IJOEAR

International Journal of Environmental & Agriculture Research

www.ijoear.com

ISSN
2454-1850

Volume-7, Issue-6, June 2021

Preface

We would like to present, with great pleasure, the inaugural volume-7, Issue-6, June 2021, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas.

Environmental Research:

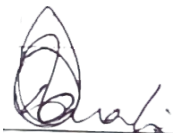
Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

Mukesh Arora
(Managing Editor)



Dr. Bhagawan Bharali
(Chief Editor)

Fields of Interests

Agricultural Sciences	
Soil Science	Plant Science
Animal Science	Agricultural Economics
Agricultural Chemistry	Basic biology concepts
Sustainable Natural Resource Utilisation	Management of the Environment
Agricultural Management Practices	Agricultural Technology
Natural Resources	Basic Horticulture
Food System	Irrigation and water management
Crop Production	
Cereals or Basic Grains: Oats, Wheat, Barley, Rye, Triticale, Corn, Sorghum, Millet, Quinoa and Amaranth	Oilseeds: Canola, Rapeseed, Flax, Sunflowers, Corn and Hempseed
Pulse Crops: Peas (all types), field beans, faba beans, lentils, soybeans, peanuts and chickpeas.	Hay and Silage (Forage crop) Production
Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
Tree Nut crops: Hazlenuts. walnuts, almonds, cashews, pecans	Berry crops: strawberries, blueberries, raspberries
Sugar crops: sugarcane. sugar beets, sorghum	Potatoes varieties and production.
Livestock Production	
Animal husbandry	Ranch
Camel	Yak
Pigs	Sheep
Goats	Poultry
Bees	Dogs
Exotic species	Chicken Growth
Aquaculture	
Fish farm	Shrimp farm
Freshwater prawn farm	Integrated Multi-Trophic Aquaculture
Milk Production (Dairy)	
Dairy goat	Dairy cow
Dairy Sheep	Water Buffalo
Moose milk	Dairy product
Forest Products and Forest management	
Forestry/Silviculture	Agroforestry
Silvopasture	Christmas tree cultivation
Maple syrup	Forestry Growth
Mechanical	
General Farm Machinery	Tillage equipment
Harvesting equipment	Processing equipment
Hay & Silage/Forage equipment	Milking equipment
Hand tools & activities	Stock handling & control equipment
Agricultural buildings	Storage

Agricultural Input Products	
Crop Protection Chemicals	Feed supplements
Chemical based (inorganic) fertilizers	Organic fertilizers
Environmental Science	
Environmental science and regulation	Ecotoxicology
Environmental health issues	Atmosphere and climate
Terrestric ecosystems	Aquatic ecosystems
Energy and environment	Marine research
Biodiversity	Pharmaceuticals in the environment
Genetically modified organisms	Biotechnology
Risk assessment	Environment society
Theoretical production ecology	horticulture
Breeding	plant fertilization

Board Members

Dr. Goswami Tridib Kumar

Presently working as a Professor in IIT Kharagpur from year 2007, He Received PhD degree from IIT Kharagpur in the year of 1987.

Prof. Khalil Cherifi

Professor in Department of Biology at Faculty of Sciences, Agadir, Morocco.

Dr. Josiah Chidiebere Okonkwo

PhD Animal Science/ Biotech (DELSU), PGD Biotechnology (Hebrew University of Jerusalem Senior Lecturer, Department of Animal Science and Technology, Faculty of Agriculture, Nau, AWKA.

Prof. Özhan ŞİMŞEK

Agriculture Faculty, Department of Horticulture, Çukurova University, Adana, 01330 Turkey.

Dr. Anka Ozana Čavlović

Working as Professor in the department of Faculty of Forestry, University of Zagreb, Svetošimunska 25, Zagreb.

Dr. Rakesh Singh

Professor in Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Also Vice President of Indian Society of Agricultural Economics, Mumbai.

Dr. Sunil Wimalawansa

MD, PhD, MBA, DSc, is a former university professor, Professor of Medicine, Chief of Endocrinology, Metabolism & Nutrition, expert in endocrinology; osteoporosis and metabolic bone disease, vitamin D, and nutrition.

Dr. Ajeet singh Nain

Working as Professor in GBPUA&T, Pantnagar-263145, US Nagar, UK, India.

Dr. Salvinder Singh

Presently working as Associate Professor in the Department of Agricultural Biotechnology in Assam Agricultural University, Jorhat, Assam.

Dr. Salvinder received MacKnight Foundation Fellowship for pre-doc training at WSU, USA – January 2000- March 2002 and DBT overseas Associateship for Post-Doc at WSU, USA – April, 2012 to October, 2012.

Dr. V K Joshi

Professor V.K.Joshi is M.Sc., Ph.D. (Microbiology) from Punjab Agricultural University, Ludhiana and Guru Nanak Dev University, Amritsar, respectively with more than 35 years experience in Fruit Fermentation Technology, Indigenous fermented foods, patulin ,biocolour ,Quality Control and Waste Utilization. Presently, heading the dept. of Food Science and Technology in University of Horticulture and Forestry, Nauni-Solan (HP), India.

Dr. Mahendra Singh Pal

Presently working as Professor in the dept. of Agronomy in G. B. Pant University o Agriculture & Technology, Pantnagar-263145 (Uttarakhand).

Dr. Sanjoy Kumar Bordolui

M.Sc. (Ag.), PhD, FSTA, FSIESRP, Assistant Professor, Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia. W.B., India. He received CWSS Young Scientist Award-2016, conferred by Crop and Weed Science Society, received Best Young Faculty Award 2019 conferred by Novel Research Academy, received Innovative Research & Dedicated Teaching Professional Award 2020 conferred by Society of Innovative Educationalist & Scientific Research Professional, Chennai.

DR. Owais Yousuf

Presently working as Assistant professor in the Department of Bioengineering, Integral University-Lucknow, Uttar Pradesh, India.

Dr. Vijay A. Patil

Working as Assistant Research Scientist in Main Rice Research Centre, Navsari Agricultural University, Navsari. Gujarat- 396 450 (India).

Prof. Salil Kumar Tewari

Presently working as Professor in College of Agriculture and Joint Director, Agroforestry Research Centre (AFRC) / Program Coordinator in G.B. Pant University of Agric. & Tech., Pantnagar - 263 145, Uttarakhand (INDIA).

Dr. S. K. Jain

Presently working as Officer Incharge of All India Coordinated Sorghum Improvement Project, S. D. Agricultural University, Deesa, Gujarat.

Dr. Deshmukh Amol Jagannath

Presently working as Assistant Professor in Dept. of Plant Pathology, College of Agriculture polytechnic, NAU, Waghai.

Mr. Anil Kumar

Working as Junior Research Officer/Asstt. Prof. in the dept. of Food Science & Technology in Agriculture & Technology, Pantnagar.

Mr. Jiban Shrestha

Scientist (Plant Breeding & Genetics)

Presently working as Scientist (Plant Breeding and Genetics) at National Maize Research Programme (NMRP), Rampur, Chitwan under Nepal Agricultural Research Council (NARC), Singhdarbar Plaza, Kathmandu, Nepal.

Mr. Aklilu Bajigo Madalcho

Working at Jigjiga University, Ethiopia, as lecturer and researcher at the College of Dry land Agriculture, department of Natural Resources Management.

Mr. Isaac Newton ATIVOR

MPhil. in Entomology, from University of Ghana.

He has extensive knowledge in tree fruit orchard pest management to evaluate insecticides and other control strategies such as use of pheromone traps and biological control to manage insect pests of horticultural crops. He has

knowledge in agronomy, plant pathology and other areas in Agriculture which I can use to support any research from production to marketing.

Mr. Bimal Bahadur Kunwar

He received his Master Degree in Botany from Central Department of Botany, T.U., Kirtipur, Nepal. Currently working as consultant to prepare CCA-DRR Plan for Hariyo Ban Program/CARE in Nepal/GONESA.

Table of Contents

Occurrence of *Alternaria alternata* causing leaf spot in Buckwheat (*Fagopyrum esculentum*) in Prayagraj area of Uttar Pradesh, India

Amit Kumar Maurya[1], Archana Udai Singh[2*], Vinny John[3], Rakhi Murmu[4]

[1,3]Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (U.P.)
[2]Division of Nematology, ICAR-IARI, New Delhi-12
[4]Senior Technical Officer, Regional Plant Quarantine Station, Kolkata
*Corresponding Author

Received:- 06 June 2021/ Revised:- 18 June 2021/ Accepted:- 22 June 2021/ Published: 30-06-2021

Abstract— *Among the pseudo-cereals grown in India, Fagopyrum esculentum Moench is known as Common buckwheat and the most cultivated species in the hilly region of India. This is a short duration, multipurpose and nutritious crop which can withstand changing climatic conditions and fit well in multiple cropping systems. At remote locations of mountain ecosystems, buckwheat is a livelihood driven crop for small and marginal farmers. Buckwheat grains are primarily used for human consumption and also for livestock, poultry and piggery feeds. Rural population of hilly region of India use buckwheat sprouts and as pancakes especially in breakfast however, the recommended intake of buckwheat sprouts are less than 40 g/day. Furthermore, it is also grown as cover crop, green manure crop, fodder crop, fertility restoring crop, honey crop and medicinal plant. The crop is also a good source of Rutin (quercetin-3-rutinosid) and Fagopyrin that are known to be used in preventing various human disorders. In January 2020 occurrence of disease on buckwheat (Fagopyrum esculentum) in the research field of SHUATS, Prayagraj Uttar Pradesh in India was observed. Black spot symptoms were noted on leaves with an approximate incidence of 50%. The disease symptoms are chlorotic leaf spots caused by Alternaria alternata uniformly distributed and having concentric margins. They are circular, oval or oblong in shape. Each spot has gray centre and brownish margin.*

Keywords— Alternaria alternata, Buckwheat, Leaf spot.

I. INTRODUCTION

Buckwheat perform multitude functions as a break crop (breaks the life cycle of insect, pests and diseases), green manure crop, smother crop (suppress weeds), nutrient conserving crop (enhanced nutrients uptake, reduces nutrients leaching and immobilization), gourd crop (protecting main crop from wild animal), cover crops (soil protection against water and wind erosions) and as land reclamation crop. Buckwheat is an ephemeral green manure crop which germinates in 3–5 days, flowers within 30–45 days and matures completely within 90–110 days. (Babu *et al.*, 2018; Ezra *et al*., 2010).

The occurrence of buckwheat ranged from Jammu Kashmir in north to Arunachal Pradesh in east and Tamil Nadu in the south. However, Jammu Kashmir, Himachal Pradesh, Uttarakhand, West Bengal (Kalimpong, Coochbehar, New Jalpaiguri and Darjeeling region), Sikkim, Assam (Upper Assam), Arunachal Pradesh, Nagaland, Meghalaya (Higher elevation region), Manipur, Kerala Tamil Nadu (Nilgiris and Palani hills) and Chhattisgarh are the major buckwheat growing areas in India.

The seed is also used in a number of culinary preparations as well as alcoholic drinks. Buckwheat flour is known as *Kuttu ka Atta* in northern part of India and mainly eaten during religious *Upvas* (fast) when cereals and pulses are not permitted to eat. The protein content (11-14%) in buckwheat seed is of high quality due to its balanced amino acid composition and rich in lysine (5.5-6%) and arginine (9.2–10%) which are generally deficit in cereals. Similarly, its grains has high content of minerals especially Ca (110 mg/100 g), Mg (390 mg/100 g), P (330 mg/00 g), K (450 mg/100 g), Fe (4 mg/ 100 g), Mn (3.37 mg/100 g), Cu (0.95 mg/100 g) and Zn (0.87 mg/100 g) and biologically active compounds like rutin, fagopyrin etc. It is a

good dietary food crop as it has high nutritional value owing to bioactive compounds like vitamins, macro and micro elements and enzymes. Further, buckwheat flour is free from gluten and can be safely consumed by people with coeliac disease. Therefore, it may be an important alternative industrial food crop in agriculture.

Several pathogenic disorders have also been reported in buckwheat. These include: aster yellows caused by *Mycoplasma;* stern rot due to *Botrytis cinerea;* root rots due to *Fusarium* spp., *Botrytis* spp.; and *Rhizoclonia* spp.; chlorotic leaf spot due to *Alternaria allernals;* stipple spot disease caused by *Bipolaris sorokiniana;* blight due to *Phyloplhora parasilka* and downy mildew caused by *Peronospora* spp. Attacks of several viruses also cause reduction in plant height and losses in grain yield. (Madhukar and Reddy 1988).

An investigation was carried out for occurrence of disease on buckwheat *(Fagopyrum esculentum)* in the research field of SHUATS, Prayagraj Uttar Pradesh in India. Black spot symptoms were noted on leaves with an approximate incidence of 50%. The disease symptoms are chlorotic leaf spots, uniformly distributed, having concentric margins. Hence the isolation of the pathogen was done in the present study by even following Koch's postulates.

II. MATERIALS AND METHODS

For isolation, surface sterilized leaves were cut from lesion edges and incubated at 25°C on Potato dextrose agar medium amended with 12 mg/l tetracycline for 7 days. Fungal colonies appeared on the plates were fast-growing, brownish, and cottony emerging from tissues had morphology and conidia typical of *Alternaria alternata*. (Vander Waals, *et al.*, 2011)

To confirm Pathogenicity 8-10 days old seedlings of buckwheat were grown in pots in three replications. (5 plants/pots) Conidial suspension of *Alternaria sp.* was prepared from 7 days old culture grown on Potato dextrose broth (PDB). Seedlings were sprayed with suspension of 10^5 conidia per ml and covered with polythene covers and incubated at 28 $\pm$ 1^0C and 12h photo period. Un-inoculated pots served as control. Polythene covers were removed after 48hrs. Plants were regularly watered and monitored for disease development.

III. RESULT

This is the first report of *A. alternata* causing leaf spot disease of Buckwheat in Prayagraj area of U.P, India. Symptoms observed on the plants were chlorotic leaf spots, concentric rings of brownish to black in color. Morphological identifications confirmed the isolation of *A. alternata*. The initial symptoms were round to be irregular (1-4 mm) on leaves. Each spot consisted of a greenish-yellow halo surrounding a necrotic lesion. Symptoms were small, brown lesions on leaves with concentric rings coalescing into larger lesions. For further study, infected leaves were collected. Conidia were greenish brown, catenate, obclavate, multi-celled, with 2-6 transverse septa, 1-2 longitudinal septa, 10-30 × 6-12 µm in size. (Fig 1 to 5)

FIGURE 1: Pure culture of *Alternaria alternata*

FIGURE 2: Microscopic view of *Alternaira alternate*

FIGURE 3: Infected leaves of buckwheat

FIGURE 4: Pure culture of *Alternaria alternata*

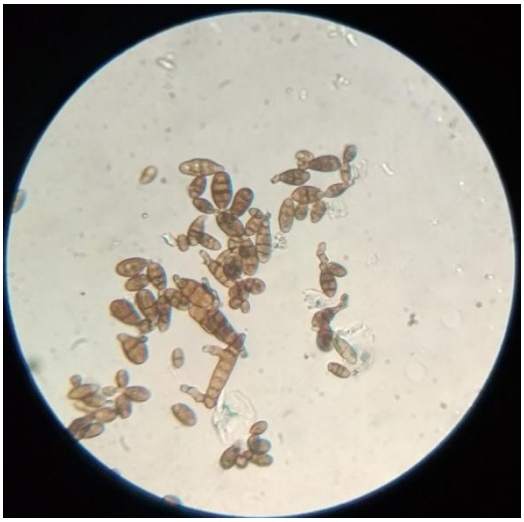


FIGURE 5: Microscopic view of *Alternaira alternata*

As regards Pathogenicity test the pathogen proved pathogenic on Buckwheat and identical disease symptoms as observed in the field symptoms on leaves were small, circular, necrotic spots that developed quickly forming typical concentric rings. Later these spots coalesced and caused blighting of leaves. Spots were initially light brown and later turned dark brown was observed 10 days after inoculation. However, no symptoms was observed on control plants. The pathogenicity was verified with Koch's postulates.

IV. CONCLUSION

It is, thus, desirable that buckwheat should be an integral crop of agricultural production systems of mountain agriculture in order to maintain nutritional standards of small and marginal farmers. Resources requirement for buckwheat cultivation is very less as compared to others cereals, hence it is a good candidate crop for rainfed ecosystems, organic farming, zero budget farming and for jhum areas in north-east India. Therefore, this crop could become an important component of the agriculture system of hill region for achieving nutrients self-sufficiency.

REFERENCES

[1] Babu, S., Yadav, G. S., Singh, R., Avasthe, R. K., Das, A., Mohapatra, K. P., Tahashildar, M., Kumar, K., Prabha, M., Devi, M. T., Rana, D. S., Pande, P. and Prakash, N. (2018) Production technology and multifarious uses of buckwheat (*Fagopyrum* spp.): A review. *Indian Journal of Agronomy* **63**: 415-427.

[2] Ezra, D., Gat, T., Skovorodnikova, Y., Vardi, Y. and Kosto, I. (2010) First report of *Alternaria* black spot of Pomegranate caused by *Alternaria alternata* in Israel. *Australasian Plant Disease Notes*, **5**, 1-2.

[3] Madhukar and Reddy (1988) Some new leaf spot diseases of Pomegranate. *Indian Journal of Mycology and Plant Pathology*, **18**, 171-172.

[4] Vander-Waals, J. E., Pitsi, B. E., Marais, C. and Wairuri, C. K. (2011) First report of *Alternaria alternata* causing brown leaf spot of Potatoes in South Africa. *Plant Disease*, 95: 363-366.

Milk marketing strategies adopted by dairy farmers: A study of Ernakulam district

Priyanka T R[1*], Dr S Harikumar[2]

[*1]Research Scholar, Department of Applied Economics, Cochin University of Science and Technology, Kerala 682022, India.
[2] Professor (Rtd), Department of Applied Economics, Cochin University of Science and Technology, Kerala 682022, India.
*Corresponding Author

Received:- 10 June 2021/ Revised:- 20 June 2021/ Accepted:- 24 June 2021/ Published: 30-06-2021

Abstract— *Various studies and reports expect that due to great potential and increased demand on consumer's side, dairy market in Kerala will grow at a CAGR of 15.7 percent during 2021-2026. But the reality and projection are quite different. Due to the involvement of many factors like lack of infrastructure facilities, transportation, interference of intermediaries, less bargaining capacity and lack of knowledge about the marketing conditions Kerala's milk marketing is facing a huge challenges and constraints. Recent studies found that more than 70 percent of milk is sold to dairy cooperative society which implies that a traditional marketing channel dominates in Kerala. In this study, Ernakulam district have chosen. Ernakulam, which has over 330 co-operative societies of Milma in the district, faces a shortage of 70,000 litres per day. This gap is met by importing milk from Tamil Nadu and Karnataka. It indicates that there is a huge scope for dairy market in Ernakulam due to the steady increase in demand on consumer's side. But recent studies reveal that the existing marketing conditions are not favourable to farmers. Therefore, in this context, the marketing strategy adopted, various milk marketing channels, the reasons for choosing, price received and quantity of milk sold to these stakeholders/channels on the producer's side to be studied in detail. All these aspects are covered under this study. Present study tries to help the government and concerned department in taking appropriate actions for boosting the milk market in Ernakulam district by giving equal importance to both production and marketing side.*

Keywords— Consumer, Distribution channels, Marketing, Milk, Producer.

I. INTRODUCTION

The International Market Analysis Research and Consulting Group' (IMARC Group) latest report, titled "Dairy Industry in Kerala: Market Size, Growth, Prices, use segments, Cooperatives, Private Dairies, Procurement and Distribution", offers an in-depth analysis of the Kerala dairy market. In 2020, the milk production in Kerala reached a volume of 2.5 billion litres. The state currently represents the twelfth largest dairy market in India (IMARC, 2020). According to the report, Kerala dairy market exhibited strong growth during 2015-2020 and dairy market grew at a CAGR of 13 percent during 2014-2019. In Kerala, milk has become the biggest product segment. Like milk, other by products such as frozen/flavoured yoghurt, cheeses, Ultra High Temperature (UHT) milk, flavoured milk and butter milk also have the scope of growing market. As per IMARC dairy market of Kerala will continue its growth in the coming years. In Kerala, Milma is the major contributor of milk and milk products. Besides Milma other cooperatives like People's Dairy Development Project (PDDP) Central Society, Jeeva Milk etc. have significant contribution in Kerala's dairy market. IMARC Group expects that Kerala dairy market will grow at a CAGR of 15.7 percent during 2021-26(IMARC, 2020).

Due to the involvement of many factors like lack of infrastructure facilities, transportation, interference of intermediaries, less bargaining capacity and lack of knowledge about the marketing conditions Kerala's milk marketing is facing a huge challenges and constraints. As a result, many of the farmers could not find market for their products which creates pricing issues and thereby lowering profit. Proper marketing strategies are essential for the better and successful running of dairy farms. There are many forms of marketing channels like consumers/households, cooperative society and intermediaries in Kerala. Farmers adopts various kinds of marketing strategies like direct marketing, marketing through intermediaries, marketing through advertisement based on their objectives and goals.

In this study, Ernakulam district have chosen. Ernakulam, which has over 330 co-operative societies of Milma in the district, faces a shortage of 70,000 litres per day. This gap is met by importing milk from Tamil Nadu and Karnataka. It indicates that there is a huge scope for dairy market in Ernakulam due to the steady increase in demand on consumer's side. Therefore, in this context, main purpose of this paper is to explain the various forms of marketing/distribution channels and the marketing strategies adopted by the dairy farmers in Ernakulam district. This paper has been divided into two parts. First part deal with the marketing strategies adopted by the farmers and second part explains the quantity of milk sold to and price received at dairy cooperative society and to local market. In this section detailed analysis of various agents/marketing channels and the reason for choosing them have been done.

II. REVIEW OF RELATED STUDIES

In the paper Rajendran et al (2004) reviewed the existing status of milk marketing and dairy cooperatives in India and also provide the recommendations to meet the future challenges. In the study, they found that more than 80 percent of milk is marketed through unorganized sector and less than 20 percent is marketed through organized sector. The paper suggests that by changing the dairy cooperatives laws and regulations we can reduce the role of unorganized sector in marketing. They also recommend that by strengthening the dairy cooperatives we can overcome the challenges in milk marketing like quality of the product, product development, infrastructure development and global marketing. In the paper, Sharma (2015) analysed determinants of market channel choices of small milk producers based on farm household survey. In this paper impact of various market channel choices on farmers' income and technology adoption has been analysed. The study has found that though there has been emerging milk marketing channels, the traditional sector still dominates. Farmers sell nearly 70 per cent of their milk to traditional marketing/distribution channels. It indicated that small dairy farmers are not excluded from the cooperatives but are excluded from the modern private sector. Nilabja et al (2017) did not find milk production commercially profitable in many cases. Paper also suggests that despite the white revolution, milk production still remains largely a subsistence activity. There are, however, large variations in milk price, animal stock, and profit among regions; urbanisation levels of districts; and main occupations of producers. The results also reveal that the producer's remuneration varies with the uses of different marketing channels. While informal traders still dominate the market, the sign of entry of private corporate buyers is also clear. In the study, Anjani Kumar et al (2018) shows that in India the dominance of smallholders in milk production is increasing. The average milk production of household is found to be directly proportional to the farm size. This study also investigates whether there is any systematic bias against the participation of poor smallholders in organized milk marketing outlets. It is found that farmers with access to institutional credit are more likely to sell their output through formal milk marketing channels like processors and cooperatives and government agencies. This paper also suggest that incentives should be provided to attract smallholders, women, and under privileged sections of the rural Indian society.

Dinesh & Singh (2017) in their study found that far more serious treatment and a more comprehensive approach are required for analysing the interaction between crop and livestock production system, gainful employment of surplus family labour and also examine the reason for rearing milch animals in gaining family nutrition. In the paper, Saravanadurai and Muthuraj (2018) has examined the role of cooperatives in dairy sector and explored constraints such cooperatives face in the successful functioning in the form of lack of professionalism in management, lack of good leadership and improper government control. This paper suggests that this sector require scientific management, value addition for the dairy products, and customer services for ensuring better performance of milk cooperatives in rural India and bringing the inclusive growth in Indian economy.

III. OBJECTIVES

Main objectives of the study are

1) To analyse the marketing strategies adopted by the farmers in Ernakulam district
2) To examine quantity of milk sold to various agents/marketing channels and to explore various reasons for choosing them.

IV. SIGNIFICANCE OF THE STUDY

The study, 'Development and testing of potential indicators for evaluation of dairy production systems', published in the Indian Journal of Animal Sciences, ranked the states on the basis of six major indicators of dairy production. Kerala stood first in three categories- animal breeding, resource availability and policies and regulations. The state was placed second in veterinary infrastructure; seventh in dairy production and eighth in value addition and marketing (The Hindu, 2020). Currently, Kerala represents the 12^{th} largest dairy market at the national level. It indicates that Kerala has the great potential

in dairy sector since there is huge market for the product due to the growing demand. In this study, Ernakulam district have chosen due to various reasons. In terms of milk production, Ernakulam stands seventh position whereas its demand for milk is growing rapidly than others due to the influence of consumers who live in cities/ towns. Ernakulam district faces a shortage of 70,000 litres of milk per day. Despite the intervention of the government by seeking help from the Tamil Nadu Co-operative Milk Producers' Federation, dairy experts wonder if the gap can be bridged (New Indian Express, 2020). It indicates that there is a huge scope for dairy market in Ernakulam due to the steady increase in demand on consumer's side. Therefore, on the producer's side, the marketing strategy adopted, various milk marketing channels, the reasons for choosing and quantity of milk sells to these stakeholders/channels to be studied in detail. All these aspects are covered under this study.

V. MATERIALS AND METHODS

Present study used both primary data and secondary data. Primary data was collected from 320 dairy farmers in Ernakulam district with the help of pre tested structured interview schedule. Primary data were collected to examine the milk marketing strategies and channels adopted by dairy farmers in Ernakulam district. Multi stage random sampling method was used in the study. Secondary data were collected from reports of various departments of state government. Descriptive statistics like frequency distribution, percentages, proportion and mean were also used to analyse the data.

VI. RESULTS AND DISCUSSION

This section has been divided into two sub sections. They are (i) marketing strategies adopted by the farmers and (ii) marketing/distribution channels and reasons for choosing such channels in Ernakulam district.

6.1 Marketing strategy adopted by dairy farmers in Ernakulam district

Marketing strategies are the long term planning of objectives and goals that the entrepreneur want to achieve. Dairy farm as an enterprise also follows some goals like expand farms by capturing huge market for product/increased sale and obtain higher price and higher profit. In order to achieve these objectives, it is very essential to choose the appropriate marketing strategies. Therefore, every farmer tries to utilize the available opportunities to find markets and increased sale for their output. Sale of milk and milk products through right and proper channels is the major concern of dairy farmers. A strategy adopted by farmers includes direct marketing, personal contact strategy and marketing through intermediaries/middlemen. All these are explained in detail below. Table 1 show the distribution of farmers who follow marketing strategy of direct marketing, personal contact strategy and marketing through intermediaries/middlemen.

6.1.1 Direct marketing strategy

Main strategy adopted by farmers is the direct marketing. Direct marketing is the direct sale of products to different channels like cooperative society, households, middlemen and hotels /shops. Main advantage of such strategy includes finding of new customers and building of relationships, increased sales, helps in finding the best channels which results in the higher price of product. In the present study direct marketing includes personal and impersonal contact strategy as well.

TABLE 1
MARKETING STRATEGY ADOPTED BY DAIRY FARMERS IN ERNAKULAM DISTRICT

Farm Size*	Direct marketing Strategy		Personal Contact Strategy		Marketing through intermediaries	
	Number of farmers	Percentage	Number of farmers	Percentage	Number of farmers	Percentage
Very small	94	29.4	59	31.1	0	0.0
Small	142	44.4	84	44.2	3	16.7
Medium	44	13.8	26	13.7	2	11.1
Large	11	3.4	7	3.7	2	11.1
Very large	29	9.1	14	7.4	11	61.1
Total	**320**	**100**	**190**	**59.4**	**18**	**5.6**

Source: Primary data

*On the basis of total investment made by farmers, farms have been divided into 5 categories. Very Small (Upto Rs. 500000), Small (Rs. 500001 - Rs. 1000000), Medium (Rs. 1000001 - Rs. 1500000), Large (Rs. 1500001 - Rs. 2000000), Very Large (Above Rs. 2000000)

From the table it is clear that all the farmers in Ernakulam district adopt direct marketing strategy. In other words, farmers sell milk directly to households and dairy cooperative society.

6.1.2 Personal contact strategy

Second most important strategy adopted by the farmer is personal contact. This strategy involves personal contact by meeting or communicating with someone regularly. In other words, farmers sell milk and milk products to different channels like cooperative society, households and hotels/shops on the basis of acquaintance with them. They may be friends, relatives, neighbours or familiar persons. Therefore, farmer can ensure some customers throughout the period. This is the main advantage of choosing this strategy. It is a part of direct marketing strategy which includes the number of farmers who sells milk to various market channels on the basis of personal knowledge or information about them. This is personal contact strategy adopted by farmers in the marketing of milk. Table 1 show the distribution of farmers who chose personal contact strategy. From the table it is clear that out of 320 farmers, 59.4 percent of farmers follow personal contact strategy to sale milk. Across different farm size, out of 190 farmers who adopt personal contact strategy, 44.2 percent are small farmers followed by very small with 31.1 percent. Only 3.7 percent of large farmers adopt personal contact strategy.

6.1.3 Marketing through intermediaries

Another important strategy adopted by the farmers is marketing through intermediaries. Generally, intermediaries are also known as middlemen. They are traders of different products try to explore and create market opportunities in order to make more profit. Middlemen act as a distributor of many products and try to reduce the gap between producer and consumer. They are like traditional middlemen who pick up the bulk amount of milk from the farmers and directly sell to consumers, hotels or restaurants and take a margin on the milk while selling.

But a very few farmers approach middlemen even though they get higher price. It is due to the unawareness and unavailability of the information on middlemen. Some farmers are less confident about them. Table 1 show the distribution of farmers who opted intermediaries for selling milk. It is found from the table that only a few farmers marketing milk through intermediaries/middlemen. Out of 320 farmers, only 5.6 percent sell milk to middlemen. Out of 18 farmers who market milk through intermediaries, 61.1 percent are very large farms. Reason for low percent of farmers who adopt middlemen for marketing milk is found from the survey that firstly, they have less confidence on them. Secondly, they do not have much network facilities to reach the reliable intermediaries.

6.1.4 Sale of packed and unpacked milk

Farmers sell either packed milk or unpacked or both. They sell packed or unpacked milk on the basis of the preference of households. On the customers side, some prefer packed and some prefer unpacked milk. Normally unpacked milk is bought by some customers because unpacked milk is comparatively cheaper than packed milk. Major reason for preferring unpacked milk by customers is that farmers are nearby and easily can deliver at the doorstep with no additional cost. Major preference for packed milk is from the customers who live in cities or town areas of Ernakulam. Because packed milk ensure quality, availability, hygenity, fat content and easiness to store to its customers. In the present study by packed milk, we mean milk is packed in either glass bottle or plastic bottle. In other words, it is called as bottled milk.

Table 2 illustrates the preference of customers towards packed and unpacked milk. From the table it is clear that out of 320 farmers, 59.4 percent of farmers sell unpacked milk only and 5.9 percent of farmers sells packed milk only. And 34.7 percent of farmers sell both packed and unpacked milk. Across different farm size, out of 19 farmers who sell packed milk, 31.6 percent of them are very small and small farmers, 15.8 percent are very large farmers and 10.5 percent are medium and large farmers. Out of 190 farmers who sell unpacked milk, 40.5 percent are small farmers, 38.4 percent are very small farmers, 10.5 percent are medium farms, 2.1 percent are large farmers and 8.4 percent are very large farmers. Out of 111 farmers who sell both packed and unpacked milk, 13.5 percent are very small farmers, 53.2 percent are small farmers, 19.8 percent are medium farmers, 4.5 percent are large farmers and 9 percent are very large farmers.

TABLE 2
PACKED/UNPACKED MILK

Size of farm	Packed/ Unpacked	Total	
		Number of farmers	Percentage
Very Small	Packed	6	31.6
	Unpacked	73	38.4
	Both	15	13.5
	Total	94	29.4
Small	Packed	6	31.6
	Unpacked	77	40.5
	Both	59	53.2
	Total	142	44.4
Medium	Packed	2	10.5
	Unpacked	20	10.5
	Both	22	19.8
	Total	44	13.8
Large	Packed	2	10.5
	Unpacked	4	2.1
	Both	5	4.5
	Total	11	3.4
Very Large	Packed	3	15.8
	Unpacked	16	8.4
	Both	10	9.0
	Total	29	9.1
Total	**Packed**	**19**	**5.9**
	Unpacked	**190**	**59.4**
	Both	**111**	**34.7**
	Total	**320**	**100.0**
Source: Primary data			

6.2 Milk marketing channel

A marketing channel is the people, organizations, and activities necessary to transfer the ownership of goods from the point of production to the point of consumption. It is the way products get to the end-user, the consumer; and is also known as a distribution channel (Wikipedia). Bowersox and cooper define channel, "as a system of relationship among businesses that participate in the process of buying and selling products and services. It means that channels comprise a number of members each responsible for specific tasks." In order to achieve the goals of any enterprise we require a well organized and well planned marketing strategy. A proper and efficient marketing channel helps in achieving various goals.

There are various kinds of marketing channels in dairy market. The first and foremost requirement of any kind of business or enterprise is large number of consumers for their product. Therefore, in order to attract the customers for making profit or enlarging the market share every seller adopts some sort of marketing strategies like direct marketing and marketing through intermediaries and so on. Marketing channels act as wholesalers or retailers or distributors by providing certain functions like buying products on bulk basis and resale to other customers, direct sales to consumers and distributing the products to various kinds of customers. Therefore, the marketing channels help the producer to extend the market to a wider segment of customers through direct and indirect sale. Figure 1 shows the supply chain of milk. It tells how milk is distributed among various marketing channels.

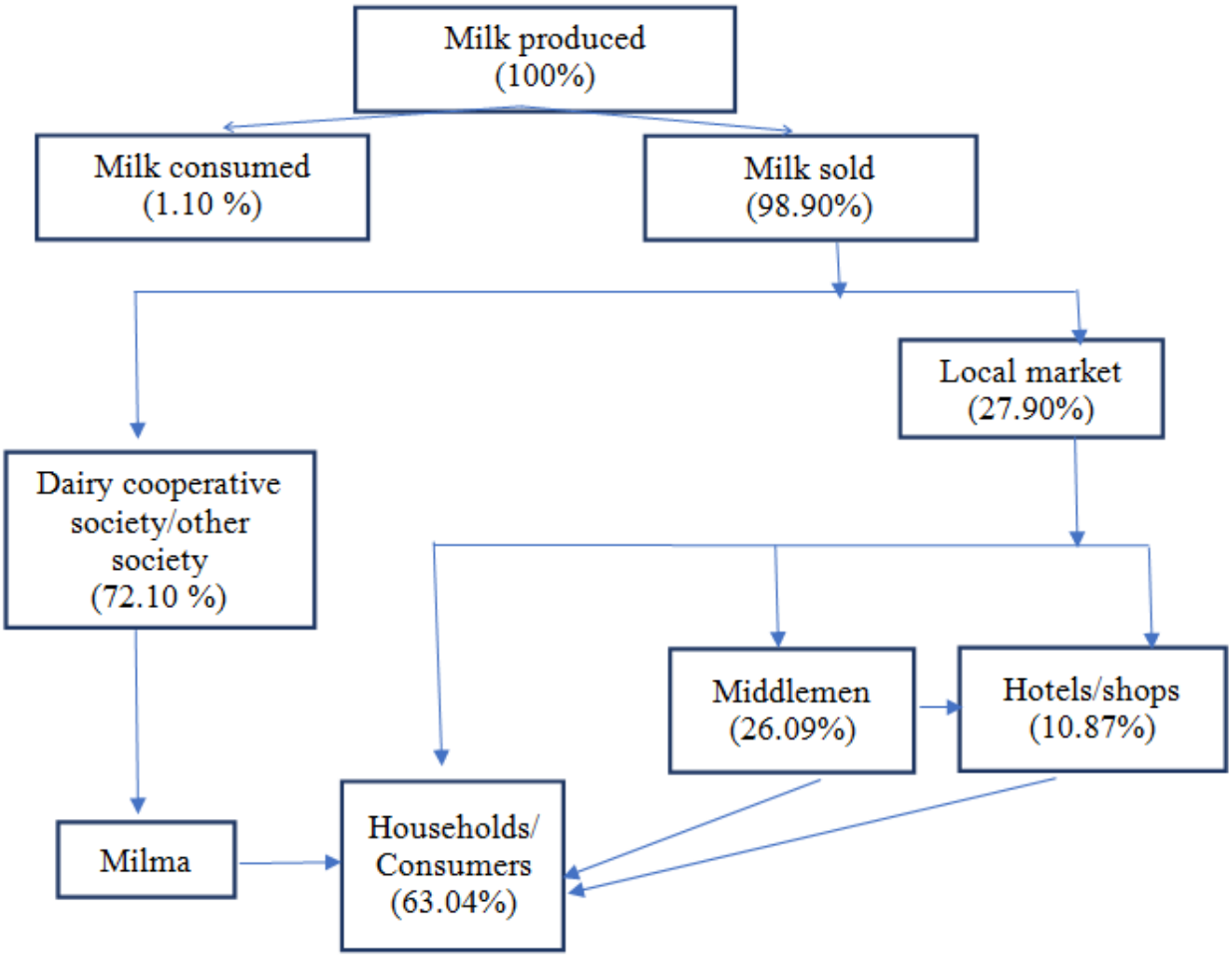


FIGURE 1: Supply chain of Milk
Source: Primary data

Figure 1 show that out of the total quantity of milk produced, 1.10 percent of milk is consumed by the dairy farmer itself and 98.90 percent of total milk produced is sold to various marketing channels such as dairy cooperative society and local market includes consumers/households, hotels/shops and middlemen. Out of the total milk sold, 72.10 percent of milk is sold to dairy cooperative society and remaining 27.90 percent is sold to local market. From the dairy cooperative society some quantity of milk is directly sold to households. Milma has given such provision to each dairy cooperative society for earning additional revenue in order to meet the daily expense of cooperative society. Milma collects remaining milk and processed in corresponding regional dairy plant and distribute milk in different qualities. When milk is sold to local market, (i) directly purchase by consumers/households (ii) sell to middlemen who sell a portion of milk to consumers/households or to shops again purchased by consumers and (iii) sell to hotels/shops, restaurant and hotels purchase a portion and remaining portion is sold to shops, then milk is purchased by consumers from the shops. From the figure it is clear that out of total quantity of milk sol to local market, 63.04 percent is sold directly to consumers/households, 26.09 percent is sold to middlemen and 10.87 percent is sold to hotels/shops.

Most of the farms follow traditional and informal marketing of milk. In Milma, price of milk is determined on the basis of FAT and Solid No Fat (SNF) content in the milk. Here in this paper, we explain the role of various marketing channels of dairy products and analyse the reason for choosing them. Milk marketing channels in Kerala takes the following form (Table 3). All these kinds of marketing channels are found functioning during the period of study. It is found that marketing channel of producer to consumer is more profitable and beneficial to producers than any other marketing channels even if farmers can sell more quantities of milk to consumers/households directly. Higher price received for milk is the main reason for it. No intermediary is involved in this process. Therefore, entire margin is received by the producer itself.

TABLE 3
MILK MARKETING CHANNELS

S No	Marketing channel	Number of intermediaries
1	Producer- Consumer	0
2	Producer-dairy coop. society-consumer	1
3	Producer-dairy coop. society-retailer-consumers	2
4	Producer-middlemen-consumer	1
5	Producer-middlemen-retailer-consumer	2
6	Producer-middlemen-processor-retailer-consumer	3
7	Producer-retailer-consumers	1
8	Producers-middlemen-retailer-consumers	2

Source: Primary data

6.2.1 Quantity of milk produced, consumed and sold per month

Milk production is the output of various factors and inputs, and a number of stages involved such as management of herd, milking, collection, transportation, processing and distribution. Out of the total milk produced by the farmers a certain amount is consumed by themselves. Remaining part of milk is sold to dairy cooperative society and local market including consumers, middlemen and hotels/shops.

Table 4 shows average quantity of milk produced by dairy farmers in Ernakulam district. In terms of quantity, on an average 3168 litres of milk is produced per month. From the table it is clear that as the farm size increases quantity of milk produced increases. It indicates that with farm size increases number of milch animals is high which leads to increased milk production.

TABLE 4
QUANTITY OF MILK PRODUCED, CONSUMED AND SOLD (IN LITRES) AND SHARE OF MILK CONSUMED AND SOLD TO TOTAL MILK PRODUCED (IN %) PER MONTH

Farm size	Quantity of milk (litre)			Share of milk (%)	
	Produced	Consumed	Sold	Consumed	Sold
Very Small	1220	27	1193	2.21	97.79
Small	2433	33	2400	1.36	98.64
Medium	3596	40	3556	1.11	98.89
Large	5337	55	5282	1.03	98.97
Very Large	11612	54	11558	0.47	99.53
Total	**3168**	**35**	**3133**	**1.10**	**98.90**

Source: Primary data

Farmer consumes a part of the total milk produced. Quantity of milk consumed by each household depends upon the size of family, age of the household members, taste and preferences etc. Table 4 present data on average quantity of milk consumed per month. On an average 35 litres of milk are consumed per month. That means on an average 1 litre of milk is consumed per day. Due to availability and high quality of milk household of farmers consume milk. From the table it is found that on an average 1.10 percent of total quantity of milk produced is consumed per month. Remaining part is sold to different marketing channel. On an average 3133 litres of milk are sold per month which indicates that 98.90 percent of total quantity of milk produced is sold per month.

6.2.2 Quantity of milk sold to cooperative society and local market per month

Out of total milk available for sale, major part of milk is sold to dairy cooperative society and local market includes households/consumers, middlemen and hotels/shops. It indicates that farmers try to sell their milk in various channels in the hope of getting a certain amount of margin. Selling milk to dairy cooperative society alone is not viable to them. Therefore, they have to find other channels and market. Quantity and share of milk sold to cooperative society and local market per month are presented in the Table 5.

TABLE 5
QUANTITY OF MILK SOLD (IN LITRES) AND SHARE OF MILK SOLD TO COOPERATIVE SOCIETY AND LOCAL MARKET (IN %) PER MONTH

Farm size	Quantity of milk sold (litre)		Share of milk sold (%)	
	Cooperative Society	Local market	Cooperative Society	Local market
Very Small	996	197	83.49	16.51
Small	1867	533	77.79	22.21
Medium	2583	973	72.64	27.36
Large	3570	1712	67.59	32.41
Very Large	7286	4272	63.04	36.96
Total	**2259**	**874**	**72.10**	**27.90**

Source: Primary data

Due to accessibility and high quantity of purchase farmers find easiness in marketing milk to cooperative society. It is found from the Table 5 that on an average more than 70 percent of total quantity of milk is sold to cooperative society. Remaining part is sold to local market. Table 6 illustrates average quantity of milk sold to local market which includes households, hotels/shops and middlemen. Quantity of milk sold to local market indicates that farmers sell a one fourth portion of the milk to local market across different farm size. On an average 874 litres are sold to local market per month. Due to reasonable price, timely payment, accessibility and high quantity of purchase farmers sell milk to the abovementioned marketing channels.

TABLE 6
QUANTITY OF MILK SOLD (IN LITRES) AND SHARE OF MILK SOLD TO CONSUMERS/HOUSEHOLDS, HOTELS/SHOPS AND MIDDLEMEN (IN %) PER MONTH

Farm size	Quantity of milk sold (litre)			Share of milk sold (%)		
	Consumers/Households	Middlemen	Hotels/Shops	Consumers/Households	Middlemen	Hotels/Shops
Very Small	197	0	0	100.00	0.00	0.00
Small	453	34	46	84.99	6.38	8.63
Medium	853	51	69	87.67	5.24	7.09
Large	1082	221	409	63.20	12.91	23.89
Very Large	1522	2189	561	35.63	51.24	13.13
Total	**551**	**228**	**95**	**63.04**	**26.09**	**10.87**

Source: Primary data

Detailed explanation for the average price and quantity of milk soldto cooperative society and other local marketing channels and reasonsfor choosing them has been given below.

6.2.3 Cooperative society

The most important milk marketing channel is the dairy cooperatives. In Kerala, Dairy Cooperative Society (DCS) performs well in the procurement of milk. These DCS are working under Kerala Cooperative Milk Marketing Federation (KCMMF) popularly known as "Milma" established in 1980 as a part of the successful implementation of Operation Flood. The socio-economic progress of the dairy farmer through procuring, processing and marketing of milk is the main goal of KCMMF. In order to achieve this goal cooperative societies are formed in every part of Kerala. A group of farmers are formed together and sell milk to cooperative society. Apart from these DCSs, there are some other cooperative societies like People Dairy Development Project (PDDP) Central Society and Jeeva Milk which have significant market share in Ernakulam district.DCS provides some services to farmers which distinguish from other marketing channels. Dairy farmers get a

somewhat fair price for the milk they sell and provide an assured marketing space for the milk and thereby financial security is maintained. Thus, dairy sector is organized in this way. Major difference between DCS and other cooperative society is that farmers get higher price for milk by other dairy cooperative society rather than DCS.

TABLE 7
NUMBER OF DAIRY FARMS SELL MILK TO AGENTS/MARKETING CHANNELS

Farm size	Cooperative society		Consumers/ Households		Middlemen		Hotels/Shops	
	No of farmers	Percentage	No of farmers	Percentage	No of farmers	Percentage	No of farmers	Percentage
Very Small	94	29.4	72	25.6	0	0.0	0	0.0
Small	142	44.4	134	47.7	3	16.7	14	46.7
Medium	44	13.8	40	14.2	2	11.1	6	20.0
Large	11	3.4	11	3.9	2	11.1	3	10.0
Very Large	29	9.1	24	8.5	11	61.1	7	23.3
Total	**320**	**100.0**	**281**	**87.81**	**18**	**5.6**	**30**	**9.4**

Source: Primary data

Table 7 illustrates the number of farmers pour milk to Dairy Cooperative Society and other society, consumers/households, middlemen and hotels/shops. From the table it is obvious that all the farmers pour milk to dairy cooperative societies across different farm size. Majority of farms belongs to small farms; as a result, 44.4 percent of small farmers sell milk to dairy cooperative society.

6.2.4 Average price and quantity of milk sold to dairy cooperative society

Average price per litre and quantity of milk pour to cooperative society per month are presented in Table 8. Price is fixed by dairy cooperative society on the basis of fat and SNF content of milk. On an average of 2259 litres of milk pour to cooperative society per month at Rs. 37 in Ernakulam district. Table shows that very small farmers get higher price (Rs.40) than other farms. Lowest price is received by small, medium and very large farms with Rs. 36 each.

TABLE 8
AVERAGE PRICE (RS.) AND QUANTITY OF MILK (IN LITRE) SOLD TO AGENTS/MARKETING CHANNELS

Farm size	Cooperative society		Consumers/ Households		Middlemen		Hotels/Shops	
	Price	Qty	Price	Qty	Price	Qty	Price	Qty
Very Small	40	996	51	197	0	0	0	0
Small	36	1867	47	453	47	34	45	46
Medium	36	2583	48	853	48	51	45	69
Large	38	3570	50	1082	44	221	48	409
Very Large	36	7286	48	1522	46	2189	46	561
Total	**37**	**2259**	**49**	**551**	**46**	**228**	**44**	**95**

Source: Primary data

It is found that selling milk to consumers/households is more profitable and beneficial to farmers than any other marketing channels even if farmers can sell more quantities of milk to consumers/households directly. Farmers get higher price for the milk from the consumers/households than any other marketing channels. But in reality, farmers sell higher quantity of milk to dairy cooperative society where they get a lower price which is not feasible and viable. When considering return from milk, dairy cooperative society contributes more. On an average, price difference of Rs. 12 has been found between the price of milk sold to dairy cooperative society and consumers/households.

6.2.5 Reason for choosing dairy cooperative society

From the Table 9, it is clear that main reason for choosing dairy cooperative is timely/regular payment (100%), high quantity of purchase (98.44%), accessibility (97.81%), no network facility for direct marketing/no household demand (92.19%) and conventional practice (80.00%). Very few farmers choose dairy society due to reasonable and higher price (26.88%) they get.

From the table it is clear that some kind of malpractices is there in cooperative society in measuring Fat and SNF content. Some farmers sell milk to cooperative society due to known persons. They personally know dairy society secretaries.

TABLE 9
REASON FOR CHOOSING VARIOUS AGENTS/MARKETING CHANNELS

Reasons	Cooperative society		Consumers/ Households		Middlemen		Hotels/Shops	
	No of farmers	%	No of farmers	%	No of farmers	%	No of farmers	%
Advance payment	0	0.00	22	7.83	0	0.00	0	0.00
Timely/ regular payment	320	100.00	249	88.61	17	94.44	28	93.33
Known Persons	6	1.88	273	97.15	18	100.00	30	100.00
No malpractice	5	1.56	273	97.15	7	38.89	30	100.00
Reasonable/ Higher price	86	26.88	278	98.93	18	100.00	30	100.00
Accessibility	313	97.81	263	93.59	18	100.00	29	96.67
High quantity of purchase	315	98.44	7	2.49	18	100.00	3	10.00
Network facilities	0	0.00	2	0.71	2	11.11	0	0.00
Conventional practice	256	80.00	110	39.15	0	0.00	7	23.33
No network facility for direct marketing/No household demand	295	92.19	1	0.36	5	27.78	7	23.33
Other reasons if any	0	0.00	0	0.00	0	0.00	0	0.00

Source: Primary data

6.2.6 Consumers/Households

Consumer plays an important role in marketing process and they act as central element in the commodity market. Household is also used in the same meaning of consumer. Recently there has been a new trend in urban Kerala in which consumers prefers fresh farm milk even though price of milk is high. For them higher price is the indicator of quality milk. Farmers find difficult in selling whole milk to dairy cooperative society since they provide less price for the milk when compared to other marketing channels. Price variation is very high from location to location. It is not viable for the farmers if they sell entire quantity of milk to society alone. Therefore, farmers try to find other market channels which provide reasonable price and easy accessibility. These marketing channels are commonly known as local market. Consumers/household is one among local market channels. Table 7 reveals that out of 320 farmers, 87.81 percent sell milk directly to consumers/households. Remaining 39 farmers (12.19%) do not sell to consumers/households.

6.2.7 Average price and quantity of milk sold to consumers/households

Average price per litre and quantity of milk sold to consumers/households per month is illustrated in Table 8. It can be seen that on an average 551 litres of milk are sold per month at Rs. 49. It helps the farmers to increase their revenue from selling milk to consumers. Table shows that very small farmers get higher price (Rs.51) than other farms. Lowest price is received by small farmers with Rs. 47. Both very small and large farmers receive higher price than the district average. Along with price, average quantity of milk sold is very much important for a farmer in getting more revenue. When look at the data it is shown that average quantity of milk sold to consumers fluctuates over different farm size.

6.2.8 Reason for choosing consumers/households

From the Table 9, it is clear that due to reasonable price /higher price (98.93%), known persons (97.15%), no malpractice (97.15%), accessibility (93.59%), timely/regular payment (88.61%) and conventional practice (39.15%) farmers have chosen consumers/households. It also can be seen from the table that very few farmers chose consumers/households due to advance payment (7.83%), high quantity of purchase (2.49%), network facilities (0.71%) and no network for direct marketing

(0.36%). When sell milk to consumers farmers get fair prices but higher quantity of purchase by consumers is not possible. Farmers do not have much network for expanding their sale. Majority of farmers have the opinion that no malpractices is from consumers in selling milk directly to consumers.

6.2.9 Middlemen

Yet another important marketing channel adopted by dairy farmer in Ernakulam district is middlemen. They act as a distributor of products and try to reduce the gap between producer and consumer. They are like traditional middlemen who pick up the bulk amount of milk from the farmers and directly sell to consumers, hotels or restaurants and take a margin on the milk while selling. Present study found out that very few sells milk to these intermediaries even though they provide reasonable or higher price. It is due to the asymmetric information possessed by farmers regarding price. Table 7 reveals that out of 320 farmers, only 5.6 percent sell milk directly to middlemen. It indicates that majority do not depend on middlemen in selling milk due to various reasons.

6.2.10 Average price and quantity of milk sold to middlemen

Average price per litre and quantity of milk sold to middlemen per month is illustrated in Table 8. It can be seen that on average milk sold to middlemen at Rs.46. On an average 228 litres of milk are sold to middlemen per month. It is found from the table that only small and medium farmers receive higher price with Rs 47 and Rs. 48 respectively which is higher than that of district average. Very small farmers do not sell milk to middlemen. When considering average quantity of milk sold to middlemen, it is seen that very large farmers sell larger quantity of milk (2189 litres) to middlemen. When compared to the price of milk sold to middlemen with other marketing channels, on an average, difference of Rs. 9 has been found between DCS and other cooperative society and middlemen where price of milk sold to middlemen is higher. Price difference of Rs. 3 and Rs. 2 is found between middlemen and consumers/households and between middlemen hotels/shops respectively where price of milk sold to consumers/households are higher and price of milk sold to hotels/shops are lower than that of the price of milk sold to middlemen.

6.2.11 Reason for choosing middlemen

Reasons for choosing middlemen as marketing channel is presented in the Table 9. Percentage of farmers who sell to middlemen due to various reasons is calculated by using the number of farmers who sell to the same and excluded the number of farmers who do not sell to middlemen. From the table it is clear that due to known persons (100%), reasonable price /higher price (100%), accessibility (100%), high quantity of purchase (100%), timely/regular payment (94.44%), no malpractice (38.89%) no network facility for direct marketing/no household demand (27.78%) and no network facilities (11.11%) farmers have chosen middlemen. Main advantage of selling to middlemen is the high quantity of purchase When compared to other local marketing channels. Data indicates that some kind of malpractices in the form of price reduction is there. Middlemen sometimes try to mislead the farmers by giving wrong information about price. Due to this asymmetric information on the producer's side they have to accept that price.

6.2.12 Hotels/shops

Fourth important channel in milk market is institutional buyers like hotels/shops. Some farmers sell a part of their surplus milk to hotels/shops to get a margin. Table 7 reveals that out of 320 farmers, only 9.4 percent sell milk directly to hotels/shops. It indicates that majority do not sell milk to hotels/shops. Out of 30 farmers who sell milk to hotels/shops, 46.7 percent are small farmers followed by very large farmers with 23.3 percent, medium farmers with 20 percent and large farmers with 10 percent. Very small farmers do not sell milk to hotels/shops since cooperative society and consumers/households are the only marketing channels to them.

6.2.13 Average price and quantity of milk sold to hotels/shops

Average price per litre and quantity of milk sold to hotels/shops per month is illustrated in Table 8. It can be seen that on average milk sold to hotels/shops at Rs.44. Farmers have opined that they do get fair price when they sell milk to hotels/shops. On an average 95 litres of milk is sold per month. Both large and very large farmers sell higher quantity of milk to hotels/shops and get a higher price than that of district average with Rs.46 and Rs.48 respectively. When compared to the price of milk sold to hotels/shops with other marketing channels, on an average, difference of Rs. 7 has been found between DCS and hotels/shops where price of milk sold to hotels/shops is higher. Price difference of Rs. 5 and Rs. 2 is found between hotels/shops and consumers/households and between hotels/shops and middlemen respectively where price of milk sold to consumers/households and middlemen are higher than that of the price of milk sold to hotels/shops.

6.2.14 Reason for choosing hotels/shops

Reasons for choosing hotels/shops as marketing channel have presented in the Table 9. Percentage of farmers who sell to hotels/shops due to various reasons is calculated by using the number of farmers who sell to the same and excluded the number of farmers who sell milk to others channels. From the table it is clear that due to known persons (100%), reasonable price /higher price (100%), no malpractice (100%), accessibility (96.67%) and timely/regular payment (93.33%) and conventional practice and no household demand (23.33%) farmers have chosen hotels/shops. It also can be seen from the table that very few farmers chose hotels/shops due to high quantity of purchase (10%) and no malpractice (3.33%). Even though farmers get fair price when sell milk to hotels/shops they are unable to sell higher quantity to them due to various reasons like unavailability of information, no network facilities etc. Data indicates that no kind of malpractices is there. Farmers do not have much network for expanding their sale. Therefore, it is found that due to the higher price received for milk from consumers/households, selling milk to consumers/households is more profitable and beneficial to farmers than any other marketing channels if and only if farmers can sell more quantities of milk to consumers/households directly. But in reality, due to timely/regular payment, high quantity of purchase, accessibility, and no network facility for direct marketing/no household demand, out of total milk sold, 72.10 percent of milk sold to dairy cooperative society where they get a lower price which is not feasible and viable and remaining portion is sold to other local market. Therefore, as one of the main objectives of rural development is to ensure economic well being of people by providing adequate income and employment, it is necessary to ensure reasonable price for the milk produced by farmers without affecting their willingness to produce.

VII. CONCLUSION

It is evident that Kerala has the great potential in dairy sector since there is huge market for the product due to growing demand. Due to the involvement of many factors like lack of infrastructure facilities, transportation, interference of intermediaries, less bargaining capacity and lack of knowledge about the marketing conditions Kerala's milk marketing is facing a huge challenges and constraints. As a result, many of the farmers could not find market for their products which creates pricing issues and thereby lowering profit. Proper marketing strategies are essential for the better and successful running of dairy farm. In this context the present study has analysed the marketing strategy adopted, various milk marketing channels, quantity of milk sell to these channels and the reasons for choosing in Ernakulam district are studied in detail.

Present study reveals that procurement prices are lower in the cooperative societies. Therefore, it is found that due to the higher price received, selling milk to consumers/households is more profitable and beneficial to farmers than any other marketing channels if and only if farmers can sell more quantities of milk to consumers/households directly. When considering return from milk, dairy cooperative society contributes more since average quantity of milk sold to dairy cooperative society is higher than that of any other marketing channels. It implies the existence of various reasons such as timely/regular payment, high quantity of purchase, accessibility, and no network facility for direct marketing/no household demand. Therefore, out of total milk sold, 72.10 percent of milk is sold to dairy cooperative society which indicates that farmers are not able to extend their market and they have to entirely depend on cooperative society which is found non feasible and non-viable. On an average, price difference of Rs. 12 has been found between the price of milk sold to dairy cooperative society and consumers/households. Apart from that, due to the lack of extended marketing facility/unawareness about the extended marketing opportunities, and lack of transportation facility only 27.90 percent of total milk sold is available for local sale which indicates the dominance of traditional marketing channel like cooperative society. In order to reach a break-even point, some quantities of milk have to be sold to other local marketing channels other than cooperative society. Otherwise, farmers will incur huge loss which in turn adversely affects the willingness of the farmers in producing milk and it will reflect in the decline of milk production in Ernakulam district. Therefore, as the main objective of rural development is to ensure economic well being of people by providing adequate income and employment, it is necessary to ensure reasonable price for the milk produced by farmers without affecting their willingness to produce. In this context, in order to meet the increased demand for milk on the consumer's side, government and concerned department have to take appropriate actions to boost the milk market in Ernakulam district by focusing on both production side and marketing side with equal importance.

REFERENCES

[1] Anjani Kumar, Ashok K Mishra, Shinoj Parappuarathu, Girish Kumar Jha (2018). Framer's Choice of Milk marketing Channels in India. *Economic and Political Weekly*: Vol.53, Issue No. 51, 29 Dec, 2018.

[2] Ghosh, Nilabja, Amarnath Tripathi, M Rajeshwor and Roopal Singh (2017). Do producers gain from selling milk? An economic assessment of dairy farming in Contemporary India", *Economic & Political Weekly*. Vol 52. No. 25-26, pp 88-96

[3] M, Dinesh & Singh, O (2017). Economics of Dairy Farming in India. Economic and Political Weekly. 52. 77-79.

[4] Rajendran K, Samarendu Mohanty (2004). Dairy Co-operatives and Milk Marketing in India: Constraints and Opportunities. *Journal of Food Distribution Research* 35(2)

[5] Saravanadurai A, Muthuraj S (2018). A study on marketing of milk through dairy cooperatives in Akkarapalayam Panchayat. *Indian Journal of Applied Research:* Volume 8, Issue 11, November 2018

[6] Vijay Paul Sharma (2015). Determinants of Small Milk Producers' Participation in Organized Dairy Value Chains: Evidence from India. *Agricultural Economics Research Review:* volume 28(No.2) July-December 2015 pp 247-261

[7] Dairy Industry in Kerala: Price, Consumption Analysis and District wise Milk Production Report 2021-2026 (imarcgroup.com). Available from https://www.imarcgroup.com/dairy-industry-kerala. Data accessed on 04/11/2020

[8] https://www.thehindu.com/news/national/kerala/kerala-tops-ndri-study-on-dairy-production/article31076118.ece. Data accessed on 15/03/2020

[9] https://www.newindianexpress.com/cities/kochi/2020/feb/18/milk-shortage-hits-district-2104728.html. Data accessed on 18/02/2020

[10] https://en.wikipedia.org/wiki/Marketing_channel. Data accessed on 12/05/2021.

Fresh Biofertilizer: A Novel Concept in Improving Soil Fertility

Prakash Vaghasiya[1*], Krishna Patel[2], Anjali Nair[3]

Vise Innovation Solution Enterprise Pvt. Ltd, Vadodra
*Corresponding Author

Received:- 15 June 2021/ Revised:- 22 June 2021/ Accepted:- 26 June 2021/ Published: 30-06-2021

Abstract— *Biofertilizers are gaining tremendous importance in agriculture due to the detrimental effect of chemical fertilizers on plants and soil health. It consists of living beneficial microorganisms that enhance plant growth and maintain soil health by using different mechanisms. For improving the soil health along with the growth of plants Efficiency of biofertilizers depends upon different factors such as quality and formulation of inoculant, total number of living microbes, and shelf life. .Therefore it is very important to discuss the shelf life of biofertilizers and another alternative such as use of fresh biofertilizers. Fresh biofertilizers is a concept that emphasises immediate use of biofertilizer after production to ensure maximum microbial count and hence is a revolutionary idea in the field of agriculture. So this study shows the importance of fresh biofertilizer in improving soil health and plant growth.*

Keywords— Microorganisms, Shelf life, Fresh biofertilizer, Soil fertility.

I. INTRODUCTION

Our dependence on chemical fertilizers helped the survival of many industries that are producing life threatening chemicals which are disturbing the ecological balance. The problem of feeding an increasing global population when the agricultural sector is facing many environmental issues can be solved with the help of biofertilizers. (Deepak Bharadwaj *et al* 2014). Because of the increasing potential of biofertilizer in sustainable agriculture, its demand among farmers is increasing. However, many of the biofertilizers that are produced worldwide are often of poor quality, resulting in loss of confidence of farmers (Herrmann, L., & Lesueur, D. 2013).The formulation and shelf life of inoculant used, act as key components for the development of a successful biofertilizer. This review discusses the importance of good quality fertilizers and the factors determining it. (Herrmann, L., & Lesueur, D. 2013).

II. WHY BIOFERTILIZERS ARE CONSIDERED AS AN ASSET FOR FARMERS?

Biofertilizers are considered as a viable alternative for chemical fertilizers that cause various environmental hazards. Microorganisms such as plant growth promoting rhizobacteria and mycorrhizal fungi are mainly used in the formulation of biofertilizers because of their ability to provide plants with the essential nutrients that enhance their growth (D.Mishra *et al* 2013). Compared to chemical fertilizers, biofertilizers are more accessible to small and marginal farmers (Thomas, L., & Singh, I. 2019). The positive agronomical effect of microbial based products has opened a worldwide market for biofertilizers.

Biofertilizers are cultures of living microorganisms packed in a carrier material. Biofertilizers consist of living or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic microorganisms. (Paula García-Fraile, *et al. AIMS Bioengineering*, 2015.). The major phosphate solubilizers which are free living include *bacillus, aspergillus, pseudomonas, enterobacter, and penicillium* but the N-fixing bacteria could be free living (*rhizobium*) or symbiotic (*azospirillum and azotobacter*) (Elmerich and Newton, 2007; Raimi *et al*., 2017). Biofertilizers helps in increasing the number of beneficial microorganisms in the soil and accelerate their microbial processes that helps increases the availability of nutrients that can be easily assimilated by plants. Biofertilizers play very important role in fixing atmospheric nitrogen and releasing growth promoting substances such as gibberellin, indole acetic acid (IAA), cytokinins and siderophores (Suyal *et al*., 2016). Hormones and antimetabolites released by biofertilizers help in promoting root growth. Another function of biofertilizer

includes decomposition of nutrients and soil mineralization [2-4]. Biofertilizers consist of different types of microbes with similar or different functional capabilities (Lesueur *et al.*, 2016).

Organic farming mostly depends on the natural microflora of the soil that contains all beneficial bacteria and fungi called Plant Growth Promoting Rhizobacteria (PGPR). Biofertilizers helps in keeping the soil rich in beneficial microorganism by nitrogen fixation, phosphate and potassium mobilization and solubilization, release of plant growth promoting substances, biodegradation of organic matter in the soil and production of antibiotics (Sinha RK *et al* 2014). Application of biofertilizers helps in multiplying the nutrient cycling and promotes crop productivity (Singh JS *et al* 2011). PGPR act as bio protectants that help in crop improvement under stress (Yang JW *et al* 2009). Even under salinity stress conditions the number of nodulation increased with the application of Rhizobium trifolii inoculated with Trifolium alexandrinum (Hussain N *et al* 2002) (Antoun H *et al* 2005). A root endophytic fungi Piriformospora indica helped the host plant in defending against salt stress (Ansari MW *et al* 2003).Apart from acting as growth promoting agents, biofertilizers provide resistance against pathogens by producing metabolites (Backman PA, Sikora RA: Endophytes: an emerging tool for biological control. Biol Control 2008). In banana roots fusarium infestation can be controlled with the help of Bacillus subtilis N11 along with compost application (Zhang N *et al* 2011). B.subtilis is used in cotton to provide resistance against R.solani along with induction of foliar and root growth (Medeiros FHV *et al* 2011).

III. WHAT DETERMINES THE QUALITY OF A BIOFERTILIZER?

Like any other product, the success of biofertilizer depends upon its quality. Biofertilizers of poor quality are not found helpful in increasing crop yield (Lupwayi et al., 2000; Simiyu *et al*., 2013) because the microbial element that is essential for field action will be missing (Herrmann et al., 2015; Raimi *et a*l., 2019). Poor biofertilizers causes financial losses to the farmers when applied in the field because they do not form associations with host plants (Corkidi *et al*., 2004; Faye et al., 2013). Several biofertilizers have been reported to have contaminants instead of microbes that are mentioned in the products label (Herrmann *et al*., 2015; Olsen et al., 1996).It is very important to have an efficient production system with proper quality control (Herridge et al., 2002; Simiyu *et al*., 2013). Presence of recommended strains in active forms determines the quality of a biofertilizer (joginder singh 2001).

The quality parameters used by India and China include Total Viable Cell(TVC), pH, shelf life, particle size, water content and contaminations (Malusa and Vassilev 2014).Other quality parameters used for biofertilizers include type, effectiveness and functional capabilities of microbe present in the biofertilizer (Lupwayi et al., 2000; Vessey, 2003).

IV. TOTAL VIABLE CELL COUNT AND ITS SIGNIFICANCE

Total Viable Cell count is an important parameter used to identify the quality of a biofertilizer. The microorganisms present in the biofertilizer should be living to ensure the initial infectivity or colonisation of the host plant as well as for the exhibition of other functional abilities (Habte and Osorio, 2001). Hence it is very important for the biofertilizers to contain viable cells and spores that are metabolically and physiologically competent for field efficiency (Raimi A *et al*.2020). Dilution plate technique can be used for estimating total viable cell count using a tenfold serial dilution with saline solution as diluents (Motsara and Roy, 2008). A rotary shaker is used for agitation at 150rpm for 25 minutes before further dilution up to 10-9. Then 0.1 mL of dilution 10-5 to 10-9 is spread on different culture media plates in triplicate. After incubating for 2-5 days the colonies are enumerated and the microbial count are expressed as **Colony Forming-Unit [CFU]** (Raimi A *et al*.2020). CFU is an important criteria to determine the quality of a biofertilizer. This is because a biofertilizer must supply a substantial amount of microorganisms in to the field to ensure guaranteed field efficiency. Therefore, Total Viability Count of a good biofertilizer should be within the acceptable quality standard or should match with those declared by the product or label (Raimi A *et al*.2020).

V. FORMULATION OF A BIOFERTILIZER

Formulation of inoculant is a very crucial process in the manufacturing of biofertilizers. A successful formulation should result in involving one or more microorganism in a suitable carrier, protecting them from harsh conditions during storage, maintaining the count of viable cells and ensuring their survival and establishment after inoculating in to the soil (Herrmann, L., & Lesueur, D. 2013).Formulation decides the potential success of inoculants (Fages 1992). The quality of a microbial inoculant depends mainly on the number of viable cells present in it (Sahu, P. K., & Brahmaprakash, G. P. 2016). The

relationship between effectiveness of a biofertilizer and number of viable cells are directly proportional. Formulation is a multi step process that results in different strains of microorganisms in a particular carrier with additives that helps in protection of cells during storage and transport (Xavier et al. 2004). The microorganism present in the formulation should be well protected to survive under harsh conditions so that the numbers of living microbes are maintained. A formulation is considered to be excellent if it provides good condition for survival of microorganism in the soil and helps in enhancing their activity in the soil that helps in plant growth (McQuilken et al. 1998). Different types of formulation used include liquid, peat, granules, powder and success of a formulation depend on different factors such as target crop, environmental constraints, cost, and market availability (Arora et al. 2011). With time, total viability count or total number of living cells of microbes present in a biofertilizer reduces along with its quality. This can be changed with the introduction of the concept of 'FRESH BIOFERTILIZERS'. Fresh biofertilizers should be applied in the field immediately after manufacturing, ensuring the maximum number of living microbes in the biofertilizer. Farmers receive their biofertilizers a long time after its production. During this time period microbial count of the biofertilizer reduces affecting its potential. This can be avoided if biofertilizers are produced by farmers by themselves and applied in the field immediately after production. Technologies enabling this are introduced by biofertilizer companies and awareness about such technology should be created among farmers to assure proper utilization of biofertilizers. FRESH BIOFERTILIZER is a novel concept and should reach all farmers.

VI. SHELF LIFE OF A BIOFERTILIZER

Biofertilizers consist of living organisms that benefit the plant resulting in improved growth and productivity. Therefore viability of these organisms during production, formulation, storage, and transport and field application is directly proportional to the plant growth promoting ability of a biofertilizer formulation. Improper storage and long duration between production and field application is one of the major reasons behind the inefficiency of biofertilizers. This limits the use of biofertilizers due to their stability, compatibility and survival under different soil conditions. Hence improved shelf life or immediate use of biofertilizers after production might helps in maintaining the rate of colony forming unit in biofertilizers and helps in further popularization of biofertilizer application (Satinder Kaur *et al* 2012).

Different strategies are applied to ensure maximum viability of formulations used in bio-fertilizers .These strategies include (Satinder Kaur *et al* 2012):

1. Use of thermo-tolerant/ drought-tolerant/ genetically modified strains.(Satinder Kaur *et al* 2012).
2. Optimization of biofertilizer formulation(Satinder Kaur *et al* 2012).
3. Use of liquid biofertilizers(Satinder Kaur *et al* 2012).

Carriers are used in biofertilizers as a vehicle for the convenient application of microorganisms. This also helps in maintaining the viability of cells and also provides a condition that promotes rapid growth of microorganisms upon their release. For better shelf life of biofertilizers, a carrier or a mixture of carrier material such as peat, vermiculite, lignite powder, clay etc. are selected on the basis of viability of micro-organism mixed with them. Another method used for improving the shelf life of bio-fertilizer is pre-sterilization and nutrient enrichment of carrier material .This allows the micro-organism to grow in a non-competitive environment (Yardin MR *et al* 2000). One of the potential strategies for improving shelf life of biofertilizer is liquid biofertilizers. Liquid biofertilizers allow the manufacturer to include sufficient amount of nutrients, cell protectant and inducers that result in formation of cell/spore/cyst that promotes prolonged shelf life of biofertilizers. In case of solid biofertilizers the shelf life is around 6 months but in case of liquid biofertilizers can be around 2 years (Mahdi SS *et al* 2010). Liquid bio-fertilizers provide improved shelf-life due to their thermo-tolerant capabilities (Mahdi SS *et al* 2010). But the cost of production of liquid biofertilizers is higher than solid biofertilizers thus, successful commercialization of less expensive liquid biofertilizers are still a concern.

VII. FACTORS AFFECTING THE QUALITY AND EFFICACY OF AN INOCULANT

The Quality of an inoculant during production depends on a number of factors (Herrmann, L., & Lesueur, D. 2013). During large scale production of an inoculant a number of technical difficulties occur. For example in case of bacteria, the nature of growing media and the condition of incubation like pH , temperature, and time should be controlled and adjusted to ensure optimum growth of specific strain and good physiological condition of cells. Operators should be well trained to assure

implementation of right methodologies. Throughout the process, the purity of culture is maintained to ensure production of good quality product (Malusa *et al*. 2012; Okon and Hadar 1987).

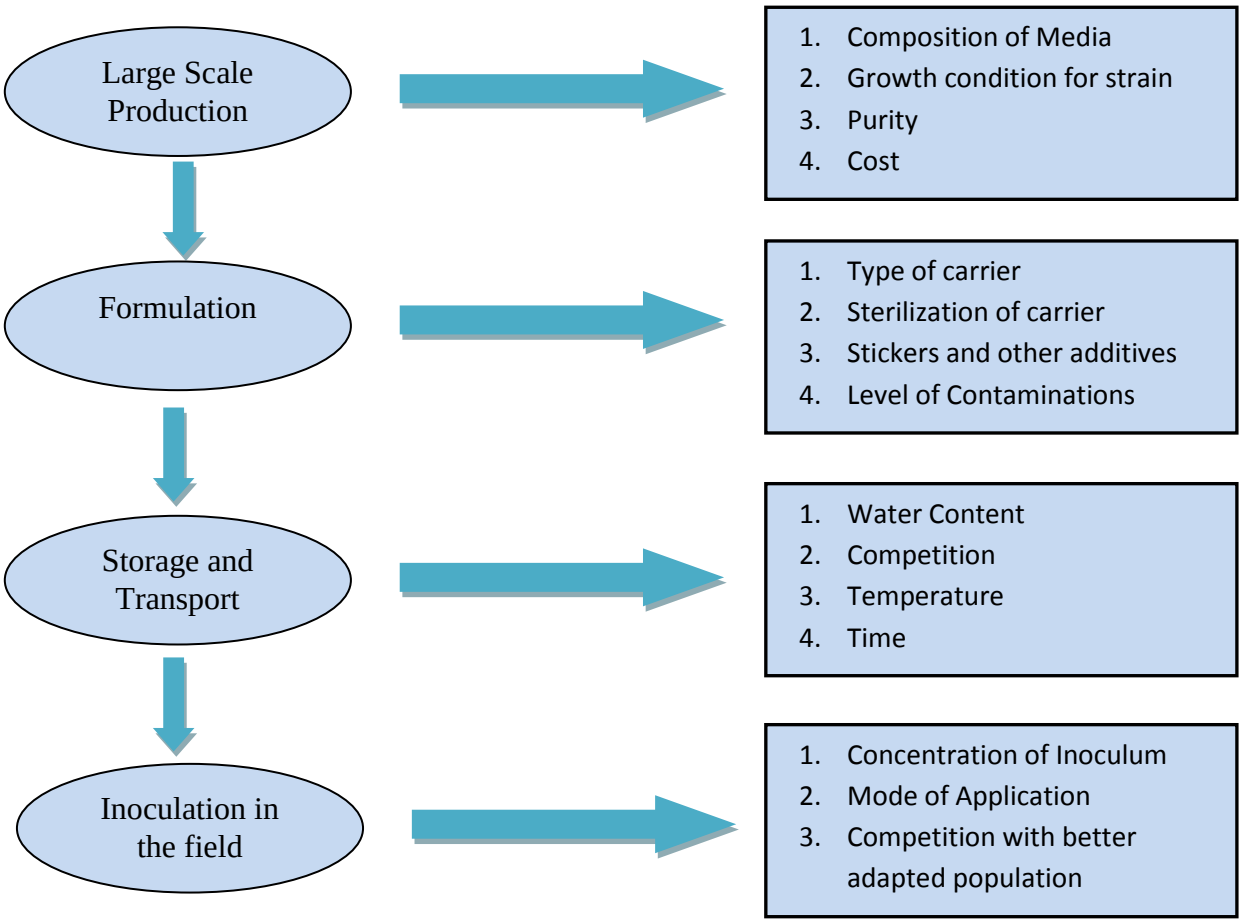


FIGURE 1: Factors affecting quality of inoculants during different stages.

Introduction of new carriers will help to overcome the limitations due to use of peat like its availability, environmental impact and toxicity and it will provide a more sustainable environment for the growth of microorganisms, its viability during storage and on seed and soil after application (Deaker *et al*. 2004; McQuilken et al. 1998).

Many factors affect the viability of cells during transport and storage. In order to maintain viability at storage cool temperature is generally recommended but it is very expensive and lacking in many developing countries (Herridge et al. 2002; Temprano *et al*. 2002).Several studies have reported that the inoculation efficiency reduced due to declining population in inoculation over time. (Biederbeck and Geissler 1993; Catroux *et al.* 2001; Maurice et al. 2001; Revellin *et al*. 2000; Trivedi and Pandey 2007). If the products are not stored under optimal condition then the population of contaminants increases (Hartley *et al*. 2005). Efficiency of a inoculant also depends on the mode of application like seed coating, soil application or on-site seed application (Deaker et al. 2004; Malusa *et al*. 2012).One of the major barrier for successful inoculation is nature and size of native population in the soil. It is challenging for the newly introduced cell to survive in the new potentially harsh condition and along with that, they also have to compete for a protective niche and nutrients with the indigenous, better adapted population (Bünemann et al. 2006; Kloepper *et al*. 1989).

The ability of an introduced strain to maintain a high population level in an unfriendly environment and to live as a member of soil microflora even in the absence of its host legume determines the success of inoculation (Lupwayi *et al*. 2006).

VIII. CONCLUSION

Since biofertilizers are composed of living microorganisms, maintaining the viability of living organisms present in it is an integral step towards production of a good quality biofertilizer. The concept of fresh biofertilizer is a novel approach towards use of biofertilizers. Maintaining cell viability is an important factor affecting biofertilizer quality and that can be achieved

with the use of fresh biofertilizers. Hence, this article discuss about the importance of biofertilizers, factors affecting its quality and about the significance of fresh biofertilizer concept.

REFERENCES

[1] Paula García-Fraile, et al. *AIMS Bioengineering*, 2015. 2(3): p. 183-205.

[2] H. A. Rather, et al. *J Phyto*. 2010, 2(10).

[3] Rakesh Kumar, et al. *Popular Kheti*. 2017. 5(4).

[4] Boraste A, et al. *Int J Micro*. 2009. 1(2): p. 23-31.

[5] Bhardwaj, D., Ansari, M.W., Sahoo, R.K. et al. Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity. Microb Cell Fact 13, 66 (2014). https://doi.org/10.1186/1475-2859-13-66

[6] Raimi, Adekunle, et al. "Insights into the microbial composition and potential efficiency of selected commercial biofertilizers." *Heliyon* 6.7 (2020): e04342.

[7] Herrmann, Laetitia, and Didier Lesueur. "Challenges of formulation and quality of biofertilizers for successful inoculation." *Applied microbiology and biotechnology* 97.20 (2013): 8859-8873.

[8] Dastogeer, Khondoker MG, et al. "Plant microbiome–an account of the factors that shape community composition and diversity." *Current Plant Biology* (2020): 100161.

[9] T.K., Ghosh & R.P., Singh & Duhan, Joginder & D.S., Yadav. (2001). A review on quality control of biofertilizers in India. Fertilizer Marketing News 0257-8034. 32. 1-9.

[10] Thomas, Lebin, and Ishwar Singh. "Microbial biofertilizers: types and applications."*Biofertilizers for Sustainable Agriculture and Environment*. Springer, Cham, 2019. 1-19.

[11] Brar, Satinder & Sarma, Saurabh & Chaabouni, Emna. (2012). Shelf-life of biofertilizers: an accord between formulations and genetics. Journal of Biofertilizers and Biopesticides. 3.

[12] Agarwal, Prashant, Ritika Gupta, and Imneet Kaur Gill. "Importance of biofertilizers in agriculture biotechnology." *Annals of Biological Research* 9.3 (2018): 1-3.

[13] Thomas, Lebin, and Ishwar Singh. "Microbial biofertilizers: types and applications."Biofertilizers for Sustainable Agriculture and Environment. Springer, Cham, 2019. 1-19.

[14] Mishra, D., et al. "Role of bio-fertilizer in organic agriculture: a review." *Research Journal of Recent Sciences ISSN* 2277 (2013): 2502.

[15] Sahu, P. K., and G. P. Brahmaprakash. "Formulations of biofertilizers–approaches and advances."Microbial inoculants in sustainable agricultural productivity. Springer, New Delhi, 2016. 179-198.

Irrigation Water Quality Assessment for Water Resources Used in Irrigation of Agricultural Fields of Kütahya - Alayunt Village

Ahmet Melih Yılmaz[1*], Gülşah Kaplan[2]

Department of Farm Building and Irrigation, Faculty of Agriculture, University of Selçuk, Konya-Turkey
*Corresponding Author

Received:- 10 June 2021/ Revised:- 20 June 2021/ Accepted:- 24 June 2021/ Published: 30-06-2021

Abstract— *This study was conducted to assess the irrigation water quality of deep wells in Kütahya- Alayunt village and to assess the salinity-alkalinity of agricultural fields irrigated with these waters. The pH values of water samples taken in May, June, July, August and September varied between 7,12 - 8,57 and electrical conductivity (EC) values varied between 563 - 1483 µmhos/cm. According to US Salinity Lab. Classification System, water samples were classified as C_2S_1 (moderately saline – low alkaline) and C_3S_1 (highly saline – low alkaline). Differences were observed in irrigation water quality criteria throughout the irrigation season. Soils of the research site had loamy (L) and clay-loam (CL) textures. Soil pH values varied between 7,23 - 7,94 and EC values varied between 485 - 1652 µmhos/cm.*

Keywords— Irrigation, irrigation water quality, soil salinity.

I. INTRODUCTION

Just because of insufficient precipitations in several regions throughout the cropping year, irrigation has become the essential component of production activities to get high quality and quantity yields. Efficient and productive use of water resources plays a great role in sustainable management of available water resources. Such issues are also quite significant for meeting the domestic water needs of increasing population (over 80 million today), water needs of developing industries and water demands of agricultural irrigations. Natural quality water supply for these uses will only be possible with proper soil and water management practices [1].

Salts in irrigation water increase osmatic pressure of soil solution and thus negatively influence plant water use. High osmatic pressure reduces plant water uptake and ultimately results in plant die out. Therefore, salinity is used as quality and classification criterion for irrigation waters [2].

Annual total precipitations in arid and semi-arid regions of the world are not sufficient in leaching soluble salts accumulated within the root zones due to evaporation and water table close to soil surface. Therefore, in land reclamation practices, current salinity problems should be well-identified and leaching-induced change in soil salinity should be well-estimated [3].

Soil salinity is among the most significant abiotic stress factors directly limiting plant production worldwide. Salt stress also directly designates plant diversity in agricultural fields. Plant response to salt stress is controlled by complex molecular mechanisms. Salt stress results in various physiological changes in plants and plants develop different tolerance mechanisms against salt stress. Such changes and differences may sometimes emerge as plant-specific mechanisms or be common in all plants. These complex mechanisms could either develop directly as a response to salt stress or be accompanied with the other mechanisms developed against the other abiotic stress factors like drought. Therefore, salt stress and plant tolerance mechanisms should be well-comprehended both at plant level and tolerance level and salt-tolerant plant cultivars should be developed accordingly [4].

Total salt concentration of irrigation waters is expressed as electrical conductivity (EC x 106) in µmhos/cm (1000µmhos/cm= 1mmhos/cm= 1dS/m). Reliable irrigation waters mostly have total salt concentrations of lower than 2250 µmhos/cm. In terms only of total salt concentrations, electrical conductivity of irrigation waters should be less than 750 µmhos/cm. However, irrigation water with electrical conductivity values of between 750 - 2250 µmhos/cm are also largely used on irrigated lands

provided that proper drainage and operational conditions are provided. In case of insufficient leaching practices under improper drainage conditions, such waters may result in salinity problems in agricultural fields [5].

Anlıatamer [6] conducted a study to assess soil salinity in irrigation district of Ankara Haymana Türkşerefli Dam and indicated that Babayakup Creek merging with sub-branch of Şerefli Stream within the study area had a high electrical conductivity level, thus precautions should be taken while using this water in irrigations. It was also indicated that the increase in salinity levels of some areas was mostly resulted from unconscious irrigation practices of the farmers and application of low-quality irrigation waters through surface irrigation methods.

In another study, effects of different quality irrigation waters on alfalfa were investigated and it was reported that saline waters recessed the growth, reduced the yield and quality of alfalfa. On the other hand, when the sufficient leaching was provided and excess salt was removed from the field, plant growth and development reached back to normal levels. It was concluded that for high yield in alfalfa farming, irrigation water salinity should be less than 1.5 dSm^{-1} [7].

Gürcan [8] assessed the quality of irrigation waters in irrigation district of Ankara Haymana Soğulca Village Irrigation Cooperative and indicated that majority of irrigation water samples was classified as C_3 (highly saline) and these waters should not be used in fields with limited drainage facilities. Despite the use these saline waters in irrigations, salinity problems were not encountered in irrigated lands. However, it was also indicated that for potential salinity problems not to be encountered in the future, open or underground drainage systems should be constructed in these fields.

Topçu and Taş [9] conducted a study on Çanakkale Biga Plain and assessed electrical conductivity (EC), pH, potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), carbonate (CO_3), bicarbonate (HCO_3), chlorine (Cl), sulphate (SO_4), nitrate (NO_3) and boron (B) parameters of irrigation water samples taken from 20 different groundwater wells. Samples were classified based on Water Pollution Control Regulation of Turkey. In terms of salinity, 11 of 20 samples were classified as the second-class and the rest was classified as the first-class. Apart from nitrate pollution, generally no problem was encountered in study area during the study period.

Demer and Hepdeniz [10] conducted a study on Isparta Plain and assessed the water quality parameters of samples taken from 21 groundwater wells and reported the quality class of some water samples as C_3S_1 (highly saline – low alkaline) and the quality class of the rest as C_2S_1 (moderately saline – low alkaline).

It was indicated in another study conducted in Left-Bank of Menemen irrigation district that improper irrigation methods and low water use efficiencies resulted in rising groundwater levels. High water tables negatively influence agricultural productions, thus to prevent high groundwater levels, either proper drainage facilities should be constructed or already available ones should be rehabilitated and maintained [11].

Dorak and Çelik [12] conducted a study to determine the effects of domestic and industrial wastewater effluents on water quality of Nilüfer Creek by taking water samples from the effluents of 5 treatment plants discharging their effluents into Nilüfer Creek and from the streams receiving effluents of these treatments in 4 different periods between August 2013 – May 2014. It was indicated that wastewater quality parameters varied with the sampling periods and in terms of EC and SAR, water samples were classified as between C_2S_1 - C_4S_4 classes. Quality parameters of water samples taken before and after discharge of treated effluents indicated that wastewater effluents negatively influenced pH, EC, ammonia, phosphorus, sulphate, boron and chlorine values of Nilüfer Creek.

Akaroğlu and Seferoğlu [13] conducted a study in Sultanhisar town of Aydın province and indicated that irrigation water quality classes varied between C_2S_1 - C_3S_1, canal water quality influenced fruit quality and boron contents of the plants irrigated with these waters were greater than the control plants.

Aregahegn and Zerihun [14] assessed the water quality of Awash River and tributaries through selecting 17 different sampling locations throughout the Awash River and taking water samples four times in a year. For general water quality and suitability for irrigation, pH, EC, SAR, RSC, Na^+, K^+, Ca^{++} + Mg^{++}, CO_3^{2-}, HCO_3^- and Cl^- like several water quality parameters were looked for. Research findings revealed that all quality parameters of the samples taken from Beseka Lake were greater than allowable limits, physicochemical characteristics of Awash River exhibited changes based on different sampling sites and water quality parameters, pH and SAR values only of Beseka Lake and Meteka thermal water were greater than the allowable limits, EC values of Mojo, Wonji, Beseka, Melkasedi, Werer, Ambash, Meteka and Meteka thermal waters exhibited moderate-to-high salinity and these waters had quite a high RSC value. Treatment of industrial effluents was recommended to improve water quality.

II. MATERIALS AND METHODS

Water samples were taken from 20 deep wells opened in agricultural fields of Kütahya – Alayunt village in May, June, July, August and September and soil samples were taken from the fields irrigated with the waters of these deep wells. Kütahya province with a surface area of 11.875 km^2 is located in Western Section of Central Anatolia Region. The province geographically is located between 38^o 70^I - 39^o 80^I north latitudes and 29^o 00^I - 30^o 00^I east longitudes. Kütahya province with an altitude of 969 m is surrounded by Bursa province on the north and northwest, Balıkesir province on the west, Bilecik province on the northeast, Afyonkarahisar province on the southeast, Uşak province on the south and Manisa province on the southwest. According to 2018 address-based census, province population is 577.941 people [15]. Kütahya-Centre-Alayunt village is 13 km far from the city center. Geographical position of the research site is presented in Figure 1.

FIGURE 1: Geographical position of research site

The research site has a transitional climate between Aegean, Central Anatolia and Marmora Regions. Temperatures are dominated by Central Anatolia Region and precipitations are dominated by Marmora Region. As a result of terrestrial climate, precipitations are mostly encountered in spring, autumn and winter seasons. Summers are generally dry. Annual average temperature is 10.8^{o}C. Annual average precipitation is 545.6 mm. The research site has climate characteristics with Kütahya province [15].

Natural plant cover of Kütahya province has characteristics of Mediterranean, Central Anatolia and Marmora Regions. Dry forests are common in the province and they were followed by steppe-type plant populations. Forests are mostly located along the skirts of mountains. Steppe plants are dominant over forest lands and they include red poppy, sagebrush, mountain rhubarb common snapdragon and toy wort species [15].

Kütahya province has a land inventory of 1.187.500 hectares. Of these lands, 64% are constituted by forests (756.776 ha), 7% by pasture and meadows (84.370 ha) and 29% by agricultural lands (346.354 ha) [16].

In Kütahya province, winters are cold and summers are generally dry. Climate and soil structure negatively influence agricultural development. Soils are mostly shallow soils and are not able to store sufficient water with winter and spring precipitations, thus fallow is practiced on significant portion of the lands.

Fallowed rain-fed farming is common in the province. Cereal production is generally practiced in rain-sensitive agriculture method. Therefore, cereals have a significant place in field crops Wheat and barley are the primary cereal crops of the region. Wheat and barley cultivated fields constitute about 40% province agricultural fields.

Kütahya province has limited industrial crop production. Limited irrigation opportunities and undulated land structure are the primary factors limiting the cultivation of industrial crops. Opium poppy and hemp are the traditional industrial crops of the province.

Apart from wheat and barley, cultivated crops include hemp, opium poppy, sunflower, onion, potato, chickpea, beans and sugar beet. Legumes also included in intercropping systems with barley and wheat (cereal in one year, legumes in the other year). Chickpea is the most common legume cultivated in the province. Peach, grape, apple, sour cherry and strawberry-like fruit species are also cultured in the province.

Climate and soil conditions of Kütahya province are quite available for vegetable cultivation, especially for tomato, radish, zucchini, cabbage, lettuce, spinach and leek. Yields are quite high in irrigated lands and bottom lands around the settlements. Vegetable cultivation is mostly practiced for local consumptions, but vegetable cultivated lands are increasing [15].

Irrigation water is supplied from surface and groundwater resources. Farmers receive water from the hydrants placed at the beginning of their lands or from the deep wells within their fields. Mostly drip and sprinkler irrigation methods are preferred in irrigation practices of the farmers.

Water samples were taken from 20 wells already operating in irrigated fields of the research site. Throughout the irrigation season (May – September), water samples were taken 5 times from each well in each month.

Soil samples (6 samples) were taken from irrigated fields during the most intensive irrigation period (July). Disturbed and undisturbed soil samples were taken from 0 – 90 cm soil profile in 30 cm depth segments. Sampled were brought to laboratory and passed through relevant analyses. Soil and water sampling sites are presented in Figure 2.

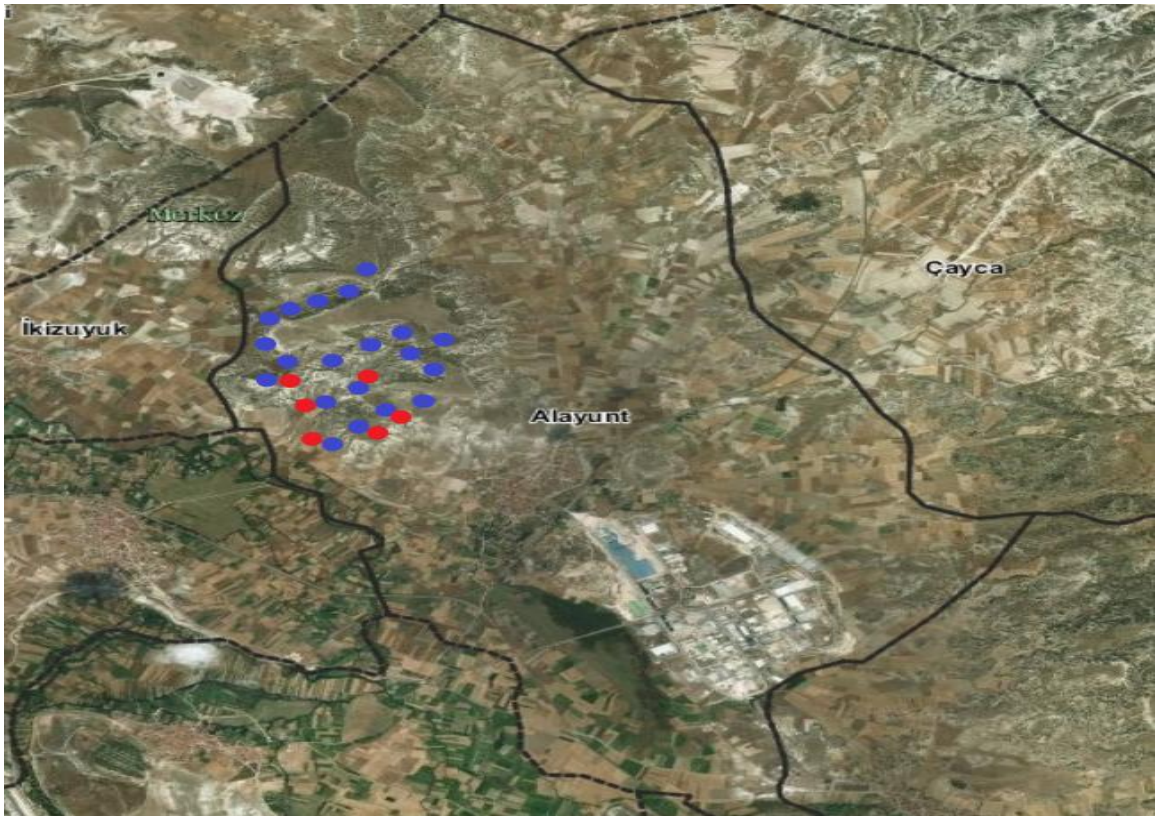


FIGURE 2: Soil and water sampling places (blue color: water sampling points; red color: soil sampling points)

III. RESULTS AND DISCUSSIONS

Water samples were taken from deep wells in each month throughout the irrigation season (May, June, July, August, September).

Electrical conductivity (EC) and pH of water samples taken in May, June, August and September are provided in Table 1 based on well numbers. Irrigation water pH values varied between 7,35 - 8,57 and EC values varied between 563 - 1483 µmhos/cm in May; pH values varied between 7,12 - 7,76 and EC values varied between 713 - 1229 µmhos/cm in June; pH values varied between 7,42 - 8,54 and EC values varied between 585 - 890 µmhos/cm in August; pH values varied between 7,18 - 8,28 and EC values varied between 693 - 834 µmhos/cm in September.

In terms of EC values of irrigation water samples taken in May, the greatest EC values were observed in samples 4 and 5; the samples 1, 6, 11, 14, 16, 17, 18 and 20 had EC values of greater than threshold value (750 µmhos/cm) and the other samples had EC values of lower than threshold value (750 µmhos/cm), thus considered to be more suitable for irrigations. In June, the greatest salinity values were observed in samples 14, 12, 3 and 19 with EC values greater than threshold values (750 µmhos/cm); samples 1, 4 and 20 had EC values of lower than threshold value (750 µmhos/cm), thus considered to be more suitable for irrigation; the other samples had EC values of greater than threshold value (750 µmhos/cm). In August, the greatest salinity values were observed in samples 1, 17 and 20 with EC values of greater than threshold value (750 µmhos/cm); the samples 2, 7, 14, 18 and 19 had EC values of greater than the threshold value (750 µmhos/cm), thus considered to be more suitable for irrigation; the other samples had EC values of greater than the threshold value (750 µmhos/cm). In September, the greatest salinity values were observed in samples 2 and 4 with EC values of greater than the threshold value (750 µmhos/cm); samples 1, 6, 8, 12, 14, 18 and 20 had EC values of lower than the threshold value (750 µmhos/cm), thus considered to be more suitable for irrigation; the other samples had EC values of greater than the threshold value (750 µmhos/cm).

Chemical analysis results of irrigation water samples taken in July are provided in Table 2. Samples pH values varied between 7,41 - 7,89; EC values varied between 709 - 1292 µmhos/cm; boron concentrations varied between 0.11 - 0.1 ppm. In terms of water-soluble anion and cations, it was observed that Mg was dominant cation and HCO_3 was dominant anion. Sodium adsorption ratios (SAR) varied between 0.26 - 0.45, % Na values varied between 5,94 - 7,66 and residual sodium carbonate (RSC) values were not seen. According to US Salinity Lab. Classification systems, water samples taken in July were classified as C_3S_1 and C_2S_1 irrigation waters.

The EC values of irrigation water samples taken in July are presented in Figure 3 based on sample numbers. The greatest salinity values were observed in samples 18, 19, 13, 10 and 17 with EC values of greater than the threshold value (750 µmhos/cm); samples 15, 16 and 20 had EC value of lower than the threshold value (750 µmhos/cm), thus considered to be more suitable for irrigation; the other samples had EC values of greater than the threshold value (750 µmhos/cm).

Boron concentrations of irrigation water samples taken in July are presented in Figure 4 based on sample numbers. Boron concentrations of all samples were lower than the threshold value (0,7 ppm), thus considered to be suitable for irrigation in terms of boron concentration.

Physical analysis results of disturbed and undisturbed soil samples taken from 0-30 cm, 30-60 cm and 60-90 cm soil depths are provided in Table 3. Degree of saturation values varied between 28 - 33,2%, volume-based field capacity (FC) values varied between 29,61 - 35,19%, permanent wilting points (PWP) varied between 11,67 - 28,84% and bulk density values varied between 1,23 - 1,43 g/cm^3. Soils had loamy (L) and clay-loam (CL) textures.

Chemical analysis results of soil samples taken from the research site are provided in Table 4. Soil pH values varied between 7,23 - 7,94, salinity values varied between 638 - 1652 µmhos/cm which were lower than the threshold value (4000 µmhos/cm). Ca was the dominant cation and HCO_3 was the dominant anion. Cation exchange capacity (CEC) values varied between 6,89 - 12,93 me/100 g, exchangeable sodium percentage (ESP) values varied between 4,20 - 13,64 with were lower than the threshold ESP value of 15%. Sample lime contents varied between 4 - 8,14 and boron concentrations varied between 0,25 - 0,13 which were lower than the threshold boron concentration of 4 ppm.

As can be seen in Table 4 and considering the cereal cultivation of the province, soils of the present research site were suitable for cultivation of almost all plant species. Lower boron concentrations of all samples than the threshold value of 4 ppm indicated that there was no risk of boron toxicity in the region, thus almost all plant species could reliably be grown without any risks of boron toxicity.

TABLE 1
EC AND PH VALUES OF THE SAMPLES TAKEN IN MAY, JUNE, AUGUST AND SEPTEMBER

Sample No	May		June		August		September	
	pH	EC x 10^6 µmhos/cm 25 °C	pH	EC x 10^6 µmhos/cm 25 °C	pH	EC x 10^6 µmhos/cm 25 °C	pH	EC x 10^6 µmhos/cm 25 °C
1	7,49	981	7,20	714	7,79	890	8,25	697
2	7,46	602	7,12	815	7,98	599	7,30	834
3	7,54	679	7,19	1171	7,57	786	7,39	809
4	7,39	1483	7,39	713	7,79	773	7,18	830
5	7,57	1286	7,29	877	7,49	801	7,47	787
6	7,50	805	7,51	841	7,57	767	8,28	693
7	8,33	682	7,30	792	8,54	707	7,45	774
8	7,58	667	7,33	791	7,74	787	8,14	729
9	7,96	662	7,48	942	7,87	768	7,50	786
10	7,65	828	7,51	843	7,58	778	7,31	817
11	7,44	786	7,47	942	7,68	791	7,49	789
12	7,75	592	7,35	1174	7,51	803	8,08	744
13	7,66	563	7,61	933	7,53	775	7,42	778
14	7,58	895	7,42	1229	8,19	585	8,19	733
15	8,57	610	7,69	846	7,50	779	7,86	770
16	8,05	969	7,46	905	7,42	804	7,55	786
17	7,83	751	7,40	874	7,56	813	7,77	779
18	7,43	729	7,34	815	8,20	637	8,00	739
19	7,72	628	7,61	1032	7,76	626	7,60	789
20	7,35	832	7,76	743	7,49	812	8,04	716

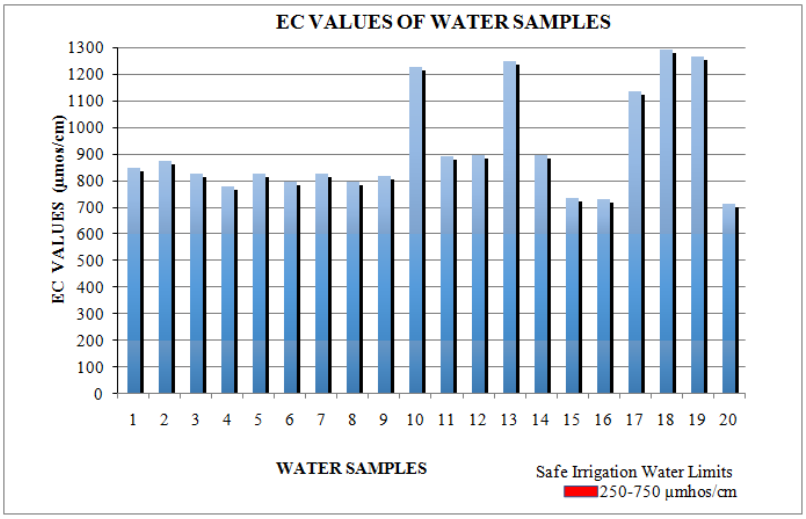


FIGURE 3: EC values of water samples taken in July

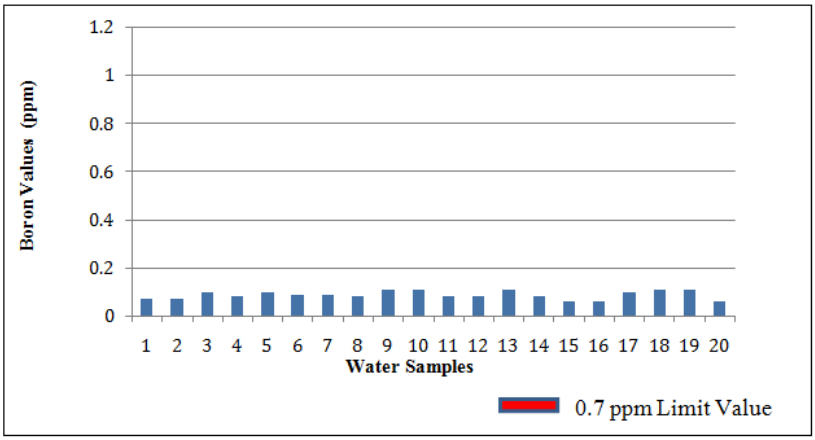


FIGURE 4: Boron concentrations of water samples taken in July

TABLE 2
CHEMICAL ANALYSIS RESULTS OF IRRIGATION WATER SAMPLES TAKEN IN JULY

Sample No	pH	ECx10^6 µmhos/cm 25 ^oC	WATER-SOLUBLE										RSC	SAR	%Na	Irrigation Water Class	Boron (ppm)
			Cations (me/l)					Anions (me/l)									
			Na^+	K^+	Ca^{+2}	Mg^{+2}	Total	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Total					
1	7,53	847	0,69	0,34	3,40	5,76	10,19	-	6,00	1,40	2,80	10,2	-	0,32	6,77	C_3S_1	0,07
2	7,60	872	0,68	0,33	3,69	5,75	10,45	-	5,16	1,60	3,50	10,26	-	0,31	6,50	C_3S_1	0,07
3	7,41	816	0,71	0,29	3,56	4,79	9,35	-	5,32	1,80	2,15	9,27	-	0,34	7,59	C_3S_1	0,1
4	7,58	778	0,64	0,29	3,36	4,56	8,85	-	5,09	1,50	2,35	8,94	-	0,32	7,23	C_3S_1	0,08
5	7,46	815	0,71	0,29	3,56	4,80	9,36	-	5,54	2,0	1,15	9,49	-	0,34	7,58	C_3S_1	0,1
6	7,49	796	0,68	0,28	3,50	4,71	9,17	-	5,92	1,30	2,00	9,22	-	0,33	7,41	C_3S_1	0,09
7	7,42	815	0,71	0,29	3,56	4,80	9,36	-	4,94	1,50	2,70	9,14	-	0,34	7,58	C_3S_1	0,09
8	7,54	797	0,65	0,30	4,0	5,86	10,81	-	4,56	1,70	3,75	10,01	-	0,29	6,01	C_3S_1	0,08
9	7,67	808	1,06	0,5	5,88	7,76	15,2	-	8,13	3,86	3,10	15,09	-	0,40	6,97	C_3S_1	0,11
10	7,64	1226	1,04	0,48	5,65	7,66	14,83	-	7,37	3,28	3,95	14,6	-	0,40	7,01	C_3S_1	0,11
11	7,89	892	0,64	0,30	3,98	5,84	10,76	-	5,85	2,10	2,80	10,75	-	0,28	5,94	C_3S_1	0,08
12	7,69	897	0,65	0,30	3,96	5,83	10,74	-	4,78	2,50	3,36	10,64	-	0,29	6,05	C_3S_1	0,08
13	7,62	1245	1,06	0,49	5,88	7,76	15,19	-	6,91	3,20	4,70	14,81	-	0,40	6,97	C_3S_1	0,11
14	7,83	893	0,65	0,30	4,02	5,88	10,85	-	5,39	2,16	3,00	10,55	-	0,29	5,99	C_3S_1	0,08
15	7,64	730	0,54	0,25	3,21	4,46	8,46	-	5,09	1,10	2,50	8,69	-	0,27	6,38	C_2S_1	0,06
16	7,54	731	0,54	0,25	3,22	4,47	8,48	-	3,80	1,25	3,25	8,3	-	0,27	6,36	C_2S_1	0,06
17	7,81	1134	1,03	0,47	4,79	7,33	13,62	-	6,08	2,67	4,83	13,58	-	0,41	7,56	C_3S_1	0,1
18	7,45	1292	1,2	0,50	6,04	7,91	15,65	-	8,66	3,10	3,95	15,71	-	0,45	7,66	C_3S_1	0,11
19	7,58	1265	1,08	0,50	5,88	7,81	15,27	-	7,06	2,70	4,50	14,26	-	0,41	7,10	C_3S_1	0,11
20	7,63	709	0,51	0,24	3,13	4,31	8,19	-	3,26	2,55	2,20	8,01	-	0,26	6,22	C_2S_1	0,06

TABLE 3
SOIL PHYSICAL CHARACTERISTICS OF THE RESEARCH SITE

Soil Sampling		Saturation (%)	FC (Volume, %)	PWP (Volume, %)	Available Water	Bulk Density (g/cm^3)	Soil Texture			
Plot No	Depth (cm)						Sand %	Clay %	Silt %	Texture
1	0-30	33,2	30,80	16,10	14,70	1,36	38,70	26,30	35,00	L
	30-60	30,8	29,90	16,75	13,15	1,39	41,20	26,30	32,50	L
	60-90	30,4	29,61	16,56	13,05	1,43	38,70	23,80	37,50	L
2	0-30	30,10	35,04	18,93	16,11	1,34	33,70	26,30	40,00	L
	30-60	31,4	35,19	20,06	15,13	1,35	38,70	26,30	35,00	L
	60-90	29,10	33,59	28,84	4,75	1,37	33,70	28,80	37,50	CL
3	0-30	30,12	30,01	18,45	11,56	1,34	38,70	28,80	32,50	CL
	30-60	28,4	30,67	18,65	12,02	1,35	41,20	31,30	27,50	CL
	60-90	30,8	32,00	11,67	20,33	1,37	41,20	31,30	27,50	CL
4	0-30	29,6	32,97	19,28	13,69	1,30	38,70	23,80	37,50	L
	30-60	32,2	33,20	19,60	13,60	1,32	41,20	28,80	30,00	CL
	60-90	27,4	32,33	19,77	12,56	1,39	41,20	23,80	35,00	L
5	0-30	31	33,89	19,68	14,21	1,29	31,20	33,80	35,00	CL
	30-60	29,8	33,71	20,11	13,60	1,30	33,70	31,30	35,00	CL
	60-90	33	34,58	20,09	14,49	1,36	38,70	31,30	30,00	CL
6	0-30	28	31,97	20,03	11,94	1,31	43,70	26,30	30,00	L
	30-60	29	32,32	20,22	12,10	1,33	43,70	23,80	32,50	L
	60-90	28,10	31,53	20,56	10,97	1,37	46,20	23,80	30,00	L

TABLE 4
SOIL CHEMICAL CHARACTERISTICS OF THE RESEARCH SITE

Soil Sampling		pH	EC x 10^6 µmhos/cm 25 ºC	Water- Soluble										CEC (me/100gr)	Exchangable Cations			ESP (%)	Lime (%)	Boron (ppm)
				Cations (me/L)					Anions (me/L)											
Plot No	Depth (cm)			Na^+	K^+	Ca^{+2}	Mg^{+2}	Toplam	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Toplam		Na^+	K^+	$Ca^{+2}+Mg^{+2}$			
1	0-30	7,47	1077	0,45	1,22	9,74	2,20	13,61	-	7,44	1,12	4,97	13,53	8,27	0,62	2,86	4,89	7,49	4	0,14
	30-60	7,48	996	0,47	1,12	8,90	2,15	12,64	-	6,30	4,06	2,35	12,71	9,12	1,00	2,75	5,56	10,96	4	0,13
	60-90	7,54	840	0,47	1,07	8,84	2,10	12,48	-	6,00	2,06	3,37	11,43	6,89	0,67	2,02	4,47	9,7	4	0,13
2	0-30	7,53	1334	0,59	2,11	12,85	2,83	18,38	-	11,55	2,84	3,50	17,89	10,08	1,34	3,88	5,76	13,29	8,14	0,25
	30-60	7,58	1652	0,58	2,18	12,68	2,82	18,26	-	10,26	2,36	5,00	17,62	9,41	0,76	3,58	6,92	8,07	6,14	0,25
	60-90	7,72	1359	0,56	2,11	12,19	2,73	17,59	-	9,42	4,84	3,27	17,53	12,93	1,28	4,13	8,04	9,89	6,4	0,24
3	0-30	7,38	1243	0,51	1,96	10,20	2,36	15,03	-	9,88	2,34	2,70	14,92	8,53	0,43	3,08	4,04	5,04	6,18	0,15
	30-60	7,54	827	0,52	1,72	9,98	2,21	14,43	-	8,20	5,66	2,57	16,43	8,49	1,00	3,16	3,28	11,77	6,4	0,14
	60-90	7,84	1096	0,54	1,77	10,33	2,27	14,91	-	7,22	1,2	5,49	13,91	9,07	0,64	3,32	4,52	7,05	6	0,14
4	0-30	7,46	1290	0,41	3.00	10,91	2,47	16,79	-	12,61	0,6	3,45	16,66	9,01	0,72	3,16	5,34	7,9	6	0,2
	30-60	7,38	1073	0,42	3,05	11,20	2,51	17,18	-	13,37	1,4	2,44	17,21	9,03	0,68	4,02	4,98	7,53	6,2	0,2
	60-90	7,23	1259	0,41	2,90	10,51	2,42	16,24	-	10,10	1,8	4,31	16,21	8,36	0,61	3,42	4,72	7,29	6,4	0,19
5	0-30	7,78	712	0,50	2,30	11,18	2,55	16,53	-	9,27	1,6	5,36	16,23	10,55	1,44	4,80	6,80	13,64	6,12	0,17
	30-60	7,64	685	0,52	2,19	11,20	2,53	16,44	-	9,5	2,54	4,24	16,28	11,99	1,51	4,12	5,98	12,59	6,4	0,17
	60-90	7,62	638	0,50	2,20	11,28	2,55	16,53	-	8,89	2,6	4,49	15,98	11,26	1,30	4,70	6,84	11,54	4,14	0,17
6	0-30	7,73	737	0,48	3,04	12,72	2,69	18,93	-	9,65	3,54	5,23	18,42	9,76	0,41	3,72	4,85	4,20	6,12	0,24
	30-60	7,94	670	0,45	2,86	12,49	2,64	18,44	-	9,88	3,46	5,00	18,34	7,79	0,97	3,17	4,66	12,45	6,4	0,24
	60-90	7,88	608	0,37	2,53	2,16	2,62	7,68		5,09	4,68	2,01	11,78	11,25	1,39	3,80	6,92	12,35	6,10	0,24

IV. CONCLUSION

Following conclusions could be drawn from the findings of the present study conducted to assess irrigation water quality and salinity-alkalinity of the agricultural fields of Kütahya-Alayunt village:

a) The samples with salinity values of lower than the threshold value (750 µmhos/cm) were classified as **moderately saline (C_2),** thus could reliably be used in irrigation of agricultural fields. The other water samples with salinity values of greater than the threshold value (750 µmhos/cm) were classified as **highly saline (C_3),** thus could be be used in irrigation of salt-resistant plant species and special measures should be taken for salinity control. Irrigation water pH values varied between 7,12 - 8,57 and EC values varied between 563 - 1483 µmhos/cm. Based on salinity-alkalinity values, water samples were classified as C_2S_1 (moderately saline – low alkaline) and C_3S_1 (highly saline – low alkaline).

b) In terms of water-soluble anion and cations, it was observed that Mg was the dominant cation and HCO_3 was the dominant anion. Sodium Adsorption Ratios (SAR) varied between 0,26 - 0,45, % Na values varied between 5,94 - 7,66 and boron concentrations varied between 0,11 - 0,1 ppm. Boron concentrations of all samples were lower than the threshold value of 0,7 ppm specified for irrigation waters. Such a case revealed that there was no risk of boron toxicity in experimental fields.

c) Soil pH values varied between 7,23 - 7,94, EC values varied between 638 - 1652 µmhos/cm, cation exchange capacity (CEC) values varied between 6,89 - 12,93 me/100g, exchangeable sodium percentages (ESP) varied between 4,20 - 13,64%, lime contents varied between 4.0 - 8,14% and boron concentrations varied between 0,25 - 0,13 ppm, which were lower than the threshold value of 4 ppm specified for soils.

d) Soil textures were identified as loamy (L) and clay-loam (CL). Soil degree of saturation values varied between 28,0 - 33,2 and bulk densities varied between 1,23 - 1,43 g/cm^3.

e) Exchangeable sodium percentage (ESP) of all samples was lower than the threshold value of 15% specified for soils.

f) Although irrigation water samples were generally classified as highly saline (C_3), salinity was not encountered in soils of the research site since sufficient salt accumulation with irrigation hasn't been reached, yet.

RECOMMENDATIONS

a) There is a need for development of water resources in the research site to prevent future salinity problems (as it was in GAP and KOP projects). In this sense, more suitable irrigation waters in terms of quality should be supplied.

b) Drainage systems should be developed to prevent potential salinity problems.

c) Soils should be enriched in organic matter and soil tillage systems should be emphasized.

d) Measures should now be taken to prevent potential salinity problems. In this sense, soil reclamation and leaching practices should be emphasized.

e) Proper irrigation methods should be selected to prevent loss of yield and quality. Because of leaching function, sprinkler irrigation should be preferred in places with limited water resources and basin (ponding) irrigation should be preferred in places with sufficient water resources.

f) Farmers should be trained on efficient and conscious water use in irrigation by universities or agricultural organizations.

Note: This study was derived from the Master Thesis of Gülşah KAPLAN.

REFERENCES

[1] N. Aksungur, and Ş. Fridin. N., Firidin, Ş. 2008. "Su Kaynaklarının Kullanımı ve Sürdürülebilirlik", Sumae Yunus Araştırma Bülteni, 8:2 (In Turkish).

[2] E. Yurtseven. 2016. "Sulama Suyu Kalitesi ve Tuzluluk", Ankara Üniversitesi, Ziraat Fakültesi, Tarımsal Yapılar ve Sulama Bölümü, Açık Ders Malzemeleri (In Turkish).

[3] F. Mikailsoy. 2014. "Tuzlu toprakların yıkanmasının matematiksel modellenmesi".Toprak Bilimi ve Bitki Besleme Dergisi 2 (2) 33 – 37 (In Turkish).

[4] İ. Tiryaki. 2018. "Bazı tarla bitkilerinin tuz stresine gösterdikleri adaptasyon mekanizmaları". KSÜ Tarım ve Doğa Derg 21 (5):800-808 (In Turkish).

[5] M. Ayyıldız. 1983. "Sulama Suyu Kalitesi ve Problemleri", Ankara Üniversitesi Ziraat Fakültesi Yayınları, No:876, Ders Kitabı 224, Ankara (In Turkish).

[6] E. Anlıatamer. 2007. "Ankara Haymana Türkşerefli Göleti Sulama Alanındaki Toprakların Sulama Parametreleri ve Tuzluluk Yönünden incelenmesi", A. Ü. Fen Bilimleri Enstitüsü Y.L.Tezi, Ankara (In Turkish).

[7] T. Yeter, and E. Yurtseven. 2015. "Sulama suyu tuzluluğu ve yıkama gereksinimi oranlarının yoncada çimlenme ve gelişmeye etkisi. Toprak Su Dergisi, 4(1):36-42 (In Turkish).

[8] S. Gürcan. 2016. "Ankara Haymana Soğulca Köyü Sulama Kooperatifi Sulama Sahasındaki Su Kaynaklarının Sulama Suyu Kalitesi Yönünden Değerlendirilmesi", S.Ü. Fen Bilimleri Enstitüsü Y. L. Tezi, Konya. (In Turkish)

[9] E. Topçu, and İ. Taş. 2020. "Sulama suyu kalitesi açısından Çanakkale–Biga Ovası yeraltı sularının durumu". ÇOMÜ Zir. Fak. Derg. (COMU J. Agric. Fac.) : 8 (1): 251– 260 (In Turkish).

[10] S. Demer, and K. Hepdeniz. 2018. "Isparta Ovasında (GB-Türkiye) sulama suyu kalitesinin istatistik ve coğrafi bilgi sistemleri kullanılarak değerlendirilmesi". Türk Coğrafya Dergisi, 70, 109□122 (In Turkish).

[11] N. Korkmaz, M. Gündüz, and Ş. Aşık. 2016. "Gediz nehri'nin güneyindeki tarım alanlarının taban suyu seviyesi ve kalitesinin zamansal değişimi". Derim, 33 (2): 263-278 (In Turkish).

[12] S. Dorak, and H. Çelik. 2017. "Irrigation water quality of Nilüfer Stream and effects of the wastewater discharges of the treatment plants". Ege Üniv. Ziraat Fak. Derg., 54 (3):249-257.

[13] Ş.N. Akaroğlu, and S. Seferoğlu. 2018. "Sulama suyu kalitesinin çileğin (Fragaria x ananassa Duch. Rubygem) besin maddesi içerikleri ve bazı meyve kalite özellikleri üzerine etkileri". ADÜ Ziraat Dergisi, 15(1):47-54 (In Turkish).

[14] Z. Aregahegn, and M. Zerihun. 2021. "Study on irrigation water quality in the Rift Valley Areas of Awash River Basin, Ethiopia". Applied and Environmental Soil Science Article Volume 2021 Article, ID 8844745 | https://doi.org/10.1155/2021/8844745

[15] Anonymous. 2018. "İl Tarım ve Orman Müdürlüğü 2018", Kütahya faaliyet raporu (In Turkish).

[16] Anonymous. 2019. https://kutahya.tarimorman.gov.tr/Menu/24/Kutahya-Hakkinda (In Turkish).

AD Publications
Sector-3, MP Nagar, Rajasthan, India
www.adpublications.org, www.ijoear.com, info@ijoear.com