REPORT

ON

TWO WEEKS OF INTERNSHIP I (ACTIVITY-BASED)

Carried out on

A Comparative Study on Emerging Agricultural Equipment's Applications

Submitted to

NMAM INSTITUTE OF TECHNOLOGY, NITTE

(**Off-Campus Centre, Nitte Deemed to be University, Nitte - 574 110, Karnataka, India**)

In partial fulfilment of the requirements for the award of the

Degree of Bachelor of Technology

in

Biotechnology Engineering

by

Kishan Raj

USN **NNM23BT027**

Under the guidance of

Dr. Santhosh Poojary

Assistant Professor Gd-III

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

CERTIFICATE

This is to certify that Mr. **KISHAN RAJ**, *bearing* USN-**NNM23BT027** *of I year B.Tech., a bonafide student of NMAM Institute of Technology, Nitte, has undergone Internship I on "***A Comparative Study on Emerging Agricultural Equipment's Applications***" during 2023-24, fulfilling the partial requirements for the award of degree of Bachelor of Technology in* ***Biotechnology*** *Engineering at NMAM Institute of Technology, Nitte***.**

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Name and Signature of Mentor	*Signature of Dean (Academics)*

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who have contributed to the completion of this comparative study on emerging agricultural equipment applications.

I extend my heartfelt gratitude to N M A M Institute of Technology, Nitte for providing me with the opportunity to conduct this comparative study on emerging agricultural equipment applications. I am especially thankful to Dr. Santhosh Poojary for their continuous support, encouragement, and insightful guidance throughout the research and report process.

Dr. Santhosh Poojary's invaluable guidance and support throughout this research and report on emerging agricultural equipment applications are deeply appreciated. Their expertise shaped the direction of this study and ensured its quality.

Additionally, thanks to my teammates, Kaushik Srinivas, Khhushi Singh, Lipi PV and M Pavan Shenoy, for their significant contributions to data collection and field visits. Their collaborative efforts greatly enriched the report process.

Finally, I would like to express my deepest appreciation to my family for their unwavering support and patience while I worked on this report. Their belief in me served as a constant source of motivation during challenging times.

Thank you

KISHAN RAJ

Table of Contents

ABSTRACT

Mechanization has become the most important aspect of modern agriculture in India due to increasing demand, less yield, scarcity of farm labourers', etc. To maintain sustainability in the agricultural sector, it is essential to spread awareness of Farm Mechanization among the farmers. A summary of the different machines and some important agricultural tools which are currently used towards Farm Mechanization in India and their development is also studied. With a rising population and a demand for increased agricultural output, traditional farming methods in India are struggling to keep pace. This challenge is compounded by factors like declining yields and a shrinking pool of farm labour. Farm mechanization has emerged as a critical solution, offering the potential to improve efficiency, productivity, and sustainability in the agricultural sector. However, the widespread adoption of these technologies requires increased awareness among farmers. This internship report based on agricultural mechanization explores the current state of farm mechanization in India, highlighting the different machines being used and their developmental trends and a field visit on related topic. By promoting awareness and understanding of these advancements, we can empower farmers to leverage the benefits of mechanization for a more sustainable and prosperous agricultural future.

1. INTRODUCTION:

Farm mechanization, the application of machines to agricultural tasks, is a critical driver of progress in India's vast rural sector. While it holds immense potential to transform lives and economies, significant challenges need to be addressed for widespread adoption.

India's agricultural sector witnessed a significant transformation in the 1960s with the Green Revolution. This initiative aimed to address food scarcity through a multi-pronged approach that included introducing improved high-yielding crop varieties, promoting the use of chemical fertilizers, expanding irrigation systems, and educating farmers on modern agricultural practices. While successful in boosting food production, the Green Revolution primarily focused on seed and fertilizer advancements, with less emphasis on farm mechanization.

Two key trends are driving the need for increased farm mechanization in India. Firstly, urbanization and the emergence of alternative employment opportunities in factories and service sectors are leading to a decline in the agricultural workforce. This creates a labour scarcity in rural areas, making it imperative to find ways to improve farm productivity with a reduced workforce.

The Indian farm mechanization market is estimated at a substantial US$16.73 billion in 2024 and is projected to reach US$25.15 billion by 2029. This significant growth reflects the increasing recognition of mechanization's role in agricultural development.

The Government of India has recognized the importance of farm mechanization and has launched initiatives like the Sub-Mission on Agricultural Mechanization (SMAM) to promote its adoption. SMAM provides subsidies for purchasing agricultural machinery and implements, facilitates custom hiring services to make machinery accessible to small and marginal farmers, and promotes research and development in farm mechanization technologies.

Government initiatives play a vital role in providing subsidies, promoting credit facilities, and facilitating access to rental services for machinery.

2. MECHANIZATION HISTORY:

The earliest innovations involve the invention of the first implements to advance farming beyond working directly with hands, sticks, and simple stone hoes. A few examples include:

2.1. Use of Animal-drawn Plows:

2.1: Wooden animal-drawn Plows

Beginning with the domestication of oxen (first in the Indus Valley around 4000 BC) draft animals would soon allow for much more efficient use of emerging plough technologies. Wooden, animal-drawn ploughs would become the preferred method of tilling by 1500 BC. Some of the earliest wooden plough examples are found In Ancient Sumerian (modern-day Iraq).

2.2. Sickle (Simple flint or stone blades):

2.2: Sickle (Simple flint or stone blades)

Sickles, with their flint/stone blades on wooden handles, are ancient tools that revolutionized grain harvesting. Early metalworking led to copper and bronze versions for improved durability. Despite a stooped working position, their simplicity and affordability kept them in use. Even today, sickles remain a valuable tool for harvesting crops and gardening.

2.3. Steel Plows:

2.3: Steel Plow by John Deere

Before the Early Middle Ages, European agriculture primarily relied on wooden ploughs. These implements proved to be less effective in the region's colder climate. Wooden ploughs were susceptible to warping and cracking due to freezing temperatures.

While metal ploughs represented a significant advancement, the innovation continued with the development of steel ploughs. The first commercially successful steel plough is credited to John Deere in 1837. However, Deere's contribution went beyond simply using steel. His design incorporated a polished steel share, a key feature that addressed the challenge of tilling land with sticky soil. This innovation, particularly beneficial for the thick prairie sods of the American Midwest, revolutionized agriculture. The steel plough's increased efficiency allowed farmers to cultivate previously difficult land, leading to a substantial rise in agricultural productivity.

3. CHALLENGES IN THE ROUTE OF MECHANIZATION:

a) Knowledge Gap:

Farmers accustomed to traditional methods may be hesitant to embrace new technologies. Educational programs and demonstrations are crucial to bridge the knowledge gap and showcase the benefits of mechanization.

b) Land Fragmentation:

Small, divided landholdings make large-scale machinery impractical and uneconomical. Solutions like custom hiring services or promoting smaller, more manoeuvrable machines are needed.

c) Financial Constraints:

The high upfront cost of machinery and limited access to credit pose a significant barrier for resource-constrained farmers. Government subsidies and innovative financing schemes can incentivize investment.

d) Technological Inadequacies:

Existing machinery may not be suitable for India's specific needs, such as small farm sizes and diverse soil types. Increased R&D efforts are required to develop cost-effective, multi-functional machines for Indian farms.

e) Infrastructure and Support Issues:

Limited availability of spare parts and a sparse service network can make maintaining machinery challenging. Strengthening the infrastructure for spare parts supply and establishing a wider service network are essential.

f) Geo-diversity:

The vast variety of soil types across India necessitates machinery designed to handle these diverse conditions. Developing regionally specific machinery solutions can address this challenge.

4. CURRENT MACHINES:

4.1. Tractor:

4.1: Tractor

Post-Independence Period: Initially, tractors were imported post-independence, making mechanized technology unaffordable for farmers. However, this changed in the 1970s when Indian companies began manufacturing indigenous tractors, marking a shift towards self-sufficiency in tractor production.

1961 and Beyond: Tractor production in India commenced in 1961 with five key manufacturers - Eicher, Mahindra and Mahindra, TAFE, Gujarat Tractors, and Escorts. In the early years, production was limited to just 880 units annually. The first fully developed indigenous tractor was the Swaraj 724, a 26.5 HP model manufactured by Punjab Tractors Limited in 1974.

Present Scenario: Today, India stands as the largest manufacturer and market for tractors globally. With over 16 tractor companies operating in the country, market leaders like Mahindra, TAFE, and John Deere, among others, produce a wide range of tractors ranging from 14 hp to 120 hp. These companies offer advanced technology to facilitate various farm operations efficiently.

4.2. Sowing and planting equipment:

4.2: Sowing and Planting equipment

Traditional vs. Modern Methods: Traditional ways of sowing, like the animal drawn Dufan and tifan, though cost-effective, are time-consuming and prone to errors, leading to inferior work quality. However, these traditional methods have been largely replaced by modern mechanized solutions like mechanically metered seed drills and seed-cum-fertilizer drills operated by tractors. These modern implements offer higher efficiency and precision, with tractor-drawn seed drills capable of working up to nine rows, significantly improving the speed and accuracy of planting operations.

Seed Cum Fertilizer Drill Components: The seed cum fertilizer drill comprises essential components such as a seed box, fertilizer box, seed and fertilizer metering mechanisms, seed tubes, furrow openers, seed and fertilizer rate adjusting lever, and transport cum power transmitting wheel. These components work together to ensure accurate and uniform seeding while optimizing the application of seeds and fertilizers, contributing to enhanced crop yields and overall farming efficiency.

The evolution from traditional sowing methods to modern mechanized equipment highlights the agricultural sector's continuous drive towards innovation and efficiency, ultimately benefiting farmers by improving planting accuracy, reducing labour, and enhancing crop productivity.

4.3. Interculture & plant protection equipment:

4.3: Interculture & plant protection equipment

The history of weed control in agriculture has evolved from traditional manual methods to modern mechanized solutions, aiming to address the challenges posed by weeds in both irrigated and rain-fed farming:

Traditional Methods: Historically, tools like Khurpi/Vila or scythe were commonly used for weeding removal in agriculture. While these manual tools are popular and cost-effective, they are labour-intensive and time-consuming, leading to increased expenses for farmers.

Mechanized Solutions: Over time, manually operated equipment like long-handle wheel hoes, peg weeders, and Cono weeders have gained popularity due to their mechanical advantages, which help reduce the time spent on weeding tasks. Despite being time-consuming, these tools are considered highly effective in weed control as they allow for precise and targeted weed removal, minimizing crop damage compared to other methods.

The historical progression in weed control methods reflects a shift towards mechanization to improve efficiency and productivity in agriculture while effectively managing the challenges posed by weeds, ultimately contributing to enhanced crop yields and sustainable farming practices.

4.4. Harvesting & Threshing:

4.4: Harvesting & Threshing

Harvesting is the most mechanised area compared to other domains of cropping. Traditional harvesting practices include cutting crops using a sickle followed by threshing with animal trampling or manual threshing.

Harvesting is called gathering a ripe crop from the fields. Threshing is the loosening of the crop from the husks and straw. Wind winnowing is an agricultural method that was developed by ancient cultures and used for separating grain from chaff.

Further stationery threshers replaced manual threshing. Most of the cereals and pulses crops are harvested in this way, like wheat, rice, gram, jowar, etc. Stationery harvesters come in different ranges depending on the type of crop and require rotational input energy which is either supplied electric motor or tractor PTO.

Combine harvesters and tractor-mounted harvesters which came to India in the 1970s have acquired a major place in harvesting. It is a reaper cum thresher which works together to harvest, threshes and clean the grains from the straw in one operation.

5. IMPORTANT AGRICULTURAL TOOLS IN DAILY LIFE:

5.1. Pruners / Pruning Shears:

5.1: Pruners/Pruning Shears

Pruning shears are known as secateurs. They are strong enough to cut hard branches of trees and shrubs. The garden tool trims shape plants and shrubs and removes dead growth. Pruners are high-quality farm tools that stay sharper for a long time, easily cut thicker branches, and are easy to use.

Cutting plants as part of gardening dates to antiquity in both European and East Asian topiaries, with specialized scissors used for Chinese penjing and its offshoots – Japanese bonsai and Vietnamese Hòn Non-Bộ – for over a thousand years.

In modern Europe, scissors used only for gardening work have existed since 1819, when the French aristocrat Antoine-François Bertrand de Molleville was listed in 'Bon Jardinier' as the inventor of secateurs. During the late 1890s, secateurs were sold all over Europe and the U.S. Today secateurs are widely used by gardeners, vintners and fruit farmers.

The world's first anvil pruners were developed and produced in 1923 by Walther Schröder in Kiel, Germany. The pruners were given the product name "Original LÖWE" and were distributed internationally as far back as 1925. Other companies producing anvil pruners include Bahco, Edma, Felco, Fiskars Gardena and Wolf Garten.

5.2. Brush Cutter:

5.2: Brush Cutter

Brush cutters are powerful gardening tools used to clear overgrown areas, trim small trees, and harvest crops. They come in handheld, walk-behind, and tow-behind options.

Brush cutters, available in handheld, walk-behind, and tow-behind types, offer versatility with various blade attachments for different tasks, delivering power for tough jobs, unlike trimmers, boasting durable blades for years of use, and featuring comfortable designs with anti-vibration technology.

Popular options in India include the affordable Balwaan CROP CUTTER priced at ₹16,800 with its backpack design, the reputable Husqvarna 143R-II priced at ₹34,000, the premium Honda UMK450T UTNT priced at ₹38,187 featuring a 4-stroke engine, and the budget-friendly Neptune BC-360 priced at ₹6,999.

Modern brush cutters have evolved to incorporate advanced features like anti-vibration technology for user comfort, durable blades for longevity, and versatile attachments for various applications. These enhancements make modern brush cutters efficient, powerful, and comfortable tools for a range of agricultural and landscaping tasks.

5.3. Gardening fork:

5.3: Gardening Fork

A garden fork, also called a spading fork or digging fork, is a tool widely used for digging. The gardening machine consists of a handle and several (usually four) short, sturdy tines.

Choosing Gardening Fork:

Digging Fork - The digging fork typically has strong, thinner square tines and is great for turning undisturbed soil for a new garden or bed. They can also be used for many of the same chores as a garden fork.

Garden Fork - The most popular garden fork has four flat tines with a flat face facing the front of the fork for lifting. With their flat-faced tines, these forks are good for digging in loamy, sandy, or loose soil, aerating, mixing in nutrients, turning your soil in the spring, and harvesting potatoes and other root vegetables.

Border Fork - The border fork is usually just a smaller head-size version of the garden fork and is becoming very popular.

Compost Fork - The compost fork has long, thin tines and is made for lifting lightweight materials such as compost (not made for digging).

Broad Fork - This monster fork has two long handles attached to a wide fork with many times. It is used to turn undisturbed soil into a new garden. If you've got a lot of soil to turn, this is the beast to do it.

5.4. Thermal Fogger Machine:

5.4: Thermal Fogger Machine

Thermal foggers are like fog machines for pest control and disinfection. They heat a liquid solution (pesticide, disinfectant) and release it as a fine fog, reaching nooks and crannies for better coverage.

Uses:

Pest Control: Keeps crops, gardens, and urban areas free of insects and pests.

Disinfection: Helps disinfect hospitals, schools, public transport, and buildings, especially during public health emergencies.

Mosquito Control: Controls mosquito populations to prevent diseases like dengue and malaria.

Prices in India: The price depends on brand, size, and features. Expect a range of a few thousand rupees to several tens of thousands. Check local suppliers, distributors, or online marketplaces for current prices.

Important Cautions:

Always follow safety instructions and use the right solutions for the job.

Be aware of local regulations regarding thermal fogger use.

6. MODERN TECHNOLOGY IN EMERGING AGRICULTURAL EQUIPMENT:

6.1. Vertical farming:

6.1.1. Basic ideas of “Vertical farming”:

Vertical farming is a method of growing crops in vertically stacked layers, instead of the traditional horizontal rows used in outdoor agriculture. This method often uses controlled-environment agriculture (CEA) technology to optimize plant growth and soilless farming techniques like hydroponics, aquaponics, and aeroponics.

6.1.2. Characteristics of Vertical Farming:

Increased yield: Vertical farms can produce up to 10 times more food per square foot of land compared to traditional farming methods. This is because they can stack multiple layers of crops on top of each other and control the growing environment to optimize plant growth.

Reduced water usage: Vertical farms typically use 90% less water than traditional farms. This is because they can recycle water and control the humidity levels in the growing environment.

Reduced pesticide use: Because vertical farms are controlled environments, they are less susceptible to pests and diseases. This means that farmers can use fewer or even no pesticides.

Year-round production: Vertical farms are not limited by seasonal weather conditions, so they can produce food year-round. This is especially important in areas with harsh climates or limited growing seasons.

Reduced transportation costs: Vertical farms can be located close to urban centres, which reduces the need to transport food long distances. This can help to reduce food waste and greenhouse gas emissions.

6.1.3. Challenges associated with vertical farming:

High initial investment: Vertical farms can be expensive to set up and operate.

Energy consumption: Vertical farms require a lot of energy to power the lights, ventilation, and other systems.

Limited crop selection: Not all crops are suitable for vertical farming.

Despite these challenges, vertical farming is a promising technology that has the potential to revolutionize the way we grow food. As the technology continues to develop and costs come down, we can expect to see more vertical farms popping up in urban areas around the world.

6.1.4. Techniques employed in vertical farming:

1) Hydroponics:

6.1.4.1: Hydroponic System

Hydroponics plays a crucial role in vertical farming, allowing for efficient and productive crop cultivation in stacked layers. It is a method of growing food in water using mineral nutrient solutions without soil. The basic advantage of this method is that it reduces soil-related cultivation problems like soil-borne insects, pests and diseases.

a) Benefits of Hydroponics in Vertical Farming:

Increased Yield: Precise control over growing conditions and efficient nutrient delivery often lead to higher yields per square foot than traditional soil-based farming.

Reduced Water Usage: Closed-loop systems minimise water waste, making hydroponics ideal for water-scarce regions or urban environments.

Reduced Space Requirements: Vertical stacking maximizes growing space within a limited footprint, perfect for urban farms with limited land availability.

Year-Round Production: Controlled environments enable year-round cultivation, not affected by seasonal weather.

Reduced Pest and Disease: The controlled environment minimizes exposure to pests and diseases, often reducing the need for pesticides.

b) Examples of Crops Grown Hydroponically in Vertical Farms:

Leafy greens (lettuce, spinach, kale)	Strawberries
Herbs (basil, mint, cilantro)	Tomatoes
Leafy greens (lettuce, spinach, kale)	Peppers, Cucumbers

2) Aeroponics:

6.1.4.2: Aeroponic System

Aeroponics, a technology where plant roots are misted with nutrient-rich water instead of being grown in soil, offers exciting possibilities across various fields.

The invention of aeroponics was motivated by the initiative of NASA (the National Aeronautical and Space Administration, USA) to find an efficient way to grow plants in space in the 1990s.

In aeroponics, there is no growing medium and hence, no containers for growing crops. In aeroponics, mist or nutrient solutions are used instead of water. As the plants are tied to support and roots are sprayed with nutrient solution, it requires very little space, very little water and no soil.

a. Agriculture:

Vertical farming: Aeroponics thrives in controlled environments, making it ideal for vertical farms in urban areas. This saves space, reduces water usage, and allows year-round production. Leafy greens, herbs, strawberries, and even root crops can be successfully grown.

Water conservation: Compared to traditional farming, aeroponics uses 90-98% less water, making it a sustainable option in drought-prone regions.

Increased yields: Plants in aeroponic systems often experience faster growth and higher yields due to optimal nutrient delivery and oxygen exposure to roots.

Reduced pesticide use: The controlled environment minimizes pest and disease problems, leading to less reliance on harmful chemicals.

b. Research and development:

Plant research: Aeroponics allows for precise control over nutrient and environmental factors, making it ideal for studying plant growth, responses to stress, and developing new varieties.

Space exploration: Aeroponics is being explored for growing food in space due to its efficient water usage and controlled environment capabilities.

c. Other applications:

Home gardening: Aeroponic systems can be scaled down for home use, allowing individuals to grow fresh herbs and vegetables indoors year-round.

Education: Aeroponic systems can be used in schools and science centres to teach students about plant biology and sustainable agriculture.

Organ transplantation: Research is exploring the use of aeroponics to grow organs for transplant purposes, potentially addressing the shortage of donor organs.

d. Things to consider:

Initial setup cost: Setting up an aeroponic system can be more expensive than traditional farming methods.

Technical expertise: Operating and maintaining an aeroponic system requires some technical knowledge and skills.

Limited crop variety: While many crops can be grown aeroponically, some, like large fruits and trees, are not well-suited.

3) Aquaponics:

6.1.4.3: Aquaponic System

Aquaponics, the integration of aquaculture (fish farming) and hydroponics (soilless plant cultivation) offer a unique and resource-efficient approach to food production. By harnessing the natural synergy between fish and plants.

The term “aquaponics” is coined by combining two words: aquaculture, which refers to fish farming, and hydroponics, the technique of growing plants without soil, to create symbiotic relationships between the plants and the fish. The symbiosis is achieved as nutrient-rich waste from fish tanks serves as “fertigate” to hydroponic production beds. In turn, the hydroponic beds also function as bio-filters that remove gases, acids, and chemicals, such as ammonia, nitrates, and phosphates, from the water. Additionally, the gravel beds provide habitats for nitrifying bacteria, which augment the nutrient cycling and filter water. Consequently, the freshly cleansed water can be recirculated into the fish tanks.

a. Urban Agriculture:

Space-saving: Vertical aquaponic systems can thrive in urban environments, transforming rooftops and balconies into productive micro-farms, offering local, fresh produce even in densely populated areas.

Increased Food Security: Communities can establish shared aquaponic systems, fostering food sovereignty and resilient food systems, particularly in regions with limited land or water resources.

Reduced Environmental Impact: Closed-loop systems minimize water usage and waste generation, making them an eco-friendly alternative to traditional agriculture.

b. Education and Research:

Engaging Learning: Schools and research institutions can utilize aquaponics as a living laboratory, providing hands-on learning experiences in ecology, sustainability, and food production.

Optimizing Aquaponics: Research can focus on enhancing plant-fish interactions, improving system efficiency, and developing new varieties suitable for aquaponic environments.

Sustainable Food Solutions: Research can investigate the use of aquaponics in disaster relief, providing nutritious food and promoting community resilience.

c. Environmental Restoration:

Water Filtration: Aquaponic systems can purify wastewater from various sources, including fish farms and even greywater from households.

Habitat Creation: By fostering healthy aquatic ecosystems, aquaponics can contribute to restoring damaged ecosystems and supporting biodiversity.

e. Beyond Food Production:

Ornamental Aquaponics: The visually appealing combination of fish and plants can be used to create aesthetically pleasing aquascapes in homes, offices, and public spaces.

6.1.5. What about Vertical farming in India?

a) The Rise of Vertical Farming in India a Promising Solution for Food Security:
Across India's bustling urban landscapes, a revolution is quietly taking root. Vertical farms, defying limitations of land and weather, are transforming how fresh produce is grown and delivered. These indoor ecosystems, stacked shelves bathed in controlled lighting, represent a paradigm shift in agricultural practices, offering remarkable efficiency and sustainability.

b) **Efficiency Redefined:**
Imagine leafy greens cascading down illuminated shelves, nourished by nutrient-rich mists instead of thirsty soil. Companies like UrbanKisaan and Triton FoodWorks are redefining agricultural output, producing up to 30 times more food while slashing water usage by a staggering 95%. This is particularly crucial for India, a nation grappling with a growing population and water resource scarcity.

c) **Market on the Rise:**
The vertical farming industry in India is experiencing exponential growth, projected to reach $2.77 billion by 2026. This rapid ascent reflects not just the technology's potential but also the urgent need for sustainable solutions. As cities expand and traditional farming struggles to keep pace, vertical farms offer a beacon of hope, promising year-round access to fresh, local produce regardless of season or location.

d) **Challenges and Innovation:**
However, the path to vertical farming success isn't without hurdles. Power outages can disrupt the delicate balance within these indoor ecosystems, and initial investment costs can be substantial. Envision communities coming together to establish rooftop farms, transforming unused spaces into vibrant sources of fresh food.

6.2. Harvest quality vision (HQV):

6.2.1: Harvest quality vision

Harvest Quality Vision (HQV) is a technology developed by Croptracker that uses artificial intelligence (AI) to analyse the size, colour, and quantity of fruits and vegetables. It is a rapid, cost-effective, and objective way to monitor and analyse harvest progress.

6.2.1. HQV technology: An overview

Harvest quality vision (HQV) technology is a cutting-edge system that uses computer vision, machine learning and artificial intelligence to assess the quality and ripeness of vegetables during harvesting. It allows for real-time, non-destructive evaluation of produce providing farmers with precise information on when and which vegetables to harvest. HQV technology is particularly valuable in vegetable farming, where the timely and accurate harvesting of crops is crucial for maintaining product quality and reducing post-harvest losses.

6.2.2. How does HQV technology work?

HQV technology employs advanced imaging systems, including high-resolution cameras and sensors, to capture images of vegetables in the field. These images are then analysed using machine learning algorithms that have been trained to recognise different aspects of vegetable quality, such as size, colour, shape and ripeness. The system can differentiate between ripe and unripe vegetables, as well as identify defects, diseases and signs of pest damage. By integrating this data with other relevant information like weather conditions and crop growth stages, HQV technology provides actionable insights to farmers and allows for precise decision-making.

6.2.3. Benefits of HQV:

a) **Improved accuracy and efficiency:** HQV can analyse hundreds of data points for each piece of fruit in seconds, with an accuracy of within 3mm in optimal conditions. This is much faster and more accurate than manual inspection.
b) **Reduced labour costs:** HQV can eliminate the need for manual inspection, which can save growers a lot of time and money.
c) **Improved quality control:** HQV can help growers ensure that their fruits and vegetables meet quality standards. This can help to reduce waste and improve profitability.
d) **Better decision-making:** HQV can provide growers with valuable data that they can use to make better decisions about their harvest, such as which bins to pick first and which trucks to load with which fruit.

6.2.4. Applications of HQV:

- Harvest timing and scheduling
- Quality assessment
- Pest and disease detection
- Yield estimation

6.2.2: Yield forecasting of tomato

6.2.5. Limitations:

a) **Initial investment:**

Implementing HQV technology requires a significant initial investment in equipment and training. Small-scale farmers may find it challenging to adopt this technology.

b) **Data privacy and security:**

Collecting and analysing data from the field can raise concerns about data privacy and security. Farmers need to ensure that their data is protected from unauthorised access.

c) **Integration with existing systems:**

Integrating HQV technology with existing farming systems and practices may require adjustments and investments in infrastructure and software.

d) **Technical expertise:**

Farmers and farm workers need training to use and maintain the technology effectively. Access to skilled labour can be a limiting factor in some regions.

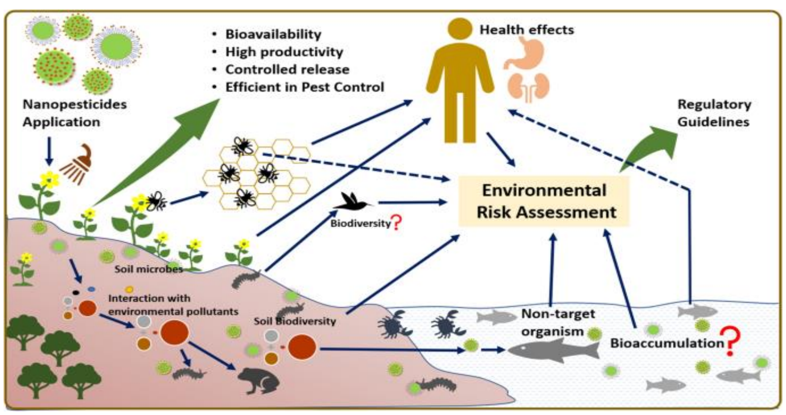
By providing real-time, data-driven insights into crop quality and ripeness, HQV technology enhances productivity, quality control and sustainability in the industry. It empowers farmers to make informed decisions and reduce post-harvest losses while improving profitability. With ongoing developments in technology and increased adoption, HQV technology is self-confident to become a standard practice in farming, benefiting both farmers and consumers alike.

6.3. Nanotechnology in Sustainable Agriculture Development

Nanotechnology is rapidly transforming the field of agriculture, offering innovative solutions to some of the biggest challenges faced by farmers today. The burgeoning field of nanotechnology holds significant promise for transforming modern agriculture, offering solutions for increased food production, reduced environmental impact, and efficient resource utilization. Some data/research on a professional exploration of recent advancements, lingering challenges, and the promising perspectives that lie ahead:

6.3.1. Enhanced crop protection:

a) Nano pesticides:



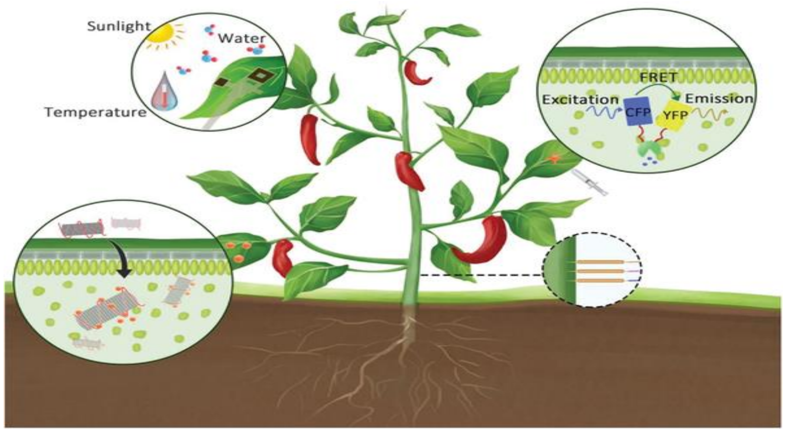
6.3.1.a: Nanopesticides

These are pesticides formulated with nanoparticles that can target specific pests and diseases more effectively, reducing the amount of pesticide needed and minimizing harm to beneficial insects and the environment. Nanopesticides represent an emerging technology in the field of pest management, utilizing engineered particles in the nanometer range (1-100 nanometers) to deliver active ingredients. These developments hold promise for:

Enhanced efficacy: Nanopesticides may exhibit increased potency compared to conventional formulations, potentially allowing for reduced application rates.

Targeted delivery: Specific nanocarriers can be designed to deliver the active ingredient directly to the target pest, minimizing exposure to non-target organisms.

b) **Nanosensors:**



6.3.1.b: Nanosensors

These tiny sensors can detect the presence of pests, diseases, and other threats to crops early on, allowing farmers to take preventive measures and reduce crop losses.

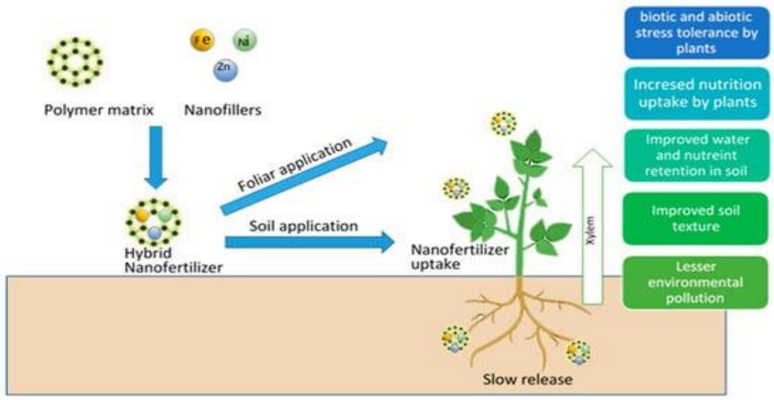
These sensors can be used to monitor the quality of food during storage and transportation, helping to prevent spoilage.

Nanotechnology is still in its early stages of development in agriculture, but it has the potential to revolutionize the way we grow food. As research continues, we can expect to see even more innovative applications of nanotechnology that will help to improve food security, sustainability, and efficiency in agriculture.

It is important to note that there are also potential risks associated with the use of nanotechnology in agriculture, such as the potential for nanoparticles to harm human health and the environment. More research is needed to assess these risks and develop regulations to ensure the safe and responsible use of nanotechnology.

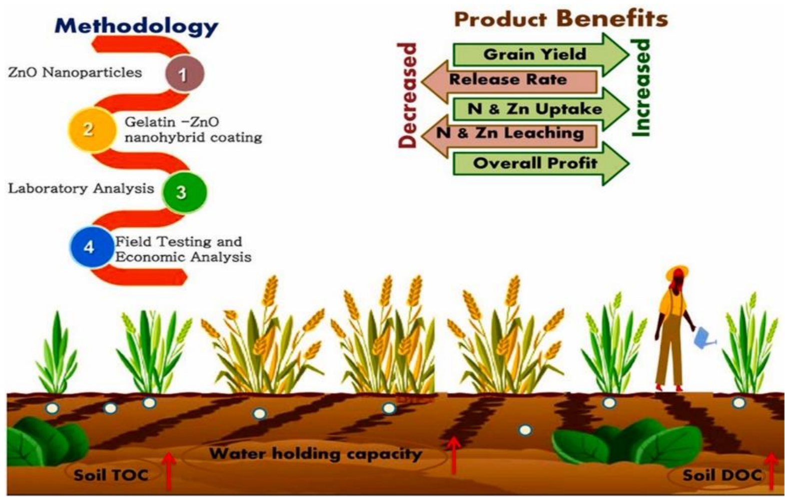
6.3.2. Improved nutrient delivery:

a) **Nanofertilizers**: These are fertilizers encapsulated in nanoparticles that can deliver nutrients directly to plant roots, improving nutrient uptake and reducing fertilizer waste.



6.3.2.a: Nanofertilizers

b) **Nanoscale coatings:** These coatings can be applied to seeds or plants to improve nutrient uptake and reduce water loss.



6.3.2.b: Nanoscale coatings

Nanoscale coatings offer a wide range of potential benefits, including:

- ~ Improved wear and corrosion resistance
- ~ Enhanced electrical and thermal conductivity
- ~ Increased scratch and impact resistance
- ~ Self-cleaning and anti-fouling properties
- ~ Improved biocompatibility

6.3.3. Precision Agriculture:

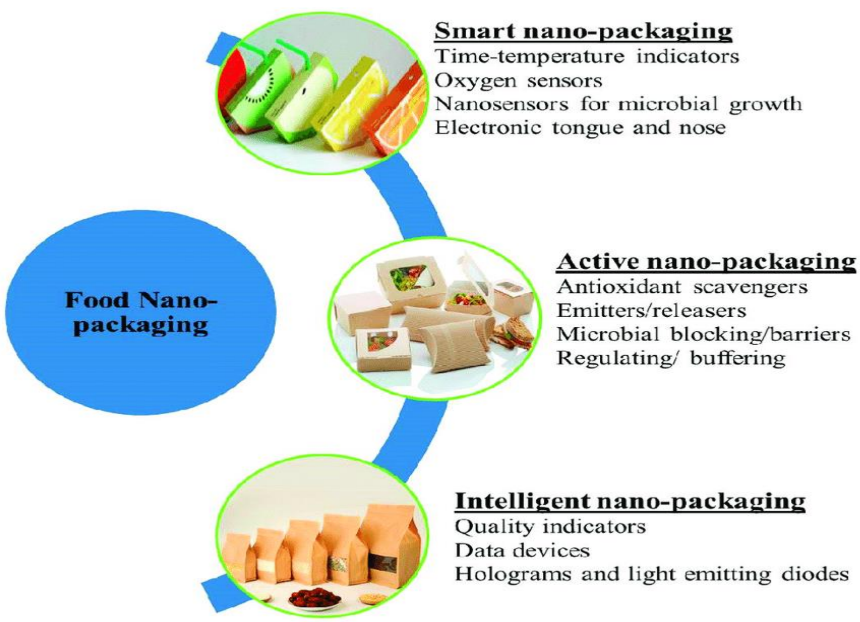
Nano biosensors: These sensors can be used to monitor soil health, water quality, and other environmental factors in real time, allowing farmers to make more informed decisions about their crops.

Nano-enabled irrigation systems: These systems can deliver water to crops more precisely and efficiently, reducing water waste and improving crop yields.

Nano-enabled Irrigation Maximizing Water Efficiency: Superabsorbent nanoparticles act like tiny sponges, improving water retention and delivery in soil, particularly crucial in drought-prone areas, leading to reduced water usage and improved crop yields.

6.3.4. Postharvest management:

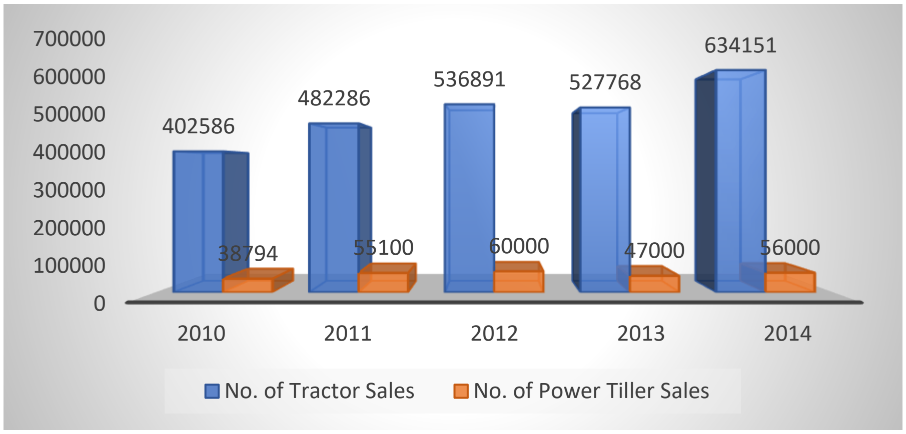
Nano packaging: Nanoparticles can be used to create packaging materials that extend the shelf life of fruits, vegetables, and other items.



6.3.4.a: Nanopackaging

7. FARM POWER:

7.1. Sales of Agricultural Machines:

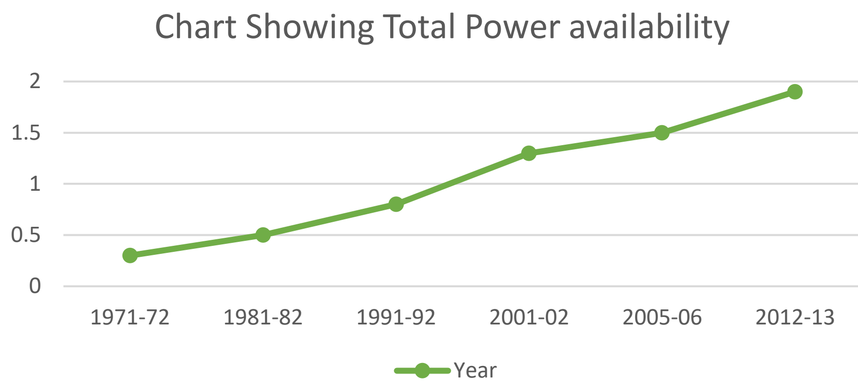


7.1 Sales of Agricultural Machines

Engines (petrol, kerosene, and diesel) were extensively used for post-harvest processing like floor making, rice milling, and grinding from 1960 to 1980. During this period, over 90% of public investment in agriculture was directed towards developing irrigation facilities, particularly in states like Punjab, Haryana, and Uttar Pradesh. This focus on irrigation led to a substantial expansion of irrigated land. The Green Revolution era saw a boost in agricultural productivity through the introduction of various inputs such as agrochemicals and farm machinery, resulting in a significant increase in farm power availability from electrical and mechanical sources.

In the present context, there have been notable advancements in agricultural practices and technologies. The use of engines for post-harvest processing continues but with a shift towards more sustainable and energy-efficient methods. There is a growing emphasis on renewable energy sources like solar power for drying and processing activities. Additionally, modern irrigation techniques such as drip irrigation systems are gaining popularity for their efficiency in water usage. Agricultural productivity has further improved with the adoption of precision farming techniques, advanced machinery, and digital technologies that optimize resource utilization and enhance crop yields.

7.2. **Growth in total power availability**:



7.2: Chart Showing Total Power availability

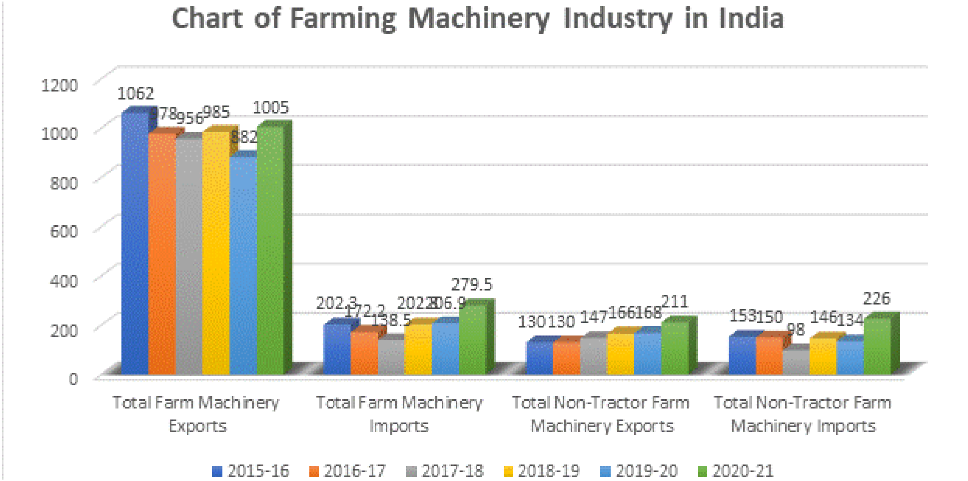
Farm Power is the amount of energy to indicate the extent of mechanization the farm has in terms of kW per hectare of land. It includes animate as well as mechanical and electrical power. In India, the total farm power availability from animate and mechanical sources in 1951-52 was 0.20 kW/ha which increased to 1 kW/ha in 1996-97.

Animate power contributed 60% of the total farm power in 1971-72 and mechanical and electrical together contributed only 40%. In 1996-97 the contribution from animate power reduced to 21% and from mechanical and electrical power it increased to 79%. The figures show that the Green Revolution period found out to be not only progress in biological but also technologically in farming.

The statistics of 2012-13 show that the share of power from the tractor in the total farm power is increasing substantially, further the share of Electric Motors is also increasing i.e., 26.80% then from Diesel Engine and Power Tillers contribute 16.30% and 0.80% respectively. At the same time, conventional sources like Agricultural Workers and Draught animals are decreasing and contributing 5% and 5.10% respectively.

Therefore, there is a need to increase the availability of farm power from 2.02 kW per ha (2016-17) to 4.0 kW per ha by the end of 2030 to cope with the increasing demand for food grains.

8. FARM MACHINERY INDUSTRY IN INDIA:



8.1: Chart of Farming Machinery Industry in India

In the current scenario, the adoption of mechanization technology in Indian agriculture is influenced by various factors such as cost, manufacturer reputation, after-sales services, ease of use, and government-provided credit and financial incentives.

The landscape of agricultural machinery manufacturers in India ranges from village artisans, blacksmith units, and small-scale industries to large multinational corporations and organized sectors producing sophisticated machinery like tractors, engines, mills, and dairying equipment.

The agriculture machinery sector in India holds immense growth potential due to factors like a growing population, high economic reliance on agriculture, shifting demographics, and concerns regarding food security.

In the Asia-Pacific region, India continues to be a key player driving growth in the agricultural equipment market, driven by its heavy dependence on agriculture and a rising trend towards technology adoption.

The Indian agricultural machinery market is characterized by consolidation, with major players dominating a significant share of the market. Notable companies such as Mahindra & Mahindra Ltd, CNH Industrial NV, Tractors and Farm Equipment Ltd, Escorts Group, and Sonalika are prominent figures in this sector. These leading players focus on strategies like new product launches, partnerships, and acquisitions to maintain their competitive edge in the market.

9. FIELD VISIT 01:

This field visit was conducted by Kishan Raj. The supplier I found is located in Udupi, Karnataka, at Karavali Junction.

Visit: Canara Complex, Karavali Junction Kochi, Panvel - Kochi - Kanyakumari Hwy, Adi-Udupi, Karnataka 576101

Source from Google maps

9.1. Here's an Overview of the Supplier:

I don't know the name of the salesperson I met. As I visited this supplier during closing time, there was no time to ask more about the machines and tools. However, I convinced him to give me some ideas about the products which are actually on the market. Here's my list of questions and the answers he provided:

1. **What is the most preferred product**?
   According to the salesperson, the most preferred products depend on the season. For example, during rainy days, products do not sell at all. During the harvesting season, most of the machines as well as some types of agricultural tools are sold. Some of the agricultural tools available in this showroom include land mowers, chainsaws, wheelbarrows, mowers and trimmers, farming accessories, etc. Heavy machines are not supplied year-round; they are sold according to consumer preferences.

2. **Which machine is the best value for money**?
   There are no value-for-money products in this showroom. Most machines sold to consumers are priced above 60k.
3. **What type of products are supplied to this showroom**?
   Most machines and tools supplied by manufacturers include power weeders, power tillers, advanced harvesting machines, mowers and trimmers, wheelbarrows, etc."
4. **About any one of the working machines**:
   “He explained about the power tiller. The below image is from Google because they did not allow me to take a picture of the machine:

9.1.1: Power Tiller

Power tillers are workhorses for land preparation, offering a variety of functions for soil cultivation. Some points on working of Power tillers:

Engine Power: They run on gasoline or diesel engines, providing the muscle for the job.

Transmission: The engine power is delivered to the wheels or tracks via a transmission system, allowing forward and backward movement.

Attachment Ready: Power tillers can be equipped with various attachments like ploughs, harrows, cultivators, and seeders.

Soil Cultivation: Depending on the task, the farmer chooses the right attachment a plough for breaking new ground or a cultivator for finer work.

Control at Your Fingertips: Operators can adjust tilling depth and machine speed for optimal results based on soil type and crops.

Nimble Navigation: The compact design allows for manoeuvring in tight spaces and efficient field coverage.

Fuel and Care: Proper fueling and maintenance are essential, including oil changes, belt/chain checks, and keeping the machine clean.

9.2. Field visit at "Easy Life Enterprises" Udupi:

Field visit 01 at Udupi

10. FARM MECHANIZATION ADVANTAGES:

a) **Input Savings and Increased Yield:** Reduced seed and fertilizer usage (15-20%) due to precise application by machinery. Lower labour costs by minimizing manual work. Increased cropping intensity (5-20%) leading to more plants and higher yield per hectare.

b) **Enhanced Efficiency:** Faster execution of tasks with machinery, saving time (15-20%). Improved work quality due to precision in operations like sowing, harvesting, and spraying. Reduced production costs and increased yield and income.

c) **Social Benefits:** Cultivation of previously unusable land through heavy machinery for tilling. Improved farmworker safety by replacing them with machines for hazardous tasks. Reduced drudgery and workloads, attracting younger generations to agriculture. Increased farm yield and reduced production costs, making farming more resilient for smallholders. Creation of new job opportunities in manufacturing, repair, and custom machine hiring services.

d) **Reduced Work Costs:** Economies of scale achieved by using machinery on larger farms for intensive farming. Improved cost-yield balance through mechanization.

e) **Reduced Reliance on Work Animals:** Lower costs associated with machinery downtime compared to maintaining animals during non-working periods. Increased efficiency for tasks requiring rapid completion.

11. IMPROVEMENTS & SUGGESTIONS:

a) **Affordable Farm Equipment:**

No other farm implement segments have succeeded as far as the tractors. Tractors are relatively pricey and thus become non-affordable for small farmers. As the per-capita land holding of Indian Farmers is decreasing, small farm machinery/implements which would be inexpensive need to be manufactured keeping in view the versatility of various crops, cropping patterns, geographical conditions and agriculture operations.

b) **Finance:**

Easily available loans and subsidies would be of much help to farmers, as they will increase the buying tendency of the farmer. Along with the loans, they should be given at a much lower rate with longer payback periods.

c) **Awareness & Education:**

Education and awareness about the use of machinery, servicing and maintenance of machines, the importance of mechanization, economic benefits, and related information are very decisive for developing the farm machinery sector. On-field demonstration and training on machines should be part of marketing for agro-machinery manufacturers.

d) **Development of Custom Hiring Service Centres (CHC) & Urbanization:**

CHC is nowadays becoming popular as it enables farmers to use heavy machines with relatively negligible investment. The tractor is the best example of this kind of business model, in a similar way other modern machines can also be brought under this business model of custom hiring which will not only provide easy access to heavy machines to the farmers but also be the choicest opportunity for an entrepreneur. Just the business model needs to be revolutionized for the machine owners with the value addition of newer technologies.

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