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Preface

We would like to present, with great pleasure, the inaugural volume-8, Issue-12, December 2022, 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.

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Desalination of Seawater through Gas Hydrates

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Abstract— *Water is an elixir of life and was basis of human civilization. Rapid growth in population promotes consumption of freshwater due to more industrialization and urbanization. Hence, the demand of freshwater is being increased for agriculture, industrial and domestic sectors day by day. Moreover, per capita water availability is also decreasing from 5117 m^3/year in to 1371 m^3/year in 2025 (MWR, GOI 2019). Shortage of water lies in more than 80 countries and almost 40% population of the world facing this problem (Sabil et.al., 2013). As about 97 % of water existed on the planet earth as seawater (Brown, 2017) and it may be good alternative for fulfill the demand of freshwater after desalination. Desalination is the process of the removal of salts from the seawater using economical processes to convert them to fresh water. It is estimated that about over 75 million people worldwide obtain fresh water by desalinating seawater or brackish water (Khawajia et al., 2010). Therefore, many countries in the world are investing heavily in the seawater desalination for production of freshwater. The five world leading countries by desalination capacity are Saudi Arabia (17.4%), USA (16.2%), United Arab Emirates (14.7%), Spain (6.4%), and Kuwait (5.8%) (Khawajia et al., 2008). Among the different methods of seawater desalination (reverse osmosis and multi-stage flash distillation etc.), gas hydrate-based desalination technology is a relatively new one that has created an interest among the researchers and institutions (Sangwai et.al, 2013). Gas hydrates are crystalline solids made of the water (host) and the gas molecules (guest) such as methane, carbon dioxide, nitrogen, etc., which are held within water cavities that are composed of hydrogen-bonded water molecules (Babu et.al 2018). Process in gas hydrates-based desalination technology is depend upon the phase change of liquid to solid thereby removing the solids from the liquid phase. Economically gas hydrates-based desalination technology as compared to the conventional technologies such as reverse osmosis (RO) and multi stage flash (MSF) distillation looks a promising alternative for desalination of seawater (Park et al., 2011). As low temperature requirement is an important factor in gas hydrate formation process, implementation of gas hydrate desalination technology in the colder region would also enhance the economy of process by saving the energy cost for chilling the sea water. In future, the hydrate process can be made more economical by using some cheap and easily available hydrate formation promoter. Hence, the research in this direction is an ongoing process and may be very useful for fulfil the future demand of freshwater.*

Keywords— Desalination, Gas hydrates, Seawater.

I. INTRODUCTION

Many nations are experiencing fresh water crisis as a result of population increase and the tremendous development of industrial and agricultural operations. 1 in 6 of the people (approximately 1.2 billion) do not have enough access to safe drinking water, and the 1 out of 6 children dies for every 8 seconds after drinking polluted water. By 2025, 1.8 billion people will live in nations and territories with absolute water scarcity, and two-thirds of the world's population may face water scarcity. The management of water resources affects nearly every aspect of the economy, especially health, food production and safety, domestic water and sanitation, energy, industry and environmental sustainability. The future of water and energy resources is inextricably linked, requiring the development of innovative technologies to strengthen the water-energy relationship. Freshwater resources represent the total amount of water available on earth. The total freshwater supply available for ecosystems and humans is less than 1% of total freshwater resources. In recent decades, seawater has emerged as an important source of freshwater, as it is one of the most abundant resources on earth (97.5%) and a core technology for alleviating freshwater scarcity. MSF remains the dominant desalination technology in the Middle East, accounting for 50% of global consumption, due to the ready availability of fossil fuels and poor feed water quality. RO is the current state of the art for seawater desalination The RO process can treat feedwater within the TDS (Total Dissolved Solids) range of 10,000 to 60,000 mg/L. A typical seawater RO plant has a total water recovery of less than 55%. Total water recovery is the ratio of the amount of water produced to the amount of feed water The total energy required for RO is 3-6 kWh per m3 of recovered potable water. The biggest disadvantage of these methods is that they consume a lot of energy. The energy cost of meeting the expected global water demand with current technology is significant, particularly in a carbon-constrained society. Because water and energy. To meet the future demand for fresh water, there is a need to create novel technologies that may enhance the water-energy junction and increase the efficiency of existing thrust of freshwater. For seawater desalination, hydrate-based desalination has been suggested. The procedure essentially comes under the category of freezing or freeze desalination technologies. In the process water molecules create cages around a guest gas/liquid component in this mechanism, successfully isolating themselves from brine solution even at temperatures beyond the freezing point of water. When these hydrate crystals are melted, they become virtually fresh water, and the guest component may be reused in the desalination process. One mole of hydrate contains around 85% water and 15% guest gas, indicating that this technique has a great potential for creating reasonably pure water. The salt is only a thermodynamic inhibitor and is thus not allowed in the hydrate cages (Han *et.al.*,2017). The procedure has the benefit of using less energy because it runs at temperatures well above the freezing point of water.

II. MATERIAL AND METHOD

2.1 Hydrate based desalination

Hydrates are crystals consisting of hydrogen-bonded water molecules and guest (hydrate precursor) molecules contained within hydrogen-bonded cages. Hydrates can occur in liquid saltwater containing former (Precursor in table 1) in the form of solid phase when particular temperature and pressure conditions are met. The development of hydrate crystals is accompanied by the exclusion of dissolved ions and salts. The hydrate-based approach is closer to the freezing method among saltwater desalination technologies. The hydrate-based approach requires high pressure and low temperature to produce driving power, but the freezing method requires considerably lower temperature. As a result, judging them in terms of energy is difficult. It is said that the salts may become trapped in ice and be difficult to extract if the freezing rate is not very slow. As a result, further mechanical purification techniques like washing and centrifuging are still required after the freezing procedure. Researchers are likely to use a hydration-based approach to determine the key distinction between ice and hydrate as a result.

TABLE 1
TYPES OF FORMERS USED IN GAS HYDRATE DESALINATION (HERE, CP REPRESENTS CYCLOPENTANE AND R141B REPRESENTS CH3CCL2F (HCFC-R141B) ZHENG ET.AL.,2019)

Former types	Advantages	Disadvantages	Representative formers	Features
Gaseous	Easy to separate with water	High cost for pressurization	CO2 C3H8	Non-toxic and accessible More moderate conditions but flammable
Gaseous + liquid	Lower cost for pressurization	Need to be separated furtherly	CO2 + CP CO2 + R141b	Insoluble and improve formation greatly Inexpensive with triple efficiency

When we compare some findings (table 2), we get better opinion about the gas hydrate-based desalination Recently, several researchers around the world have done this removal Efficiency Test of Hydrate-Based Desalination. 2012 cha Seol et., measured the removal efficiency of high salinity (9 wt.%) water that utilizes CO2 and insoluble hydrocarbons to form double hydrates in a stirred reactor thus achieved over 90% removal efficiency of salts (Na+, Mg2+, K+, and Ca2+) In the same year, Yu et al., conducted step-by-step demonstration of the CO2 hydrate desalination effect with brine solutions of different concentrations. they analyzed and investigated the relationship between initial salinity and residual salinity and suggested that residual salinity should be controlled below 4% by weight. In 2013, Liu et al., assumed multi-stage hydrate-based desalination using CO2 with the addition of CH3CCl2F (R141b). They observed the Improved removal of R141b (1:70 volume ratio with seawater) which gave the removal efficiency tripled, potentially increasing desalination rate that is the grade goes up, up to

98.4%. Later in 2014, Kang et al., analyzed and observed the removal characteristics of dissolved ions by squeezing gas hydrate pellet which resulted that there was no obvious difference was found (less than 1%) efficiency between cations and anions using CO2 as hydrate former. The removal efficiency of each ion using methane is relatively low than the applicable use of CO2. In 2017, Kang et al., used the same device to produce CO2 hydrate ICP-AES (Inductively Coupled Plasma) has confirmed a removal efficiency of over 75% of dissolved ions. Therefore, there is a great opportunity Hydrate-based desalination as a method of seawater treatment.

TABLE 2
MILESTONE OF RESEARCH PROGRESS OF HYDRATE-BASED DESALINATION

Year	Reference	Description
1942	Parker, A	Proposed application of hydrates for seawater desalination
1961	Knox *et.al.,*	Flowsheet and Material balance with propane as hydrate former was presented
1962	Barduhn *et.al.,*	Criteria for choice of good hydrate former was laid down
1964	Koppers Co	Two pilot plants were built at Wrightsville Beach with R-12 and Propane as hydrate former
1998	McCormack *et.al.,*	Pilot plants at Hawai and San Deigo were built by Thermal energy systems based on R141b as hydrate former
2008	Bradshaw *et.al.,*	Extensive kinetic as studies by Sandia National Laboratories employing HFC 32. R152a, R141b hydrate former
2011	Park *et.al.,*	A new apparatus with dual cylinder units producing CO_2 hydrate pellets was developed and demonstrated
2014	Babu *et al.,*	Fixed bed approach utilizing LNG cold energy was proposed

2.2 Process and water recovery

When saltwater or salt solution comes into contact with a hydrate-forming agent at the right temperature and pressure, a solid phase is created (clathrate or gas hydrate). Salts and dissolved ions are excluded from the hydrate crystals during the hydrate formation process. As a result, it provides a foundation for the separation of clean water from an electrolyte (salt) solution, such as seawater or brackish water. It should be noted that the temperature during formation might rise over the water's freezing point. Additionally, the brine and hydrate crystals can be mechanically separated. The hydrate crystals can be removed and then broken down by depressurization or heat stimulation. The water and the molecules that comprise the hydrate are released when the hydrate crystals dissociate. The latter is recyclable and recoverable.

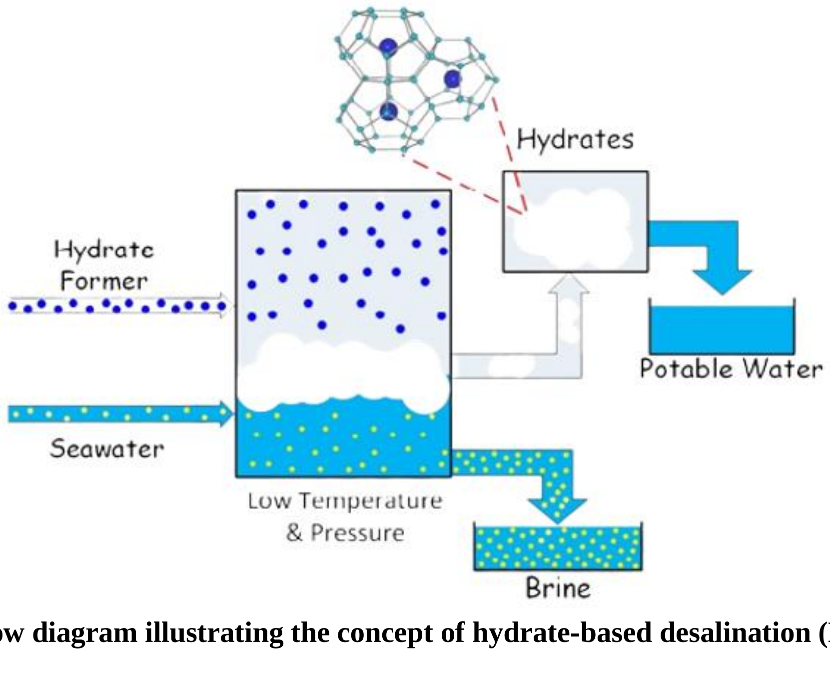

FIGURE 1: Block flow diagram illustrating the concept of hydrate-based desalination (Babu P *et.al.,* 2018)

III. RESULT AND DISCUSSION

The volumetric process effectiveness of hydrate-based desalination is represented by water recovery. The amount of water in the feed solution that is used in the process is transformed into hydrate. But often, fewer than 100% of the hydrate crystals are recovered. As a result, the percentage of the hydrate generated that can be recovered during the process of separating the hydrate crystals from the brine is used to determine the water recovery (%). To retrieve water, the collected hydrate from the hydrate/brine separation will be dissociated so the water recovery can be defined as the volume of water converted to hydrate to the volume of feed solution with consideration of fraction of hydrate formed will the percentage of water recovered from the total amount of water feed for desalination(Sadeq *et.al.*,2017) (Note: Here fraction/factor is the hydrate recovered which represent the separation efficiency of hydrate-based desalination process). Higher water recovery is seen if it results in the production of more hydrates and the efficient separation of hydrate crystals from brine (Lv *et.al.*,2018).

Although laboratory tests have demonstrated the viability of hydrate-based desalination, there are still two issues that must be resolved through innovation in the near future. One factor that significantly affects production costs is the choosing and operation of the hydrate forming. This requires thorough research on various former types, taking into account the phase state, solubility, safety, price, recycling, and other factors. Another factor that determines how effectively fresh water is removed is additional separation and purification.

IV. CONCLUSION

One of the most promising solutions to help with a growing water issue is desalination. The most common desalination process in use today, reverse osmosis requires a lot of energy. Therefore, to increase the energy-water confluence, revolutionary energy-efficient technology must be developed. One such method is hydrate-based desalination. this paper gives an overview of some emphasised process and general information regarding hydrates and the function of desalination technology, the technology has been explored over the past 70 years, but due to delayed hydrate formation kinetics, challenges in hydrate crystal separation from brine without contamination, and expensive refrigeration costs, it was never commercialised. Using a more inventive reactor design, better hydrate-forming agents, and other technological advancements can be formalized for better mitigating the upcoming water scarcity issues in the world.

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Technological Advancement in Digital Farming and India's Present Scenario: A Review

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Abstract— *Technological advancements in agriculture practices for improving the crop overall life cycle is essential requirement for countries like India. In order to compete day to day increasing food demand for growing population and also to strengthen the economy, advancement in agriculture practices has become immensely necessary. In India, same practice use differently because of its highly variable climatic and geographical condition. Agriculture practices in India faces many problems like, small land holding, climate change, agroclimatic variation in different states, uneven rainfall, conventional (old) practices, traditional knowledge and political and economic tantrum unavailability of storage and transport facilities, inspite of this economic losses also occur due to the lack of indispensable information to the farmer.*

To overcome these obligatory problems we have to acknowledge technological advancements and digitalization in agricultural practices. Some of the furtherance like Sensing, Geoinformatics, mobile applications and data analytics which will provide us the useful information about moisture percentage, soil health, fertilizer doses requirements, disease and pest management and exact prediction of the crop nutrient demand and also helpful in making appropriate schedule and storage arrangements to decrease the post harvest losses. We can also make marketing strategies according to the data we get and can convert old farming practice into high profitable enterprise. To make this review paper possible we went through vast literature, data, websites, journals, magazines and research papers directly or indirectly related to the agriculture advancement and digital progression.

With the help of available information we tried give our reader an brief and Hi-tech understanding of Digital Technologies like Artificial Intelligence, Internet of Things, Big Data Analytics, sensors, companies, Satellite Imagery and Remote Sensing, Machine Learning, Robotics Unmanned Aerial Vehicles (Drones) and their mobile Applications like mKisan, Meghdoot, Damini etc.

Keywords— Digitalization, Internet of Things, Sensors, Drone, Artificial Intelligence.

I. INTRODUCTION

Number of research based documents, websites, journals and papers were explored to get an in depth understanding of the concerned heading. Genetic diversity and architecture for climatic adaptation in different crop like cole group of vegetables, roots crop, bulb vegetables. Vegetables are a key factor in their availability in different season spite of photo thermo sensitive in nature. Area under protected cultivation across the world has increased many folds in the last one decades and presently estimated more than 5.0 million hectare. Several innovative technologies have been developed over time in different areas viz.; green house structure and environment control energy saving, precision input control technology, fertigation, Abiotic management, mechanization and use of nutrient management sensors, robotics, processing management, harvesting, marketing and farming plus advance storage. In contrast to conventional agricultural technique, using digital Data can escalate resource and Cost efficient, decrease negative environmental impact, modern data technique to be adapted to a specific field, integration of smart Agricultural technologies and to ensure an production process. The application of IT support in farming to make informed decision based on solid data.

1.1 Why we need advancement?

The average farm area in US is 179.20 Ha, in Australia, it is 433.121 Ha and in Europe, 161.22 Ha while that in India, it is 1.0823 Hectares. Farmers average income in India is estimated at Rupees 77, 97625. 70% of farm time is just managing and monitoring. “Smart Agriculture” need arises due to this demand where management is main concern not the actual field work. As privatization is bringing in, Given the volume of agricultural products consumed in India, Indian agriculture will progress toward digitization. Contract farming operations are in line with the evolving food needs of modern consumers, and as a result of interconnected agriculture value chains, not only are farmers but also all other players in the value chain, such as input suppliers, traders, consumers, and processors, are given digital empowerment.

II. LITERATURE REVIEW

Miller et al. (2013)[5]:"Reported that in their paper, the authors emphasised the usefulness of timely information, mobile phone availability, financial inclusion, and crisis organisation information services, among other factors, in creating more efficient and resilient agricultural value chains".

Hrustek (2020)[6:] "Observed in the timely dissemination of information, personalised product development based on customer needs, traceability, proper policy implementation, and an overall connected agriculture value-chain that results in an environment-friendly and sustainable form of agriculture, the role of digital transformation in agriculture has been highlighted".

Mane et al. (2018)[7]: "Noted that in their research, the authors underlined the fact that GPS and camera services are currently the most popular features found in mobile applications. In addition, applications for conferences, market intelligence, farm information, illnesses and pests, and other apps were developed for mobile devices".

Raj et al.(2020)[8]: "Reported that in their paper, discuss how different mobile apps are being developed to create a farm-to-fork connectivity in the agriculture value chain, where different farmers are connected to their potential customers to meet their needs and simultaneously address the problems of fair prices, waste, and middlemen".

Saxena (2020)[9]:"He noted in his article that by 2022, smart agriculture will have a global market worth of roughly 23.14 billion US dollars. The agriculture sector has a variety of mobile applications that deal with peer connectivity and information exchange, online loan services, e-marketplaces, weather forecasting, GPS tracking, value-chain process traceability, and animal management services. These applications have a variety of features, such as chat capabilities, cloud support, machine learning, payment gateways, information stacks, and weather predictions".

Ohlan (2020)[10]: "Mentioned in her research that Bengaluru-based agritech firms raised the most money in 2016, followed by Delhi in second place and Mumbai in third.50 percent of the start-ups established in the previous five years did so between 2015 and 2016".

Choudhary et al.(2016)[11]: "observed for farm management and other related objectives, farmers are given 24/7 access to their soil-related, weather-related, and other types of data using devices that have cloud accessibility. Without having to personally visit the farms, other system participants such as specialists, consultants, and researchers can also obtain this data, saving both time and resources".

Biberacher(2018)[12]: "Illustrated in his post how IAAS, PAAS, and SAAS may be used in the agriculture industry. SaaS applications include big data analytics, artificial intelligence, information, and monitoring software. PaaS applications include technology like drones, satellites, robots, and sensors. IaaS applications include high-tech farming infrastructure".

Elijah et al.(2018)[13] "The authors of this study focused that the use of wireless sensors for IoT and data analytics based approaches to increase agricultural activity productivity and efficiency and adopt smart agriculture. Along with wireless sensors, IoT also uses technology like cloud computing, radio frequency identification, and similar ones. Through web-based platforms, farmers can schedule education and training sessions on topics such as production methods, market analysis, post-harvest procedures, customer preferences, weather forecasting, input availability and credit availability, early warning systems for pests, diseases, and the like".

Kour et al. (2020)[14]:" Showed how supply chain management, crop monitoring, crop management, irrigation, and disease monitoring are some of the ways that the agriculture business is using the Internet of Things more and more".

Pawar (2020)[15] " Illustrated about applications of cloud computing in agriculture, like crop data, crop monitoring, soil data, region specific farming data, and agricultural marketing".

Talaviya et al. (2020)[16] "Observed image recognition and perception, chatbots, robotics, and autonomous systems in the form of automatic plant irrigators, soil moisture sensors, vision-based weed detection technology, weed prevention robots, and drone technology applications for pesticide spraying, crop monitoring, yield mapping, yield calculation, and similar tasks are just a few of the many applications of artificial intelligence that are discussed in their paper".

ICT Madan et al.(2020)[17:]" Highlighted in their report that despite having the second-largest area of arable land in the world, we are still lagging far behind when it comes to adopting more advanced digital technologies. They cited mainstream areas like policy implementation to make farming a futuristic industry with guaranteed livelihoods".

Beriya (2020)[18:] "Argued that because the majority of technologies being created in India are still based on foreign models, Indian farmers cannot afford them. Additionally, the significance of pay-per-use technology and leasing business models is emphasised. In his research, he also makes note of the crucial role that FPOs play in financially and technologically assisting small and marginal farmers. Artificial intelligence, the Internet of Things, big data analytics, and other digital technology applications are examples of current and emerging trends. The Indian agriculture sector's overall issues and future opportunities are also discussed".

III. RESULT AND DISCUSSION

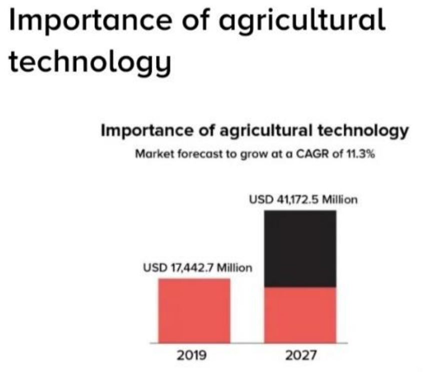
Average Monthly Income of Agriculture Household

SAS 2021	**Rs . 10218**
SAS 2014	**Rs. 6426**

In their work, **Kumar et al. (2011)** emphasised the importance of knowledge transfer and how it must be pushed forward to precisely meet the demands of farmers so that their previously amassed body of knowledge can also be used in the future. In order to create belief, knowledge must also be shared in a way that is transparent and factual, taking into account all the barriers connected to culture, language assurance that Indian farmers have demonstrated.. **Shukla et al.(2018)[2]** mention in their report that most Agri start-ups offer IOT based solution, AI, big data analylitic in the value-chain.

Countries	Total Arable land (million hactare)	Cereal production Million tonnes	Average farm area in hectares	Farmers average income in rupees	Contribution in total GDP
India	159.7	314.51	1.08	122616	19.9
USA	152.2	467	179.20	13148960	5.9
Russia	79.95	116.46	150	511284	3.9
China	126	612	0.6	1330165.2	7.3
Netherland	0.53	1.34	41.7	1575546	1.58
World average	1574.93	_	_	_	6.4

The future of food is undoubtedly digital, and the future of digital is unavoidably AI (Artificial Intelligence). AI applications are being established throughout different parts of agriculture, from gene sequencing in seed development and sensors that create data to image recognition tools that assay and grade crops and commodities." The year 2019 (**Gurumurthy and Bharthur**)[3]. "A New Indian Model of ICT-led Growth and Development, " a project from Columbia University and The Energy and Resources Institute (TERI). The project looks at the possibilities for a new model of research and development in India's agriculture industry that is led by information and communication technologies and aims to give recommendations on how India might move the development process forward.



Involvement of Multinational Companies.

The largest agricultural firms have applications that now cover millions of acres of farmland and ask farmers for data in exchange for suggestions and discounts on how to use their products. The largest seed and pesticide manufacturer in the world, **Bayer**, claims that work on their app is already underway and moving in this direction.

The good news is that agribusiness is following the trend of supplying data to farmers via their cell phones so they can receive "advice" from them.

E. tech from Japan On a plot of land outside of Hanoi, **Fujitsu** constructed a test vertical farm. The high-tech farm, which resembles a factory more than a farm, grows lettuce on stacked shelves in an enclosed high-tech greenhouse under the control of central computers in Japan. Computers are linked to a cloud that Fujitsu runs in collaboration with **Aeon**, one of the biggest grocery merchants in Japan.

For instance, **Microsoft** is attempting to promote a digital farming platform called **Azure FarmBeats** that utilises the company's enormous, worldwide cloud computing platform**, Azure**.

The platform is intended to give farmers real-time data and analysis on their soil and water conditions, the current situation with pests and diseases, the growth of their crops, and weather and potential climatic changes. The usefulness of this knowledge and guidance depends on the quantity ad quality of data that Microsoft can gather and employ algorithms to analyse.

The largest seed and pesticide manufacturer in the world, **Bayer**, has an estimated 24 million hectares of land under cultivation in the US, Argentina, Canada and Europe.

E. Walmart made a splash in India in 2016 when it paid US$3.3 billion to acquire the online retailer **Jet.com**. In 2018, it acquired **Flipkart**, the country's largest online retailer, for US$16 billion. Amazon is following closely. Today, roughly two thirds of India's internet retail market is controlled by **Walmart and Amazon**. The largest cloud service platform in the world is **Amazon Web Services (AWS**), surpassing Microsoft, Google, and Alibaba.

One of the agri-tech startups supported by Microsoft's 4 Afrika programme is **Twiga Foods**. Founded by a US scholar who saw the possibility for connecting farmers directly to small vendors and avoiding the dominant cartels while researching Nairobi's wholesale markets. Twiga Foods developed a successful business with the assistance of the World Bank, Microsoft, and other venture investors.

Multinational company	Total Turn over in USD
Amazon	$386 Billion
Microsoft	$192 Billion
Walmart	$13.9 Billion
Bayer	$20.6 Billion
Monsanto	$14.6 Billion
Aeon Japan	$77 Billion

In order to acquire food from farmers outside of Nairobi and distribute it directly to a network of small vendors in the city, Twiga Foods developed a fleet of trucks. All of the transactions, including payments, are managed through mobile devices and are powered by the cloud services of **Azure** and the **Microsoft digital platform**.

Ubamarket, a UK company founded by **Will Broome**, creates a shopping software that lets users make lists, scan products for ingredients and allergens, and pay for purchases using their phones.The more you shop, the more the AI learns about the kinds of items you enjoy. AI technology tracks people's behaviour patterns rather than their purchases. Farmers in Karnataka, India, started utilising **Twitter** to interact and broadcast videos of their harvest.

Monsanto claimed then that “data science” could be a $20 billion revenue opportunity beyond its Core business.

Looking Into The Advancements

Artificial intelligence (AI), which may be divided into three basic divisions, is steadily becoming more prevalent in agriculture as a result of technical advancement.

- Agricultural Robots - Robots will take over labor-intensive human duties in this industry.
- Computer vision and deep learning algorithms can be used for crop and soil monitoring.
- Predictive Analytics: Create and apply machine learning models to track and forecast the effects of numerous environmental factors, such as weather fluctuations, on agricultural productivity.

ISAAA, 2019 Global Status of Commercialized Biotech/GM crop

Countries adopted biotech in agriculture	Biotech Crops used in cultivation
China	Cotton, Papaya
Vietnam	Maize
Philippines	Maize
Indonesia	Sugarcane
Australia	Cotton, Safflower, Alfalfa
Myanmar	Cotton
Bangladesh	Brinjal
India	Cotton
Pakistan	Cotton
Sudan	Cotton
Ethopia	Cotton
Malawi	Cotton
Eswatini	Cotton
South Africa	Cotton, Maize ,Pea
Nigeria	Cotton
Brazil	Pea, Maize, Cotton, Sugarcane
Paraguay	Pea, Maize, Cotton
Uruguay	Pea, Maize
Argentina	Pea, Maize, Cotton, Alfalfa
Chile	Maize, Canola
Bolivia	Pea
Colombia	Maize, Cotton
Costa Rica	Cotton, Pineapple
Mexico	Cotton
Honduras	Maize
USA	Maize, Pea, Cotton, Canola, Alfalfa, Sugarbeet, Potato, Papaya, Squash, Apples
Canada	Canola, Pea, Maize, Sugarbeet Alfalfa, Potato
Portugal	Maize
Spain	Maize

With the help of **Information Communication Technologies (ICTs)**, **Innovative Practises (IPs)**, and **Decision Support Systems (DSS), Resource Conserving Technologies (RCTs)** and innovative practises are targeted at precise levels with the highest accuracy to achieve more precision in the application of inputs like seed, fertilisers, pesticides, irrigation, etc. at the farm level. This is known as smart agriculture.The practise of applying inputs what is required, when and where they are required is known as smart or precision agriculture.

Agriculture 1.0, "Mechanization", This is seen as a time when agriculture required a great deal of physical labour, roughly from antiquity until the 1920s. Now, the emphasis is shifting toward mechanisation.

Agriculture 2.0, "The green revolution with its genetic modification", Machines, fertiliser, and improved seed let farmers produce more with less labour from the 1920s to 2010. pushed agriculture to its financial limit and compromised food security.

Agriculture 3.0, "Changing the narrative around agriculture from subsistence to sustainability", The integration of high-tech sensors, cloud computing, specialised software, and the internet of things into farming is a sign that we have reached a new era.

Agriculture 4.0. "Integrated internal and external networking of farming activities", As including advances in post harvest processing using AI and data analysis help a lot in farming more efficiently.

Agriculture 5.0, " Robotics and (some sort of) artificial intelligence will serve as its foundation", A multidisciplinary overview of the most recent advancements in the field of smart farming is provided by artificial intelligence information technology and machine learning. Continuous industrial innovation has made it possible. It's likely that the European Commission has officially declared 2021 to be the start of an era. 5.0 Industry

Country	Agricultural GDP (%)	Level of Mechanization
USA	1	95
Western Europe	<5	95
Russia	4	80
Brazil	5	75
China	10	48
India	14	40

European Agricultural Machinery Association (CEMA) defines, All farm sectors and operations exist in digital form, connection with external partners, such suppliers and end customers, also happens online and data transfer, processing, and analysis are (mostly) automated. The processing of enormous volumes of data can be facilitated by the usage of Internet-based portals. Digital agriculture is the combination of precision agriculture and smart agriculture.

In the agriculture sectors of nations including the USA, Australia, and Israel, digital technologies like Artificial Intelligence, The Internet Of Things, Big Data Analytics, Satellite Imagery and Remote Sensing, Machine Learning, Unmanned Aerial Vehicles (Drones), and Robotics are finding extensive use. With changing consumer needs and behaviours, India is also making room for these technologies, albeit it is still relatively early in this change.

Sensors in Farming

Additionally, sensors called **ISE (Ion Selective Electrode)** and **ISEFT (ion-sensitive field effect transistor)** have been employed to track ion intake by plants. The demand of the plant, which is based on the rate of growth and the condition of the plant's nutrient content, determines the rate of nutrient uptake. Its numerous uses include disease detection and diagnosis, fertiliser calculation, soil and water analysis, crop needs estimation, crop production readiness analysis, and identification of temperature and humidity (for horticulture crops).

AgroPad: Farmers can monitor the health of their soil and water with the use of AI technology. AgroPad10 is a paper gadget created by **IBM** that is roughly the size of a business card. In less than ten seconds, the microfluidics chip inside the card performs a chemical analysis of the sample on-the-spot.

Plantix and **WhatsApp** for agricultural disease identification.Plantix is a mobile application created by German startup **PEAT** that contains a sizable database of images of plant diseases that can be used for comparison.Users only need to send an image of the infected leaf to the Plantix WhatsApp number, and the diagnosis is immediately messaged back to them via WhatsApp. Many farmers in India use this service.

Pay per use based farm tech and mechanization:

Trringo13 and **EM3 Agriservices** are the two pioneers of farm equipment rental service, have successfully replicated the uberisation of renting farm machinery and tractors in India.

Grain Bank Model of 'Ergos':

Ergos has one of the most unusual models on the Agri-tech market. Small and marginal farmers can use their **"Grain Bank model"** which provides doorstep access to end-to-end postharvest supply chain solutions, to transform their grains into tradable digital assets, obtain credit against those assets through associate NBFCs and Banks, and increase the price of their produce. The Ergos concept gives farmers the choice of storing or withdrawing one bag of grain.The network of scientifically run micro-warehouses that Ergos maintains at the farm gate allows farmers to store even one bag of grains.

AgNext19 developed the technology platform **Qualix** to assess trade quality and safety criteria for a range of commodities (grains, pulses, tea, spices, herbs, milk, and honey, among others).

It serves as a platform to quickly introduce quality assessments into the agricultural and food value chains utilising technologies like **AI-based spectral** and **AI-based image analytics**.

Digital tools for agriculture farm monitoring and risk management:

Yuktix Technologies

The technologies are powered by the hardware and software platform known as **GreenSense** IoT devices and GreenSense dashboard. **Yuktix GreenSense** is an off-grid remote monitoring and analytics system for farming. In order to gather information from many sources, utilise existing indigenous knowledge, mix it with research, and give a digital tool that let them disseminate crop-specific recommendations to a group of tribal farmers, a network of Yuktix micro-weather stations was implemented in Odisha. Dashboard-equipped GreenSense nodes are a useful monitoring and DPI (Disease, Pest, and Irrigation) management tool.

Leaf Colour Chart:

A plant's nitrogen status can be reasonably accurately predicted by the colour of its leaves. By matching the supply of nitrogen to the crops' observed needs, nitrogen utilisation can be maximised. The **International Rice Research Institute** in the Philippines created a leaf colour chart that might be helpful to farmers since leaf colour intensity correlates with leaf nitrogen status in a rice plan, which is always simple, straightforward, and affordable. According to studies, following the leaf colour scheme can help conserve between Ten to fifteen percent of nitrogen.

NDVI Sensors:

According to **Bijay Singh et al. (2015)**[4], Normalised Difference Vegetation Index (NDVI) sensors can reduce nitrogen use by 15-20% without affecting yield. This increases farmer profit margins.

SPAD Rating:

A cheap, rapid, and portable diagnostic tool called SPAD (Soil Plant Analysis Development)can be used to monitor the nitrogen (N) status of rice leaves and to better time the application of N topdressing. Farmers can afford SPAD, a low-cost chlorophyll metre. Lower leaves were considerably better than upper leaves at separating N levels, if total N was employed as an indicator, so measuring SPAD readings leaves in lower places may be more appropriate to serve as testing sample for N status diagnosis. The management of nitrogen using SPAD metres appeared to be more effective and wiser.

A Nutritional Expert (NE)

Nutrient decision support system, based on site-specific nutrient management (SSNM) principles, has been created by the **International Plant Nutrition Institute (lPNl)** in partnership with CTMMYT. This system uses a methodical strategy to gather site-specific data that is crucial for creating a suggestion for a particular area. Compared to previous fertiliser recommendations, higher production, and farm profitability in the nation's key maize-growing agro-ecologies.

Automated irrigation System:

System of automatic irrigation Farmers will only be able to interfere when absolutely essential by integrating these irrigation systems with more sophisticated **Internet of things (loT)** enabled sensors to continuously monitor moisture levels and plant health.

Artificial lntelligence And Automation In Weed Management:

The most important components of plant growth and development that can be flawlessly managed by autonomous robots are weed and pest management. Only a few prototypes are currently being created. Future integration of powerful machine learning technologies, including artificial intelligence (Al), may eliminate the need for humans to physically weed or monitor crops. The drones are equipped with sensors, cameras, and sprayers to identify pests and apply insecticides, allowing them to perform crop spraying herbicides, fertilisers, and pesticides more accurately, efficiently, and with less waste thanks to a combination of GPS, laser measurement, and ultrasonic positioning.

Precision land levelling, which utilises a laser-guided device to create perfectly level fields, is another resource-conserving technology.

Internet of Things (IOT) In Agriculture Merket Size, 2021 to 2030 (USD Billion)

Years	Market Size
2021	12.5
2022	13.7
2023	15.02
2024	16.46
2025	18.05
2026	19.78
2027	21.68
2028	23.77
2029	26.05
2030	28.56

Drone Technology in Farming:

The industry for using drones in agriculture is predicted to develop from a $1.2 billion (USD)market in 2019 to a $4.8 billion market in 2024.Drone-collected data from farms is frequently utilised to better guide agronomic choices and is already a component of the system typically referred to as "agriculture" in large-scale precision farming operations. combining geospatial mapping with sensor data to provide information on the density, moisture, and nutritional content of the soil. For use in sowing and planting, prototype drones are being developed and tested. These drones have the ability to shoot seed pods with fertiliser and nutrients directly into the ground using compressed air.

❖ **Scouting/Monitoring Plant Health**

Keeping an eye on plant health. The Normalized Difference Vegetation Index (NDVI), a specialised imaging tool used by drones, uses precise colour data to assess the health of plants. While satellite imaging may provide accuracy down to the metre, Drone imaging can produce millimeter-level accuracy in image placement.

❖ **Monitoring Field Conditions**

Nitrogen level in soil using improved sensors is also offered by some agricultural drone vendors and service providers. This makes it possible to apply fertilisers precisely, removing troublesome growth areas and enhancing soil health for years to come.

❖ **Planting & Seeding**

Drone planting makes it possible to replant inaccessible locations without putting workers in danger. With a crew of two operators and 10 drones that can plant 400, 000 trees each day, they are also able to plant considerably more effectively.

- **Spray Application**

South Korea uses drones for about 30% of its agricultural spraying, and spray treatments are already common in south-east Asia. Drone sprayers spare workers from carrying backpack sprayers through fields, which can be harmful to their health. To improve productivity and reduce chemical costs, drone sprayers offer very fine spray treatments that can be targeted to particular locations. Currently, laws governing drone sprayers vary greatly between nations. They are not currently authorised in Canada since further research is required to fully understand the effects of spray drift. **Yamaha** leases spray drone services that include licenced operators but does not sell the spray drones they make.

- **Security**

It is more efficient to use drones to frequently check on difficult-to-reach areas of a farm rather than having to travel there in order to do so. Instead of adding more security people, surveillance drones can be used to keep an eye on the perimeter and fence of more important crops, including cannabis. By finding lost or hurt herd animals in distant grazing regions, drone cameras are also being used in innovative ways to protect farm animals. Today, remote area monitoring tasks that once required hours of travelling may be finished quickly.

- **Drone Pollination**

One of the most publicized and often functionalized uses in pollination drone technology. Researchers in Netherland and Japan are developing small drones capable of pollination.

- **Drone in Irrigation**

Using microwave sensing drones are able to capture a very accurate soil health information including moisture level and can effectively apply irrigation spray.

Global Agriculture Drone Market 2015-2021(USD Million)

YEAR	REVENUE
2015	673.79
2016	690.90
2017	995.80
2018	1230.89
2019	1656.76
2020	1988.78
2021	2978.69

Remote Sensing

Fundamentally, remote sensing entails inspecting terrain using sophisticated equipment from a great distance. The physical qualities of a plot of land are checked. By calculating the radiation that is produced and reflected by the land, the method builds a picture of the land and enables experts to assess certain areas of it.

- **Use**

In a competitive market, growers frequently take advantage of the most latest technology available to enhance crop development and maximise production. Farmers need their harvests to be in the best possible health in order to provide the highest output. The use of remote sensing in agriculture makes it substantially easier to monitor the size of harvests across a large area. Precision growing is supported by the data obtained during the process, enabling farmers to increase harvest yields.

- **Specifically For Area Estimation Of Sown Crop**

A crucial application of remote sensing in horticulture is the evaluation of the area where crops are sown. Aerial and satellite sensor data provide a precise study of planted areas and aid in the risk assessment process in the event of a disaster or catastrophic event.

- **Identification Of Crop Disease**

Gis remote sensing in agriculture makes it easier to spot insect infestations and contaminations in crops over large areas at the beginning of their life cycles. This allows farmers enough time to use any defensive strategies to protect their harvests from severe losses. Through the use of satellite inspection and imaging, this is made possible.

- **Properties Of Soil**

The right support of soil is perhaps the most important factor in ensuring a good yield of harvests. It has a direct impact on the harvest. Any improvements in farming practises or farm management alter the soil, which in turn affects the soil's ability to produce. Remote sensing can be used to identify characteristics including soil salinity, soil pH, organic substance level, and soil texture. This data can then be processed to carry out any substantial soil treatment. With the use of soil moisture mapping, any improvements to the design of the irrigation system can be made with greater accuracy.

- **Flood Impact And Catastrophic Disaster**

Agriculture remote sensing can help with evaluating current and predicting Natural Catastrophe dangers. utilising the data sent by sensors and the actions of typical dangers. This calls for risk mapping and evaluating hazards, which are completed using computer-simulated disaster models. In order to give areas with a high potential for flooding with high hazard ratings, remote sensing maps that were created with the help of historical data and current data collected from various sensors are helpful. This helps farming since it prevents planting in areas with higher risk ratings and allows for greater flood protection the next season.

- **Crop Damage Assessment Using Drone Image Analysis**

Invasions, tree counting, and crop damage assessment are all done using drone picture analysis. As accurate as the input spatial resolution is the drone imagery. which might be raised based on the situation.

India's Effort:

"In order to advance digital agriculture, the **Ministry of Agriculture and Farmers Welfare** signed 5 Memorandums of Understanding (MOU) with commercial businesses "**www.Krishi jagran.com**

Digital agriculture is described as "the use of **ICT (Information and Communication Technologies)** and **Data ecosystems** to support the development and delivery of timely, targeted information and services to support farming profitability and sustainability while delivering safe, wholesome, and affordably priced food for all**. "AgriStack**:A collection of technology-based agricultural interventions called "AgriStack" is being developed by the Ministry of Agriculture and Farmers Welfare. In order to provide farmers with end-to-end services along the agriculture food value chain, it is will establish a unified platform for them.

The mission for digital agriculture has been set for 2021–2025.

Unified Farmer Service Platform (UFSP): The UFSP combines core infrastructure, data, applications, and tools to facilitate smooth interoperability between multiple public and private IT systems in the nation's

National e-Governance Plan in Agriculture (NeGP-A): A Centrally Sponsored Scheme, it was initially launched in 2010-11 in 7 pilot States.

To develop a strong digital infrastructure in the nation that includes market data, land records, agricultural patterns, soil health information, satellite imaging, and more.Digital Elevation Model (DEM), Digital Topography, Land Use & Land Cover, Soil Map, etc. are some methods for improving data efficiency.

Government agri expenditure and share of PM Kisan Scheme:

YEAR	PM-KISAN BUDGET IN CRORE	AGRICULTURE BUDGET IN CRORE
2019	1241	53620
2020	54370	109750
2021	75000	142792

Budget Allocation For Agriculture Over 10 Years

Years	Budget Allocation (Rs. Crore)
2009-10	12,256
2010-11	14,103
2011-12	16,316
2012-13	18,715
2013-14	19,819
2014-15	31,063
2015-16	24,910
2016-17	44,485
2017-18	51,026
2018-19	57,600

Hi-Tech agriculture companies on digital platform

An automated agronomy service called **Mothive** assists farm managers in increasing productivity, cutting waste, and improving crop predictability and management.

Their technology, the **Mothive Ladybird**, automates farm operations based on current crop requirements, anticipates diseases and improves yields, and tells farmers about the best time to harvest and related logistics.

Cropx, an ag. analytics company, develops cloud-based software solutions with integrated wireless sensors to boost agricultural output and save water and energy.

"The Arable **Mark** is the first integrated weather station, crop monitor, and irrigation control tool with IoT capabilities. It has cellular connectivity, constant field visibility, and solar power. Arable is a company that offers agricultural analytics and data. It is the only device that collects over 40 pertinent plant and climatic data streams, including precipitation, chlorophyll content, radiation, reflectance, temperature, and humidity. This gadget uses modern, patented technology, including an **acoustic disdrometer** and a **seven-band spectrometer "**www.science direct.com The main services provided by **Gamaya,** a Swiss company engaged in smart farming, include growth monitoring for fertilisation optimization, yield prediction, early disease and insect identification, stress detection and diagnostics (mechanical damage, nutrient shortage, water stress, and soil compaction). Farmers can realise significant financial gains thanks to the Gamaya solution, including a 30% increase in yield, a 40% drop in costs, and a 70% decrease in disease-related risks, all of which encourage the development of high-quality goods and minimise negative environmental effects.

AgriData digitises agriculture by offering a method for tracking assets for perennial crops (trees and vines, aka high-value crops).

Agrowatcher employs multispectral imaging and computer vision technologies to identify different types of crops and identify water stress, pests, infestations, and diseases. Images are processed using a custom computer vision algorithm and machine learning, and a precise treatment (watering, pesticide/herbicide application, etc.) is then applied right away.

Rise Of Mobile Phones

Access to markets, information, mobile banking, and weather-related intelligence are just a few of the ways that ICTs can help farmers. Additionally, since mobile and smart phone usage has grown across agricultural populations, more people may now easily access the afore mentioned services without having to spend money on desktops, laptops, or other similar bulky hardware components. In addition, social media platforms like **Facebook** and **YouTube** offer inexpensive and simple ways to share information in the form of photographs and other media, enabling greater communication between farmers and other groups including politicians, academics, and specialists.

In his research, **Yared (2015)**[19] emphasised the importance of mobile financial services, one of the most promising areas for agriculture-based mobile applications where governments can contact farmers notably those who come from a low-income background and use a variety of credit facilities to better their lives.

Yared (2015)[19]: The importance of mobile financial services, one of the most promising fields for agriculture-based mobile applications where governments may get in touch with farmers, especially those from modest backgrounds and take advantage of a range of financing facilities to better their life.

Belakeri et al. (2017)[20]: Emphasised in their article how farmers may now receive timely market information and travel cost savings thanks to mobile phones, which is especially helpful for perishable goods. Additionally, because mobile applications come with a full suite of audio, video, graphic, text, and animation-based elements, they are a highly engaging way for farmers to stay up to date with current discoveries in the agricultural area as well as mobile applications centred on agriculture.

In their paper, **Brugger (2011)**[21]: Detailed the numerous mobile applications used in agriculture. Market intelligence, trading platforms, operation tracking and monitoring, quality control, logistics management, financial services, and data surveillance and collecting are some of these uses.

In their paper, **Mane et al. (2018)**[22] noted that GPS and camera services are currently the most popular features found in mobile applications.

In addition, applications for conferences, market intelligence, farm information, illnesses and pests, and other topics were developed for mobile devices.

Raj et al. (2020)[23] discussed how different mobile applications are being developed to bring about a farm-to-fork connectivity in the agriculture value chain, where different farmers are being connected to their potential consumers to serve as per their demands and overcome the challenges they may face.

Uses of ICT tools by the farmers (Expressed in percentage) (N=100)

ICT Tools	Percentage of farmers having access to the ICT tools including out sourcing	Percentage of farmers use tool on production purpose
Television	100	50
Radio	57	13
Computer	47	47
Mobile phones	90	70

Game Changing Applications.

In India, there were roughly 320 million mobile phone users in rural areas.As a result, phones serve as the ideal platform for information sharing and the simplest method of communication. Using this information, the government and the commercial sector launched agriculture apps to help farmers by giving them information, training, and support.

mKisan Portal:

All national and state government organisations in the agricultural and related sectors are empowered to provide information or services to farmers regarding agricultural practises through the SMS gateway known as mKisan, which was created by the Hon'ble President of India specifically for farmers. Unstructured Supplementary Service Data, or mKisan USSD, is what IVRS uses.Pull SMS and (Interactive Voice Response System) are value-added services that have allowed farmers to allowing other parties to access web-based services on their devices, in addition to broadcast messages.without access to an internet connection.

Meghdoot Portal:

- Meghdoot is a collaborative project between the **Indian Council of Agricultural Research (ICAR)** and the **Indian Meteorological Department (IMD)** that aims to provide farmers with high resolution weather forecast-based agricultural advises in their native tongue Every Tuesday and Friday, Agro-Mate field units deliver pertinent district- and crop-level alerts. Farmers and other interested people can easily obtain these alerts with the Meghdoot App.
- Whenever possible, advisories are also released in the native tongue. Besides crop warnings, the app also offers weather data and forecasts.

Damini

The Damini Lightning App was created by ESSO and IITM-Pune. The software keeps track of all electrical activity taking place solely in India. Additionally, it sends you a GPS warning when lightning hits within 20 and 40 kilometres of you.

- Applications in lightning-prone areas come with specific instructions and safety precautions.
- Strictly adhered to dos and don'ts in particular circumstances when lightning hits nearby with the intention of your security.

Kisan Suvidha

Prime Minister Narendra Modi introduced this app in 2016. It offers data on the present weather, a forecast for the next five days, market pricing in the nearby town, and knowledge of fertilisers, seeds, machines, etc. The software has a very user-friendly interface and is available in many different languages.

Pusa Krishi

The Indian Agriculture Research Institute created this app, which the Union Agriculture Minister unveiled in 2016. (IARI). It informs farmers about novel crop types created by the Indian Council of Agriculture Research (ICAR).

IFFCO Kisan

This application was released in 2015. Users can access a number of information modules, such as weather forecasts, market prices, and a library of texts, audio files, photos, and videos in certain languages that pertain to agriculture.

Kheti Badi

Kheti Badi is a social initiative app aimed to promote and support organic farming in the country`

Plantix

An agriculture app called Plantix links the world's farmers. The app enables farmers to take images of their ailing plants and receive advice from the global community. Along with professional farmers, the software also empowers private farmers that engage in farming as a pastime or plant researchers.

MyAgriGuru

MyAgriGuru is a digital platform for farmers, an initiative by the **Mahindra Group**.The app is aimed at creating an integrated network in the agriculture community in India.

Mobile Application	Number of farmers using	Advisories
mKisan portal	51376458	436847
Meghdoot Portal	200000+	42000000
Damini app	10 lakhs +	-
Kisan Suvidha app	10 lakhs +	3423234
Pusa krishi app	50000 +	232331
IFCCO Kisan	5 lakhs +	-
Kheti Badi	1 lakhs +	232322
Plantix	10 million +	-

Purpose of Use Of Mobile Phones(Expressed in Percentage) (N = 100)

Purpose	High	Moderate	Low	Total
Communication with other	50	40	10	100
To know about Marketing	7	43	27	77
To get higher price of produce	0	13	10	23
To get new information on agriculture	37	50	13	100
To get general information	56	37	7	100
To get health information	0	0	30	30
For increasing production	0	27	43	70
To know improved skill on agriculture	0	50	20	70

IV. CHALLENGES AND LIMITATION

Through the efficient use of inputs, sustainability in production, and increased resistance to risks, shocks, and long-term climate variability, the transformation of Indian agriculture must be more productive. In order to simultaneously address the concerns of food security and climate change, Climate-smart agriculture (CSA) is one of the three pillars of sustainable development, according to the FAO (economically, socially, and environmentally).

1) Steadily raising agricultural output and revenue;
2) 2)Adapting to climate change and fostering resilience;
3) Reducing and eliminating emissions of greenhouse gases.

Around 80% of farmers in India are small and marginal farmers with access to modest land holdings, and the average farm size in that country is 1.08 Hectares.As a result, Indian farmers don't need more sophisticated technologies like farm robots and drones, etc.

Inability to target small and marginal farmers with limited land holdings was noted by **Blommestein et al. (2006)[24]**.

Madan et al(2020)[17]:

Stated that first and foremost, the technologies under development must be strengthened to better withstand the unpredictable nature of farming and make judgments in real time to fulfil the varying needs of an agricultural field. Second, the solutions must be more reasonably priced so that a typical farmer with less literacy may access them and use them on a daily basis.

Birner and others (2021)[25]

Stated some of these difficulties include a lack of funding, a smaller market that makes it difficult for companies to satisfy their individual development expenditures, high development costs for embodied technology types, and an unfavourable business environment. The primary obstacles to the digital growth of agriculture were noted by **Bayne et al. (2021)[26]** in their report. The issues include inadequate power, electricity, and telecommunications networks; inadequate regulations and procedures to be governed by government agencies and a lack of digital literacy and skills among agricultural populations.

V. CONCLUSION

In a nation of 1.4 billion people, each with own language, religion, and way of life. Half of the population works in agriculture, thus there is opportunity for improvement and a need for expansion.

Digital platforms with regional language interfaces, low input and high output investments, easy communication routes, on spot solution based software could be driving factors and with a positive acceleration can become reason for the Indian farm sector's digitalization.

Digitalization in present world is in great demand as it makes farming more precise and high profit orient business which is very essential for a country like India with huge population.

From Drone technology, Remote sensing, Mobile phone applications, Internet of Things, Mechanized processing post harvest units and Artificial intelligence are some examples manifesting the advancement recently emerged,

Enhancing the ordinary regular, day to day farming practices into accomplishing enterprise.

As one of the member of the developing country India needs to make obligatory changes in agriculture policies making it more open to international market and easily reachable for local young entrepreneur and foreign multinational to make pertinent investment in Indian markets. Therefore, we can say in clear words that while completing the journey from agriculture 1.0 to 5.0, mechanization, digitalization, use of various agriculture portals, Industrialization are fully adopted in farming activities. As a result advancement in farming income will eventually double, employment to educated youth increase, it will be helpful in increasing the GDP of India to a greater extent. It will not be too late for India to become a Golden Bird again.

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Effect of Bioculture Fertilizer and Biological Fertilizer on the Growth and Yield f Tomato Plants (*Solanum Lycopersicum L.*), Servo F1 Variety

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Abstract— *The aim of the research was to determine the effect of bioculture and biofertilizers and their interactions on the growth and yield of Servo F1 tomato varieties and to obtain appropriate concentrations of biocultural and biofertilizers for tomato plants.*

The research was conducted from May to July 2022, at the UPTB Agricultural Training Center (BAPELTAN) Jl. Thoyib Hadiwijaya No.36, South Sempaja urban village, North Samarinda sub-District, Samarinda, East Kalimantan Province.

The study used a 4x4 factorial experiment in a completely randomized design with four (4) repetitions. The first factor was the concentration of bioculture fertilizer (B), consisting of 4 levels, namely: no bioculture fertilizer application or control (b_0), 10 ml L^{-1} water (b_1), 20 ml L^{-1} water (b_2), and 30 ml L^{-1} water (b_3). The second factor is biofertilizers (H) consisting of 4 levels, namely: no biofertilizers application of control (h_0), 5 ml L^{-1} water (h_1), 10 ml L^{-1} water (h_2), and 15 ml L^{-1} water (h_3).

The data collected were plant height at 20, 40 and 60 days after planting, plant age at flowering, number of fruits per plant and fruit weight per plant. Data analysis was carried out using analysis of variance and continued with the leasr significant difference test at the 5% level.

The results showed that: (1) application of bioculture fertilizers had a very significant effect on the plant height at 20, 40 and 60 days after planting, and fruit weight per plant. The highest fruit weight per plant was produced in the treatment 30 ml L^{-1} water (b_3) namely 156,25 g crop^{-1}, and the lowest was produced in the treatment without bioculture fertilizers (b_0), namely 128,75 g crop^{-1}; (2) application of biofertilizers had a significant to very significant effect on the plant height at aged 40 and 60 days after planting, number of fruits per plant and fruit weight per plant. The highest fruit weight per plant was produced in the treatment 15 ml L^{-1} water (h_3) namely 156,25 g crop^{-1}, and the lowest was one was produced in the without biofertilizers (h_0), namely 128,75 g crop^{-1}; and (3) there is an interaction between the treatment of bioculture fertilizers and biofertilizers on the plant height at the age of 20, 40 and 60 days after planting.

Keywords— Bioculture Fertilizer, Biofertilizer, Tomato Plant.

I. INTRODUCTION

Tomato is a commodity that has high economic value and is cultivated by farmers in their farming activities to meet the needs of consumers and industry. From year to year, market demand for tomatoes is increasing, while tomato productivity has not been able to balance this increase. Tomato productivity needs to be further increased to meet domestic and export needs.

Efforts to increase tomato production through extensification (expansion of the planting area) are carried out not only on potential land but also on marginal land with low soil fertility and are sensitive to erosion. Many things can be done to increase tomato productivity, from technical improvements in tomato cultivation to postharvest treatment. Efforts to improve tomato cultivation techniques are the availability of sufficient nutrients as plant food to grow and develop thereby affecting the quality and quantity of tomato yields. Therefore, it takes nutrients from outside, such as fertilizer.

Conventional farming systems, including the use of artificial fertilizers, can multiply crop yields. However, the negative impact can cause environmental damage, namely decreasing soil fertility so that agricultural land becomes damaged. The use of artificial fertilizers in large quantities resulted in a decrease environmental quality (Benbrook 1991). The use of artificial chemical fertilizers has a negative impact on the environment which results in damage to ecosystems (Cahyono, 2008). Intensive and continuous use of synthetic fertilizers can lead to hardening of the soil caused by the accumulation of residual artificial fertilizers, making it difficult for the soil to decompose. Hard soil produces several negative impacts including; (1) it becomes more difficult for plants to absorb nutrients, (2) the use of higher doses of fertilizer to get the same yield as the previous crop, and (3) the root system is disrupted so that the root function is not optimal (Notohadiprawiro, 2006).

To overcome this, technology is needed that can save on the use of agrochemicals including artificial fertilizers, maintain soil fertility, improve product quality, use seeds from superior varieties as well as proper and balanced fertilization, and increase farmers' income (Rosliani et al. 2004).

At present it is known that there is a new agricultural technology, namely enzymatic technology in an effort to increase agricultural production. This enzymatic technology focuses on improving the physical, chemical and biological properties of the soil. One type of product of this enzymatic technology is bioculture which is made from a mixture of biological enzyme substrates, complex biological chelates, vitamins, and electrolyte salts and is added to water and then aerated for 1 week. Bioculture can change the soil to be more friable, increase soil pH, and beneficial microbes can develop properly, while soil pathogens can be suppressed (Setiono Hadi 2005).

Biological fertilizer (biofertilizer) is a fertilizer made from microbes that have the ability to provide nutrients and hormones for plant growth. Microbes contained in biological fertilizers applied to plants are able to bind nitrogen from the air, dissolve bound phosphates in the soil, break down complex organic compounds into simpler compounds, and stimulate plant growth (Suwahyono, 2011).

The aim of the study was to determine the effect of bioculture fertilizers and biofertilizers and their interactions on the growth and yield of Servo F1 variety tomatoes and to obtain concentrations of bioculture fertilizers and biofertilizers suitable for tomato plants.

II. RESEARCH METHODS

2.1 Place and time of research

The research was conducted from May to July 2022, at the UPTB Agricultural Training Center (BAPELTAN) Jl. Thoyib Hadiwijaya No.36, South Sempaja, North Samarinda sub-District.

2.2 Materials and Research Tools

The research materials were: tomato seeds (the Servo F1 variety), liquid bioculture fertilizers, biofertilizers, topsoil, polybags measuring 25 x 30 cm. Tools used include: hoe, tape measure, camera, notebook, label to mark treatment, bucket, hand spayer, and ruler.

2.3 Research design

The study used a completely randomized design with 4 x 4 factorial analysis with four (4) replications. The first factor was the concentration of bioculture fertilizer (B), consisting of 4 levels, namely: no bioculture fertilizers application or control (b_0), 10 ml L^{-1} water (b_1), 20 ml L^{-1} water (b_2), dan 30 ml L^{-1} water (b_3). The second factor is biofertilizers (H) consisting of 4 levels, namely: no biofertilizers application or control (h_0), 5 ml L^{-1} water (h_1), 10 ml L^{-1} water (h_2), dan 15 ml L^{-1} water (h_3).

2.4 Research Activities

The research activities carried out are as follows: preparation of planting media; sowing seeds, transferring seedlings and planting, applying bioculture fertilizers and biofertilizers, maintaining plants (watering, loosening the soil, setting stakes, controlling pests and diseases), harvesting, data collection and analysis, reporting.

2.5 Data collection

The data collected were plant height at 20, 40 and 60 days after planting, plant age at flowering, number of fruits per plant and fruit weight per plant.

2.6 Data analysis

Data analysis was carried out using analysis of variance and continued with the least significant difference test of 5%.

III. RESULTS AND DISCUSSION

3.1 Bioculture Fertilizer

The results of the analysis of variance showed that bioculture fertilizers had a significant to very significant effect on the plant height at aged 20, 40 and 60 days after planting, and fruit weight per plant, but had no significant effect on plant age at flowering and number of fruits per plant. The results of the research on the effect of bioculture fertilizers on the growth and yield of Servo F1 tomato variety are presented in Table 1.

TABLE 1
RECAPITULATION OF RESEARCH DATA EFFECT OF BIOCULTURE FERTILIZERS ON THE GROWTH AND YIELD OF TOMATO, SERVO F1 VARIETY

Treatment Factor Bioculture Fertilizers (B)	Plant height (cm)			Age of Flowering Plants (days)	Number of Fruits/ Plants (fruits)	Weight of Fruit / Plant (g)
	20 HST	40 HST	60 HST			
Analysis of Variance	**	**	**	tn	tn	**
No bioculture fertilizers (b0)	7,07c	42,71c	82,43d	22,13	10,50	111,00d
10 ml l^{-1} water (b1)	8,91b	42,38c	84,33c	23,36	11,73	133,25c
20 ml l^{-1} water (b2)	9,09b	46,55b	86,83b	23.31	11,19	143,25b
30 ml l^{-1} water (b3)	9,51a	47,50a	88,28a	23,44	11,06	170,75a

Remark : The average number in each column followed by the same letter is not significantly different based on the results of the LSD test at the 5% level. HST = days after planting.

Based on the results of the research presented in Table 1, it shows that the application of various concentrations of bioculture fertilizers 10 ml L^{-1} water (b1), 20 ml L^{-1} water (b2), and 30 ml L^{-1} water (b3) produced higher tomato plants, higher number of fruits per plant, and higher fruit weight per plant compared to the treatment without bioculture fertilizers (b0). The highest fruit weight per plant was produced in the treatment 30 ml L^{-1} water (b3) namely 170,75 g $crop^{-1}$, followed by treatment 20 ml L^{-1} water (b2) and 10 ml L^{-1} water (b1) that is, censecutively 143,25 g $crop^{-1}$ and 133,25 g $crop^{-1}$, and the lowest was produced in the treatment without bioculture fertilizers (b0) namely 111,00 g $crop^{-1}$. The results of this study are in line with those reported by Setiono Hadi (2005) on rice plants, the use of bioculture can increase average rice yields up to 10 tons ha^{-1}, then the yield of hybrid corn with the application of bioculture fertilizers reached 20-25 ton ha^{-1} harvested dry corn kernels while the average yield was only 9-10 ton ha^{-1}. Nurtika, Sofiari, and Sopha (2008) reported that the highest yield of potato tubers was achieved by using inorganic fertilizers recommended by Balitsa. + bioculture 2.000 L ha^{-1} namely 15,30 kg $plot^{-1}$ (14,57 ton ha^{-1}), whereas without bioculture the results are only 13,06 kg $plot^{-1}$ (12,43 ton ha^{-1}); further reported by Lasmini et al. (2018) that application of bioculture fertilizers with as many doses 750 L ha^{-1} had a better effect on plant height, plant fresh weight, tuber excretion weight, tuber dry weight, tuber diameter, tuber moisture content and shallot bulb yield compared to other treatments. The highest yield of shallot bulbs was obtained by giving as much bioculture fertilizers 750 L ha^{-1} namely 9.27 ton ha^{-1}. This situation indicates that the application of bioculture fertilizers can improve the physical, chemical and biological properties of the soil, and can further increase the availability and uptake of nutrients by plants. As stated by Sumiarti and Soetiarso (2003) that liquid bioculture complementary fertilizers can improve soil physical properties, increase soil biological activity and increase the availability of nutrients for plants.

3.2 Biofertilizer

The results of variance showed that biofertilizers had a significant to very significant effect on the plant height at aged 20, 40 and 60 days after planting, number of fruits per plant and fruit weight per plant, but had no significant effect on plant age at flowering. The results of the research on the effect of biofertilizers on the growth and yield of the tomato (Servo F1 variety) are presented in Table 2.

TABLE 2
RECAPITULATION OF RESEARCH DATA EFFECT OF BIOFERTILIZERS ON GROWTH AND YIELD OF TOMATOES. SERVO F1 VARIETY

Treatment Factor Biofertilizers (H)	Plant height (cm)			Age of Flowering Plants (hari)	Number of Fruits / Plants (fruit)	Weight of Fruit / Plant (g)
	20 HST	40 HST	60 HST			
Analysis of Variance	tn	**	**	tn	*	**
No biofertilizers (h0)	8,51	44,10c	83,70d	22,81	9,12 b	128,75c
5 ml l^{-1} water (h1)	8,52	44,46bc	84,58c	23,25	11,56 a	133,75bc
10 ml l^{-1} water (h2)	8,72	44,80b	86,18b	23,19	11,44 a	139,50b
15 ml l^{-1} water (h3)	8,47	45,78a	87,40a	23,00	11,75 a	156,25a

Remark : The average number in each column followed by the same letter is not significantly different based on the results of the LSD test at the 5% level.
HST = days after planting.

Based on the results of the research presented in Table 2, it shows that the application of various concentrations of biofertilizers, namely 5 ml L^{-1} water (h_1), 10 ml L^{-1} water (h_2), and 15 ml L^{-1} water (h_3) produced higher tomato plants, higher number of fruits per plant, and higher fruit weight per plant compared to the treatment without biological fertilizers (h_0). The highest fruit weight per plant was produced in the treatment 15 ml L^{-1} water (h_3) namely 156,25 g crop^{-1}, followed by treatment 10 ml L^{-1} water (h_2) and 5 ml L^{-1} air (h_1) that is, consecutively 139,50 g crop^{-1} dan 133,75 g crop^{-1}, and the lowest was produced in the treatment without biofertilizers (h_0) namely only 128,75 g crop^{-1}. The results of this study are in line with the results of research reported by Kaya et al (2020) that the application of Kesta biofertilizer combined with organic fertilizer and NPK fertilizer resulted in plant height aged 35 days after planting, fresh weight and dry weight of tomato plants in the nursery compared to the treatment without Kesta biofertilizer. The results of another study reported by Nazimah et al (2020) stated that the application of biofertilizers at doses 6 g plot^{-1} gave a very good effect on the growth and yield of tomato plant varieties compared to other treatments including treatment without biofertilizers. The increase in plant growth and yield from the application of biofertilizers is due to the fact that biofertilizers are fertilizers made from microbes that have the ability to provide nutrients and hormones for plant growth. Microbes contained in biofertilizers applied to plants are able to bind nitrogen from the air, dissolve bound phosphates in the soil, break down complex organic compounds into simpler compounds, and stimulate plant growth (Suwahyono, 2011).

3.3 Interaction of Bioculture Fertilizers and Biofertilizers

The results of variance showed that the interaction between bioculture fertilizers and biofertilizers had a significant to very significant effect on the plant height at aged 20, 40 and 60 days after planting, but it had no significant effect on the plant age at flowering, number of fruits per plant and fruit weight per plant. This situation indicates that the dosage factor of bioculture fertilizers and biofertilizers concentration factor did not jointly or individually affect the growth and yield of tomato plants. As stated by Steel and Torrie (1991), that if the effect of different interactions is not significant, then it is concluded that the treatment factors act independently of each other.

The results of the research on the effect of the interaction between bioculture fertilizers and biofertilizers on the growth and yield of tomatoes (Servo F1 variety) are presented in Table 3.

TABLE 3
INTERACTION EFFECT RESEARCH RESULTS

Interaction (B×H)	Plant height (cm)			Age of Flowering Plants (days)	Number of Fruits / Plants (fruit)	Weight of Fruit / Plant (g)
	20 HST	40 HST	60 HST			
Analysis of Variance	*	**	**	tn	tn	tn
b0h0	7,05ef	40,20h	80,50k	21,25	8,25	100,00
boh1	7,30e	43,05e	81,20j	23.25	11,25	113,00
b0h2	6,70f	43,10e	83,40h	21,00	10,75	111,00
boh3	7,22ef	44,50d	84,60g	21,50	11,75	120,00
b1h0	8,33d	42,20fg	82,60i	23,00	10,25	120,00
b1h1	8,85bcd	41,10g	82,90hi	24,00	11,25	122,00
b1h2	8,65cd	42,90ef	85,60f	22,75	11,00	126,00
b1h3	8,40d	43,30f	86,20e	22,75	12,00	165,00
b2h0	9,03bc	46,40c	84,50g	23,50	8,75	138,00
b2h1	8,78cd	46,90bc	86,70de	23,75	11,75	141,00
b2h2	9,68a	45,70d	87,50c	23,75	12,25	139,00
b2h3	8,85bcd	47,20bc	88,60b	22,25	12,00	155,00
b3h0	9,68a	47,60ab	87,20cd	23,50	9,25	157,00
b3h1	9,13b	46,80b	87,50c	22,00	12,00	159,00
b3h2	9,83a	47,50ab	88,20b	23,75	11,75	182,00
b3h3	9,38ab	48,10a	90,20a	24,50	11,25	185,00

Remark: The average number in each column followed by the same letter is not significantly different based on the results of the LSD test at the 5% level.
HST = days after planting

In general, the results of the research presented in Table 3 show that the combined treatment of various concentrations of bioculture fertilizers with various concentrations of biofertilizers, as well as the combined treatment of various concentrations of biofertilizers with various concentrations of bioculture fertilizers tend to produce higher plants, the number of fruits per plant is higher more and the weight per plant is heavier than the combination without bioculture fertilizers and without biofertilizers. The highest fruit weight per plant was produced in the combination 30 ml L^{-1} water bioculture fertilizers and 15 ml L^{-1} water biofertilizers (b_3h_3) namely 185,00 g $crop^{-1}$, while the lowest was produced in a combination without bioculture fertilizers and without biofertilizers (b_oh_o), namely 100,00 g $crop^{-1}$. This is because the application of both fertilizers can improve the physical, chemical and biological properties of the soil. As stated by Barus (2011) that the addition of organic matter is necessary so that the ability of the soil can be maintained or even increased to support efforts to increase plant productivity through the efficient use of inorganic/chemical fertilizers. Then stated by Muklis (2020) biofertilizers contain microbes that function and are able to break down complex organic compounds found in the soil into simpler compounds and form other compounds so that they are easier for plants to use. Another function of biofertilizers is as a soil enhancer because they can change the physical condition of the soil so that it makes the soil a stable aggregate.

On the parameter of plant age at flowering, both bioculture fertilizer and biofertilizer treatment and their interactions had no significant effect, this is because the age of plants at flowering is largely determined by the plant's own genetic factors. As stated by Darjanto and Satifah (2002) that the transition from the vegetative period to the generative period (marked by the appearance of flowers) is partly determined by the genotype or internal factors and partly determined by external factors such as temperature, light, water, nutrients and so on other.

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

Based on the results of the research and discussion, it can be concluded as follows:

1. Application of bioculture fertilizers had a very significant effect on the plant height at aged 20, 40 and 60 days after planting, and fruit weight per plant, but had no significant effect on the plant age at flowering and number of fruits per plant. The highest fruit weight per plant was produced in the treatment 30 ml L^{-1} water (b_3) namely 170,75 g $crop^{-1}$, and the lowest was produced in the treatment without bioculture fertilizers (b_0), namely only 111,00 g $crop^{-1}$.
2. Application of biofertilizers had a significant to very significant effect on the plant height at aged 40 and 60 days after planting, number of fruits per plant and fruit weight per plant, but had no significant effect on plant height 20 days after planting and plant age at flowering. The highest fruit weight per plant was produced in the treatment 15 ml L^{-1} water (h_3) namely 156,25 g $crop^{-1}$, and the lowest was produced in the treatment without biofertilizers (h_0), namely only 128,75 g $crop^{-1}$.
3. There is an interaction between the treatment of bioculture fertilizers and biofertilizers on the plant height at the age of 20, 40 and 60 days after planting.

4.2 Suggestion

For the cultivation of tomato plants in polybags, can be suggested using 30 ml L^{-1} water bioculture fertilizers and 15 ml L^{-1} biofertilizers.

Similar research can be carried out in various conditions in the field.

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Pollution Potential of Jaggery Industry: A Case Study

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Abstract— *Jaggery industries are one of the agrobased cottage sectors in India. Jaggery production involves extraction of juice from the sugarcane and heating it to obtain a concentrate i.e. Jggery or Gur. Sugarcane bagasse and wood are used as fuel in the heating furnace, which is the main source of pollution. The pollution potential of the Jaggery industries was assessed in the present work that is based on the actual measurements at Jaggery industry sites. Two representative Jaggery industries were identified for detailed field studies including the stack emission monitoring. While selecting the representative industries, the production capacity and provisions of emissions monitoring were considered. Measurements were carried in respect particulate matters, sulthur dioxide, oxides of nitrogen and carbon monoxide. The particulate matter emissions were observed as 751.5 mg/Nm*^{3} *in one industry and 682.5 mg/Nm*^{3} *in other industry. It was also noted that the emission of gaseous pollutants namely, sulphur dioxide, oxides of nitrogen and carbon monoxide from both the industries were low*.

Keywords— Jaggery industry; Air pollution, Sugarcane; Gur; Kolhu.

I. INTRODUCTION

The Jaggery industries (also known as *Kolhus)* make Jaggery or *Gur* from the sugarcane juice and are one of the agrobased unorganized cottage sectors in India. The industries are owned and operated by farmers using knowledge and expertise gained over the generations. The Jaggeries are constructed using locally available resources such as bricks, soil, sand and mud. Sugarcane bagasse is used as fuel in the furnace. The consumption of sugarcane for Jaggery and *Khansari* production is given in Table 1 (SBI, 2016).

TABLE 1
DIFFERENT USAGES OF SUGARCANE IN INDIA

Year	Sugar (%)	Seed & feed (%)	Gaggery and *Khansari* (%)*
1971-72	30.2	12	57.8
1981-82	46-90	11.7	41.4
1991-92	53.7	11.8	36.8
2001.02	60.7	11.7	27.6
2011-12	71.2	11.9	16.9
2012-13	73.4	11.8	14.7

Authentic data for separate Jaggery production is not available.

It can be noticed from Table 1 that the production of Jaggery and *Khansari* show a decline trend over the decades. Emergence of sugar industries in large number, lack of hygiene, quality of products, changing food habits of population and the economics involve in the Jaggery production may be reasons for decrease in the Jaggery production (Dwivedi, 2010). However, these units are still popular in sugarcane growing states in India. The jaggery industries are seasonal and temporary in nature. Hence, their precise numbers and location are not available.

Jaggery is reported to have higher nutritional value as compared to the sugar. Jaggery preserves all the minerals and vitamins present in sugarcane juice such as calcium, iron and phosphorous (Jagannadha Rao et al. 2007; Kumar and Singh, 2020). Contrary to this, in sugar manufacturing, the valuable nutrients and minerals are discharged along with the molasses.

Most Jaggery industries are constructed using traditional knowhow. Inefficient burning of fuels and lack of adequate pollution control measures lead to significant air pollution. The present study seeks to present the pollution potential of Jaggery industries based on field studies and the measurement of emissions at site.

II. MATERIALS AND METHODS

The background information about Jaggery industries was collected from the available literatures and few preliminary visits at the Jaggery sites. Based on information received, two representative Jaggery industries were identified for the detailed field studies including the stack emission monitoring. While selecting the representative industries, types, sizes, technology adopted, locations and the provisions of pollution control devices were considered. At the Jaggery sites, the stack emissions were measured in respect of particulate matter, sulphur dioxide, oxides of nitrogen and the carbon monoxide. The chemicals, reagents, equipments and the method of measurements were followed as recommended by CPCB, 2012.

III. RESULTS AND DISCUSSIONS

3.1 Production process

A conventional Jaggery plant consists of sugarcane crusher and juice boiling pans. The crushers for extracting juice from sugarcane were found to have horizontal or vertical rollers. The sugarcane crusher use two rollers or three roller assembly. The top roller can be moved up or down by screw jack to adjust the pressure between top and bottom rollers as per the requirement. The crushers are locally available or can be fabricated by artisans or blacksmiths. It is driven by electric motor or diesel engine. The extraction of juice from sugarcane crusher is found in the range of 50 to 70% of total sugarcane crushed. After extraction of the juice, suspended matters are removed by cotton cloth or fine mesh screen before further processing.

The boiling pans are large shallow and thick vessels called '*Karahi*' that is positioned above furnace. The furnace is constructed using ordinary masonry bricks, cement, sand and clay. Depending on the production capacity, the furnace is designed to cater to one or more pans in series to make a counter current with the flow of hot flue gases. The sugarcane juice is added in the first pan only and the same is preheated with the heat contained in the flue gases. The preheated juice from the first pan is transferred to the second pan and from the second pan to next one. The last pan is positioned above the fuel combustion stage wherein actual boiling and evaporation take place. Heat transfer under this boiling pan is mainly through convection and radiation. Other pans installed downstream of the hot flue gas path also fetch heat through convection from the hot gases moving towards the stack (chimney) under a natural draft.

Even after filtration and sedimentation, the sugarcane juice contains colloidal matter, inorganic salts, fibers, various nitrogenous substances, lipids, gums, wax, organic acid, inorganic acid and pectin (Singh et al., 2007). The impurities have to be removed totally or partially by adding organic or inorganic clarificants in the juice contained in the pan. The organic clarificants are vegetable origin or inorganic clarificants. The vegetable origin clarificants are derived from roots, stem or seeds from certain plants.

The vegetables clarificants contain albumin that coagulates upon heating. This process agglomerate dehydrated colloids of juice that move to the surface in the form of scum. Chemical clarificants include lime, hydrous powder (sodium hydrosulphite), sodium carbonate and super phosphate.

After juice is taken in pan, firing starts slowly so that the dissolved air escapes and gummy, and colloidal substances get coagulated by the addition of clarificants as per the requirement. The juice with clarificants is continuously stirred during heating with the help of large ladles that avoid sticking of the juice at the bottom of the pan. The clarified impurities tend to rise to the juice surface that is known as scum that is removed continuously. In this process temperature requirement is 70-80 ºC. After certain consistency, the juice temperature is raised till it reaches about 100-105º C at which, the hot juice starts frothing. In order to suppress the froth formation, little quantity of cooking oil is added in the juice. The desired concentration is achieved by vigorous boiling and at this stage, the temperature of boiling mass is maintained about 110 ºC to 115 ºC that is known as striking temperature. When a semi-fluid material (concentrate) is formed, it is transferred into molds and then allowed to cool to form a Jaggery. The schematic of production process is shown in Figure 1.

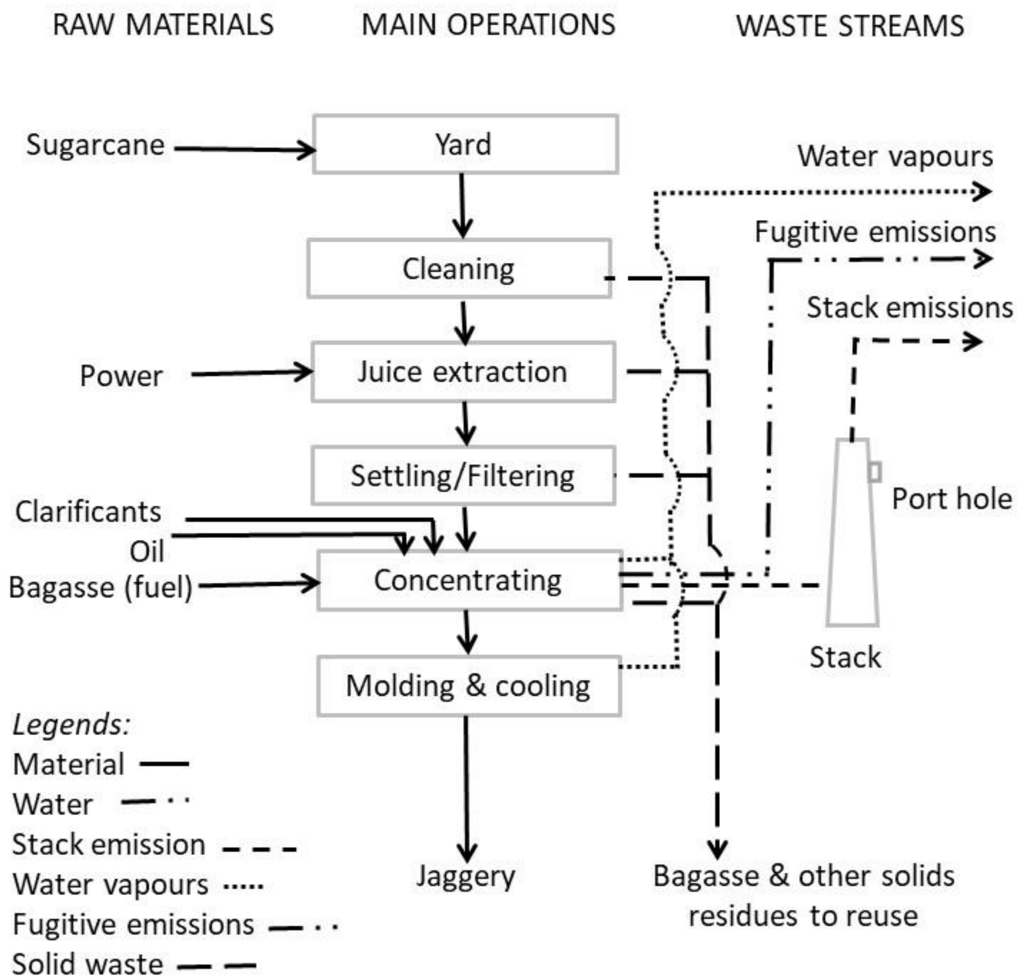

FIGURE 1: Process flow diagram and sources of pollution

3.2 Pollution generation

The stack is the main source of air pollution. Besides the stack emissions, fugitive emissions are also generated from the furnace. The stack emissions are let out at a certain height. The plume of flue gases floats with the wind stream and the pollutants get dispersed away from the jaggery plant location. The fugitive emissions, on the other hand, start getting dispersed near the furnace that affect work place environment. In case, diesel engine is employed to operate sugarcane crusher, its exhaust also a significant source of pollution. The solid residue discharged by the crusher is the bagasse that is mostly used as fuel in the furnace after drying. Addition of clarificants in juice form scum that is removed time to time. A little quantity of solid waste is also generated from the filtration and sedimentation of fresh sugarcane juice. The scum and wastes are burnt along with the sugarcane bagasse in furnace. Burning of bagasse generates ash which can be disposed to agriculture fields. Sources of pollution and waste generation are shown in Figure 1.

3.3 Air pollution monitoring

The emission monitoring was conducted during the routine and normal operation of Jaggery industries. The particulars of the jaggery industries identified for the study are given in Table 2. The wind direction was noticed East-West at the site. Measurements were conducted in respect of particulate matters, sulphur dioxide, oxides of nitrogen and carbon monoxide. The flue gas emission from stack did not show a definite plume shape. Besides the emission from stack, fugitive emissions were seen above the furnace. The stack emission monitoring results are shown in Table 3.

TABLE 2
PARTICULARS OF JAGGERIES

S. No.	Parameters	Industry A	Industry B
1	Production capacity (tons/d)	1.2	1
2	Pans in series (no.)	3	3
3	Diameter of stack (m)	0.64	0.61
4	Stack height (m)	5.2	6.1

TABLE 3
EMISSION MONITORING RESULTS

S. No.	Parameters	Industry A	Industry B
1	Ambient temperature (ºC)	28	30
2	Flue gas temperature (ºC)	310	290
3	Velocity of gases(m/sec)	10.04	9.26
4	Particulate matter (mg/Nm^3)	751.5	682.5
5	Sulphur dioxide (ppm)	9	7
6	Oxides of nitrogen (ppm)	0	0
7	Carbon monoxide (ppm)	4	3
8	Carbon dioxide (%)	0.12	0.11

It can be noticed from Table 3 that the emissions of particulate matters were observed as 751.5 mg/Nm^3 and 682.5 mg/Nm^3 in stacks of industry A and industry B, respectively. The high value of particulate matter may be due to the inefficient furnace structure and inadequate stack height. It was noticed that the emission levels of gaseous pollutants namely, sulphur dioxide, oxides of nitrogen and carbon were found low. Low carbon dioxide concentrations of 0.12 ppm and 0.11 ppm from industry A and industry B, respectively indicate excess supply of air in the furnace.

The furnaces employed by Jaggary industries were found constructed in a traditional manner that generate higher emissions of particulate matters. The industries were seen having open fuel feed hole. This may result in excess air flow of air in the furnace. There were no fire grates in the furnaces. Chimney was constructed using mud, soil etc., with inadequate height.

3.4 Material balance

Operation of Jaggery industries generate bagasse that is reused as fuel for heating and boiling the sugarcane juice. A little quantity of solid waste is also generated from the filtration and sedimentation of fresh sugarcane juice. The colloidal impurities are separated by addition of the clarificants in the hot juice and is removed as scum.

It was estimated that out of 100 kg of sugarcane crushed, 60 kg of the juice was measured to generate from the crusher. The sugarcane bagasse generation was measured as 40 kg. Of 60 kg of the sugarcane juice, the Jaggery production was measured to be 12 kg. During the process of heating, about 48 kg of water content of the juice was found to get evaporated. The quantity of sediments and scum were observed negligible and burnt along with bagasse as fuel in the furnace. The bagasse consumption in furnace is reported as 2.8 kg/kg of Jaggary produced with thermal efficiency of furnace 27.7% (Singh et al., 2021). However, the consumption of bagasse depends on moisture content. Similarly, the efficiency of furnace may vary depending on its structure and design.

IV. CONCLUSIONS

In the present study, two representative Gaggery industries were monitored to assess the pollution potential of these units. The particulate matter emissions were observed as 751.5 mg/Nm^3 in one industry and 682.5 mg/Nm^3 in other industry. Emissions of sulphur dioxide, oxides of nitrogen and carbon monoxide from both the industries were found low. The furnaces of the jaggery industries were seen constructed traditionally. As a result, significant heat loss is expected. The energy efficient furnace design with improved flue gas path and use of multi-pan heating arrangement can substantially reduce emission of pollutants

(Arya et al., 2013). In addition, provision of baffles in the flue gas path can reduce particulate matter in stack. Use of flap on fuel feed hole can properly control air flow. In addition, a fire grate, if proved, can ensure complete burning of fuel. These measure can reduce pollution problem besides improving process efficiency.

DECLARATIONS

Data availability

The information and data presented are based on the field studies and actual measurements at Jaggery sites. Interpretation of data are based on available literature and author's experience in the field.

Conflict of interest

The author declares no financial or non-financial conflict of interests.

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Modeling and Forecasting for Agricultural Production – Food grains in India

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Abstract— *Food grains are cultivated in different proportions in different parts of India depending upon its intensity and cropping pattern. It is also useful to know the area, production and yield rates of food grains grown across the country over the years and to predict the future performance of these food grains by providing suitable forecasting methods. The data regarding production of food grains for the period from 1950 to 2021 is to be analyzed by applying forecasting method. Applying the worldwide accepted Box-Jenkins method would be a suitable tool for forecasting the performance of food grains in India. The study will prompt the government to take appropriate and necessary policy measures to sustain and arrest the fluctuating performance of food grains in India and take necessary steps to enhance its overall performance.*

Keywords— Modeling, Forecasting, ARIMA, ACF, PACF, Food Grain.

I. INTRODUCTION

The Green Revolution in India, which began in the late 1960s, helped the country achieve self-sufficiency in food by the late 1980s. The growth of agricultural production exceeded all expectations, reaching a total food grain production of 191.2 million tonnes in 1996–97. While the population grew from 439 million in 1961 to 834 million in 1991, at a rate of 2.2% per year, food grain production nearly kept pace with population growth. However, the struggle to maintain food security for a population that reached one billion in August 1999 continues and given that an estimated 35% of Indians are still below the poverty line (IFPRI, 1999). Other emerging concerns and developments are also beginning to have an impact on the future prospects of agricultural development. The yield of major food crops has either reached its highest level or has started declining. Ground water and surface water sources for irrigation are depleting. The traditional diet, heavy in grains, fails to meet basic nutritional requirements. The adverse effects that modern agriculture has on the environment and human health are a matter of concern for environmentalists, planners, and the public alike. These emerging issues have led many to believe that the original goal of the Green Revolution of 'productivity enhancement' needs to be redefined to include 'sustainability' and 'diversity' in food production. As the limits of growth in traditional food sectors are rapidly being reached, urgent national attention should be given to seeking ways to diversify food production

II. OBJECTIVES

- To analyze the future food grain production in India. Considering ever increasing Population.
- To suggest and use appropriate model for forecasting of food grain production in India.

III. METHODOLOGY

This study has been used on the secondary data obtained from “Ministry of Agriculture and Farmers Welfare, Government of India, 2020-2021”. The study period is from 1950 to 2021. This study attempts to analyze food grains production for the above mentioned years. Auto Regressive Integrative Moving Average (ARIMA) is a model fitted to time series data so that a variable has the ability to represent stationary as well as non-stationary time series. This model is also known as the Box Jenkins model which was introduced in 1960. While implementing this model it is essential to follow the steps involved in building this model. “Gretel” software is used for the analysis of the data.

A pure **Auto Regressive (AR only) model** is one where Yt depends only on its own lags. That is, Yt is a function of the ‘lags of Yt’.

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + .. + \beta_p Y_{t-p} + \epsilon_1$$

Likewise a pure **Moving Average (MA only) model** is one where Yt depends only on the lagged forecast errors.

$$Y_t = \alpha + \epsilon_t + \phi_1 \epsilon_{t-1} + \phi_2 \epsilon_{t-2} + .. + \phi_q \epsilon_{t-q}$$

where the error terms are the errors of the autoregressive models of the respective lags. The errors Et and E(t-1) are the errors from the following equations:

$$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + .. + \beta_0 Y_0 + \epsilon_t$$

$$Y_{t-1} = \beta_1 Y_{t-2} + \beta_2 Y_{t-3} + .. + \beta_0 Y_0 + \epsilon_{t-1}$$

[Error: The beta coefficients in the second equation above is incorrect.]

That was AR and MA models respectively.

So what does the equation of an ARIMA model look like?

An ARIMA model is one where the time series was differenced at least once to make it stationary and you combine the AR and the MA terms. So the equation becomes:

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + .. + \beta_p Y_{t-p} + \phi_1 \epsilon_{t-1} + \phi_2 \epsilon_{t-2} + .. + \phi_q \epsilon_{t-q}$$

ARIMA model in words:

Predicted Yt = Constant + Lags of Y + Lagged forecast errors

Let’s start with finding the ‘d’.

Partial autocorrelation of lag (k) of a series is the coefficient of that lag in the autoregression equation of Y.

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \alpha_3 Y_{t-3}$$

That is, suppose, if Y_t is the current series and Y_t-1 is the lag 1 of Y, then the partial autocorrelation of lag 3 (Y_t-3) is the coefficient of Y_t-3 in the above equation.

Data:

TABLE 1
AGRICULTURAL PRODUCTION – FOODGRAINS (LAKH TONNES)

Year	Total Food Grains (Lakh Tones)
1950	508
1951	520
1952	592
1953	698
1954	680
1955	669
1956	699
1957	643
1958	771
1959	767
1960	820
1961	827
1962	802
1963	806
1964	894
1965	724
1966	742

1967	951
1968	940
1969	995
1970	1084
1971	1052
1972	970
1973	1047
1974	998
1975	1210
1976	1112
1977	1264
1978	1319
1979	1097
1980	1296
1981	1333
1982	1295
1983	1524
1984	1455
1985	1504
1986	1434
1987	1404
1988	1699
1989	1710
1990	1764
1991	1684
1992	1795
1993	1843
1994	1915
1995	1804
1996	1994
1997	1931
1998	2036
1999	2098
2000	1968
2001	2129
2002	1748
2003	2132
2004	1984
2005	2086
2006	2173
2007	2308
2008	2345
2009	2181
2010	2445
2011	2593
2012	2571
2013	2650
2014	2520
2015	2515
2016	2751
2017	2850
2018	2852
2019	2975
2020	3107
2021	3157

IV. ANALYSIS AND INTERPRETATION

4.1 Production under the Food grains:

The first step in a ARIMA model building is to plot the data into a graph. After plotting the graph, it will give an insight of the nature of the data. So in this study the series of data have been plotted in a graph as it is shown below in the figure. It is clear from the graph that data is not stationary and it deviates more from mean and variance. So now it becomes necessary to make the data stationary because it is one of the preconditions of building a model using secondary data to make it stationary. For this purpose, differencing of data is applied starting with first order, if necessary, going for the second order differencing. After going for the first order differencing the data becomes stationary as it is shown in the figure below. Now the data after first order differencing is now suitable for building a model.

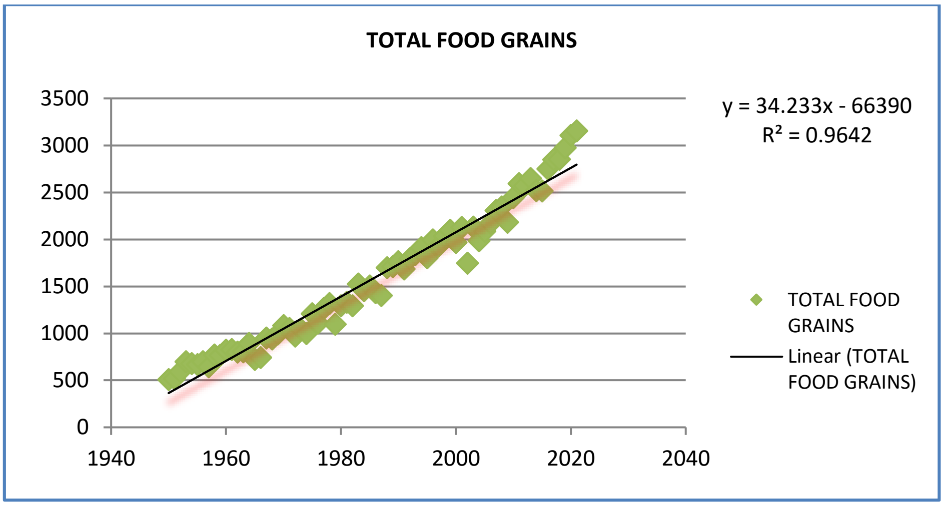

FIGURE 1: Linear Trend for Total Food Grain

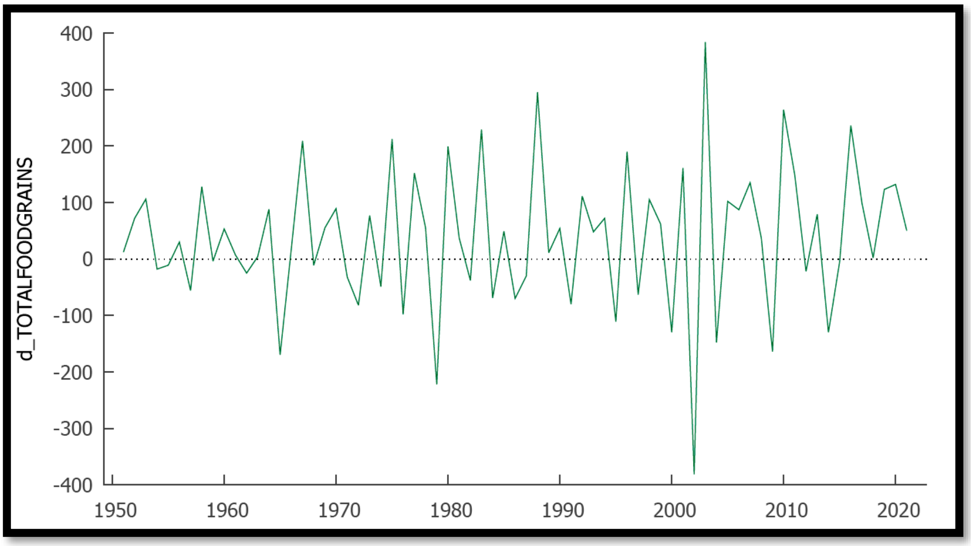

FIGURE 2: Time Series Plot for Stationary

The auto correlation functions and the partial auto correlation functions of the first order difference for the Production under food grains cultivation over the study are given in the above figure in the form of correlogram. The plots in the correlogram show that after the first order difference the data becomes stationary because the spikes are not lying outside the confidence interval which is shown in the dotted lines.

Auto Correlations and Partial Auto Correlations for food grains area and production

***, **, * indicate significance at the 1%, 5%, 10% levels using standard error 1/T^0.5

TABLE 2
AUTOCORRELATION FUNCTION FOR D_TOTAL FOOD GRAINS

LAG	ACF	PACF	Q-stat. [p-value]
1	-0.4992 ***	-0.4992 ***	18.4485 [0.000]
2	0.1085	-0.1873	19.3330 [0.000]
3	-0.0014	-0.0422	19.3331 [0.000]
4	-0.152	-0.2086 *	21.1205 [0.000]
5	0.1968 *	0.0258	24.1623 [0.000]
6	-0.152	-0.0549	26.0058 [0.000]
7	0.1487	0.0814	27.7959 [0.000]
8	-0.0326	0.0855	27.8831 [0.000]
9	-0.0301	0.0483	27.9591 [0.001]
10	0.0184	-0.0063	27.9877 [0.002]
11	0.0613	0.1488	28.3123 [0.003]
12	-0.179	-0.1481	31.1283 [0.002]
13	0.1863	0.0435	34.2287 [0.001]
14	-0.0791	0.0251	34.7977 [0.002]

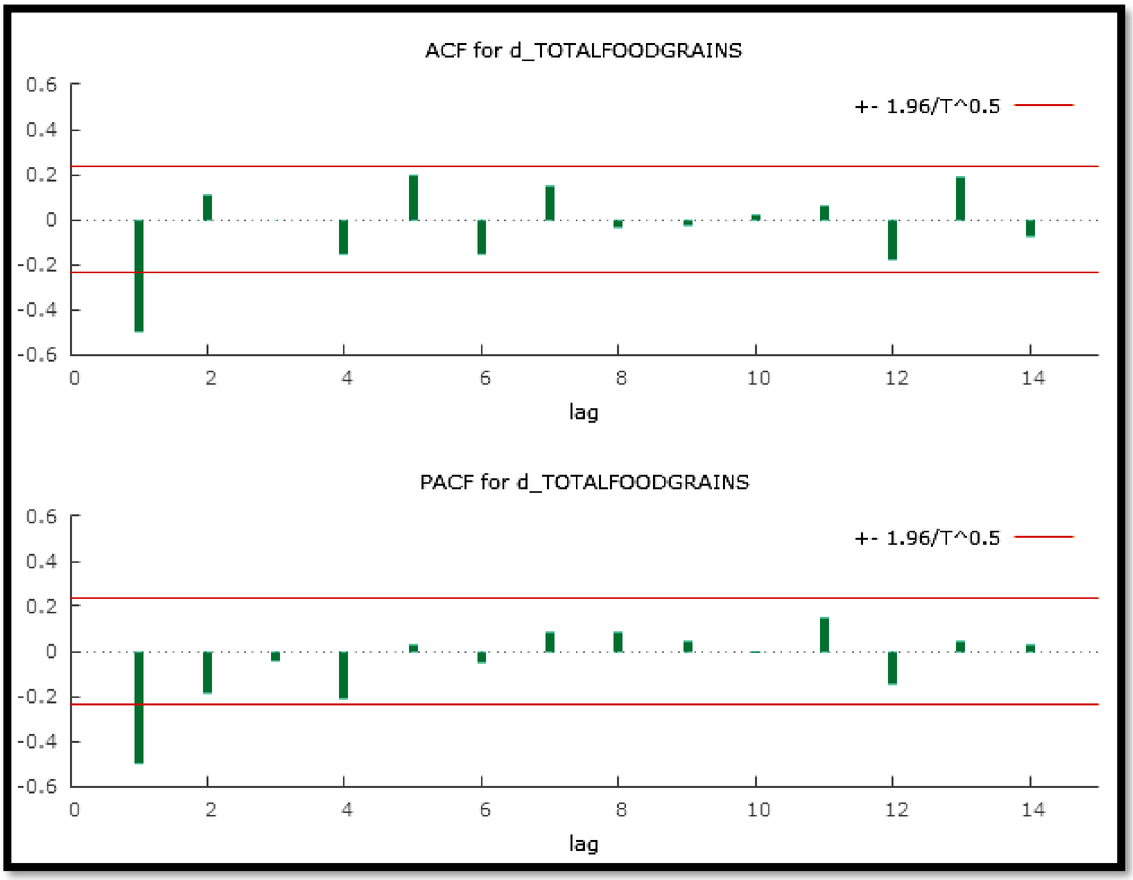

FIGURE 3: Correlogram plot for food grain

The correlogram of production of food grains after first order differentiation, it is clear that the d_total food grain becomes stationary and is of white noise as it shows no significant pattern in the correlogram and all the bars are lying within the confidence level. It is inferred that ARIMA (1,1,1) model will be suitable for the time series. The constructed model is assessed and estimated based on the parameters given, the corresponding diagnostics of the residuals, to select the best model for forecasting the future. Out of the alternate models for the production of food grains ARIMA of (1,1,1) was much suited and appropriate one.

TABLE 3
ESTIMATES OF THE FITTED ARIMA MODEL FOR FOOD GRAINS AREA

Fit Statistic	Mean
Stationary R-squared	0.763
R-squared	0.979
RMSE	106.187
MAPE	5.871
MAE	83.774
Normalized BIC	9.449

St. Stationary R-Square, R-Square, RMSE-Root Mean Square Error, MAPE-Mean Absolute Percentage Error, MAE- Mean Absolute Error.

Model 1: ARIMA, using observations 1952-2021 (T = 70)

Estimated using AS 197 (exact ML)

Dependent variable: (1-L) d_ TOTAL FOODGRAINS

Standard errors based on Hessian

TABLE 4

Parameter	coefficient	std. error	z	p-value
const	0.61161	0.420658	1.454	0.146
phi_1	−0.500054	0.101621	−4.921	8.62e-07 ***
theta_1	−1.00000	0.0387578	−25.80	8.59e-147 ***

	Real	Imaginary	Modulus	Frequency
		AR		
Root 1	-1.9998	0.0000	1.9998	0.5000
		MA		
Root 1	1.0000	0.0000	1.0000	0.0000

The result of the estimated output is presented in table above. It is clear from the table that the model coefficients are significant based on the P value which is below 0.01 percent and all the inverted AR and MA roots satisfy the minimum condition. The constructed model is assessed and estimated based on the parameters taken, the corresponding diagnostics of the residuals, to select the best model for forecasting the future. Out of the alternate models for the productivity of ARIMA of (1,1,1) is suitable and appropriate one.

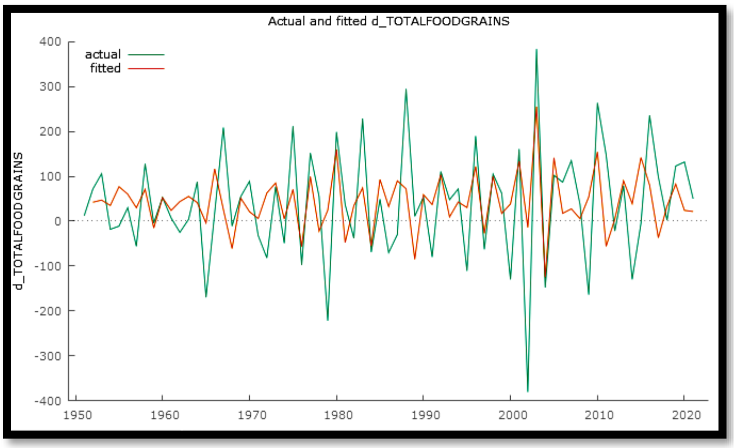

FIGURE 4: Forecasting for Actual and Fitted Value

The above Figure seen to actual and fitted value for first order difference in total food grain data.

TABLE 5
MODEL FIT

Model	Number of Predictors	Model Fit statistics	Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	Statistics	DF	Sig.	
Total_Foodgrains-Model_1	0	0.763	9.676	16	0.883	0

TABLE 6
EXPONENTIAL SMOOTHING MODEL PARAMETERS

Model			Estimate	SE	t	Sig.
Total_Foodgrains-Model_1	No Transformation	Alpha (Level)	0.345	0.096	3.59	0.001
		Gamma (Trend)	0.087	0.083	1.042	0.301

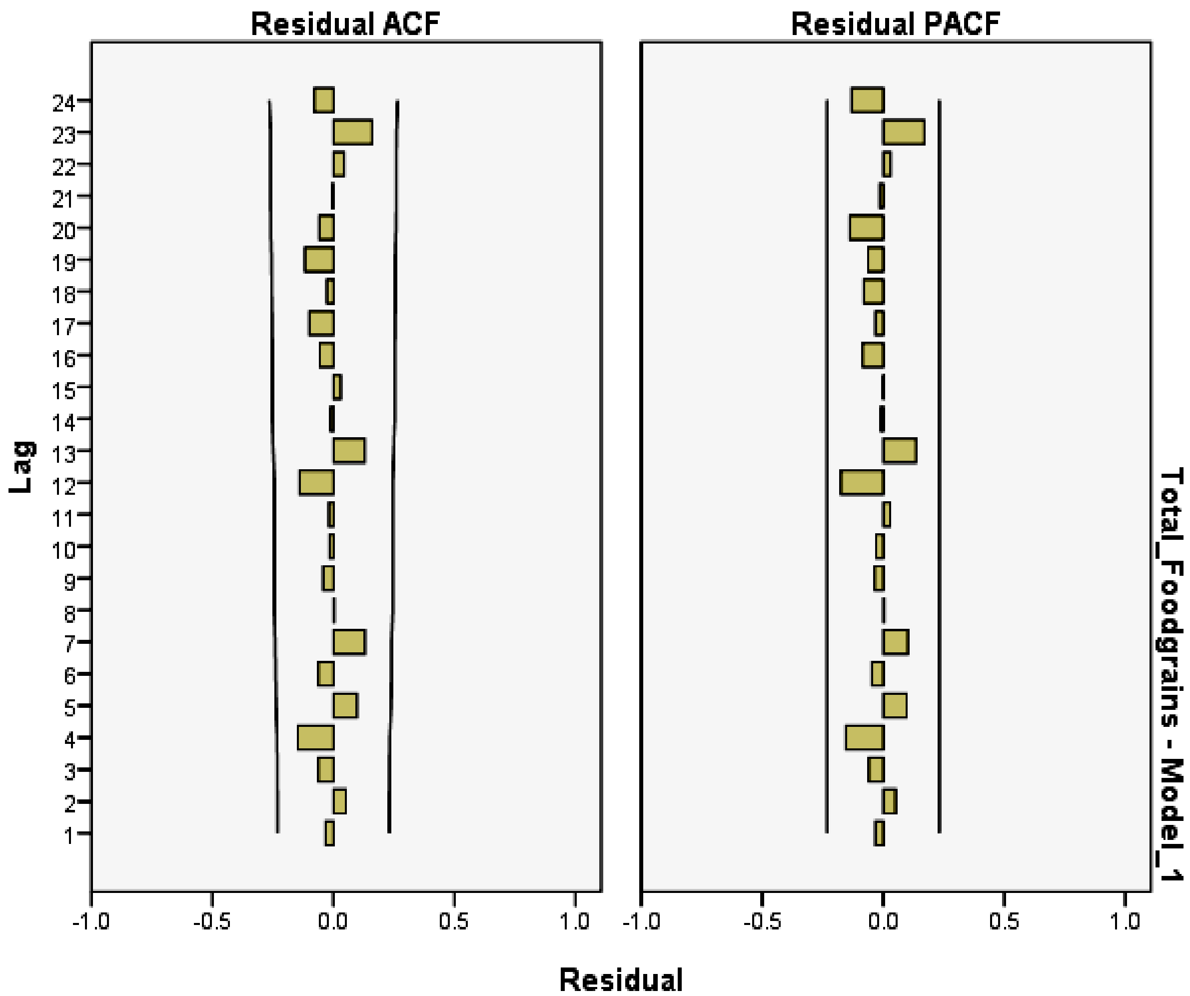

FIGURE 5: ACF and PACF of residuals of fitted ARIMA model for Food grains production

TABLE 7
FORECASTED VALUES OF FOOD GRAINS CULTIVATED AREA AND PRODUCTION WITH 95% CONFIDENCE LEVEL (CL)

Model		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Total Food grains	Forecast	**3154**	**3211**	**3269**	**3327**	**3384**	**3442**	**3500**	**3557**	**3615**	**3673**
	UCL	3366	3438	3511	3586	3661	3738	3816	3895	3975	4055
	LCL	2942	2985	3027	3068	3107	3146	3183	3220	3255	3290

LCL – Lower Confidence Level UCL – Upper Confidence Level

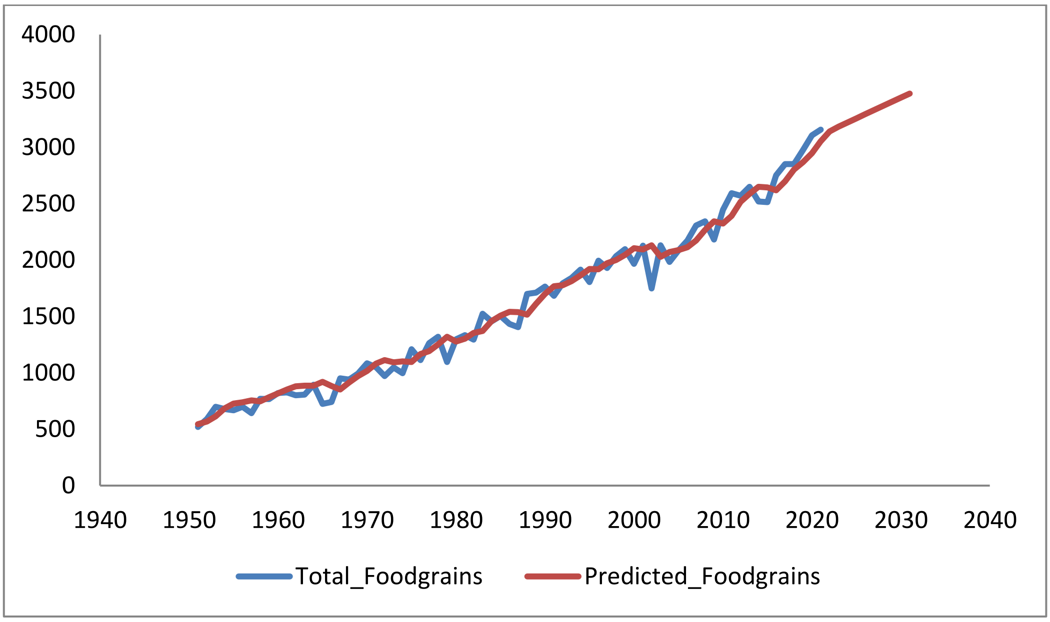

FIGURE 6: Forecasted values of food grains

V. CONCLUSION

In this study the model developed for analysis was ARIMA (1,1,1) for production of food grains ARIMA (1,1,1) was applied. The production and productivity of the different food grain crops have increased during the period under review due to the combined effects on area, production and productivity. In addition to that, productivity can be further increased by adopting appropriate technologies. In light of these findings, following suggestions are recommended for formation of appropriate policies.

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Standardization of Blended Squash using Banana Pseudostem Sap with Mango, Papaya and *Aloe Vera*

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Abstract— *The present investigation entitled "Standardization of blended squash using banana pseudostem sap with mango, papaya and Aloe vera" was carried with 11 treatments along with different blending combinations of banana pseudostem sap: mango: papaya: Aloe vera (T_1-75:0:25:0, T_2-75:0:20:5, T_3-75:5:20:0, T_4-75:5:15:5, T_5-75:10:15:0, T_6-75:10:10:5, T_7-75:15:10:0, T_8-75:15:5:5, T_9-75:20:5:0, T_{10}-75:20:0:5, T_{11}-75:25:0:0,). The prepared blended squash was filled in PET bottles and stored at room temperature up to 6 months. Chemical parameters like total soluble solids (°Brix), titrable acidity (%), total sugars (%), reducing sugars (%), carbohydrates (%), proteins (%) , iron (mg/100 ml), potassium (mg/100 ml), total phenols (mg/100 ml), calorific value (Kcal/100 ml), β-carotene (mg/100 ml) and microbial parameters were recorded at initial, 2, 4 and 6 months of storage. The results were statistically analysed using completely randomized design with 3 repetitions. From the experimentation it was revealed that, the TSS, titrable acidity, total sugars, reducing sugars showed increasing trend and carbohydrates, proteins, iron, potassium, total phenols, calorific value, β-carotene showed decreasing trend up to 6 months storage of blended squash and no microbial growth was observed during 6 months storage period. Results revealed that, best quality blended squash with stable nutritional quality can be prepared using 75 per cent banana pseudostem sap, 10 per cent mango pulp, 10 per cent papaya pulp and 5 per cent Aloe vera juice. Thus, the developed technology can be commercially explored by the food processors for production of quality blended squash. Therefore, it will be helpful for profitable utilization of banana pseudostem and also helps in development of different value added products.*

***Keywords*— Banana, Blended, Pseudostem, Storage.**

I. INTRODUCTION

Banana is one of the major fruit crop grown in India. It is a monocarpic, monocotyledonous and herbaceous plant belonging to the family Musaceae and order Zingiberales. It has been suggested that cultivated bananas are originated from the islands of South-East Asia with India as one of its origin and have been developed by the cross of *Musa accuminata* and *Musa bulbisiana* and their natural hybrids which are originally found in the rain forests of South-East Asia. At present, banana is being cultivated throughout the warm tropical regions of the world between 30^0 N and 30^0 S of the equator. Banana is basically a tropical crop, grows well in a temperature range of 15 ºC to 35 ºC with relative humidity of 75 to 85 per cent. It prefers tropical humid low lands and is grown from the sea level to an elevation of 2000 m above mean sea level. Banana is well known for its antiquity and has an ancient history as old as Indian history.

It is popularly called as '*Kalpataru*' (Tree of heaven) due to its socio-economic and multiple uses. It is consumed as staple food in many tropical and subtropical countries around the world. It provides balanced nutritional diet when compared to any other fruit. Plantain banana are the raw fruits which are consumed after cooking where as dessert bananas are consumed after ripening. 100 g of banana fruit contains 75 per cent of water, 89 Kcal of energy, 22.84 g of carbohydrates, 12.23 g of sugars, 2.6 g of dietary fibres and 8.7 mg of vitamin C with 358 mg of potassium (Sidhu and Zafar, 2018). Strongest natural fibre can be extracted from pseudostem and currency note paper was prepared from banana fibre in Japan (Meena *et al.*, 2018).

Pseudostem juice is potential source of antioxidants such as gentisic acid, catechin, ferulic acid and protocatechuic acid. Thus, it is having the ability to cure urinary disorders and stone formation in gall bladder (Sharma *et al*., 2017). It helps to dissolve calcium oxalate which is responsible to cause kidney stones.

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae. India is the leading producer of mango in the world. Mango is called the king of all fruits because of its luscious, aromatic flavour and a delicious taste in which sweetness and acidity are delightfully blended. Mango has also strong antioxidant, anti-lipid peroxidation, immunomodulation, cardiotonic, hypotensive, wound healing, antidegenerative and antidileutic activities (Chaudhary *et al*., 2017).

Papaya (*Carica papaya* L.) belongs to family Caricaceace. It is a common man's fruits, which is reasonably priced and has a high nutritive value. It is low in calories and rich in natural vitamins and minerals. Papaya places first among the fruits for vitamin C, vitamin A, riboflavin, foliate, calcium, thiamine, iron, niacin, potassium and fibre. Papaya when consumed regularly will ensure a good supply of vitamin A and C, which are essential for good health especially for eyesight and can help to prevent early age blindness in children. In recent years, the consumption of carotene products have increased steadily due to their recognition as an important source of natural antioxidant besides, anticancer activity of β-carotene being a precursor of vitamin (Gowri and Sri, 2015).

Aloe vera belongs to family Lilliaceae. It is most widely used and commercially available medicinal plant because of its nutritional and therapeutic properties (Olariu, 2009). It is useful in curing various diseases like tumour, liver complaints, vomiting, asthma, jaundice and ulcer (Malhotra *et al*., 2010). *Aloe vera* gel contains a glucomannan, which is a polysaccharide similar to guar and locust bean-gums and is believed to be the active constituents. The active principle of *Aloe* is a mixture of glycosides called aloin and a complex carbohydrate called acemannan. (Hamid *et al*., 2014). *Aloe vera* contains around 98.5-99 per cent moisture, the dry matter incorporates polysaccharides (55 %), sugars (17 %), minerals (16 %), proteins (7 %), lipids (4 %) and phenolic compounds (1 %). Carbohydrates comprising of mono and polysaccharides, are derived from the mucilage layer of the plant under the rind, surrounding the inner parenchyma or gel. The Egyptians call *Aloe vera* as "The plant of immortality".

II. MATERIALS AND METHODS

The experiment was carried out at the Department of Post Harvest Technology, ASPEE College of Horticulture and Forestry as well as Banana Pseudostem Processing Unit, Soil and Water Management Research Unit, Navsari Agricultural University, Navsari, Gujarat during October 2020 to April 2021. Banana pseudostems were harvested from the fields of Soil and Water Management Research Unit, Navsari Agricultural University, Navsari immediately after harvesting of bunch in the second week of October. The banana pseudostems were washed and cleaned. These pseudostems were hygienically used for product processing in experiment. Pseudostem was split by sharp stainless steel knife and washed. From the sheaths juice was extracted with the use of sugarcane juicer. The collected juice was filtered by using muslin cloth to remove any pithy matter from juice.

Extraction of aloe vera juice: After sorting and washing, the lower 1 inch of the leaf base (the white part attached to the large rosette stem of the plant), the tapering point (2-4 inch) of the leaf top and the short sharp spines were removed to avoid presence of bitter compound *i.e*., aloin content in the gel. The gel was extensively washed with drinkable water followed by cutting into small pieces and pre-treated with soybean extract (1.5 % for 12 h) to remove aloin content (US Patent, 2007). After pre-treatment, the *Aloe vera* gel was washed with water. Then juice was extracted from gel using grinder. The juice was further boiled at 95 ºC for 30 minutes then filled in glass bottles.

Extraction of papaya pulp: Fully ripened papaya fruits were sorted and then washed. The washed fruits are peeled, cut into halves and deseeded. After deseeding, the pulp was extracted using grinder. Then the pulp was boiled at 95 ºC for 30 minutes. Pulp was filled in polyethylene bags and was cooled by keeping them in cold water, pulp was further used for blended squash preparation.

Blended squash was prepared using banana pseudostem sap along with juice/pulp of mango, papaya and *Aloe vera*. Total 11 treatments were fixed for preparation of blended squash using different blending proportions of mango, papaya and *Aloe vera*.

Banana pseudostem sap was used instead of water for preparation of squash. The TSS and acidity of blended squash was kept constant 40 ºB and 1 %, respectively in all the treatments. The blended squash was periodically observed up to 6 months. The samples were subsequently used for organoleptic evaluation for 0, 2, 4 and 6 months of storage. The squash was stored in Polyethylene Terephthalate (PET) bottles of 200 ml capacity. The bottles were kept at room temperature which is ranged from 20 to 35ºC temperatures. The experiment was carried out using 11 treatments with 3 replications. The treatment combinations were presented in Table 1.

TABLE 1
TREATMENT DETAILS WITH DIFFERENT BLENDING PROPORTION

Treatments	Banana pseudostem sap(%)	Mango pulp(%)	Papaya pulp(%)	*Aloe vera* juice(%)
T_1	75	0	25	0
T_2	75	0	20	5
T_3	75	5	20	0
T_4	75	5	15	5
T_5	75	10	15	0
T_6	75	10	10	5
T_7	75	15	10	0
T_8	75	15	5	5
T_9	75	20	5	0
T_{10}	75	20	0	5
T_{11}	75	25	0	0

2.1 Assessment of physico-chemical and microbial parameters

The prepared blended squash was analyzed periodically for physico-chemical and microbial parameters at initial, 2, 4 and 6 months interval. The TSS content of blended squash was measured using abbe's refractometer. Titrable acidity was estimated using 0.1% NaoH as per Ranganna (1986). For the estimation of total sugars and reducing sugars, Lane and Eynon method as described in Ranganna (1986) was used. The carbohydrates content was estimated by anthrone method suggested by Sadasivam and Manickam, (1991). Total phenols were estimated by measuring optical density at 660nm. The Calorific value was calculated using the Atwater factor method as described by Eneche (1991). Protein content was estimated by Lowry's method as described by Sadasivam and Manickam (1991). Iron content was estimated by Atomic Absorption Spectrophotometer and potassium content was analyzed by flame photometric method. β-carotene was determined by spectrophotometeric method as detailed by Raj et al. (2016). Microbial analysis was carried out by standard plate count method. All these methods were carried as described by Ranganna (1986).

2.2 Statistical Analysis

Experiment data were statistically analyzed using Completely Randomized Design (CRD) as described by Panse and Shukatme (1985) at the Department of Agricultural Statistics, ASPEE College of Horticulture, Navsari, Gujarat.

III. EXPERIMENTAL RESULTS AND DISCUSSION

3.1 TSS (ºBrix)

The highest TSS *i.e.*, 41.12 ºB was recorded in the treatment T_7 which was statistically at par with T_{11} (40.95 ºB) while, the lowest TSS (40.47 ºB) was recorded in the treatment T_4 have been presented in Table 2. The TSS (ºBrix) level of blended squash varied significantly with respect to different treatments. Storage period of 6 months showed significantly increased TSS content in all the treatments. Increased TSS during the storage might be due to conversion of polysaccharides like starch, cellulose and pectin substances into simple sugars. Similar results were recorded by Uddin *et al.* (2019) in blended mango and guava squash during 3 months storage period and Chaudhary *et al*. (2017) in blended mango and *Aloe vera* squash during storage period. Borane and Khan (2015) also reported in blended banana pseudostem juice with papaya during 90 days of storage period. Rani and Rao (2014) also observed in blended *Aloe vera* and sapota squash during storage period.

TABLE 2
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON TSS (°BRIX) DURING STORAGE

Treatments	Storage Period (P)				Mean (T)
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	
T_1 (75:0:25:0)	40	40.51	40.79	40.87	**40.54**
T_2 (75:0:20:5)	40	40.59	40.81	40.94	**40.58**
T_3 (75:5:20:0)	40	40.58	40.77	40.93	**40.57**
T_4 (75:5:15:5)	40	40.48	40.62	40.79	**40.47**
T_5 (75:10:15:0)	40	40.75	40.88	40.97	**40.65**
T_6 (75:10:10:5)	40	40.89	40.94	41.1	**40.73**
T_7 (75:15:10:0)	40	41.19	41.44	41.84	**41.12**
T_8 (75:15:5:5)	40	40.89	40.94	41.1	**40.73**
T_9 (75:20:5:0)	40	40.8	40.89	40.94	**40.66**
T_{10} (75:20:0:5)	40	40.73	40.83	41.1	**40.66**
T_{11} (75:25:0:0)	40	40.7	41.67	41.43	**40.95**
Mean (P)	**40**	**40.74**	**40.96**	**41.09**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.12	0.09	0.28		
C.D. at 5 %	0.34	0.24	NS		
C.V. %	0.99	1.21			

TABLE 3
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON TITRABLE ACIDITY (%) DURING STORAGE

Treatments	Storage Period (P)				Mean (T)
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	
T_1 (75:0:25:0)	1	1.12	1.33	1.44	**1.23**
T_2 (75:0:20:5)	1	1.18	1.35	1.44	**1.24**
T_3 (75:5:20:0)	1	1.22	1.35	1.45	**1.25**
T_4 (75:5:15:5)	1	1.27	1.37	1.47	**1.28**
T_5 (75:10:15:0)	1	1.26	1.36	1.46	**1.27**
T_6 (75:10:10:5)	1	1.29	1.33	1.46	**1.27**
T_7 (75:15:10:0)	1	1.25	1.39	1.47	**1.28**
T_8 (75:15:5:5)	1	1.22	1.39	1.42	**1.26**
T_9 (75:20:5:0)	1	1.28	1.35	1.43	**1.26**
T_{10} (75:20:0:5)	1	1.27	1.4	1.5	**1.29**
T_{11} (75:25:0:0)	1	1.24	1.4	1.5	**1.28**
Mean (P)	**1**	**1.24**	**1.37**	**1.46**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.006	0.004	0.01		
C.D. at 5 %	0.02	0.01	0.04		
C.V. %	1.5	1.74			

3.2 Titrable acidity (%)

It was found that treatment mean (T) titrable acidity of blended squash varied from 1.23 to 1.29 per cent. The highest titrable acidity *i.e.*, 1.29 % was recorded in the treatment T_{10} which was statistically at par with T_4 (1.28 %), T_7 (1.28 %), T_{11} (1.28 %), T_5 (1.27 %) and T_6 (1.27 %). The lowest titrable acidity (1.23 %) was recorded in the treatment T_1 have been presented in Table 3. The titrable acidity of blended squash varied based on the different blending ratio of fruits. During 6 months of storage titrable acidity of blended squash increased significantly and standard methodology was followed to maintain 1.0 per cent titrable acidity while preparation of blended squash. The increased titrable acidity during storage might be due to the blending effect of fruits used for blending and also due to the accelerated degradation of pectin substances, sugars and formation of organic acid during storage. Similar results were also observed by Thirukkumar *et al*. (2018) in noni fruit juice blended squash with amla juice during 180 days of storage. Borane and Khan Sumaiya (2015) also reported in blended banana pseudostem juice with papaya during 90 days of storage period. Priyanka *et al*. (2015) also reported similar results in jamun blended squash with mango, grapes and pineapple juice during storage period.

3.3 Total sugars (%)

Data showed that the treatment mean (T) total sugars content of blended squash prepared using different combinations of banana pseudostem sap, mango, papaya and *Aloe vera* juice/pulp varied significantly from 36.29 to 39.98 per cent have been presented in Table 4. The maximum total sugars content was reported in treatment T_6 (39.98 %), it might be due to the equal concentration of papaya and mango pulp and the minimum total sugars was found in treatment T_{10} (36.29 %). Total sugars content in blended squash varied based on the blending ratio of different treatments. The total sugars level of blended squash showed increasing trend during 6 months of storage. This might be due to hydrolysis of starch into sugars as well as conversion of complex polysaccharides into simple sugars. Similar findings were reported by Chaudhary *et al*. (2017) in mango and *Aloe vera* blended squash during the storage period. Dhiman *et al.* (2017) also noted similar findings in ripe pumpkin based squash during 6 months of storage. Similar results were also reported by Saleem *et al.* (2011) in peach squash during 6 months of storage.

TABLE 4
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON TOTAL SUGARS (%) DURING STORAGE

Treatments	Storage Period (P)				Mean (T)
	P_1 (Initial)	**P_2 (2 month)**	**P_3 (4 month)**	**P_4 (6 month)**	
T_1 (75:0:25:0)	37.65	37.77	37.97	38.2	**37.9**
T_2 (75:0:20:5)	36.5	36.78	36.92	37.16	**36.84**
T_3 (75:5:20:0)	37.72	37.95	38.06	38.27	**38**
T_4 (75:5:15:5)	36.21	36.37	36.81	37.16	**36.64**
T_5 (75:10:15:0)	38.53	38.45	38.79	39.24	**38.75**
T_6 (75:10:10:5)	39.41	39.92	40.27	40.35	**39.98**
T_7 (75:15:10:0)	37.43	37.4	37.87	38.06	**37.69**
T_8 (75:15:5:5)	35.98	36.28	36.69	36.69	**36.41**
T_9 (75:20:5:0)	37.13	37.25	37.58	37.85	**37.45**
T_{10} (75:20:0:5)	35.93	36.16	36.39	36.67	**36.29**
T_{11} (75:25:0:0)	36.65	36.84	37.01	37.35	**36.96**
Mean (P)	**37.2**	**37.38**	**37.67**	**37.91**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.12	0.08	0.25		
C.D. at 5 %	0.36	0.21	NS		
C.V. %	1.14	1.16			

3.4 Reducing sugars (%)

Data revealed the treatment mean (T) reducing sugars of blended squash varied significantly from 18.35 to 20.66 per cent have been presented in Table 5. Maximum reducing sugars (20.66 %) were reported in treatment T_6 followed by T_5 (19.83 %). Minimum reducing sugars (18.35 %) content was observed with treatment T_2. Reducing sugars content of blended squash showed significantly increasing trend during 6 months of storage period. This might be due to partial acid hydrolysis of starch and disaccharides of blended squash converted into invert sugar and also inversion of part of non-reducing sugars into glucose and fructose and gradual degradation of polysaccharides in sqaush through acid hydrolysis. The results were supported by the findings of Chaudhary *et al*. (2017) in mango and *Aloe vera* blended squash during the storage period. Dhiman *et al.* (2017) also noted similar findings in ripe pumpkin based squash during 6 months of storage. Similar results were also reported by Saleem *et al.* (2011) in peach squash during 6 months of storage.

TABLE 5
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON REDUCING SUGARS (%) DURING STORAGE

Treatments	Storage Period (P)				
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	Mean (T)
T_1 (75:0:25:0)	18.61	18.88	19.4	19.95	**19.21**
T_2 (75:0:20:5)	17.94	18.23	18.41	18.81	**18.35**
T_3 (75:5:20:0)	18.9	19.01	19.81	20.12	**19.46**
T_4 (75:5:15:5)	17.73	18.1	18.67	19.16	**18.42**
T_5 (75:10:15:0)	19.32	19.52	19.93	20.55	**19.83**
T_6 (75:10:10:5)	19.96	20.36	20.9	21.43	**20.66**
T_7 (75:15:10:0)	19.07	19.72	19.8	20.38	**19.74**
T_8 (75:15:5:5)	17.82	18.27	18.72	19.3	**18.53**
T_9 (75:20:5:0)	19.02	19.62	20.05	20.63	**19.83**
T_{10} (75:20:0:5)	17.89	18.38	18.8	19.34	**18.6**
T_{11} (75:25:0:0)	18.57	19.15	19.63	19.97	**19.33**
Mean (P)	**18.62**	**19.02**	**19.47**	**19.97**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.08	0.05	0.16		
C.D. at 5 %	0.23	0.14	NS		
C.V. %	1.41	1.46			

3.5 Carbohydrates (%)

Data revealed that the treatment mean (T) carbohydrates content of blended squash varied significantly from 16.94 to 19.91 per cent have been presented in Table 6. The highest carbohydrates content (19.91 %) was found in treatment T_6 and significantly lowest carbohydrates content (16.94 %) was observed in treatment T_2, it was might be due to higher carbohydrates content in mango, papaya and lower carbohydrates content in banana pseudostem juice and *Aloe vera*. Carbohydrates content of squash varied accordingly with the different blending ratio of juice. It showed significantly decreasing trend during 6 months of storage period. The decreasing trend was might be due to the hydrolysis of polysaccharides like pectin, starch *etc.* into simple sugars. Similar finding were reported by Shiva *et al.* (2018) in banana pseudostem based novel functional blended ready to drink beverages with ginger rhizome and nannari root extracts during 6 months of storage. Patel (2016) also reported similar results in blended nectar using banana pseudostem sap and mango pulp during storage period of 6 months.

TABLE 6
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON CARBOHYDRATES (%) SCORE DURING STORAGE

Treatments	Storage Period (P)				
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	Mean (T)
T_1 (75:0:25:0)	17.41	17.17	16.94	16.7	**17.06**
T_2 (75:0:20:5)	17.17	17.12	16.84	16.63	**16.94**
T_3 (75:5:20:0)	17.34	17.23	17.1	16.94	**17.15**
T_4 (75:5:15:5)	18.53	18.2	18.02	17.84	**18.15**
T_5 (75:10:15:0)	18.15	17.9	17.56	17.22	**17.71**
T_6 (75:10:10:5)	20.21	20.03	19.88	19.52	**19.91**
T_7 (75:15:10:0)	19.42	19.2	18.95	18.55	**19.03**
T_8 (75:15:5:5)	18.21	18.11	17.82	17.43	**17.89**
T_9 (75:20:5:0)	18.16	18.01	17.75	17.35	**17.82**
T_{10} (75:20:0:5)	17.38	17.15	17.09	16.94	**17.14**
T_{11} (75:25:0:0)	17.73	17.67	17.57	17.22	**17.55**
Mean (P)	**18.16**	**17.98**	**17.77**	**17.49**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.1	0.06	0.21		
C.D. at 5 %	0.29	0.18	NS		
C.V. %	1.05	1.09			

TABLE 7
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON PROTEINS (%) SCORE DURING STORAGE

Treatments	Storage Period (P)				
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	Mean (T)
T_1 (75:0:25:0)	0.93	0.91	0.9	0.88	**0.9**
T_2 (75:0:20:5)	0.89	0.86	0.85	0.83	**0.86**
T_3 (75:5:20:0)	1.03	0.99	0.98	0.92	**0.98**
T_4 (75:5:15:5)	0.95	0.93	0.93	0.9	**0.93**
T_5 (75:10:15:0)	1.33	1.31	1.3	1.28	**1.3**
T_6 (75:10:10:5)	1.25	1.21	1.16	1.05	**1.17**
T_7 (75:15:10:0)	1.39	1.36	1.34	1.32	**1.35**
T_8 (75:15:5:5)	0.88	0.85	0.83	0.82	**0.84**
T_9 (75:20:5:0)	1.04	1.02	1	0.97	**1.01**
T_{10} (75:20:0:5)	0.88	0.86	0.83	0.82	**0.85**
T_{11} (75:25:0:0)	1	0.99	0.96	0.95	**0.98**
Mean (P)	**1.05**	**1.03**	**1.01**	**0.98**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.01	0.01	0.02		
C.D. at 5 %	0.03	0.02	NS		
C.V. %	3.55	3.18			

3.6 Proteins (%)

It was found that treatment mean (T) proteins content of blended squash varied significantly from 0.84 to 1.35 per cent have been presented in Table 7. Significantly maximum proteins content (1.35 %) was observed with treatment T_7, followed by treatment T_5 (1.30 %) and significantly lowest proteins content (0.84 %) was recorded in treatment $T_{8,}$ this might be due to the lower proteins content in banana pseudostem juice and higher proteins content in mango and papaya pulp. Proteins level in blended squash decreased significantly during 6 months storage period. This might be due to the physical changes in proteins due to denaturation and oxidation during storage. Similar findings were reported by Deshmukh *et al*. (2019) in blended aonla and *Aloe vera* nectar with stevia as a sugar substitute. Patel (2016) also reported in blended nectar using banana pseudostem sap and mango pulp.

3.7 Iron (mg/100 ml)

Data pertaining to the treatment mean (T) iron content of blended squash varied significantly from 2.54 to 3.68 mg/100 ml have been presented in Table 8. The maximum iron content (3.68 mg/100 ml) was reported with treatment T_6 and the lowest iron content (2.54 mg/100 ml) was reported with the treatment T_1. Iron content in all the treatments varied according to the iron content present in the fruits used for blending and their blending ratio in preparation of blended squash. During storage iron content of blended squash showed slightly decreasing trend, this might be due to the interaction between chemical organic constituents of squash induced by high temperature actions and presence of catalyst as reported by Kumar *et al*. (2012). Similar finding were reported by Deshmukh *et al*. (2019) in blended aonla and *Aloe vera* nectar with stevia as a sugar substitute and Patel (2016) in blended nectar using banana pseudostem sap and mango pulp. Kumar *et al.* (2012) also reported similar results in value added nutraceutical beverages of guava blended with *Aloe vera* and roselle.

TABLE 8
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND ALOE VERA ON IRON (MG/100 ML) DURING STORAGE

	Storage Period (P)				
Treatments	**P_1 (Initial)**	**P_2 (2 month)**	**P_3 (4 month)**	**P_4 (6 month)**	**Mean (T)**
T_1 (75:0:25:0)	2.68	2.59	2.45	2.43	**2.54**
T_2 (75:0:20:5)	2.73	2.64	2.58	2.63	**2.64**
T_3 (75:5:20:0)	2.93	2.86	2.78	2.65	**2.81**
T_4 (75:5:15:5)	3	2.94	2.86	2.73	**2.88**
T_5 (75:10:15:0)	3.14	3.05	2.94	2.74	**2.97**
T_6 (75:10:10:5)	3.84	3.72	3.66	3.49	**3.68**
T_7 (75:15:10:0)	3.53	3.4	3.37	3.36	**3.41**
T_8 (75:15:5:5)	3	2.93	2.81	2.61	**2.84**
T_9 (75:20:5:0)	2.93	2.76	2.66	2.57	**2.73**
T_{10} (75:20:0:5)	2.85	2.71	2.67	2.42	**2.66**
T_{11} (75:25:0:0)	2.9	2.83	2.73	2.67	**2.78**
Mean (P)	**3.05**	**2.95**	**2.86**	**2.76**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.04	0.02	0.06		
C.D. at 5 %	0.11	0.05	NS		
C.V. %	4.22	3.69			

3.8 Potassium (mg/100 ml)

It was found that the treatment mean (T) potassium content of blended squash varied significantly from 41.94 to 46.42 mg/100 ml have been presented in Table 9. Maximum potassium content 46.42 mg/100 ml was observed with treatment T_8 followed by treatment T_5 (45.88 mg/100 ml) while, the minimum potassium content was recorded in treatment T_{10} (41.94 mg/100 ml), this might be due to higher potassium content in pseudostem sap, mango pulp and lower potassium content in papaya. During storage slightly decreased potassium content was observed, this results were in accordance with the results of Patel (2016) in blended nectar using banana pseudostem sap and mango pulp. Anonymous (2015) also noted slightly decreased potassium content in ready to serve beverage from banana pseudostem sap during 6 months storage period.

TABLE 9
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON POTASSIUM (MG/100 ML) DURING STORAGE

Treatments	Storage Period (P)				Mean (T)
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	
T_1 (75:0:25:0)	43.35	43.08	42.82	42.72	**42.99**
T_2 (75:0:20:5)	42.7	42.4	42.2	41.78	**42.27**
T_3 (75:5:20:0)	44.42	44.13	44.07	43.9	**44.13**
T_4 (75:5:15:5)	45.62	45.37	45.08	44.99	**45.26**
T_5 (75:10:15:0)	46.3	46.15	45.7	45.38	**45.88**
T_6 (75:10:10:5)	45.23	45.19	45.17	44.76	**45.09**
T_7 (75:15:10:0)	44.94	44.45	44.17	44	**44.39**
T_8 (75:15:5:5)	46.43	46.6	46.43	46.21	**46.42**
T_9 (75:20:5:0)	43.29	43.12	42.8	42.46	**42.92**
T_{10} (75:20:0:5)	42.46	42.09	41.8	41.43	**41.94**
T_{11} (75:25:0:0)	42.26	42.08	41.99	41.48	**41.95**
Mean (P)	**44.27**	**44.06**	**43.84**	**43.55**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.14	0.09	0.28		
C.D. at 5 %	0.4	0.24	NS		
C.V. %	1.09	1.11			

TABLE 10
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND *ALOE VERA* ON TOTAL PHENOLS (MG/100 ML) DURING STORAGE

Treatments	Storage Period (P)				Mean (T)
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	
T_1 (75:0:25:0)	29.81	27.09	25.95	23.79	**26.66**
T_2 (75:0:20:5)	30.08	28.5	26.83	24.65	**27.51**
T_3 (75:5:20:0)	34.96	32.35	31.2	29.71	**32.06**
T_4 (75:5:15:5)	37.69	35.74	33.4	31.2	**34.51**
T_5 (75:10:15:0)	44.89	42.85	42.05	40.95	**42.68**
T_6 (75:10:10:5)	49.05	47.67	46.1	44.67	**46.87**
T_7 (75:15:10:0)	47.96	45.31	43.39	42.26	**44.73**
T_8 (75:15:5:5)	41.63	40.01	38.87	35.63	**39.04**
T_9 (75:20:5:0)	38.24	36.9	35.17	33.25	**35.89**
T_{10} (75:20:0:5)	31.43	29.56	28.23	26.39	**28.91**
T_{11} (75:25:0:0)	28.16	26.42	23.51	21.33	**24.85**
Mean (P)	**37.63**	**35.67**	**34.06**	**32.17**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.18	0.14	0.47		
C.D. at 5 %	0.53	0.4	NS		
C.V. %	1.81	2.35			

3.9 Total phenols (mg/100 ml)

Data regarding the treatment mean (T) total phenols content of blended squash varied significantly from 24.85 to 46.87 mg/100 ml have been presented in Table 10. Significantly highest total phenols content (46.87 mg/100 ml) was observed with treatment T_6 followed by treatment T_7 (44.73 mg/100 ml) and significantly lowest total phenols content (24.85 mg/100 ml) was recorded with treatment T_{11}. The variation in total phenol content in different blends might be due to variation in initial total phenol content of produce. Decreasing trend of total phenols were reported during storage period of 6 months. This might be due to their oxidation during storage period reported by Sridhar *et al*. (2017). Thakur *et al.* (2018) also noted similar results in wild pomegranate squash. Tahasildar (2016) also reported similar findings in preparation of blended nectar using *Aloe vera*, guava and jamun.

3.10 Calorific value (Kcal/100 ml)

It was found that the treatment mean (T) calorific value of blended squash varied significantly from 71.18 to 84.32 Kcal/100 ml have been presented in Table 11. Maximum calorific value (84.32 Kcal/100 ml) was recorded with the treatment T_6 and significantly minimum calorific value (71.18 Kcal/100 ml) was observed in treatment T_2. It showed decreasing trend during storage. Calorific value of blended squash varied according to the proteins, fat and carbohydrates content in blended squash. These findings were also supported by Patel (2016) and Anonymous (2015) ready to serve beverage from banana pseudostem sap during 6 months storage period.

TABLE 11
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND ALOE VERA ON CALORIFIC VALUE (KCAL/100 ML) DURING STORAGE

Treatments	Storage Period (P)				Mean (T)
	P_1 (Initial)	P_2 (2 month)	P_3 (4 month)	P_4 (6 month)	
T_1 (75:0:25:0)	73.37	72.39	71.36	70.29	**71.85**
T_2 (75:0:20:5)	72.21	71.92	70.73	69.84	**71.18**
T_3 (75:5:20:0)	73.47	72.88	72.31	71.41	**72.52**
T_4 (75:5:15:5)	77.92	76.52	75.79	73.81	**76.01**
T_5 (75:10:15:0)	77.91	76.85	75.41	73.97	**76.04**
T_6 (75:10:10:5)	85.85	84.96	84.17	82.28	**84.32**
T_7 (75:15:10:0)	83.24	82.25	81.17	79.49	**81.54**
T_8 (75:15:5:5)	75.21	75.84	74.63	72.99	**74.67**
T_9 (75:20:5:0)	76.79	76.13	74.99	73.28	**75.3**
T_{10} (75:20:0:5)	73.04	72.04	71.68	71.05	**71.95**
T_{11} (75:25:0:0)	74.89	74.63	74.12	72.71	**74.09**
Mean (P)	**76.72**	**76.04**	**75.12**	**73.74**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.5	0.37	1.22		
C.D. at 5 %	1.46	1.04	NS		
C.V. %	2.28	2.81			

3.11 β-carotene (mg/100 ml)

Data revealed that treatment mean (T) β-carotene content of blended squash varied Significantly from 0.22 to 0.39 mg/100 ml have been presented in Table 12. Significantly maximum β-carotene (0.39 mg/100 ml) was found with the treatment T_5 which was statistically at par with T_6 (0.36 mg/100 ml) and significantly minimum β-carotene content (0.22 mg/100 ml) was found in the treatment T_2, it might be due to higher β-carotene content in mango and papaya pulp where as lower β-carotene content in pseudostem sap and *Aloe vera* juice. β-carotene content varied according to the blending ratio of fruits. Storage studies showed significantly decreasing trend in β-carotene content of blended squash. The decrease in the β-carotene with the storage period might have been due to the reason that the β-carotene gets oxidized with storage and also by the biochemical degradation of the pigment. Similar findings were reported by Prabha *et al*. (2019) in papaya and mango blended squash during 6 months of storage period. Dhiman *et al.* (2017) also observed that decreased β-carotene content in ripe pumpkin based squash during the storage period.

TABLE 12
EFFECT OF BLENDED SQUASH USING BANANA PSEUDOSTEM SAP WITH MANGO, PAPAYA AND ALOE VERA ON Β-CAROTENE (MG/100 ML) DURING STORAGE

Treatments	Storage Period (P)				
	P_1 (Initial)	**P_2 (2 month)**	**P_3 (4 month)**	**P_4 (6 month)**	**Mean (T)**
T_1 (75:0:25:0)	0.25	0.24	0.22	0.19	**0.23**
T_2 (75:0:20:5)	0.23	0.21	0.21	0.21	**0.22**
T_3 (75:5:20:0)	0.34	0.32	0.31	0.29	**0.31**
T_4 (75:5:15:5)	0.37	0.34	0.33	0.31	**0.34**
T_5 (75:10:15:0)	0.41	0.39	0.39	0.36	**0.39**
T_6 (75:10:10:5)	0.4	0.39	0.34	0.3	**0.36**
T_7 (75:15:10:0)	0.38	0.36	0.34	0.32	**0.35**
T_8 (75:15:5:5)	0.29	0.28	0.25	0.21	**0.26**
T_9 (75:20:5:0)	0.36	0.34	0.33	0.31	**0.34**
T_{10} (75:20:0:5)	0.37	0.35	0.32	0.28	**0.33**
T_{11} (75:25:0:0)	0.3	0.28	0.27	0.25	**0.27**
Mean (P)	**0.33**	**0.32**	**0.3**	**0.28**	
	Treatment (T)	**Period (P)**	**TXP**		
S.Em. ±	0.008	0.004	0.015		
C.D. at 5 %	0.022	0.012	NS		
C.V. %	10.26	8.17			

3.12 Total plate count (cfu/ml)

There was no microbial growth observed in the blended squash up to 6 months of storage at ambient temperature. Microbial parameter of blended squash revealed that no microbial growth was observed up to 6 months of storage at room temperature, it indicates that blended squash can be used up to 6 months without any microbial deterioration.

IV. CONCLUSION

Based on the above findings, best quality blended squash with stable nutritional quality can be prepared using 75 per cent banana pseudostem sap, 10 per cent mango pulp, 10 per cent papaya pulp and 5 per cent *Aloe vera* juice. It can be stored successfully for 6 months in PET bottles at ambient temperature when preserved by 350 ppm of KMS and citric acid. Utilization of banana pseudostem sap/juice helps to reduce the cost of production as well as it helps to increase nutritional status of product. Blending of fruit juice/pulp resulted in good sensory as well as nutritional quality in blended squash. Thus, the developed technology can be commercially explored by the food processors for production quality blended squash. Therefore, it will be helpful for profitable utilization of banana pseudostem and also for development of different value added products.

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Risk Possibility of Plane trees in Chahār Bāgh Abbasi Street of Isfahan

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Abstract— *Trees are one of the most critical indicators in green space and urban forestry planning. Knowing information about street trees is of paramount importance for proper planning and management. Any defect that causes trees to be hazardous can result in dangers to humans and vehicles. For this reason, qualitative and quantitative features and the risk potential of Oriental Plane (Platanus orientalis L.) trees on both sides of Chahār Abbasi Street and part of Chahār Bāgh Paeen Street, Isfahan, were investigated using the point transect method with a random starting point. Results showed that two criteria of deviation from a vertical position (62%) and root problems (44%) have the greatest contribution to hazard creation. Sixty-three percent of surveyed trees were classified as very low-risk trees. By selecting the most suitable tree species, taking preventive measures prior to the incidence, and applying proper management techniques, we can avoid the hazards of these trees to a large extent.*

Keywords— Urban Forestry, Oriental Plane, Urban Management, Isfahan, Risk Possibility.

I. INTRODUCTION

As one of the most important development indicators of urban communities, green space has various functions in different dimensions of urban life, including air softening, shading, and reducing heat (Akbari & Dorsano, 1992), reducing noise pollution (Nowak, 1992; 48), decreasing water and soil erosion (Colding, 2007), creating physical privacy fences (Tang et al., 2007), developing tourism industry and creating beautiful landscapes (Fung & Wong, 2003). First and foremost, urban space is a geographical space that is determined by distances, areas, and densities. Urban green spaces have social, economic, and ecological roles; they have benefits such as treating diseases, and at the same time, they are considered as an indicator for promoting the quality of living space and improving community (Nahibi & Hasandokht, 2014). Among important debates on urban streets are green space and green space aesthetics. Due to its environmental values, urban green space is one of the most important characteristics of each city such that the first step in planning and managing urban green space is to know information about street trees (Pourmajidian et al., 2014, Nafian et al. 2019). Urban green spaces play a main role in the function of cities, and their shortage can cause disturbances in urban life (Mohammadi et al., 2007). Today, hazard trees are of particular importance in the management of urban forests. Hazardous trees are often neglected unless damage occurs due to their hazard (Mortimer & Kane, 2004). Additionally, we cannot separate the hazardous and non-hazardous trees regularly since most trees are potentially hazardous (Harris, et al, 1999). Always large numbers of people and vehicles pass by hazardous trees, and if these trees are damaged and broken for any reason, they will directly damage people, vehicles, and facilities adjacent to them (Pourhashemi et al., 2012; Pourmajidian et al., 2014, Nafian et al. 2020).

Oriental Plane (*Platanus orientalis* Linn.) is one of the most ancient and oldest trees that have received attention from all ethnic groups and different nations, especially Iranians (Sharifinia, 1992). Having unique characteristics such as great stature, well-shaped branches, wide crown, and broad shadow, the Plane tree has created beautiful landscapes and is considered one of the important and effective factors in green space (Khoshgoftarmanesh, 2007). The large size, beauty, and rapid growth rate of the Plane tree have made it the first choice for streets margin in many parts of Iran (Mortimer & Kane, 2004; Roohani, 2005;

Shiravand & Rostami, 2009). Additionally, the presence of plane trees of great antiquity in most streets of Isfahan city indicates the history of using these trees in creating urban green space (Khoshgoftarmanesh et al., 2013). Pourhashemi et al. (2012) assessed the hazardous oriental plane (*Platanus orientalis* Linn.) trees on Valiasr Street in Tehran. Results showed that dead branches and twigs and structural weakness have the greatest contribution to hazard trees while unsuitable branching and decay are the least important criteria. Assessing hazardous Plane trees in Babol city, Pourmajidian et al. (2014) found that dead branches and twigs and root problems criteria had the greatest contribution to hazard. In a case study conducted in Shahrekord city, Moradian et al. (2016) investigated the hazard of Elm (*Ulmus carpinifolia var. umbelifera*) trees planted on the verge of the streets. Results showed that dead branches and twigs and structural weakness in 49% and 39% of the whole trees had the greatest contribution to hazard potential in trees, respectively, while the existence of cracks in the trunks was the least important criterion. Finally, it was recommended to take corrective and care measures such as crown and dead branches pruning. Banj Shafiei et al. (2015) also sought to determine the quantitative and qualitative characteristics and the level of risk posed by Plane trees in Urmia city. In their study, which was conducted based on risk factors rating, 18 trees with moderate risk ratings were identified. Today, in different developed countries, criteria for diagnosis and identifying hazardous trees have received a lot of attention from environmental and urban green space researchers (Golkar, 2001; Pourhashemi et al., 2012: Albers et al, 1992: Kane, 2008; Kong, 2000; Laflamme, 2005; Maruthaveeran & Yaman, 2010; Murad, 2000; Roloff et al., 2009; Yang, 2009).

Investigating the level of risk posed by urban trees in Chahār Bāgh Abbasi Street and part of Chahār Bāgh Paeen Street, Isfahan, is of paramount importance. Given the necessity of awareness of hazards posed by street trees as one of the prerequisites for their proper management and the importance of Plane tree as one of the largest and oldest trees from past to present, attempts were made to identify the hazardous Plane trees in Isfahan city and investigate the level of risk posed by them in the above-mentioned region for the first time so that in addition to identifying and investigating these trees, urban forestry of Palm trees can be managed in a better way.

II. METHODS AND MATERIALS

2.1 The study area

The study area, in Isfahan province, Isfahan city, is situated between the latitudes 30° 43' to 34° 27' N and longitudes 49º 36' to 55º 31' E of Greenwich Meridian. Isfahan province is located in the central part of Iran (Fig. 1). After field visiting and observing the number of oriental Plane trees, Chahār Bāgh Abbasi Street and part of Chahār Bāgh Paeen Street, Isfahan, were divided into four regions, including 1- between Enghelab square and Sed Ali Khan street, 2- between Sed Ali Khan street and Amadegah street, 3- between Amadegah street and Imam Hossein square (Darvazeh Doulat), 4- between Imam Hossein square and Takhti crossroad.

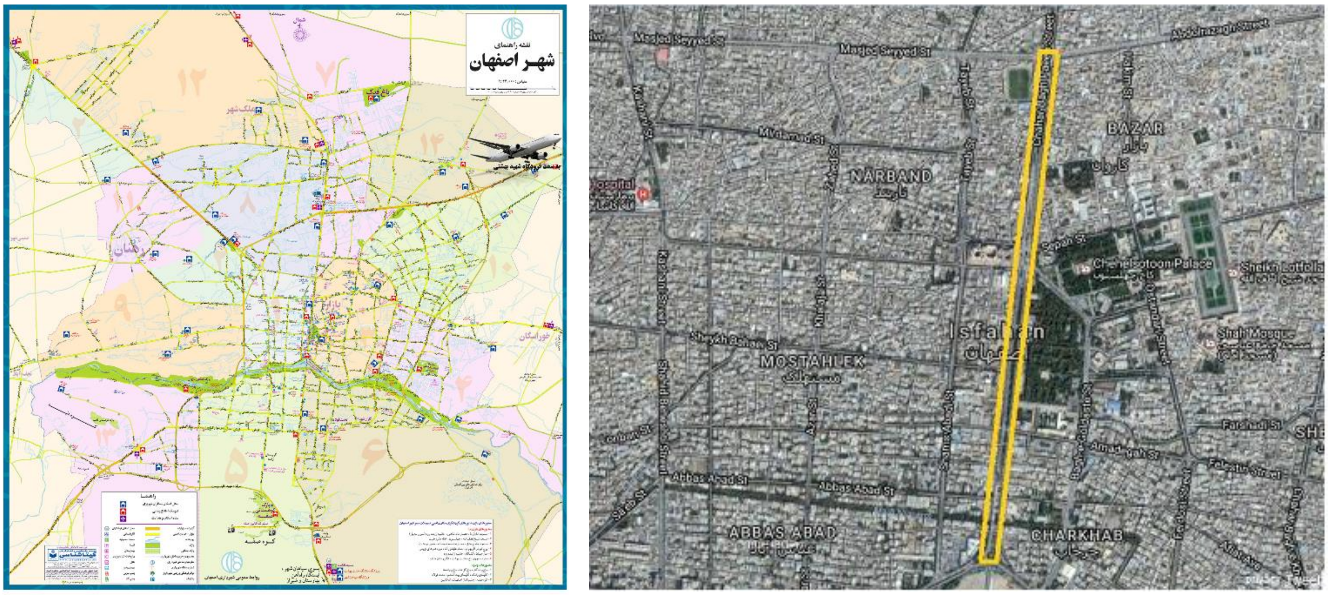

FIGURE 1: Geographical location of the study are

2.2 Methodology

In order to measure and record quantitative and qualitative variables, point transect method with random starting point was used. At first, of the first three trees one was selected randomly, and measurements were carried out every three trees.

For each tree, the diameter at breast height (DBH) and total height were measured. In order to determine the level of hazard posed by trees, the following classification was used (Pourhashemi et al., 2012).

1) Dead branches and twigs (low risk: sub-branches and twigs are dried, moderate risk: the tree crown, including thick and main branches is dried, in a way that about one third to two third of the crown is dried, high risk: the tree crown is completely dried).
2) Crack (low risk: thick branches are cracked, moderate risk: there is a deep gap in the main trunk of the tree and this gap is seen in a large length of the trunk or there is two or more gaps in a certain part of the tree, high risk: on the trunk gap or crack site there is other defects such as decay or disease).
3) Poor branching (low risk: forking in main trunk, moderate risk: multi-stemming in main trunk, high risk: there are other defects such as dead branches in the forking or multi-stemming trees).
4) Decay of the main trunk and branch (low risk: the presence of advanced decay in main thick branches, moderate risk: the presence of advanced decay in the main trunk, high risk: there are other defects such as gap or crack, forking trunk or multi stemming trunk on the site of advanced decay in the main trunk).
5) Wound (low risk: the wound perimeter is less than 10% of the entire trunk perimeter, moderate risk: the wound perimeter is greater than 10-30 % of the entire trunk perimeter, high risk: the wound perimeter includes more than 30 % of the entire trunk perimeter and on the wound site there are other defects such as gap or hole due to living and non-living things), (DBH: d, tree perimeter: C, $C = d \times \pi$)
6) Root problems (low risk: food shortage symptoms which emerge as paleness, burn, or color change in leaves, moderate risk: advanced decay is observed on roots and buttresses, high risk: more than half of the roots under the tree crown have been cut or crushed, or exposed roots)
7) Structural or physical weakness (low risk: a large and main branch is out of proportion with crown leading to an imbalance in the crown and crown asymmetry, moderate risk: the tree is slightly tilting/leaning (vertical deviation of 15 - 30 degrees), and/ or slenderness coefficient is 80-100, high risk: the tree is too much tilting (more than 30 degree) and/or slenderness coefficient is more than 100).
8) Interfering with power lines (low risk: power lines are placed 10 meters from the tree, moderate risk: power lines cross the nearby of the tree crown at a distance about 2-3 m, high risk: power line are adjacent to the crown, or pass along or through the crown).

In order to investigate the risk posed by trees, rating method was used such that the score values were assigned to each criterion in terms of its rating (High=3, Moderate=2, Low= 1) and the sum of the above scores for the above eight mentioned criteria was analyzed. Then the hazard score for each tree was determined. Considering the intended criteria, this score was between 0 and 24. Therefore, the higher the score, the greater the hazard potential of the tree was. After that, based on the obtained scores and in accordance with empirical classification, they were classified in 6 hazard classes (table 3) and the trees distribution in hazard classes was determined (Pourhashemi et al., 2012; & Pourmajidian et al., 2014, Ghehsareh Ardestani et al. 2020).

III. RESULTS

Descriptive statistics of quantitative variables for 144 Oriental Plane trees are presented in Table 1. Also, hazard criteria and their degree of importance in the studied trees are displayed in Table 2.

TABLE 1
DESCRIPTIVE STATISTICS -MEASURED QUANTITATIVE VARIABLES

Height m		DBH cm	
Mean	Standard deviation	Mean	Standard deviation
9.1	1.41	30.53	8.03

TABLE 2
HAZARD CONTRIBUTION OF ORIENTAL PLANE TREES

Hazard Criterion	Degree of importance	Hazardous trees		Number of healthy trees in the class of the investigated criterion
		Nr.	%	
Dead branches and twigs	Fully dried	-	-	96 (66%)
	More than 2/3 dried	-	-	
	1/3-2/3 dried	8	6	
	Less than 1/3 dried	40	28	
	Sum	48	34	
Trunk gap	Deep gap or crack	3	2	(%96) 139
	2 or more gaps in the trunk	-	-	
	Gap or crack in the main thick branch	-	-	
	The presence of other defects on the crack site	2	2	
	Sum	5	4	
Deviation from a straight line or vertical position	More than 30 degrees	36	25	(%38) 55
	15-30 degrees	20	14	
	5-15 degrees	33	23	
	Sum	89	62	
Deviation to the sides	Deviation toward street	88	61	
	Deviation toward building	56	39	
Root problems	Due to tree tilting/leaning some roots are coming out of the soil (exposed roots)	14	10	(56%) 80
	more than half of the roots under the tree crown have been cut or crushed	12	8	
	advanced decay is observed on roots and buttresses	15	10	
	Paleness and food shortage in the leaves	23	16	
	Sum	64	44	
Advanced decay	Decay in the main trunk	10	6	124 (88%)
	Decay in the thick branches	10	6	
	Sum	20	12	
Wound on the trunk and root	The wound perimeter is greater than half of the trunk perimeter	8	6	(%85)123
	The wound perimeter is less than half of the trunk perimeter	13	9	
	Sum	21	15	
Interfering with power and phone lines	In contact with power lines and telephone	5	3	(97%) 139
	Nearby power lines and telephones	-	-	

Results obtained from Table 2 show that among investigated hazard criteria, two criteria of deviation from a straight line (62%) and root problems (44%) had the greatest contribution to hazard, respectively. On the other hand, contact with power and telephone lines (3%), trunk gap or crack (4%), advanced decay (12%), wound on the trunk and root (15%), and dead branches and twigs (34%) had the lowest contribution to hazard, respectively.

TABLE 3
CLASSIFICATION OF THE LEVEL OF HAZARD POSED BY THE INVESTIGATED ORIENTAL PLANE TREE

Class code	Hazard score	Hazard situation	Trees percentage	Number of trees
1	0	Safe	15.27	22
2	5-Jan	Very low risk	63.2	91
3	10-Jun	Low risk	21.53	31
4	15-Nov	Moderate risk	0	0
5	16-20	High risk (hazardous)	0	0
6	21-24	Very high risk (extremely hazardous)	0	0
		Sum	100	144

Results of Table 3 show that 63.20% of surveyed trees are classified under the very low risk class. Additionally, results show that no tree with moderate risk, high risk (hazardous), and very high risk was placed in the hazard criterion classification.

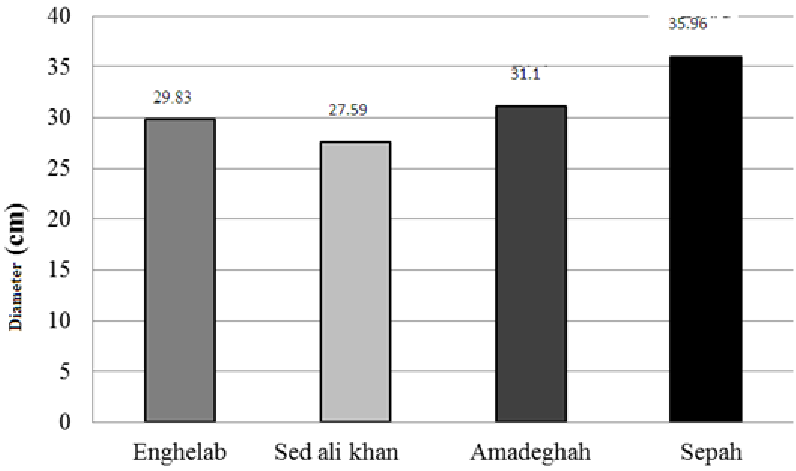

FIGURE 2: The mean DBH of trees in the investigated regions

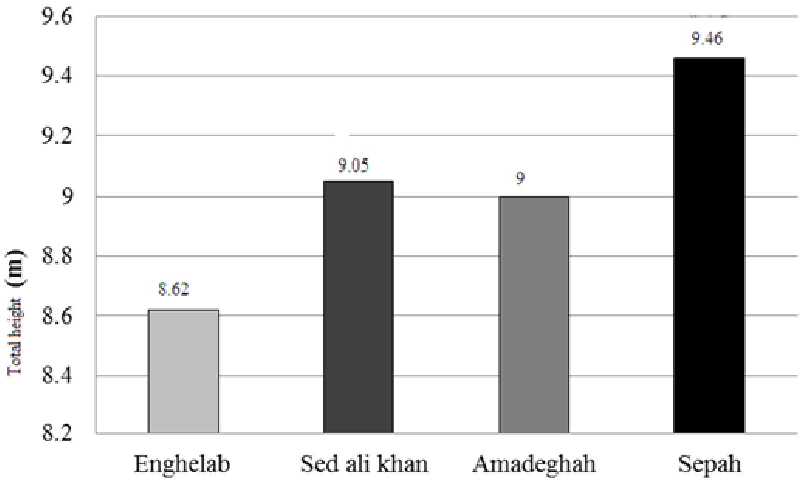

FIGURE 3: The mean total height of trees in the investigated region

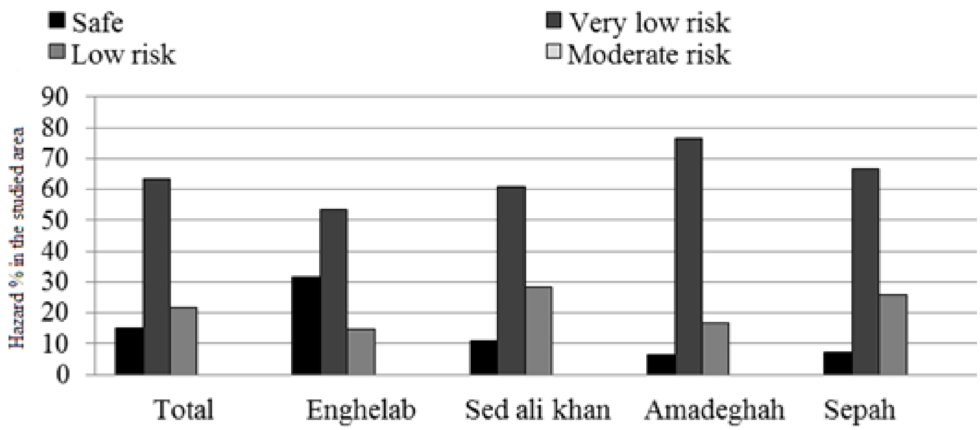

FIGURE 4: Hazard percentage of trees in the studied area

IV. DISCUSSION

Today, one of the important issues in the urban streets debate is the green space with its aesthetics. We need to pay more attention to green space and urban trees and even urban forestry and their positive effect (Panahi et al., 2003). The qualitative and quantitative information and characteristics of street trees help us plan for future. In addition, street trees are among the most important building blocks of urban green coverings. In many cases, individuals are unaware of the hazards associated with defective trees and damage caused by them (Pourmajidian et al., 2014). Therefore, it is necessary to investigate the hazard status of trees in hazard classes. This issue has received a lot of attention in many developed countries across the world (Golkar, 2001). According to the results of quantitative variables analysis in this study, the mean height of Oriental Plane trees (Table 1) is 9.1 m and the mean DHB is 30.53 cm. Overall, the old Oriental Plane trees have larger height and diameter. As Oriental Plane trees in Isfahan city have also a long history, their height and diameter values are mainly greater than the measured value. However, due to the fact that only 144 trees were randomly investigated, the height and diameter values are less than expected. Additionally, as shown in Table 2, among hazard criteria investigated, 2 criteria of deviation from a straight line (62%) and root problems (44%) had the greatest contribution to hazard, respectively. In the results of their research, Sabo et al. (2005) stated that trees planted between tall buildings suffer from shortage of light throughout the day. Marvi Mohajer (2011) also stated that the crown of trees planted on the verge of narrow streets of cities and industrial regions with tall buildings on both sides, tend to lean toward the middle of the street to get more light (figure 5).

FIGURE 5: Oriental Plane tree's deviation toward street in the studied area

FIGURE 6: Root problems of Oriental Plane tree in the studied area

Among other important hazard criteria in this study are root problems which have a high contribution to hazard. The most important root problems include a wide range of problems from roots coming out of the ground, to cut roots, root decay, and buttresses coming out of the ground, and finally the weakness and paleness of leaves due to root problems (Pourhashemi et al., 2012& Pourmajidian et al., 2014). Additionally, exposed roots can cause damage to the pavements and lead to their detachment (Fig 6), this will double the financial burden of the street (Pourhashemi et al., 2012).

Contact with power lines (3%), trunk gap or crack (12%), advanced decay and wound on the trunk and root (15%) are among other important hazard criteria which have the least contribution to hazard in the study area, respectively. Of course, the existence of advanced decay (12%) is not considered to be a low important factor, because lots of decays occurred in trees are internal decays of trunk and root. If these defects are accompanied by other hazard criteria, they will be extremely hazardous (Banj Shafiei et al, 2015 & Marvi Mohajer, 2011). Additionally, the results shown in Figures 2 and 3 in four study areas showed that the mean height (35.96 cm) and DBH (9.46 m) in the last area in Sepah Street were larger than other three areas. In Fig 5, the level of risk posed by trees in all four areas has been generally assessed. The safest area in terms of hazard is the area between Enghelab Street and Sed Ali Khan. The area between Sed Ali Khan and Amadegah was rated to be a low risk area. If the hazard criteria of these trees are accompanied by factors associated with internal decay, they will become extremely hazardous. This is while trees with moderate risk and high risk were not located in this area. Street trees are of paramount importance and it is very important to investigate and prevent events that are likely to occur by hazardous trees. Generally, there are three main ways to manage hazardous trees in urban environments: keeping away the target from hazardous tree (which is possible only for moving targets such as vehicles); taking proper corrective actions and repairing tree, and at last stage tree removal or cutting down, this is done when tree is extremely hazardous and it is not possible to change, correct, fix or repair the situation (Pourmajidian et al., 2014; Fazio, 1989; Kong, 2000; Robbins, 1986; 28, & Smiley et al., 2007). The necessity to prune or cut down the hazardous urban trees is far easier to prove than the benefits of caring them, because their presence may cause the tree to collapse suddenly (Pourmajidian et al., 2014). Therefore, considering the importance of the topic of this research, it is suggested that future research consider criteria such as the precise identification of destructive fungal pathogens and diseases of these trees. It is also suggested that during the risk assessment process some forms be prepared to record and investigate information such as problems caused by the mentioned tree for residents of the region. Additionally, urban planners should pay attention to choose the best tree species to be planted on the verge of the streets and apply the best management technique.

V. CONCLUSION

In this study the risk possibility of rate of risk possibility of oriental plane (Platanus orientalis L.) trees of Chahār Bāgh Abbasi Street of Isfahan were evaluated using transect method with random start point. Overall, results indicated that deviation from vertical position (62%) and root problems (44%) have the highest contribution to hazard creation. Applying some amending processes such as crown pruning and cutting of dead branches of the trees are proposed.

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Relationship between Lactoferrin and Beta- Lactoglobulin Genes with the Milk Quality Traits and Somatic Cell Counts in Crossbred Dairy Cattle Genotypes

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***Abstract*—** *Lactoferrin (LTF) and Beta-lactoglobulin (BLG) are two significant candidate genes known to associate with milk quality traits as well somatic cell count (SCC). In this study, the intron 3 of Lactoferrin and a region between exon 4 and intron 4 of BLG were chosen for genotyping with their relationships with milk quality trait and SCC. Results of PCR-RFLP have shown several differences among genotypes of both lactoferrin and beta lactoglobulin genes. This study shows AA was significant (P<0.05) lower than AB and BB, while as BB genotype was significantly different at (P<0.05) of beta lactoglobulin gene was high than AA and AB genotypes. The genotypes AA and AB in LTF and AA and BB in BLG are suitable for selection of milk quality. However, BB in LTF and AB in BLG have shown resistant mastitis among genotypes of crossbred dairy cows. Lactoferrin genotypes in association with SCC, SCS and Milk yield were significantly differences at 5% (P<0.05). The study reveals milk yields were high among all genotypes. Ayshire cross had the highest in AA genotype, followed by AB and the least recorded in BB genotype. Guernsey had the highest milk yield in AB genotype and low in both AA and BB genotypes. There were associations between SCC and SCS Friesian had high of level of SCC and SCS in AA and BB genotypes and AB genotype was low. Guernsey cross had high level SCC and SCC in AA and AB genotypes and low in BB genotype. And, Ayshire had high level of SCC and SCS in AA and low in BB genotype. Beta-lactoglobulin genotypes recorded high SCC, SCS and milk yields across the three genotype frequencies. The study suggests that beta-lactoglobulin and lactoferrin are candidate genes that can be used for selection against mastitis infections in a dairy herds.*

***Keywords*— *Crossbred; Genes; Genotypes; Somatic Cell Count; Milk quality*.**

I. INTRODUCTION

The beta-lactoglobulin (BLG) gene is an acid-stable, amphiphilic, and a single chain polypeptide of 18kbp. It occurs in three different forms: Tetrameric, octameric, and multimeric (Al Shabib et al., 2020). The gene comprises 10 -15% and 53 % of milk and whey protein respectively (Alim et al., 2015). It is a whey protein commonly present in milk at normal pH (Alim et al., 2015; Singh & Gallier, 2018). Beta-lacto globulin is one of the whey proteins and lipocalin present in cow milk. The lipocalin protein adheres easily to several hydrophobic molecules. The Beta-lactoglobulin gene can bind iron through siderophores, thus playing a critical role in fighting pathogens in milk. Therefore, it is a candidate gene associated with somatic cell count and milk quality trait in bovines (Alim et al., 2015; Singh et al., 2015).

Beta-lactoglobulin gene inhibits the growth of common causative agents of mastitis such as Staphylococcus aureus and Streptococcus spp. The action reduces the spreading rate of infections, which helps improve the quality of milk

(Chaneton et al., 2010; Ateya et al., 2016). Due to its ability to influence the number of somatic cells in milk, the lactoferrin gene is an appropriate novel candidate gene for selecting mastitis resistance in dairy herds (Martin et al., 2018).

The bovine lactoferrin gene belongs to the transferrin family (Firyal et al., 2017). The gene is a glycoprotein found in most biological fluids such as saliva, bile, blood, milk mucous secretions, and tears (Chopra et al., 2013; Asadollahpour et al., 2016). In bovines, the concentration varies between 0.02 and 17.8 mg/ml. The concentration can rise sharply with udder infection (Zabolewicz et al., 2012; Sharma et al., 2015). The genomic DNA of this gene has a molecular size of 34.5kb (Dinesh et al., 2015). The gene is secreted in milk during lactation by polymorph nuclear Neutrophils (Nanaei et al., 2016).

In bovine milk, the lactoferrin gene plays biological and physiological roles and is strongly correlated to Somatic Cell Count (Cheng et al., 2008; Arnould et al., 2009; Pawlik et al., 2014). The concentration of protein in milk is determined by a number of many factors, including parturition, lactation stage, days of involution, subclinical and clinical mastitis (Sharma et al., 2015). The high concentrations of the lactoferrin gene in milk can be an indicator of milk quality and subclinical mastitis (Musayeva et al., 2018). High concentrations are usually recorded in cows undergoing drying-off cows and mammary involution (Zabolewicz et al., 2014).

The increased SCC results in a decline in the amount of the beta-lactoglobulin gene in milk (Litwi et al., 2011). The gene works in an antagonistic manner to the lactoferrin gene, but both possess antibacterial effects. Therefore, the two genes can complement the mammary gland immune mechanisms against bacterial infections (Chaneton et al., 2010; Singh et al., 2014). SCCs monitor the general udder health, including subclinical mastitis in dairy cows (Singh et al., 2014). Early detection by the farmer is essential because it can help them maximize their profits by reducing the cost of milk production and disease control. Therefore, this study offers important insight into evaluation of the relationship between genes associated with milk quality and Somatic Cell Counts in crossbred dairy cattle.

II. MATERIALS AND METHODS

2.1 Samples Collection and Genomic DNA Extraction

The Crossbred dairy cows which were recruited for the present study. Composed of all lactating cows from four genotypes of Ayrshire, Friesian, Guernsey and Jersey. About 5ml of blood samples were obtained aseptically from the external jugular vein of each of the 96 crossbred dairy cattle at Kanyariri Veterinary Farm (University of Nairobi) for DNA analysis. The samples were drawn into vacutainer tubes containing EDTA as an anticoagulant.

The tubes were shaken gently to allow thorough mixing of the blood sample with anticoagulant (EDTA). They were then placed in vertical position in a cool box at (-20℃) and transported to a Molecular Genetics Laboratory at the Department of Animal Production College of Agriculture Veterinary Sciences, the University of Nairobi. The vacutainers were later transferred to the deep freezer for storage at temperature of -21℃ before DNA extraction. Prior to blood samples collection, a total of the full quarters of the 38 lactating cows. These were examined microscopically for counts of somatic cells in the microbiology Laboratory, Department of food Science and Nutrition, Faculty of Agriculture, University of Nairobi.

The DNA extraction was done using a QIAGEN kit. About 20ul of proteinase K was pipetted and added into the micro-centrifuges tube. This was later followed by the addition of 200ul of the blood sample in the tube. The volume was adjusted by adding 220ul of PBS buffer into the tube, followed by the addition of 200ul of AL buffer. The tube was vortexed for 5minutes, transferred to the heating block, and incubated for 15 minutes at the temperature of 56℃. About 200µL of absolute ethanol was added to the tube, mixed and thoroughly vortexed. The subsequent procedures were followed as per the manufacturer instructions.

2.2 Polymerase chain reaction amplification and genotyping

The BLG genotypes were analysed using polymerase chain reaction restriction fragment length polymorphism (PCR-RFLP) method. A 252 bp fragment of exon 4 (110 bases) and intron 4 (212 bases) were amplified with forward GTCCTTGTGCTGGACACCGACTACA -3' and 5'- CCCAGGACACCGGCTCCCGGTATAT-3'. A 301bp fragments of intron 4 of LTF gene was amplified with forward primer 5'- GCCTCATGACAACTCCCACAC -3, and reverse 5'-CAGGTTGACACATCG GTTGAC -3' . The amplification reactions had a final volume of 25µL, which was aggregated as

2µL (10x PCR buffer), 3µL (5x Q solution), 0.2µL of each primer, 0.4µL dNTPs mixture, 0.2µL Taq DNA polymerase, 15µL Nuclease-free water, and 4µL DNA template (100ng/µL).

The reaction for (beta-lactoglobulin) were performed in a thermal cycler with the following conditions; initialization at 94℃ for 5minutes, denaturation at 94℃ for 60 seconds, annealing of primers at 61℃ for 60 seconds, extension at 72℃ for 60 seconds and carried out in 30 cycles. The final extension performed at 72℃ for 7 minutes, and PCR products were stored at 4℃.

For lactoferrin reactions were carried out in thermal cycler with the following conditions; initialization at 95°C for 5 minutes, denaturation at 95°C for 60 seconds, annealing of primers at 57°C for 60 seconds, extension at 72°C for 60 seconds and carried out in 35 cycles. The final extension for both genes was performed at 72°C for 7 minutes and PCR products were stored at 4°C (Azam et al., 2017; Kaplan, 2018).

2.3 Screening of crossbred dairy cows for Mastitis and SCC

A total of 38 crossbred dairy cows were selected based on lactation, each of their udder quarters were screened for mastitis by California Mastitis Test kit (Schalm, 1957). Each of the udder quarters were cleaned using 75 percent ethanol before collecting 5ml of milk samples aseptically into 10ml screw cupped tubes. These were then transported at -20℃ to the Microbiology Laboratory in the Department of Food Science and Nutrition, Faculty of Agriculture, University of Nairobi. Milk samples were stored in a freezer at -21℃ before they could be analyzed for Somatic Cell Counts.

A thin layer of milk samples were spread on slides, stained with an iodine solution as a basic dye and allowed to dry. These slides were labelled to match samples' containers identification numbers, each of these slides were placed on microscopic stage and examined with a magnification of 100x independently, where leucocytes were appearing as dark spotted dots. These leucocyte cells were counted directly as somatic cells and multiplied by thousand (Prescott and Breed, 1910; Ferronatto *et al.*, 2018). To obtain Somatic Cell Scores, SCC were log transformed using the formula (Rupp *et al.,* 1999; Yuan *et al.,* 2013).

$$\text{SCS} = Log_2\left(\frac{SCC}{100{,}000} + 3\right) \tag{1}$$

2.4 Statistical analysis

The SCC data was analyzed using SPSS version 21.0. To calculate correlation coefficient, Tukey test was used for mean separation of somatic cell count among crosses of dairy cattle, LSD and to test if there was a significant difference of breed effect on mastitis resistant traits; CMT Scores were analyzed using one-way ANOVA (SPSS) at P≤0.05 level of significance. The models below were used in testing the effect of breed on SCC.

$$\boldsymbol{y_{ij}} = \boldsymbol{\mu} + \boldsymbol{G_i} + \boldsymbol{e_{ij}} \tag{2}$$

Where $\boldsymbol{y_{ij}}$ the effect of the SCS is in the udder quarters**,** $\boldsymbol{\mu}$ is the average for traits, $\boldsymbol{G_i}$ is the breed's effects, $\boldsymbol{e_{ij}}$ represent the residual error. The analysis of the association among the breeds with SCC that reflect mastitis susceptibility traits was solved using the equation below;

$$\boldsymbol{y_{ij}} = \boldsymbol{\mu} + \mathbf{G_i} + \mathbf{p_t} + \boldsymbol{e_{ij}} \tag{3}$$

Where y_{ij} is the observation of somatic cell count, μ is the overall mean of SCC, G_i and, p_t were the fixed effect of breed and the fixed effect of SCC respectively, and e_{ij} residual error.

III. RESULTS AND DISCUSSIONS

The genotypic variants of both lactoferrin and beta-lactoglobulin were shown as explained below (Table 1). The study revealed that the frequency of AA for Lactoferrin genes was significantly at (P≤0.05) higher those of AB and BB, whereas in genotype of beta-lactoglobulin shows that BB was higher than those AA and AB. This agreed with the findings of Singh et al (2014). The genotypes AA and AB in LTF as well as AA and BB are suitable for selection of milk quality trait. However, BB in LTF and AB in BLG could show more resistance against mastitis among genotypes of crossbred dairy cows (Ayshire, Friesian and

Guernsey). The higher genotype frequency are more susceptible to udder infection which in turn amount to deterioration of the quality of milk produced (Table 1).

TABLE 1
CALCULATED GENOTYPE AND ALLELE FREQUENCIES OF LACTOFERRIN (LTF) AND BETA-LACTOGLOBULIN BLG GENES

Genes	Genotype Frequency			Allele Frequency	
	AA	AB	BB	A	B
LTF	0.559 (n=85)	0.329 (n=50)	0.112 (n=17)	0.724	0.276
BLG	0.316 (n =48)	0.223 (n=34)	0.461 (n=70)	0.428	0.572

The gene has multiple effects in milk, such as ferrous-binding, antimicrobial action, and inhibitory nature against microorganisms. These properties play crucial roles in regulating the growth and multiplications of pathogenic agents and maintaining milk quality against bacterial; this is agreed with (Ateya et al., 2016). Furthermore, the gene's inhibitory nature reinforces mammary gland immune mechanics when the innate immune system is impaired and provides a faster, more efficient, and timely defense against intra-mammary gland infections (Lukač *et al.*, 2013). The innate immune responses act against mastitis pathogens and reduce bacterial loads present in milk naturally. This gene plays a key role in addressing challenges caused by mastitis and selecting for it can improve animal milk safety and increase milk production.

Table 2 &3, the study have revealed a significant associations of Somatic Cell Counts among the udders' quarters of the three crosses of dairy cows. These associations are important diagnostic tool to address matters related to milk quality and hygiene, this was line with Nyman *et al. (*2014). The udder health status is one of the significant aspects in milk quality and yield this statement agreed with finding of several researchers globally (Tarbal *et al*, 2020; Shraf *et al*., 2018). Malik *et al, .2018,* also argued that in a dairy farm where milking processes are automated, a high level of somatic cell counts are recorded in milk produced as compared those in local farms. An aged dairy cow previously exposed to several incidences of intra-mammary infections also produces huge quantity of in milk as stated by Bhakat *et al.* 2019).

TABLE 2
RELATIONSHIPS BETWEEN THE LACTOFERRIN GENOTYPES WITH MILK QUALITY TRAIT AND SOMATIC CELL COUNTS AMONG CROSSBRED COWS (AYRSHIRE. FRIESIAN AND GUERNSEY)

Cows	Traits	Genotypes (n)		
		AA	AB	BB
Ayshire	Milk yield*	2545.97±121.91[a]	2125.45±296.50[a]	2025.45±196.45
	SCC*	246.64±15.177[a]	178.59±10.008[a]	174.67±13.212
	SCS*	1.65±2.16	1.44±1.95[a]	1.43±1.95[a]
Friesian	Milk yield*	2355.86±210.09	2456.40±205.21	2234.50+135.10
	SCC*	245.64±14.145	200.64±11.156	245.69±12.543
	SCS*	1.64±2.33	1.51±2.12[a]	1.64±2.12
Guernsey	Milk yield*	2343.06±116.92[a]	2405.02±197.68[a]	2225.34±290.59
	SCC*	235.55±13.256[a]	235.78±12.180	195.78±14.351[a]
	SCS*	1.61±2.24[a]	1.61±21.24[a]	1.49±2.33

Least Square (LS) means bearing superscripts in a row indicate statistically significant differences. * Significant at 5% level of interval (P<0.05); SCC= Somatic Cell Counts and SCS = Somatic cell Scores

TABLE 3
RELATIONSHIPS BETWEEN THE BETA-LACTOGLOBULIN GENOTYPES WITH MILK QUALITY AND SOMATIC CELL COUNTS AMONG CROSSBRED COWS (AYRSHIRE. FRIESIAN AND GUERNSEY)

Cows	Traits	Genotypes (n)		
		AA	AB	BB
Ayshire	Milk yield*	2666.45±166.45[a]	2477.34±198.04	2556.194±185.56[a]
	SCC*	235.65±13.214[a]	200.55±14.512	215.45±13.456[a]
	SCS*	1.61±1.55[a]	1.51±1.78[a]	1.55±1.94[a]
Friesian	Milk yield*	2556.45±186.12[a]	2456.45±160.45	2667.54±146.23[a]
	SCC*	260.44±14.523[a]	235.96±12.134	245.56±13.445[a]
	SCS*	1.69±2.85[a]	1.61±2.65[a]	1.64±2.56
Guernsey	Milk yield*	2445.67±159.81[b]	2678.68±196.40[a]	2784.14±156.02[a]
	SCC*	245.55±12.621[a]	212.74±12.114[b]	212.25±12.412[b]
	SCS*	1.64±2.67[a]	1.54±2.45[b]	1.54±2.52[b]

Least Square (LS) means bearing superscripts in a row indicate statistically significant differences. * Significant at 5% level of interval (P<0.05); SCC= Somatic Cell Counts and SCS = Somatic cell Scores

This study (Table 2 & 3) also indicated clearly that the amount of somatic cell count in milk varies from breed to other, this was in line with the findings by Anon, 2016; Thomas *et al*., 2015; Hadrich *et al*., 2018; Ruegg and Pantoja, 2019; Tarbal *et al*., 2020. However, the presence of somatic cell count in milk are influenced by several physiological and environmental factors. These other factors which may include; the age of an animal, level of production, lactation stage, number of parity, breed types, frequency of milk and udder injury Hadrich *et al*., 2018; Ruegg and Pantoja, 2019. Alhussein & Dang, 2018, further argued that an animal's environment such as climatic variations may results into changes in the level of somatic cell count. In wet season high quantity of somatic cell count recorded as compared to dry season which are usually less.

The even distributions of somatic cell counts across the udder quarters have resulted into a faster rate of infection of the intra-mammary gland as stated by Das *et al.* 2018; Jadhav *et al*,. 2018. However, the declined in milk productions have been attributed to other factors such as physiological aspects of lactation, lactation stages, nutrition and feeds, climatic conditions, and geographical locations of an area (Maraya, 2019; MOHAMED, 2019; Lees *et al*., 2019). Therefore, amount of SCC in the udder quarters of a dairy cow can be treated as an important milk quality trait. This can be utilized in selective breeding for mastitis resistance in dairy herds (Davis and South, 2015; Iraguha *et al*., 2017). Thus, the higher heritability it possessed as compared to clinical mastitis.

In Table 2 & 3, the amount of SCS were significant difference at P<0.05 for the major of genotypes of the crosses as seen. Somatic Cell Score is a pseudo phenotypic trait for milk quality (Jadhav *et al*., 2018). Nevertheless, the least values of Somatic Cell Scores in milk indicate the low incidence of mastitis and intra-mammary gland infections of the udders as mentioned by Maye *et al*., (2017). Alam *et al*., 2015 and Rainard *et al*., 2018 argued that several lactation trait models were used for analyses of somatic cell scores, and they have evidenced as strong trait for selection against mastitis in the dairy herds.

Unlike mastitis, somatic cell scores have slightly higher heritability which could be utilized in a marker assisted selection for reduced incidence of mastitis (Singh *et al.,* 2014; Rainard *et al.,* 2018). They further stretched that it is the one way to reduce incidences of mastitis, because conventional breeding practices have showed no any positive progress.

In table 2 & 3, somatic cell scores and lactation stages have shown significant associations between first and second lactation, second and third lactation stages at P<0.05 level of significant. This result is agreement with Alam *et al.* (2015) who stated that there were associations between Lactation stages and increased SCS in milk. This demonstrated that the greater level of somatic cell scores in milk, greater resistance to intra-mammary infections among the crossbred dairy cows, this statement was supported by Alam *et al.* (2015) and Rainerd *et al.* (2018). They further stated greater the lactation somatic cell scores, the greater resistance against mastitis by crossbred dairy cows. This helps an animal resists infection in case its immune system is impaired. They further stated that amount of Somatic Cell Scores in milk are usually higher in early lactation periods than late lactation stages (Alam *et al.,* 2015; Rainard *et al.,* 2018).

The associations between the lactation stages (LSs) and Somatic Cell Scores (SCS) are crucially important in determining animal's ability to resists mastitis infections. It has been witnessed in selection for mastitis resistant breeds, where success were recorded when the low estimated breeding values were considered (Rainard *et al.,* 2018). Ultimately, the least values of SCS indicates the low incidence of mastitis and intra-mammary gland infections of the udders (Maye *et al*., 2017). Moreover, several lactation traits model revealed that somatic cell scores can result in mastitis resistant breeds of dairy cattle (Alam *et al*., 2015; Rainard *et al*., 2018; Jadhav *et al*., 2018).

In Table 2; lactoferrin genotypes in association with SCC, SCS and Milk yield were significantly differences at 5% (P<0.05). The study result reveals milk yields were high among all genotypes. Ayshire cross had the highest in AA genotype, followed by AB and the least recorded in BB genotype. And, Guernsey recorded the highest in AB genotype and low in both AA and BB genotypes.

In table 2; SCC and SCS among were showed as explained below; Friesian have showed high of level of SCC and SCS in AA and BB genotypes and AB genotype was low. Guernsey cross had high level SCC and SCC in AA and AB genotypes and low in BB genotype. And, Ayshire had high level of SCC and SCS in AA and low in BB genotype. This literally, Friesian and Guernsey crosses have shown robust immune responses against mastitis infection while Ayshire cross resisted by showing least amount of SCC and SCS in the milk.

In table; 2 & 3, Somatic Cell Count (SCC) among the udders' quarters of dairy cows, Ayshire, Friesian and Guernsey were significantly different at P<0.05. A breed's ability to produce significant amounts of somatic cells in milk is treated an indicator of robust immune responses to mastitis infections. This can be applied as a first-line response to reduce a disease's further spread across udder quarters. An increase in SCCs can facilitate a rapid and effective response to an intramammary infection (IMI) in dairy herds (Li *et al.*, 2014; Hussein *et al.*, 2018). Its presence in the udder quarters indicate that quarters' infection can occur randomly regardless of its positions (Li *et al.*, 2014).

IV. CONCLUSIONS

The SCC and SCS level varied among the crosses of dairy cows for both genotypes of beta-lactoglobulin and lactoferrin genes. These differences were as a result in differences in intramammary infections immune responses to of the udder quarters by causal agents of mastitis. Among crosses, Friesian have shown the highest level of SCC, SCS and milk yields across all genotypes for both BLG and LTF genes. This was followed by Guernsey crossed and lastly Ayshire which had the lowest as compared with the two crosses. Those that have registered high of level SCC means were susceptible to infections, where low SCC indicates the breed ability to resists infection and its robust immune responses.

CONFLICTS OF INTEREST

The authors do not have any conflicts of interest to declare with regard to the present study.

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Effect of the Combination of Liquid Biofertilizers and N, P, K Fertilizer on Soil N-Total, N Uptake, N-Fixing Bacteria and Sweet Corn (*Zea mays* L. Saccharata) Results in Fluventic Eutrudepts

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***Abstract*—** *Liquid biofertilizers containing one of the bacteria Azospirillum sp. which plays a role in overcoming soil fertility problems due to excessive use of inorganic fertilizer and provides nutrients to stimulate growth and optimize crop yields. This experiment was conducted to determine the effect combination of liquid biofertilizers with N, P, K fertilizer on various treatments on N-total Soil, N uptake, N fixing bacteria and yield of sweet corn (Zea mays L. saccharata) on Fluventic Eutrudepts. This experiment was carried out using a randomized block design (RBD) consisting of one control treatment or without fertilizer application, 2 treatment of N, P, K fertilizer and 6 combination treatment of liquid biofertilizers with N, P, K fertilizer. Each treatment was repeated three times. The results showed that the application of liquid biofertilizers combined with N, P, K fertilizer had an effect on N-total soil, N uptake, and N-fixing bacteria populations as well as sweet corn yields. The combination dose of 1 liquid biofertilizers (5 L.ha^{-1}) with ¾ N, P, K fertilizer (225 kg.ha^{-1} Urea, 112.5 kg.ha^{-1} SP-36, 75 kg.ha^{-1} KCl) gave the best results on N-total soil (1.33%), N uptake (3.46 mg.plant^{-1}), N-fixing bacteria (1.33 x 108 CFU.g^{-1}) and yield of sweet corn (Weight cob per plot 11.6 kg, cob weight 423.5 g, cob weight without cob 334.7 g, cob diameter 52.79 mm, and cob length 23.9 cm.*

Keywords*— *Combination, Liquid Biofertilizers, Sweet Corn, Fluventic Eutrudepts.

I. INTRODUCTION

The availability of nutrients in the soil is the main factor to determine the success of plant cultivation. Nutrients have an important role in increasing the yield and quality of plants. The availability of nutrients in the soil is able to maintain a balance of nutrients so that plant productivity is optimal with fertilization (Wulansari et al., 2022).

The main problem in agriculture is the decline in the quality of agricultural soil which causes low agricultural productivity due to degradation of soil fertility. This is due to excessive and uncontrolled use of inorganic fertilizers by farmers. According to Iwuagwu et al. (2016) the continuous use of inorganic fertilizers can result in damage to the physical, chemical and biological properties of the soil so that the level of soil fertility decreases. This is supported by the research of Pangaribuan et al. (2019) that excessive application of inorganic fertilizers to the soil can affect environmental factors, soil quality and cause reactions in the soil such as P fixation, NO3 and N2O volatilization. Inorganic fertilizers can also reduce soil organic matter levels to <2.00% and damage the soil structure.

Solutions to increase the value of agricultural production can be done by preserving agricultural resources, strategies and appropriate efforts such as utilizing biofertilizers. Bio-fertilizers contain symbiotic bacteria (Rhizobium) and non-symbiotic bacteria (Azotobacter and Azospirillum) which correlate with each other in improving soil fertility and increasing crop yields (Fadiluddin, 2019). This is in line with the statement of Setiawati et al. (2020) that the bacterial content in biofertilizers is able to provide nutrients and increase crop yields. Bacteria *Azospirillum* sp. is one of the bacteria that can fix nitrogen and can produce the hormone Indole Acetid Acid (IAA) as a soil aggregate stabilizer and stimulate plant growth (Eckert et al., 2001). The agricultural sector utilizes *Azospirillum* sp. optimally formulated as a special carrier material for biofertilizers in increasing nutrient availability and increasing plant productivity.

Basically, biofertilizers cannot fully optimize the availability of nutrients in the soil, because they are accompanied by the provision of inorganic fertilizers N, P and K in balanced doses so that they have an effect on plant growth and yields. According to Rop et al. (2019) N and P nutrients are needed by plants in the growth process to be precise in the vegetative phase while K nutrients are needed in the generative phase.

This study also used sweet corn (Zea mays L. saccharata) as an indicator in supporting the successful use of a combination of liquid biofertilizers with N, P and K fertilizers. Sweet corn of the Talenta variety is a plant that has a high sugar content of 13-15 obrix while in Ordinary corn has a sugar content of 2-3% (Sukur & Rifianto, 2014). The productivity of sweet corn in Indonesia in 2018 averaged 8.31 t.ha-1 while the yield potential of sweet corn was able to reach 14-18 t.ha-1 (Rinanti et al., 2021). Based on these results indicate that the low productivity of sweet corn is caused by several things, namely the limitations of sweet corn cultivation due to soil fertility problems and pest and disease attacks.

The aim of the study was to determine the effect of a combination of liquid biofertilizers and N, P, K fertilizers on soil N-total, N uptake, N fixing bacteria and sweet corn (Zea mays L. saccharata) yields in Fluventic Eutrudepts.

II. RESEARCH METHODS

The field experiment was carried out at the Soil Chemistry and Plant Nutrition Laboratory Experimental Garden, Faculty of Agriculture, Padjadjaran University, Jatinangor sub-District, Sumedang Regency 〖(6〗^0 54'56,4"S) and 〖(107〗^0 46'16,9 "E) with an altitude of 794 m above sea level. Initial analysis of soil, biofertilizers, and sweet corn plants was carried out at the Laboratory of Soil Chemistry and Plant Nutrition (KTNT), Department of Soil Science and Land Resources, Faculty of Agriculture, Padjadjaran University, Jatinangor District, Sumedang Regency, West Java. This experiment was conducted from June to September 2022.

The materials used in this experiment include the Inceptisol order soil which belongs to the Fluventic Eutrudepts sub-group. Results of initial soil chemical analysis, results of initial soil biological analysis, and description of Fluventic Eutrudepts), Talenta variety hybrid sweet corn seeds, Liquid biological fertilizer derived from Azospirillum sp. bacteria, Standard N, P, K fertilizer consisting of a single Urea fertilizer (46% N), SP-36 (36% P_2O_5), and KCl (60% K_2O), H_2SO_4, NaOH, distilled water, Conway indicators, chemical and biological materials used for analysis of soil N-total values, N uptake and N-fixing bacteria.

The tools used in this experiment included digital scales, zip plastic, hoes, calipers, stationery, observation diaries, documentation tools, rulers and equipment in the laboratory to analyze soil-total N, N uptake, analysis of N-fixing bacteria.

This experiment was carried out using a Randomized Block Design (RBD), which consisted of 9 treatments, namely: without fertilizer application (A), 2 treatments with N, P, and K fertilizer doses (B and C) with 6 treatments combined with liquid biofertilizers N, P, and K. (D, E. F. G, H. I).

TABLE 1
ARRANGEMENT OF TRIAL TREATMENT

Symbol	Treatment	FERTILIZER MEASUREMENT			
		Organic fertiliser	UREA	SP-36	KCl
		$L.ha^{-1}$	$kg.plot^{-1}$		
A	Control	0	0	0	0
B	1 N, P, and K	0	300	150	100
C	¾ N, P, and K	0	225	112.5	75
D	½ biofertilizers + ¾ N, P, and K	2.5	225	112.5	75
E	1 biofertilizers + ¾ N, P, and K	5	225	112.5	75
F	1 ½ biofertilizers + ¾ N, P, and K	7.5	225	112.5	75
G	½ biofertilizers + 1 N, P, and K	2.5	300	150	100
H	1 biofertilizers + 1 N, P, and K	5	300	150	100
I	1 ½ biofertilizers + 1 N, P, and K	7.5	300	150	100

Note:

- ***Control treatment is treatment without liquid and inorganic N, P and inorganic fertilizers K.***
- ***Dosage Treatment The recommendation for one dose of liquid biofertilizers is 5 $L.ha^{-1}$ which refers to Trinurani Research et al., (2019).***
- ***The recommended N, P, K treatment is the single recommended dose of inorganic fertilizer treatment for Sweet Corn according to the Agricultural Research and Development Katam, 2016 (recommended single dose of fertilizer 300 $kg.ha^{-1}$ Urea, 150 $kg.ha^{-1}$ SP-36, 100 $kg.ha^{-1}$ KCl).***

Data analysis was carried out using variance and follow-up tests with Duncan's Multiple Range Test (DMRT) at 5% significance level.

III. RESULTS AND DISCUSSION

3.1 Supporting Data

3.1.1 Preliminary Soil Analysis

The results of analysis at the Laboratory of Soil Chemistry and Plant Nutrition (2022) showed that the soil in the experimental land had a slightly acidic soil pH of 6.26, medium C-organic content (2.08%), low total N (0.13 %), C/N ratio is low (11), K2O is very high (65,08 mg.100g^{-1}), P_2O_5 very low (1,07 mg.100g^{-1}), KTK moderate (18,11 cmol.kg^{-1}) and moderate base saturation (67,47%). Based on this, it shows that Fluventic Eutrudepts soil has very low to moderate soil fertility, so efforts are needed to increase soil fertility.

The results of the analysis of physical properties showed that the soil in the experimental area was classified as clay with a ratio of 8% sand, 20% silt and 72% clay respectively. The results of the analysis of biological properties in the experimental field showed that the content of the bacterium Azotobacter chrococum was 0,38 x 10^8 CFU.g^{-1}, *Azospirillum* 0,21 x 10^8 CFU.g^{-1}, and solubilizing bacteria F of 1,42 x 10^8 CFU.g^{-1}. This shows that the population of *Azospirillum* bacteria belongs to the low category so that efforts are needed to increase the population of *Azospirillum* bacteria, one of which is by administering biofertilizers.

3.1.2 Data on Rainfall, Temperature, Humidity and Sunlight

Weather data is calculated from the start of the month until the end of the study, namely June to September. Rainfall, temperature, humidity and solar radiation data for June - September 2022 can be seen in the table 2.

TABLE 2
RAINFALL, TEMPERATURE, HUMIDITY AND SUNSHINE DATA FOR JUNE - SEPTEMBER 2022

Month	Total Rainfall (mm)	Average Temperature (ºC)	Average Humidity (%)	Sunlight (%)
June	169,5	22,4	91	64
July	62,0	22,5	89	83
August	26,5	22,0	86	87
September	48,5	22,4	87	78

- ***Source: Padjadjaran University Climatology Station (2022)***

Based on the data in Table 2, the highest average rainfall occurs in June of 169.5 mm while the lowest average rainfall occurs in August of 26.5 mm, the highest average temperature occurs in July of 22,5ºC while the lowest average temperature occurred in August of 22.0ºC, the highest average relative humidity level occurred in June of 91% while the lowest average relative humidity occurred in August of 86%, and the average the highest average solar irradiance occurs in August by 87% while the lowest average solar irradiance occurs in June by 69 mm.

3.1.3 Attack of Plant Pest Organisms (OPT)

Based on observations at the time of planting, it was found that pests that attacked sweet corn plants were armyworms (*Spodoptera litura*) and grasshoppers (*Locusta* sp.). Armyworm and grasshopper pest attacks cause damage to some corn crops (mild).

(a) (b)

FIGURE 1: Plant Pest Organisms (Pests)

Based on the results of observations, it was found that weeds that grew when planting sweet corn were weeds and jotang (*Acmella paniculata*) and spinach thorns (*Amaranthus spinosus* L).

(a) (b)

FIGURE 2: Plant Disturbing Organisms (Weeds)

3.1.4 Symptoms of Nutrient Deficiency

(a) (b)

FIGURE 3: Symptoms of Nutrient Deficiency

Based on the results of observations in the field, it was found that there were symptoms of N nutrient deficiency in sweet corn plantations, specifically in treatment A (control). Symptoms of this nutrient deficiency are characterized by chlorosis, namely the color of the leaves of the sweet corn plant turns yellow at the tips of the leaves and extends to the leaf veins. These nutrient deficiency symptoms arise due to the low supply of nutrients to the soil used for observation.

The results of the research and analysis can be seen in Table 3 and the histogram of plant height growth can be seen in Figure 4. Observations of plant height during the study showed that there were various differences from the administration of a combination of liquid biofertilizers with inorganic fertilizers N, P and K starting from 14 days after planting (DAP) to 56 DAP.

3.1.5 Plant Height

TABLE 3
EFFECT OF COMBINATION OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, AND K ON PLANT HEIGHT

Symbol	Treatment	Plant height (cm)			
		14 HST	28 HST	42 HST	56 HST
A	Control	28,4	43,4	106,8	130,1
B	1 N, P, and K	39,9	102,3	168,8	178,0
C	¾ N, P, and K	37,5	99,7	166,1	189,7
D	½ biofertilizers + ¾ N, P, and K	37,3	98,1	164,6	192,1
E	1 biofertilizers + ¾ N, P, and K	46,6	109,9	178,9	208,9
F	1 ½ biofertilizers + ¾ N, P, and K	40,3	105,7	169,5	192,3
G	½ biofertilizers + 1 N, P, and K	37,6	98,3	169,3	189,8
H	biofertilizers + 1 N, P, and K	39,9	100,3	166,7	191,1
I	1 ½ biofertilizers + 1 N, P, and K	38,2	99,9	165,1	191,6

Based on the data in Table 3, the results showed that the application of a combination of liquid biofertilizers with inorganic fertilizers N, P, and K gave the best results for the growth of the height of sweet corn plants. The highest results in the observation of plant height growth were achieved by treatment E (1 biological fertilizer + ¾ fertilizer N, P, and K) namely 46.6 cm (14 DAP), 109.9 cm (28 DAP), 17891 cm (42 DAP), and 208.9 cm (56 HST). The high growth of sweet corn during the vegetative period is influenced by a balanced nutrient content in the soil (Wahyudin et al., 2019). This is in line with the statement of Setiawati et al. (2021) that the height of the sweet corn plant is said to increase gradually according to the age of the plant with optimal fertilizer application.

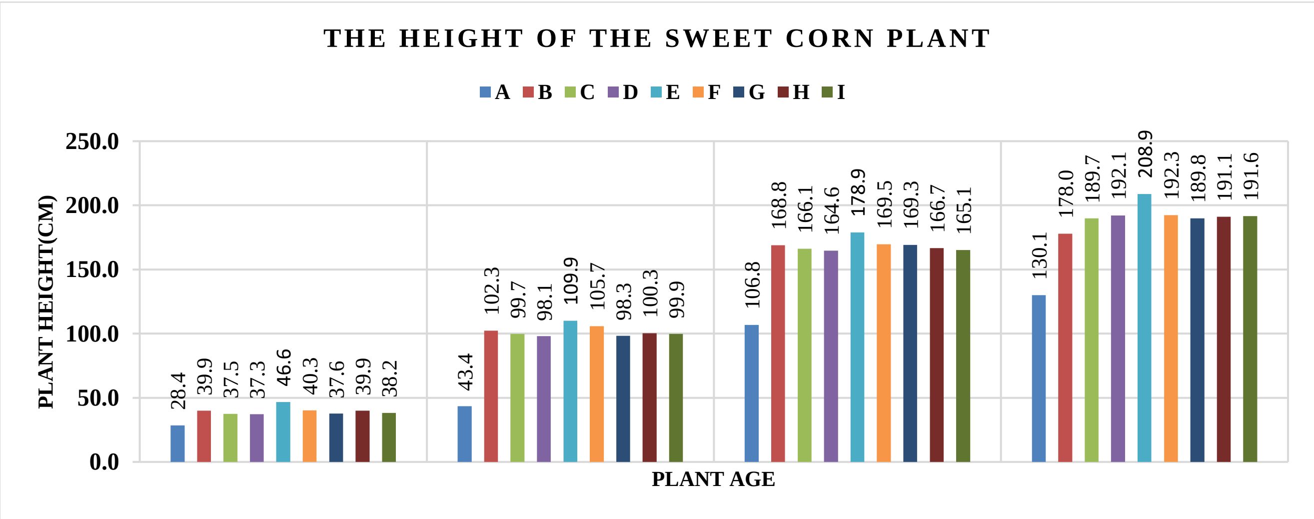

FIGURE 3: Histogram of Sweet Corn Height Growth

Description: Dark blue A (Control), Red B (1 N, P, and K), Light green C (3/4 N, P, and K), purple D (3/4 N, P, and K + ½ biofertilizers), light blue E (3/4 N, P, and K + 1 biofertilizers), orange F (3/4 N, P, and K+ 1½ biofertilizers), navy G (1 N, P, and K + ½ biofertilizers), Dark red H (1 N, P, and K + 1 biofertilizers), and Dark green I (1 N, P, and K + 1½ biofertilizers).

Based on the data in Figure 4, the observation of the height of sweet corn plants aged 14 DAP in each treatment was relatively diverse. The difference in plant height can be seen at the age of the plant entering 28 HST. The average results of plant height growth at plant age 56 HST included, treatment E (1 biological fertilizer + ¾ N, P, and K fertilizer) showed the best average yield of plant height growth of 208.9 cm and treatment A (Control) showed the lowest average yield of plant height, namely

120.4 cm. A gradual increase in plant height occurs when the application of fertilizers containing N, P and K nutrients in the soil at the beginning of planting is included in the low category and is not available to plants. This is in line with the statement of Wahyudin et al. (2019) that the increase in plant height is due to the nutrient content in biological and inorganic fertilizers N, P and K being able to meet nutrient needs for plants, stimulate plant height growth and enlarge plant stems.

3.1.6 Stem Diameter

The results of the average stem diameter observations can be seen in Table 4 and the histogram of the stem diameter of the sweet corn plants can be seen in Figure 5. Observations were made when the sweet corn plants were 14, 28, 42, and 56 HST.

TABLE 4
EFFECT OF COMBINATION OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, AND K ON STEM DIAMETER

Symbol	Treatment	Stem Diameter (cm)			
		14 HST	28 HST	42 HST	56 HST
A	Control	5,45	9,10	14,91	20,07
B	1 N, P, and K	9,06	14,05	26,91	30,65
C	¾ N, P, and K	7,69	12,57	25,77	28,16
D	½ biofertilizers + ¾ N, P, and K	9,26	15,57	27,56	32,75
E	1 biofertilizers + ¾ N, P, and K	9,81	18,77	32,15	36,29
F	1 ½ biofertilizers + ¾ N, P, and K	8,81	15,02	29,28	32,53
G	½ biofertilizers + 1 N, P, and K	9,54	15,79	29,25	31,02
H	1 biofertilizers + 1 N, P, and K	8,46	13,85	28,21	32,80
I	1 ½ biofertilizers + 1 N, P, and K	7,11	14,13	26,53	31,08

Based on the data in Table 4, the application of a combination of liquid biofertilizers with inorganic fertilizers N, P, and K gave the best results for the growth of sweet corn stem diameter. The highest results on stem diameter growth observations were achieved by treatment E (1 biofertilizers + ¾ N, P, and K fertilizer) namely 9,81 mm (14 HST), 18,77 mm (28 HST), 32,15 mm (42 HST), and 36,29 mm (56 HST).

The size of the stem diameter is influenced by the transport of nutrients by plants. This is in line with the statement of Trinurani et al. (2019) that stem growth indicates the cross-sectional area of the nutrient transport network in plants, the greater the stem diameter, the greater the cross-section of the nutrient transport network so that the nutrient translocation rate is better.

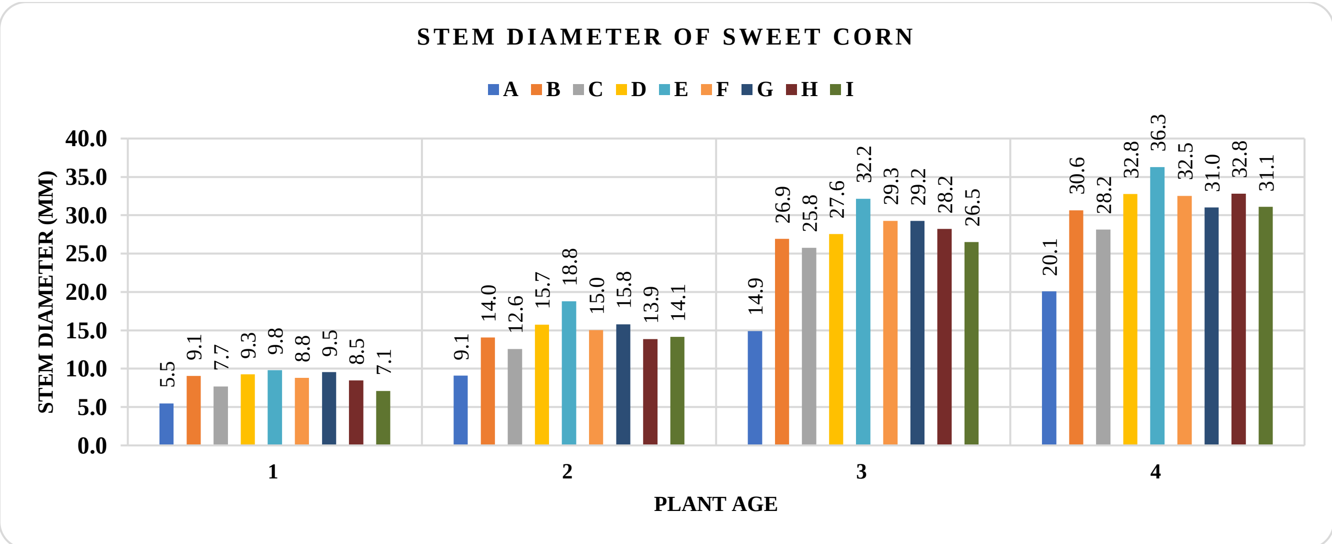

FIGURE 5. Histogram of Sweet Corn Stem Diameter

Description: Dark blue A (Control), Red B (1 N, P, and K), Light green C (34 N, P, and K), purple D (4 N, P, and K + ½ biofertilizers), light blue E (4 N, P, and K + 1 biofertilizers), orange F (34 N, P, and K+ 1½ biofertilizers), navy G (1 N, P, and K + ½ biofertilizers), Dark red H (1 N, P, and K + 1 biofertilizers), and Dark green I (1 N, P, and K + 1½ biofertilizers).

Based on the data in Figure 5, at the age of 14 DAP to 56 HST the plants gave various responses to the diameter of the sweet corn stalks. The results of the average growth of stem diameter at plant age 56 DAP included, treatment E (1 biological fertilizer + ¾ fertilizer N, P, and K) showed the best average yield of stem diameter growth of 36.3 mm and treatment A (Control) showed the lowest average growth in stem diameter, namely 20.07 mm. The enlargement of stem diameter occurs due to the activity of cell division and enlargement of cells in the lateral meristem tissue (Klau et al., 2019). This is in line with the statement of Pasta et al. (2017) that the use of inorganic fertilizers N, P, and K with liquid biofertilizers can produce a stem diameter of sweet corn plants reaching 23.5% greater than the control or without fertilizer application.

3.2 Main Data

3.2.1 N-total of soil

The results showed that the sweet corn plants which were given a combination of liquid biofertilizers with inorganic fertilizers N, P, and K had a significant effect on the total N-content of the soil. Data from observations of N-total Fluventic Eutrudepts soil can be seen in Table 5.

TABLE 5
EFFECT OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, AND K ON N-TOTAL SOIL IN FLUVENTIC EUTRUDEPTS JATINANGOR

Symbol	Treatment	N-total (%)
A	Control (no fertilizer application)	0,11 a
B	1 N, P, and K	0,23 b
C	¾ N, P, and K	0,21 a
D	½ biofertilizers + ¾ N, P, and K	0,24 b
E	1 biofertilizers + ¾ N, P, and K	0,32 c
F	1 ½ biofertilizers + ¾ N, P, and K	0,26 b
G	½ biofertilizers + 1 N, P, and K	0,22 b
H	1 biofertilizers + 1 N, P, and K	0,23 b
I	1 ½ biofertilizers + 1 N, P, and K	0,22 a

Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%.

The results of Fluventic Eutrudepts initial soil analysis on the N-total soil content showed 0.13% and became 0.11% in treatment A (Control). The total N-content in Fluventic Eutrudepts soil has decreased due to root activity. Roots release root exudates in the soil, but roots do not correspond with soil organisms so that roots do not change the structure of the rhizosphere and nutrients in the soil decrease. Giving doses of inorganic fertilizers that contain large amounts of N nutrients will increase the total N content so that the N nutrients that enter the soil will be higher (Bachtiar et al., 2019). This is in line with the statement of Setiawati et al. (2021) that taking nutrients bound to soil colloids is more optimal in increasing total nitrogen levels in the soil so that plant growth will be good and can increase productivity.

Based on the data in Table 5, it can be seen that each treatment showed different total nitrogen in the soil. The difference in the total N-content of soil in each treatment could be due to differences in the percentage of application of biofertilizers with inorganic fertilizers N, P and K. Treatment E (1 biological fertilizer + ¾ N, P, and K fertilizers) showed the highest level of soil N-total fertilizer, namely 0.32% and treatment A (Control) showed the treatment with the lowest total N-content in the soil, namely 0.11%. An increase in the total N-content of soil occurs in line with an increase in the population of N-fixing bacteria which play a role in forming a food network and maintaining the continuity of the N cycle in the soil (Bachtiar et al., 2017). The mechanism of N-fixing bacteria in providing N in the soil occurs due to bacterial nitrogenase activity in reducing N2 in the air to NH3- and increasing total N in the soil (Setiawati et al., 2021).

According to Gardner et al. (2008) the ability of N-fixing bacteria found in biofertilizers to fix nitrogen nutrients and provide available nitrogen nutrients for plants. N_2 fixation activity by bacteria is one of the things in maintaining the balance of nitrogen elements as a whole because fixed nitrogen elements can continuously be lost due to denitrification (Pamungkas & Prasetya, 2017). Based on this, it shows that the application of biofertilizers in excess amounts cannot increase the total N-content due to the denitrification process. The denitrification process is the process of converting nitrite (NO3) into nitrogen gas (N2) which is released into the atmosphere. The process of denitrification through the reduction reaction of nitrogen compounds that have been oxidized by bacteria. The denitrification reaction can be described in the following reaction.

$$2NO_3^- + 10e^- + 12H^+ \dashrightarrow N_2 + 6H_2O$$

The level of nitrogen content in the soil is also influenced by the amount of intake of nitrogen nutrients that enter the soil and loss of nitrogen nutrients due to evaporation and leaching processes (Khalif et al., 2014). This indicates that nitrogen in the soil is easily lost due to volatilization, leaching and denitrification processes. In line with the statement of Widiana et al. (2020) that the leaching and erosion processes that occur can result in leaching of basic anions and cations which play an important role in meeting the needs of plant nutrients.

3.2.2 Plant N Uptake

The results showed that sweet corn plants treated with a combination of liquid biofertilizers with inorganic fertilizers N, P, and K had a significant effect on N uptake. Observations on N uptake of sweet corn plants can be seen in Table 6.

TABLE 6
EFFECT OF LIQUID BIOFERTILIZERS WITH INORGANIC FERTILIZERS N, P, K ON PLANT N UPTAKE IN FLUVENTIC EUTRUDEPTS JATINANGOR

Symbol	Treatment	Plant N Absorption (mg.plant $^{-1}$)
A	Control (no fertilizer application)	1,99 a
B	1 N, P, and K	3,04 b
C	¾ N, P, and K	2,94 b
D	½ biofertilizers + ¾ N, P, and K	3,12 b
E	1 biofertilizers + ¾ N, P, and K	3,46 c
F	1 ½ biofertilizers + ¾ N, P, and K	3,12 b
G	½ biofertilizers + 1 N, P, and K	3,30 b
H	1 biofertilizers + 1 N, P, and K	3,13 b
I	1 ½ biofertilizers + 1 N, P, and K	3,04 b

Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%.

Based on the data in Table 6, it shows the absorption level of the sweet corn plants varies in each treatment plot. The difference in the level of nutrient uptake is influenced by the availability of nutrients in the soil. Treatment E (1 biological fertilizer + ¾ fertilizer N, P, and K) showed the treatment with the highest absorption rate of 3.46 mg.plant-1 and treatment A (control) showed the treatment with the lowest nutrient absorption rate of 1.99 mg .plant-1. This shows that the application of biofertilizers with inorganic fertilizers N, P, and K has an effect on increasing N uptake through bacterial activity. In line with the statement of Yuniarti et al. (2020) that the absorption of N nutrients by plants affects the N content of plants.

The application of fertilizers containing N nutrients is not only a source of nutrients for plants, but can play a role in releasing ammonium ions in the soil which are absorbed by plants through a mass flow mechanism so that these ions will be available to plants (Agsari et al., 2020). This is in line with Khairul's statement (2022) that applying very high N fertilizers can increase the concentration of N in the soil in the form of NH4+, so that Ca2+, Mg2+, Fe3+, Mn2+ and Na+ ions will be replaced by NH4+ in soil colloids. Increased plant N uptake correlated with increased plant dry weight, plant root development, and increased soil N availability (Wahyudin *et al*., 2019).

High levels of N absorbed by plants can increase the weight of sweet corn plant biomass. According to Anjasmara (2019) the increased weight of sweet corn cobs is due to the plant's ability to absorb available nutrients. The high cob weight value indicates that the ability of the plant to absorb nutrients is also high. Plant nutrient uptake basically depends on the concentration of nutrients in the soil in the process of plant body formation. The amount of nitrogen absorbed by plants has increased so that it correlates with plant growth in active meristematic tissue, especially in the growth of plant height and stem diameter (Febrianna et al., 2018). This is in accordance with the statement of Pamungkas & Prasetya (2017) that the growth of plant height and stem diameter correlates with the results of photosynthesis as a food reserve, resulting in heavier cob weight.

Element N is needed by plants which are supplied from the decomposition of organic matter, nitrogen fixing bacteria, organic fertilizers, and the allocation of nitrogen fertilizers in agricultural cultivation (Febrianna et al., 2018). Fulfillment of plant N nutrient needs can not only be through the provision of organic fertilizers, but can also be through the fertilization of biofertilizers. Bacteria contained in biofertilizers help to increase the N content of plants through diazotrophy or biological fixation of atmospheric nitrogen so that a qualitative increase in plant nutrition does not immediately show changes in root morphology because the bacteria are not directly related to the soil itself (Setiawati & Suryatmana, 2022). This is in line with the statement of Setiawati et al. (2020) that the role of bacteria found in biofertilizers correlates with nitrogen metabolism in plants using bacterial urease in increasing nitrogen uptake.

3.2.3 N-Fixation Bacteria

The results showed that the sweet corn plants treated with a combination of liquid biofertilizers with inorganic fertilizers N, P, and K had a significant effect on the population of N-fixing bacteria. The observational data for sweet corn N-fixing bacteria can be seen in Table 7.

TABLE 7
EFFECT OF LIQUID BIO FERTILIZERS AND N, P, K FERTILIZERS ON POPULATIONS OF N-FIXING BACTERIA

Symbol	Treatment	Population of BPN (CFU.g^{-1})
A	Control (no fertilizer application)	0,21 x 10^8 a
B	1 N, P, and K	0.47 x 10^8 a
C	¾ N, P, and K	0,77 x 10^8 b
D	½ biofertilizers + ¾ N, P, and K	0,78 x 10^8 b
E	1 biofertilizers + ¾ N, P, and K	1,33 x 10^8 c
F	1 ½ biofertilizers + ¾ N, P, and K	1,15 x 10^8 b
G	½ biofertilizers + 1 N, P, and K	0.81 x 10^8 b
H	1 biofertilizers + 1 N, P, and K	0,85 x 10^8 b
I	1 ½ biofertilizers + 1 N, P, and K	0,91 x 10^8 b

Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%.

Based on Table 7, it shows that each treatment has a different total population of N-fixing bacteria. Treatment E (1 biological fertilizer + ¾ N, P, and K fertilizer) showed the highest population of N-fixing bacteria, namely 1,33 x 10^8 CFU.g^{-1} and treatment A (Control) showed the lowest population of N-fixing bacteria, ie 0,21 x 10^8 CFU.g^{-1}. The density of N-fixing bacterial cells in this liquid biofertilizers complies with the quality standard of the Ministry of Agriculture number 70/Permentan/SR.140/10/2016 namely above 10^7 CFU.g^{-1}. This is in line with the statement of Danapriatna & Simarmata (2011) that cell density is included in the optimal standard category in increasing the root surface area by 10^7 CFU.g^{-1} per plant.

The increase in the average population of N-fixing bacteria in the soil is influenced by the amount of biofertilizers given and the growing environment of the planting medium (Ariflandha & Setiawati, 2018). The high population of bacteria can help meet the supply of nitrogen in secreting growth hormone during the vegetative phase, so as to produce the photosynthate needed in the generative phase. According to Alin & Setiawati (2017) populations of N-fixing bacteria are produced from bacterial culture ratios as carriers for biofertilizers which can increase energy and nutrient sources for bacteria. This is in line with the statement of Danapriatna & Simarmata (2011) that the addition of nutrients to each carrier formulation is due to the availability of energy sources for bacteria in the form of sucrose and glucose so as to increase microbial viability in biofertilizers.

N-fixing bacteria are able to develop and survive in new environments with stressed conditions, such as acidic soil pH and the ability to compete with other indigenous bacteria (Setiawati et al., 2020). According to Sofatin et al. (2017) several factors that affect the population of N-fixing bacteria include soil type, environmental conditions, agricultural practices carried out and previous land conditions. N-fixing bacteria can grow well in soils with a neutral pH, namely 6,00 - 8,00 (Kantikowati & Firmansyah, 2019).

Bacteria Azospirillum sp. is one of the N-fixing bacteria that acts as a biological fertilizer. Mechanism of *Azospirillum* sp. as a biological fertilizer, namely through nitrogen fixation in the atmosphere and stimulating plant growth through the synthesis of substances that support plant growth (Rosmalia, 2019). This is in line with the statement of Pamungkas & Prasetya (2017) that the use of Azosfirillum sp. It is capable of donating nitrogen and balancing nitrogen in the soil through the process of nitrogen fixation. The availability of oxygen is able to provide lower IAA production than under microaerobic conditions, so

Azospirillum sp. has great potential to produce auxin. Based on this, the bacteria *Azospirillum* sp. which is used as a raw material for the manufacture of liquid biofertilizers is an isolate that is superior in fixing N and IAA (auxin) production.

3.2.4 Yield Components of Sweet Corn

The components of sweet corn yield observed included cob weight per plot, cob weight with husks, cob weight peeled, cob diameter, and cob length. The results showed that the sweet corn plants that were given liquid biofertilizers and inorganic fertilizers N, P, and K had a significant effect on the yield components of sweet corn. Data from observations of the sweet corn yield components can be seen in Table 8.

TABLE 8
THE EFFECT OF INORGANIC FERTILIZERS N, P, AND K WITH LIQUID BIO FERTILIZERS ON SWEET CORN YIELDS

Symbol	Treatment	BTPP (kg)	BTB (g)	BTK (g)	DT (mm)	PT (cm)
A	Control (no fertilizer application)	4,7 a	309,4 a	201,3 a	43,56 a	19,7 a
B	1 N, P, and K	8,8 b	384,4 b	276,1 a	47,80 b	19,8 a
C	¾ N, P, and K	8,3 b	369,3 b	242,7 a	47,04 b	19,8 a
D	½ biofertilizers + ¾ N, P, and K	8,1 b	394,5 b	280,1 a	48,57 b	19,9 a
E	1 biofertilizers + ¾ N, P, and K	11,6 c	423,5 c	334,7 b	52,79 c	23,9 c
F	1 ½ biofertilizers + ¾ N, P, and K	8,7 b	388,9 b	280,6 a	49,11 b	20,3 b
G	½ biofertilizers + 1 N, P, and K	10,2 b	396,7 b	285,3 a	49,56 b	20,5 b
H	1 biofertilizers + 1 N, P, and K	9,3 b	395,7 b	283,8 a	49,27 b	20,4 b
I	1 ½ biofertilizers + 1 N, P, and K	7,51 b	397,3 b	285,3 a	49,68 b	19,8 a

Note: Numbers followed by the same letters do not show significant differences according to the Duncan's Multiple Range Test 5%. BTPP = Cob Weight Per Plot, BTB = Cob Weight, BTK = Cob Weight, DT = Cob Diameter, PT = Cob Length

Based on the research results in Table 8, the use of liquid biofertilizers with inorganic fertilizers N, P and K has a significant effect on the yield component of sweet corn. Treatment E (1 Biofertilizers + ¾ N, P and K Fertilizer) showed the highest sweet corn yield component compared to other treatments with the order of treatment including cob weight per plot (BTPP) of 11.6 Kg, cob weight (BTB) of 423.5 g, peeled cob weight (BTK) of 334.7 g, cob diameter (DT) of 52.79 cm, and cob length (PT) of 23.9 mm and treatment A (control) showed the yield component of sweet corn lowest compared to all treatments in the order of cob weight per plot (BTPP) of 4.7 kg, cob weight (BTB) of 309.4 g, peeled cob weight (BTK) of 201.3 g, cob diameter (DT) of 43.56 cm, and cob length (PT) of 19.7 mm. According to Indiarto et al. (2022) the increase in the yield component of sweet corn is influenced by plant growth such as plant height and stem diameter.

Sweet corn plants provide optimal results if the supply of nutrients is sufficient for plant growth. This is in line with the statement of Pasta et al. (2015) that the yield of sweet corn plants is said to be optimal if one of the conditions is met, such as the availability of sufficient nutrients. This is also supported by the statement of Darwin et al. (2017) that the need for sufficient nutrients absorbed by plants, both macro and micro elements will provide plant growth and productivity will increase. Sweet corn plants require nitrogen elements throughout their growth and are very effective in using ammonium even though most of it is taken in the form of nitrate (Sudirdja et al., 2020). Based on this, the element nitrogen in the soil can increase plant growth such as the number of leaves, stem diameter, cob length so that the weight of sweet corn cobs will be higher.

Element P has a role as a constituent of compounds to store and transfer energy from photosynthesis in the generative phase. According to Pasta et al. (2015) the role of element P in the generative phase is allocated to the process of forming plant seeds or fruit. This is in line with the statement of Puspadewi et al. (2019) that nutrient P has a function as an energy source in various plant metabolic reactions and plays an important role in increasing yields and providing lots of photosynthate which is distributed into the seeds so that the yield of corn plant seeds increases. Based on this, it shows that the harvest index describes the amount of photosynthate correlated with the formation of seeds originating from the plant canopy.

Observation of cob diameter and cob length is an overview of the results of the process of filling sweet corn kernels. The process of filling the seeds cannot be separated from the role of nutrients absorbed by plants. According to Khairul (2022) the absorbed nutrients will be accumulated in the leaves into proteins that can form seeds. This is in line with the statement of Trinurani et al. (2017) that the fulfillment of plant nutrient needs causes metabolism to run optimally so that the formation of proteins, carbohydrates and starch is not hampered, as a result the accumulation of materials resulting from metabolism in seed formation will increase so that the seeds formed have maximum size and weight.

The formation of sugar in sweet corn cobs is related to the maturity level of sweet corn cobs. According to Puspadewi et al. (2019) the developmental stages of sweet corn maturation include the pre-milk, milk and dough levels. The pre-milk level is characterized by a sweet taste with a sugar content of 6.3%, starch content of 3.3%, rather small seeds and rather clear seed endosperm. The milk level shows a sweeter taste but the seeds have become older and bigger than pre-milk and the seed endosperm looks like milk while the dough level is marked by the rapid change of seeds that look wrinkled. The low total dissolved solids is caused by a lack of nitrogen and phosphorus nutrients in plants. According to Haerani (2019) nitrogen and phosphorus nutrients for plants can increase the development of sweet corn seeds and also increase metabolic processes so that there is an increase in total dissolved solids in the seeds. This is in line with the statement of Mubarok et al. (2022) that the formation of protein in sweet corn kernels is influenced by the availability of N nutrients, so that absorption of N. The addition of the weight of the sweet corn cobs transported to the sweet corn cobs increases the weight of the sweet corn cobs.

Bio-fertilizers contain microbes that are capable of producing active compounds that play a role in breaking down nutrients in the soil (Setiawati et al., 2020). This is in line with the statement of Setiawati et al. (2021) that the activity of microorganisms can increase the ability of soil to store water, so that nutrients are more easily absorbed by plants. Hardjowigeno (2015) explained, the application of biofertilizers has a very important influence in improving the chemical and physical properties of the soil, one of which is providing nutrients for plants and helping to increase the soil's ability to hold water. The availability of nutrients can be provided through fertilization until they reach the ideal for plant growth and will increase the productivity of plants according to their genetic maximum conditions (Wulansari et al., 2022).

Biofertilizers play a role in increasing soil fertility through the application of microorganisms in providing nutrients and increasing plant productivity. According to Setiawati & Suryatmana (2022) the availability of available nutrients is due to the application of inorganic fertilizers and microorganisms contained in biofertilizers that can make the growth process and the results of photosynthesis accumulate in the assimilate storage organs and the final result is reflected through an increase in the yield component. The presence of microbes at the beginning of application and increased from day to day caused these microbes to be able to decompose soil organic matter and at the level of uptake of inorganic fertilizers by plants to be more optimal. According to Kalay et al. (2020) the use of *Azozpirillum* sp. as a nitrogen fixing bacteria (N2) it reaches 40-80% and produces IAA phytohormones which play a role in increasing plant growth and yields, especially in accelerating flowering and ripening of the fruit produced, so as to improve the quality of the yield components of sweet corn plants. Based on this, the use of biofertilizers can increase the yield component of sweet corn and reduce the dosage of inorganic fertilizers.

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

Based on the results of research and discussion it can be concluded as follows:

1. The combination of liquid biofertilizers with N, P, K fertilizers has an effect on N-total soil, N uptake, N fixing bacteria and sweet corn yield (cob weight per plot, cob weight with husk, cob weight without cob, cob diameter and cob length).
2. Dose combination of 1 liquid biofertilizers (5 $L.ha^{-1}$) with ¾ fertilizer N, P, and K (225 $kg.ha^{-1}$ Urea, 112.5 $kg.ha^{-1}$ SP-36, 75 $kg.ha^{-1}$ KCl) is the treatment dose that gives the best results on N-total soil (0.32%), N uptake (3,46 $mg.crop^{-1}$), N fixing bacteria (1,33 x 10^8 $CFU.g^{-1}$) and sweet corn yields consisting of cob weight per plot (11.6 kg), cob weight with husks (423.5 g), cob weight without husks (334.7 g), cob diameter (52.79 mm), and length cob (23,9 cm).

4.2 Suggestion

Further research is needed with different soil orders, and it is necessary to carry out a consortium analysis of combinations of liquid biofertilizers containing several symbiotic and non-symbiotic bacteria with compound fertilizers.

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Marketing of Parica Wood (*S Chizolobium Amazonicum*) Production in the Plywood Industry through Empowerment of Farming Families in East Kalimantan Province

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Abstract— *This research aims to determine the long-term business of a Dipterocarpa.sp farming family, in marketing plantation forest production to support the plywood industry in East Kalimantan Province. The research was carried out from January 2021 to June 2021. The research location is PT. Melapi, East Kalimantan Province. This research utilized an area of 10,000 m2 planted with Parica (Schizolobium amazonicum) aged 4 to 6 years. The results showed that: (1) annual incremental growth of 43.88 m3/ha/year with production marketing of 351,03 m^3/ha within 8 years within 8 years. When marketed at annual prices. When marketed at a price Rp. 300.000/m^3, then the average income per year (EAA) / ha of Rp. 7.372.300 (7372,3 US$/ha/thn), while the business scale needed to meet the needs of a farmer's family is at least 45 ha; (2) Another advantage of plantation forest exploitation is that the price of wood is cheaper per m3 and the required forest area is smaller than natural forest exploitation.*

Keywords— Marketing, Parica Wood, Business Scale.

I. INTRODUCTION

The wood processing industry in East Kalimantan Province has recently experienced difficulties in obtaining log raw materials. The productivity of natural forests is decreasing both in terms of quantity and quality. Some of the causes are uncontrolled logging operations, rampant illegal logging, encroachment and conversion of forest land into other areas, as well as fires that occur either naturally due to prolonged drought or non-naturally due to irresponsible human activities.

One of the real impacts on the forest is that it is increasingly difficult to obtain wood from commercial species, and due to the large demand for wood, the production target has shifted by utilizing other types that are less commercial. To reduce this pressure on natural forests, the development of industrial tree plantations (HTI) has begun to flourish. However, it is very unfortunate that those that should be developed in degraded and less productive areas, in fact, not a few are using potential natural forest land under the pretext of land conversion because it is no longer potential. The types of HTI plants developed can still be counted on the fingers and fast growing species are generally selected. The purpose of using wood is still limited as raw material for pulp and paper or light construction, besides that in terms of area area it has not been able to cover the demand for wood raw materials. Several pulp and paper industries are still very dependent on the supply of wood from natural forests by utilizing timber utilization permits (IPK), so that the initial goal of reducing pressure on the remaining natural forests is still far from expectations.

Parica wood (*Schizolobium amazonicum* Huber Ducke) is a lesser-known type of wood from the Leguminosae family, a native plant from Brazil which is widely found throughout the Amazon rainforest. In Indonesia this tree species is still not familiar enough because of its limited existence. From the information obtained so far, this type of parica wood is only found in the Purwodadi Botanical Garden. This type of wood can be classified as fast-growing wood because it has a high diameter increment of 3.68 cm per year at the age of 8 years (Amin et al. 2008), even higher than that of acacia wood (2.4 cm per year). years, age 4 years) (Rossi et al. 2003).

The Paricá (*Schizolobium amazonicum* Huber Ducke) is a viable native species for recuperation of disturbed areas and with a role in the wood market, nationally and internationally. Its rapid growth and adaptation to areas with low nutrient levels allow it to be optimum in agroforestry systems, being the second plant species used in reforestation in the state of Para (Ruivo, et. al. 2019).

The aim of the research was to find out the long-term business of a Dipterocarpa.sp farming family, in marketing plantation forest production to support the plywood industry in East Kalimantan Province.

II. RESEARCH METHODS

2.1 Time and Location

This research was conducted from January 2021 to June 2021. The research location is PT. Melapi, East Kalimantan Province.

2.2 Materials and tools

The materials used are Company Results Reports and consumable materials such as raffia rope, tree number paper, and others. The tools used in this research were poles, tape measure, machetes, hoes, 1.3 m wooden blocks, cameras, stationery and others..

2.3 Object of research

This research utilized an area of 10,000 m2 planted with Parica (*Schizolobium amazonicum*) aged 4 and 6 years.

2.4 Data collection

The data collected is primary data in the form of plant diameter and height; and secondary data, namely the results of company reports and estimated mathematically.

2.5 Data analysis

According to Ruchaemi (2019), calculating the volume of a log in a stand uses the following formula : $V = [\pi d^2)/4] \times h \times f$ (with a dbh of 1.3 m above the ground, and form factor /f = 0.7-0.8) whereas to calculate the annual average volume growth increment of stands (MAI) the following mathematical formulation is used MAI =TV/n**,** where : TV is the total production of parica and waru in a period of n years, and n is the measurement period, while the incremental growth of the current annual average volume of Shorea sp and CAI uses the following formula, namely CAI =ΔTV/Δn, where ΔTV á is the increase in the total amount of parica production over a period of n years, and n is the increase in the age of the parica.

Cash flow data related to cash out activities in the form of the initial planting process to the harvesting process. Meanwhile, the incoming cash component is the sales of parica wood per m3 which was valid at the time of the research.

Economic analysis in this research uses an investment approach as an analysis of long-term farming levels (Fillius, 2016; Avila.M, 2018 and Gregersen H, 1017 in Andayani W, 2021). This is because the types of commodities applied in the pattern in question are plants with long cycles (rotations), using the following parameters: (1) Payback Period; (2) Net Present Value; (3) Net Benefit Cost Ratio; (4) Internal Rate of Return, and (5) Equivalent Annual Annuity. The formula for each data analysis is as follows:

2.5.1 Payback Periods

$$PP = n_1 + (n_2 - n_1)\left[\frac{a1}{(a1 + a2}\right]$$

2.5.2 Net Benefit Cost Ratio (B/C Ratio)

$$Net\frac{B}{C} = \frac{\frac{\sum_{t=1}^{t=n} B_t - C_t}{(1+i)^t}0}{\frac{\sum_{t=1}^{t=n} B_t - C_t}{(1+i)^t}} \quad \begin{array}{l} \rightarrow \quad B_t - C_t > 0 \\ \rightarrow \quad B_t - C_t < 0 \end{array}$$

2.5.3 Net Present Value (NPV).

$$NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

2.5.4 Internal Rate of Return (IRR)

$$IRR = i_1 + \frac{NPV^+}{NPV^+ - NPV^-}(i_2 - i_1)$$

2.5.5 Equivalent Annual Annuity (EAA)

$$EAA = NPVx\frac{i^+}{i-(1+i)^{-n}}$$

III. RESULTS AND DISCUSSION

In theory, an increase in the volume of stands applies the Law of Diminishing Return, where the calculation of projected wood production at the end of the cycle must be carried out in a 'time series' so that the shape of the production growth curve can be identified. The projected volume of Parica wood can be seen in Table 1 below:

TABLE 1
PT. MELAPI PARICA VOLUME IN EAST KALIMANTAN PROVINCE

Age (Year)	n	d	h	F	V	TVst	MAI_{st}	CAI_{st}
		(cm)	(m)		(M^3)	M^3/ha	M^3/Ha/thn	M^3/Ha/thn
2	1500	10,0	12,0	0,52	0,049	73,48	36,74	
4	1300	15,0	13,0	0,51	0,117	152,23	38,06	39,38
6	1000	21,0	14,0	0,50	0,242	242,33	40,39	45,05
8	900	26,0	15,0	0,49	0,390	351,03	43,88	54,35
10	500	29,0	16,0	0,48	0,507	253,51	25,35	48,76

Note :

TVst : *Total Volumes (m^3) standing stock*
St : *Standing Stock (m^3. ha^{-1}. th^{-1})*
tot : *Total (m^3. ha^{-1}. th^{-1})*
N : *Number of trees per hectare*

Based on Table 1 above, it shows that Parica plants are expected to be harvested at the age of 8 years and have a total volume of 351,03 m^3 $year^{-1}$, with an average diameter of 26 cm and an average increase in increments 43,88 m^3. ha^{-1} $year^{-1}$

The growth graph of the incremental volume of the average standing stock can be seen in Figure 1 below:

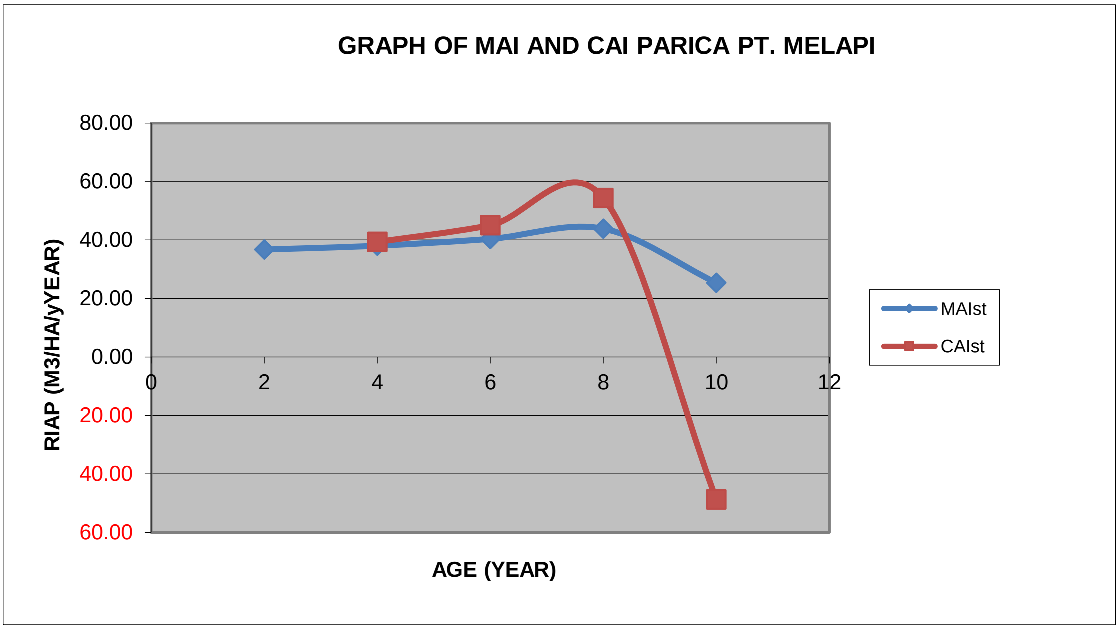

FIGURE 1: MAI and CAI Parica at PT.Melapi, East Kalimantan Province

Growth increments in average standing stock volume increased from 2 years to 8 years old, whereas after 8 years, MAI and CAI decreased. From the graph above it can also be seen that the reduced population of parica stands per hectare (under 2 years old) is due to natural death. Thinning is done at the age of 4 years 9,80 $m^3. ha.^{-1}$ after the age of 6 there is an intermediate harvest of 35,13 $m^3. ha.^{-1}$ it is estimated that the parica stands will reach the highest increment with the largest log diameter of 26 cm in the 8 year logging year with a marketing volume of 351,03 $m^3. ha.^{-1}$, The tree height is 15 meters and the shorea's annual average increment is 43,88 $m^3. ha.^{-1}. th^{-1}$.

The parica business cash flow which has been processed from start to finish involving all cost and income components is used as the basis for calculating various financial analysis criteria. The parica business at an interest rate of 5% has a Net Present Value (NPV) and Net B/C of Rp. .7,372,300 and 1.29. This statement is reinforced by the analysis of the Internal Rate of Return (IRR) model with a value of 9.5% and an average annual income (EAA) of IDR 1,140,495 and a business scale of 45 ha/family. The results above show that the parica business at an interest rate of 5% is feasible to try because the value is positive and greater than the Minimum Accessibility Rate (*MAR* = 4,5%).

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

1. Decreased standing population per hectare due to natural mortality and thinning. Natural death takes place before the age of 2 years, thinning is done at the age of 4 years, intermediate harvest is done at the age of 6 years and the optimal volume increment is at the age of 8 years because the parica cycle in East Kalimantan is 8 years long.
2. The parica business is feasible to develop, this can be seen from the value of the Internal Rate of Return which is greater than the Minimum Accessibility Rate (MAR = 4.5%), which is 9.5% and the business scale needed to meet the needs of farming families minimum of 45 ha.
3. Another advantage of plantation forestry is that the price of wood is cheaper per m^3 and the required forest area is smaller than that of natural forest.

4.2 Suggestion

Parica plantation forest is feasible to be cultivated and developed because besides the price of wood per cubic meter is cheaper, the required area of land is also smaller than natural forest.

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