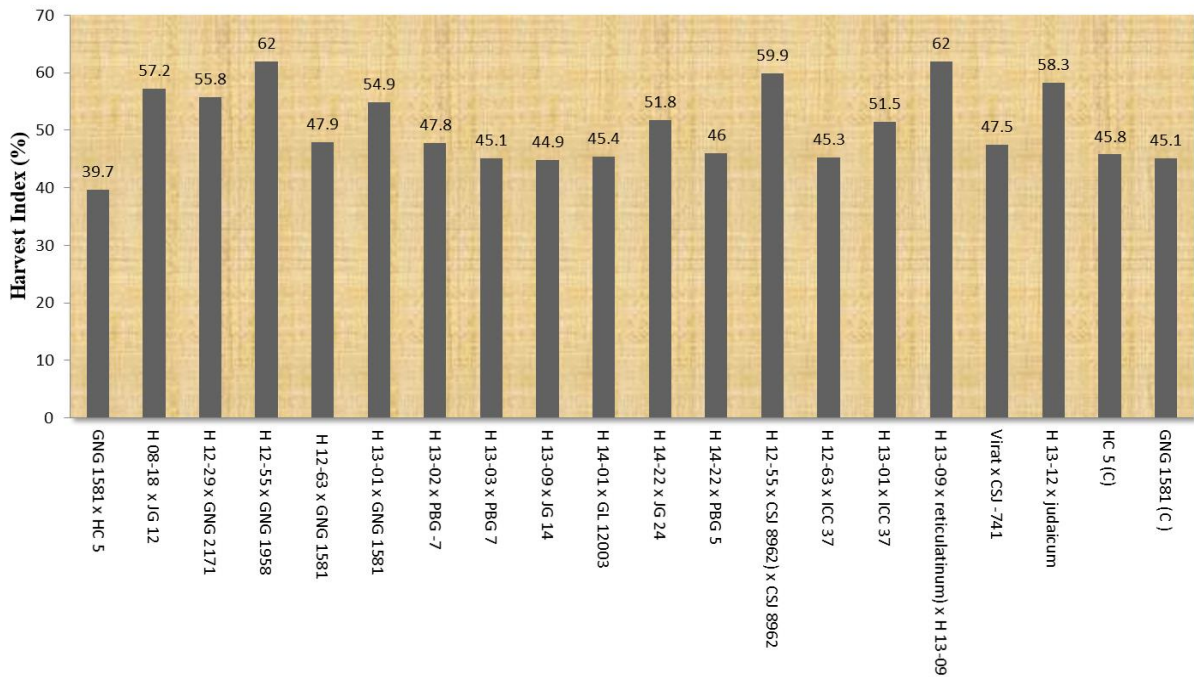


Fig. 2. Comparison of cross combination on the basis of harvest index in F<sub>2</sub> progeny during 2020-21

As reported in Table 3 and Figure 3 the mean values of cross combination ranged from 41.8 to 59.4 % in the F<sub>2</sub> and F<sub>3</sub> generation. From figure 3 highest harvest index was recorded 59.4 % by the cross-combination in (H 13-09 x *reticulatum* 237) x H 13-09 followed by 58.5 % in H 12-55 x GNG 2171 and 58.4 % in H 12-55 x GNG 1958. Whereas, the lowest harvest index was reported 41.8.7 % (GNG 1581 x HC 5) followed by 42.60 % (GNG 1581 check variety of chickpea).

Table 3. Mean values of F<sub>2</sub> and F<sub>3</sub> generations for total biomass yield, no of pods/plant, seed yield and harvest index

Sl. No	Cross-combination	Total biomass yield (kg/hectare)	Numbers of pods/plant	Seed yield (kg/hectare)	100 seed weight (g)	Harvest Index (%)
1	<b>GNG 1581 x HC 5</b>	5507	73	1989	18.5	41.8
2	<b>H 08-18 x JG 12</b>	3674	50	1735	17.9	55.6
3	<b>H 12-29 x GNG 2171</b>	4285	51	1891	17.9	53.5

4	H 12-55 x GNG 1958	3593	59	1742	24.4	58.5
5	H 12-63 x GNG 1581	4369	43	1705	18.1	46.4
6	H 13-01 x GNG 1581	4943	61	2100	18.2	51.3
7	H 13-02 x PBG -7	4369	53	1807	17.0	48.9
8	H 13-03 x PBG 7	4710	53	1827	17.4	45.3
9	H 13-09 x JG 14	4263	45	1547	20.2	43.4
10	H 14-01 x GL 12003	4609	45	1669	16.8	43.6
11	H 14-22 x JG 24	4683	58	1924	23.3	48.9
12	H 14-22 x PBG 5	4898	55	1819	19.0	43.9
13	H 12-55 x CSJ 8962) x CSJ 8962	6031	136	2962	15.0	58.4
14	H 12-63 x ICC 37	4035	64	1610	19.6	46.9
15	H 13-01 x ICC 37	3904	70	1722	18.7	52.2
16	H 13-09 x <i>reticulatum</i> ) x H 13- 09	3317	65	1642	17.7	59.4
17	Virat x CSJ -741	4594	58	1994	18.5	50.2
18	H 13-12 x <i>judaicum</i>	3609	48	1649	18.7	55.1
HC 5 (Check)		4398	65	1268	16.1	45.5
GNG 1581 (Check )		4372	56	1052	15.1	42.6

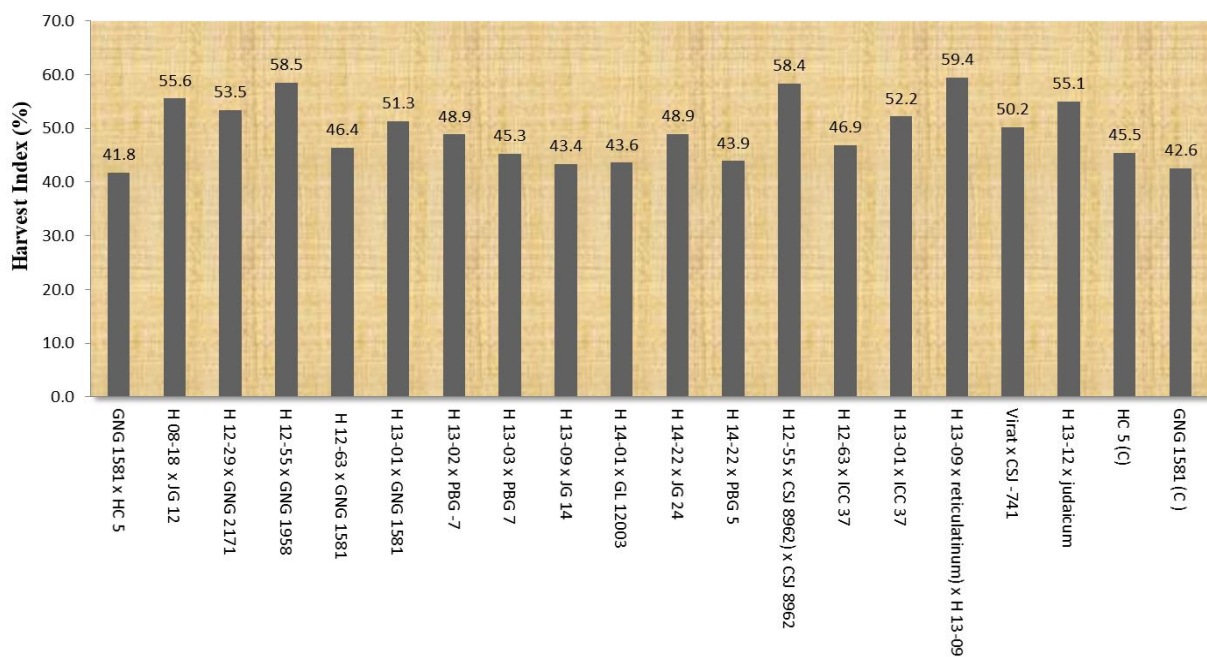


Fig. 3. Comparison of cross combination on the basis of harvest index in F<sub>2</sub> and F<sub>3</sub> progeny

The (H 13-09 x *reticulatum* 237) x H 13-09, H 12-55 x CSJ 8962) x CSJ 8962, which recorded the highest harvest index in F<sub>2</sub> as well as in F<sub>3</sub> mean indicated that these three-way crosses have better parent of mean indicating transgressive segregation. This suggests that genes involved in the inheritance of harvest index may vary due to genotype and environment interaction (G x E) in their nature and are expressed differently in different genetic backgrounds. Considering this phenomenon of segregation pattern, harvest index should be exploited in later generations (F<sub>2</sub> to F<sub>6</sub>) to select genotypes as it forms a useful measure of yield potential and easy to measure on a large number of plants. The limit up to which harvest index can be increased in chickpea is considered to be around 50 % suggests that further improvements in partitioning of biomass would be possible by Qureshi *et al*, 2004. Large variability together with high heritability coupled with high genetic advance for harvest index, as obtained in present study, indicating genetic gain in yield improvement by exerting selection pressures for harvest index in early segregating generations is possible. The results obtained in current study are in agreement with those reported by Kumar *et al*, (1999), Gumber *et al*, (2003), Singh *et al*, (1980) and Sidramappa *et al*, (2008).

Harvest index is an important aspect of dry weight partitioning in favour of seeds. It is relationship between source (leaf, stem, root) to ultimately to sink (seed). Obviously, its correlation should be positive with seed yield and often negative with total biomass yield. Suitable recombination may be recovered through line x tester, biparental mating or diallel selective mating system. In chickpea breeding programme, efforts are being made continually to make several crosses per year to accelerate the development of new varieties. In such situations, handling of segregating generations is very difficult and expensive. Therefore, selection of promising crosses for further advancement may be necessary. Our results of the present study indicated that more emphasis should be given to the (H 13-09 x *reticulatum* 237) x H 13-09, H 12-55 x CSJ 8962) x CSJ 8962, H 12-55 x GNG 1958 and H 08-18 in an effort to developing better yielding variety. From this material, we have already two new chickpea variety has been released on national level viz. H 12-55 (2020) i.e. HC 7 (Haryana Chana number 7) for north west plain zone (NWPZ) for late sown condition which mature in 140 days and H 08-18 (HC 6) for Haryana state for normal as well as late sown condition mature in 150 days. New variety H 08-18 (HC 6) recorded the highest protein content (21.76 %) as compared to other new

variety released from north zone not recorded more than 20.0 % protein content. However, it is necessary to do further study on F<sub>3</sub>-derived F<sub>4</sub>-F<sub>6</sub> population to see the response of early and advanced generation's selection for seed yield and other useful traits. Parents with diverse genetic backgrounds involving in production of several crosses would be desirable in order to exert among cross selection, and achieve accelerated yield improvement in chickpea. The results of studied also indicated that wild *Cicer* annual accessions of *C. reticulatum* species can be exploited for traits of interest for diversification of cultivated gene pool and subsequent use in chickpea improvement.

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