DETAILED PROJECT REPORT ON

VALUE ADDITION TO FOOD WASTE

Project report submitted to,

Dr. Siddhartha Singha

Assistant Professor

School of Agro and Rural Technology

Indian Institute of Technology, Guwahati

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by

JAYDEEP PANDIT - 224154002

SHASHWATA SWARUPA SAHOO – 224154006

M.TECH (RURAL TECHNOLOGY)

School of Agro and Rural Technology

Indian Institute of Technology, Guwahati

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INTRODUCTION

Food is vital for human survival and the ecosystem. It can either be consumed raw or in processed forms to produce value-added products. However, with an exponential rise in population and imbalances in supply chains from time to time, a growing concern has led to increasing food waste being generated globally. Approximately 1.3 billion tonnes of food produced is either lost or wasted globally per annum and this number is rising (Du et al., 2018). According to a recent report from Rethink Food Waste Through Economics (ReFED), the majority of the food waste arises due to inappropriate storage conditions at each level (ReFED, 2016). This food waste is generated from post-harvest at farmer level to leftovers at households, restaurants, and commercial establishments (Griffin et al., 2009). reported a detailed categorization of the waste distribution at each stage. Out of the total food waste generated, 20% constituted production waste, 1% processing waste, 19% distribution, and 60% from consumers and households. A recent survey done in 2019 in Scandinavia estimated a food loss of more than 50% in households due to a challenge in decision making between 'best before' and 'use by' (Filimonau and De Coteau, 2019).

Out of the different proportions of food materials wasted, fruits and vegetable waste constitute a significant proportion (42%) of the waste produced. These wastes are generally disposed of in landfills as they are relatively cheap to form methane as the primary product. Although methane could be used to generate fuel, the greenhouse gas has a global warming potential that is 25 times greater than that of CO_2The waste composition generated during fruit and vegetable waste may either be in the form of fruit peel, seed, crop, leaf, straw, stem, root, or tubers, depending on the raw material chosen Depending on plant species and tissues, the waste obtained from fruit and vegetable waste possesses a wide variety of properties. For instance, the waste peels and seeds are high in phytochemical compounds as giving it a possibility in food flavoring agents and preservation compounds (Sridhar et al., 2021b). Similarly, the vegetal tissues rich in carotenoids, vitamins, and fibres possess antioxidant, anti-diabetic properties, thereby aiming to prevent human diseases and disorders (Gowe, 2015; Yusuf, 2017). Thus, effective valorization of waste products in different applications provides a valuable source in reducing environmental issues as well as solving the challenges in a sustainable manner.

The urban solid wastes generation in India is approximately 147,613 tons per day (ORF data, 2020). Out of which, the major share of 40.2–51.0% is comprised of organic matter. Enormous amounts of vegetable, fruit and flower (VFF) wastes are being generated every day from centralized wholesale horticultural markets in Indian urban areas. The wastes originate at various stages that include production, transportation, storage, distribution and consumption of vegetables and fruits. Around 18–30% of these horticultural products emerge as waste, thereby ending up as wholesale vegetable, fruit and flower market wastes from Indian urban centres (Sachdeva et al., 2013; Emerson Climate Technologies, 2013; Narnaware et al., 2017). The major factors influencing these huge quanta of VFF waste generation include lack of proper infrastructure, handling methods, refrigerated transportation systems, cold storage units, improper waste processing and technical knowledge on waste storage and transport etc. The losses and waste generate from all stages of the supply and handling chain that include harvesting, transport, storage, grading, marketing and at processing. The major wastes from wholesale vegetable markets include wastes of cauliflower, cabbage, aubergine, ash gourd, onion, potato and tomato (Mozhiarasi et al. 2019; Zia et al., 2020). Similarly, the major fruit wastes originate from the wastes of bananas, watermelon, papaya, muskmelon and lime. The major flower wastes include wastes of chrysanthemum, marigold, rose and its petals, and greens like decorative leaves.

About 50 million tons of vegetable and fruit market wastes are generated every year, which has an estimated biogas potential of 4000 million m^3/year (Vijay et al., 2015). However, in India, only a small portion of vegetable, fruit and flower markets wastes (less than 20%) are utilized as animal feed or composting or burning with other wastes whereas the majority of wastes are being collected at a common point within the market premises, from where it is transported to the city's dumpsites. Altogether, the improper means of disposal could lead to severe environmental issues that include bad odour, water, air and soil pollution and as a whole, would pose a threat to food safety and well-being. In view of the targets towards climate change and fossil fuel alternatives, effective technologies to treat/utilize vegetable, fruit and flower market wastes are of great importance.

UTILITIES OF FRUIT AND VEGETABLE WASTES

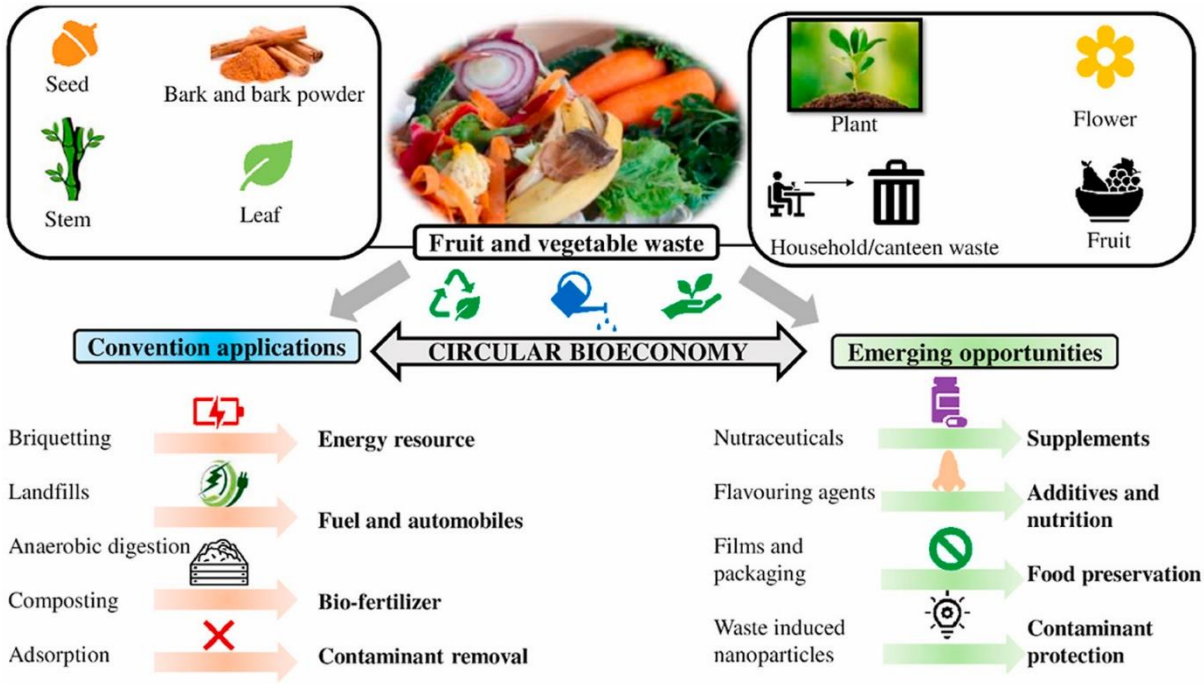

Fig.1 Uses of Fruit and vegetable wastes

Natural flocculant

Fruit and vegetable waste can be used as a natural flocculant, a substance that promotes the clumping of suspended particles in water, allowing for easier removal of pollutants and impurities. This application of fruit and vegetable waste offers several environmental benefits, including the reduction of water pollution and the conservation of natural resources.

Traditional flocculants used in water treatment processes, such as aluminium sulphate and polyacrylamide, can have negative environmental impacts, including the release of harmful chemicals into the environment and the depletion of natural resources. The use of fruit and vegetable waste as a natural flocculant provides a sustainable and eco-friendly alternative.

The effectiveness of fruit and vegetable waste as a natural flocculant is due to the high content of polysaccharides, proteins, and other organic compounds present in the waste. These compounds can bind with suspended particles in water, causing them to clump together and settle to the bottom, allowing for easier removal of pollutants and impurities.

The use of fruit and vegetable waste as a natural flocculant involves several steps. First, the waste is collected and processed to extract the polysaccharides and other organic

compounds. The extracted compounds are then mixed with water to create a solution, which is added to the water being treated. The solution binds with suspended particles in the water, allowing them to clump together and settle to the bottom, allowing for easier removal of pollutants and impurities.

The use of fruit and vegetable waste as a natural flocculant offers several advantages over traditional flocculants. It is a sustainable and eco-friendly alternative, contributing to the conservation of natural resources and the reduction of harmful chemicals released into the environment. Additionally, fruit and vegetable waste is readily available and cost-effective, making it a viable option for small-scale water treatment applications.

In conclusion, the use of fruit and vegetable waste as a natural flocculant provides a sustainable and eco-friendly alternative to traditional flocculants used in water treatment processes. This practice can contribute to the reduction of water pollution and the conservation of natural resources. By promoting the use of fruit and vegetable waste as a natural flocculant, we can contribute to a more sustainable and environmentally friendly society.

Composting:

Composting is the process of decomposing organic matter, such as food scraps, yard waste, and other plant material, into a nutrient-rich soil amendment. It is an excellent way to reduce waste, improve soil health, and grow healthier plants. In this essay, we will discuss the benefits of composting, the different methods of composting, and how to start composting at home.

The Benefits of Composting:

1. Reduces waste: Composting reduces the amount of waste that ends up in landfills, which helps to reduce greenhouse gas emissions and prevent the release of harmful chemicals into the environment.
2. Improves soil health: Composting adds nutrients to the soil, which helps to improve soil structure, water retention, and the overall health of plants. It also promotes the growth of beneficial microorganisms that help to break down organic matter.

3. Saves money: Composting can save you money on fertilizer, soil amendments, and even water bills. By using compost, you can reduce the need for chemical fertilizers and improve the water-holding capacity of your soil.
4. Supports a sustainable lifestyle: Composting is an excellent way to support a sustainable lifestyle by reducing waste and promoting healthy soil.

Methods of Composting:

1. Cold composting: This method involves simply piling up organic matter in a designated area and allowing it to decompose naturally over time. This method is low-maintenance but can take several months to a year to produce usable compost.
2. Hot composting: This method involves creating a pile of organic matter that is actively decomposing, usually with the help of added nitrogen and oxygen. The pile needs to be turned regularly to provide oxygen to the microorganisms and to speed up the process. Hot composting can produce usable compost in as little as three to four weeks.
3. Vermicomposting: This method involves using worms to break down organic matter. It is an excellent option for people with limited space, as it can be done indoors in a small container. Vermicomposting produces a nutrient-rich compost called vermicompost.

Landfills:

Landfills are one of the most common methods of disposing of solid waste. They are designated areas where waste is buried and left to decompose over time. While landfills may seem like a simple solution for waste disposal, they have several disadvantages that pose significant environmental and health risks.

One of the most significant disadvantages of landfills is their potential to pollute groundwater and soil. When waste is buried in a landfill, it decomposes and releases toxic chemicals, including methane, ammonia, and carbon dioxide. These chemicals can leak into the surrounding soil and groundwater, contaminating it and making it unsuitable for human consumption. Additionally, waste can take several years to decompose, which means that the pollutants will continue to leak into the environment for years to come.

Landfills can also have negative impacts on wildlife and ecosystems. The presence of landfills can lead to habitat destruction and loss of biodiversity. In addition, the garbage in landfills can attract scavengers such as rats and seagulls, which can lead to health and safety risks for nearby communities.

Another disadvantage of landfills is their finite lifespan. Once a landfill is filled to capacity, it must be closed and capped, which can take several years and is costly. Furthermore, landfills are not a long-term solution for waste management, as they will eventually fill up, and new landfills will need to be created.

Fruit and vegetable waste is a significant issue in landfills due to several reasons. When food waste is buried in landfills, it contributes to the production of methane, a potent greenhouse gas that is responsible for climate change. The decomposition of food waste in landfills produces large amounts of methane, which is 25 times more potent than carbon dioxide in terms of its heat-trapping capabilities.

Furthermore, fruit and vegetable waste in landfills also contributes to the formation of leachate, a toxic liquid that is formed when water comes into contact with decomposing waste. Leachate contains a range of harmful chemicals, including heavy metals, pesticides, and bacteria. If not managed correctly, leachate can contaminate nearby groundwater and surface water, posing a significant risk to public health and the environment.

The disposal of fruit and vegetable waste in landfills also wastes valuable resources, such as water and nutrients. Food waste contains high levels of water and nutrients that can be recycled and used for other purposes. For example, food waste can be composted and used to enrich soil, reducing the need for chemical fertilizers and improving soil quality. It can also be used to generate biogas through anaerobic digestion, a process that produces energy from organic waste.

Biogas production

Vegetable and fruit waste can be used as a valuable resource for the production of biogas, a renewable and sustainable energy source. Biogas production from fruit and vegetable waste offers several environmental and economic benefits.

First, using fruit and vegetable waste for biogas production reduces the amount of organic waste sent to landfills, contributing to the reduction of greenhouse gas emissions and the preservation of natural resources. Landfills are a significant source of methane emissions, a potent greenhouse gas, which can be mitigated through the diversion of organic waste from landfills.

Second, biogas production from fruit and vegetable waste provides a renewable source of energy that can be used for electricity generation, heating, and cooking. Biogas can replace fossil fuels, contributing to the reduction of greenhouse gas emissions and the promotion of sustainable energy practices.

Third, the process of biogas production from fruit and vegetable waste generates a nutrient-rich residue called digestate, which can be used as a fertilizer for agricultural crops. This reduces the need for synthetic fertilizers, contributing to the conservation of natural resources and the promotion of sustainable agricultural practices.

The process of biogas production from fruit and vegetable waste involves several steps. First, the waste is collected and transported to a biogas plant, where it is mixed with water to create a slurry. The slurry is then heated to promote the growth of anaerobic bacteria, which break down the organic matter in the waste and produce biogas as a by-product. The biogas is then collected and purified to remove impurities and stored in tanks for later use. The leftover digestate can be used as a fertilizer for agricultural crops.

Biochar production

Biochar production from fruit and vegetable waste is a sustainable waste management practice that can have numerous environmental and agricultural benefits. Biochar is a type of charcoal that is produced by heating organic materials, such as fruit and vegetable waste, in the absence of oxygen. The resulting material is a porous, carbon-rich substance that can be used as a soil amendment or as a component of livestock feed.

There are several benefits of producing biochar from fruit and vegetable waste. First, it diverts organic waste from landfills, reducing greenhouse gas emissions and the production of leachate. Instead of being buried in landfills, fruit and vegetable waste can be repurposed as a valuable resource for agricultural purposes.

Second, biochar can be used as a soil amendment to improve soil quality and fertility. Biochar can increase the water-holding capacity of soil, reducing the need for irrigation, and improving soil structure, reducing soil erosion. Additionally, biochar can increase the nutrient-holding capacity of soil, improving plant growth and reducing the need for synthetic fertilizers.

Third, biochar can sequester carbon, contributing to climate change mitigation. When biochar is added to soil, it can remain stable for centuries, sequestering carbon in the soil and reducing the amount of carbon dioxide in the atmosphere.

The production of biochar from fruit and vegetable waste is a relatively simple process that can be done on a small or large scale. The waste is first shredded or chopped into small pieces and then heated in a kiln or oven at high temperatures in the absence of oxygen. The resulting biochar can then be crushed and used as a soil amendment or added to livestock feed.

Biodegradable cups and plates from fruit and vegetable wastes

Biodegradable cups and plates made from fruit and vegetable waste are a sustainable alternative to traditional disposable plates and cups made from plastic or paper. These biodegradable products are made from natural materials, such as sugarcane bagasse, corn starch, and potato starch, which are derived from fruit and vegetable waste.

The production of biodegradable cups and plates from fruit and vegetable waste offers several environmental benefits. First, these products are made from renewable resources that are biodegradable and compostable, meaning they break down naturally into organic matter without releasing harmful pollutants. This reduces the amount of waste sent to landfills and contributes to the circular economy by creating a closed-loop system where waste is used to create new products.

Second, the production of biodegradable cups and plates from fruit and vegetable waste has a lower environmental impact than traditional disposable plates and cups made from plastic or paper. These products require less energy to produce and generate fewer greenhouse gas emissions, contributing to climate change mitigation.

Third, the use of biodegradable cups and plates from fruit and vegetable waste can reduce the consumption of single-use plastic and paper products. Single-use plastic and paper products have a significant impact on the environment, contributing to pollution of oceans and

landfills. By using biodegradable cups and plates made from fruit and vegetable waste, we can reduce the amount of waste generated and promote more sustainable consumption patterns.

The production of biodegradable cups and plates from fruit and vegetable waste is a relatively simple process. The waste is first cleaned and processed to remove any impurities, then it is ground into a fine powder. The powder is then mixed with other natural materials, such as water, to create a paste-like substance that can be moulded into cups and plates. The resulting products are biodegradable and compostable, meaning they can be disposed of in a composting facility or in a backyard compost pile.

Use in aquaculture as feed for fishes

Fruit and vegetable wastes can be used as a sustainable and cost-effective source of feed for fish in aquaculture systems. This practice can provide numerous benefits for both the environment and the aquaculture industry.

Using fruit and vegetable waste as feed for fish in aquaculture can reduce the pressure on wild fish populations and promote more sustainable aquaculture practices. Traditional fish feeds are often made from wild fish, which contributes to overfishing and unsustainable fishing practices. Using fruit and vegetable waste as a source of fish feed can reduce the demand for wild fish and promote more sustainable practices.

Furthermore, using fruit and vegetable waste as fish feed can reduce the amount of waste sent to landfills and contribute to a circular economy by repurposing waste as a valuable resource. Fruit and vegetable waste is often abundant and readily available, making it a cost-effective source of feed for fish.

Additionally, using fruit and vegetable waste as fish feed can improve the nutritional quality of the fish and contribute to the health of the fish population. Fruits and vegetables contain essential nutrients and vitamins that are beneficial for the growth and development of fish. By providing a diverse and nutrient-rich diet for fish, they can grow and develop more efficiently, reducing the need for synthetic or expensive feeds.

The use of fruit and vegetable waste as fish feed in aquaculture can also contribute to the economic sustainability of the industry. Using waste as a source of feed can reduce the costs associated with traditional fish feeds, making aquaculture more affordable and profitable.

The process of using fruit and vegetable waste as fish feed in aquaculture involves several steps. First, the waste is cleaned and processed to remove any contaminants and unwanted materials. The waste is then ground or chopped into small pieces and mixed with other ingredients, such as soybean meal or fishmeal, to create a balanced and nutritious fish feed. The feed is then fed to the fish in the aquaculture system.

Briquettes

Briquettes made from fruit and vegetable waste are a sustainable and eco-friendly alternative to traditional charcoal and wood-based briquettes. These briquettes are made from agricultural waste materials such as fruit and vegetable trimmings, nut shells, and sawdust, which are compressed to create a denser and longer-lasting fuel source.

The production of briquettes from fruit and vegetable waste offers several environmental benefits. First, it reduces the amount of waste sent to landfills and promotes a circular economy by repurposing waste as a valuable resource. This helps to reduce greenhouse gas emissions and contributes to the conservation of natural resources such as forests and other biomass.

Second, the use of briquettes made from fruit and vegetable waste can reduce the demand for traditional fossil fuel-based fuels such as coal, oil, and gas. This contributes to the mitigation of climate change by reducing the amount of greenhouse gases emitted from the burning of fossil fuels.

Third, briquettes made from fruit and vegetable waste are a cost-effective and sustainable alternative to traditional charcoal and wood-based briquettes. The production process is relatively simple and requires low energy inputs, making it an affordable and accessible source of fuel for households and small businesses.

The production of briquettes from fruit and vegetable waste involves several steps. First, the waste materials are collected and sorted to remove any impurities. The waste is then dried and ground into a fine powder before being mixed with a binder such as molasses, starch, or clay. The mixture is then compressed into briquettes of various sizes and shapes using a briquetting machine.

Briquettes made from fruit and vegetable waste have several advantages over traditional charcoal and wood-based briquettes. They burn longer and hotter than traditional charcoal, producing less ash and smoke. They also have a lower carbon footprint, releasing fewer harmful emissions during burning, and contributing to the mitigation of climate change.

As cattle fodder

Fruits and vegetable waste as cattle fodder refers to the practice of using waste products from fruits and vegetables as feed for livestock such as cattle, sheep, and goats. These wastes can be in the form of overripe or damaged fruits and vegetables, unsold produce from markets, or by-products from food processing industries such as pulp, peels, and seeds. This practice has been in use for centuries, particularly in regions where feed resources are limited.

The process of using fruits and vegetable waste as cattle fodder involves collecting and processing the waste into a suitable form for feeding. The waste is first sorted to remove any non-edible materials such as plastic, paper, and stones. The edible portion of the waste is then chopped and mixed with other feeds such as hay or silage to form a balanced diet for the livestock.

Advantages of using fruits and vegetable waste as cattle fodder

1. Cost-effective: The use of fruits and vegetable waste as cattle fodder can reduce the cost of feed for livestock farmers. The waste is often readily available and is cheaper than commercial feed.
2. Nutritious: Fruits and vegetable waste are rich in vitamins, minerals, and fiber, making them a nutritious feed for livestock. The high fiber content also helps to improve the digestion of the animals.
3. Sustainable: The use of fruits and vegetable waste as cattle fodder helps to reduce food waste and promotes sustainable food production. This practice also reduces the carbon footprint of the livestock industry by reducing the need for commercial feed production.
4. Health benefits: The use of fruits and vegetable waste in livestock feed can result in healthier animals, reducing the need for antibiotics and other medications.
5. Reduced environmental impact: The use of fruits and vegetable waste as cattle fodder can help reduce the environmental impact of the livestock industry. This is because it

reduces the need for commercial feed production, which often requires the use of fertilizers, pesticides, and other inputs that can have negative environmental impacts.

6. Increased profitability: Using fruits and vegetable waste as cattle fodder can increase the profitability of livestock farmers by reducing feed costs and increasing animal productivity.
7. Improved soil health: The use of fruits and vegetable waste as cattle fodder can also benefit the soil by providing organic matter and nutrients that can improve soil health and fertility.
8. Reduced methane emissions: The fermentation of fruits and vegetable waste in the rumen of cattle can result in the production of methane, a potent greenhouse gas. However, research has shown that the use of fruits and vegetable waste as cattle fodder can actually reduce methane emissions compared to traditional feed sources.
9. Food security: The use of fruits and vegetable waste as cattle fodder can help improve food security by reducing food waste and increasing the availability of feed resources for livestock. This can be particularly important in regions where feed resources are limited or expensive.

Challenges and barriers:

1. Quality control: The quality of fruits and vegetable waste can vary depending on the source, making it challenging to ensure consistent feed quality.
2. Nutritional balance: Fruits and vegetable waste may not provide a balanced diet for livestock, and additional feed supplements may be required to meet nutritional requirements.
3. Storage and processing: The collection, storage, and processing of fruits and vegetable waste can be challenging, particularly for small-scale farmers.
4. Transportation: The transport of fruits and vegetable waste to livestock farms can be challenging and may require specialized equipment.

NEED ASSESSMENT

The urban solid wastes generation in India is approximately 147,613 tons per day. Out of which, the major share of 40.2–51.0% is comprised of organic matter. Enormous amounts of vegetable, fruit, and flower (VFF) wastes are being generated every day from centralized wholesale horticultural markets in Indian urban areas. Around 18–30% of these horticultural products emerge as waste, thereby ending up as wholesale vegetable, fruit and flower market wastes from Indian urban centres.

One of the common practices for waste disposal is landfill. But, in the state of Assam, though there are several landfills, they are poorly maintained and managed. Also, many if the landfills are in populated areas leading to health hazards. In the recent years, the Assam state government has adopted a few practices like waste-to-energy plants and initiated awareness campaigns to promote sustainable waste management practices. But still, the waste management is not up to the mark.

Besides these, food wastes are not the ones that are suggested for energy conversions as they have low calorific value. Also, if sent to landfills, these lead to leachate formation thus affecting the performance of landfills. Therefore, we need alternate methods for disposal of fruits and vegetables wastes. Among which one method can be conversion of the waste to cattle fodder.

In the year 2020, the Indian animal feed industry was worth nearly INR 403.5 billion. Between 2021 and 2026, the industry is projected to expand at a 15 percent Compound annual growth rate, reaching a size of nearly INR 933.3 billion.

- Livestock was recorded as the primary source of income by 23% of agricultural households.
- There are 88 million In-Milk animals, according to the 19th Livestock Census.
- Since 1998, India has ranked first among the world's milk production nations, with the world's largest bovine population.
- In 2017-2018, milk production totalled 176.4 million tonnes, up 6.65% from the previous year.

The Indian livestock sector is a major employer of cattle feed products, propelling the economy toward vigorous expansion. To sustain and retain the sheer affluence of its dairy industry, the country's livestock sector is a major employer of cattle feed products.

The Indian cattle feed industry is rapidly becoming more organized, and feed manufacturers are steadily employing new and advanced methods that aim to implement best global practices. Given India's last place in the world in terms of livestock population and a high projected growth rate of about 4%, the cattle feed industry in India has a lot of room for growth. CCF products, especially branded CCF products, are rapidly gaining popularity in India, even in rural areas.

In a nutshell, the Indian cattle feed industry is certainly a big yes for investments with the projection of spiking dependability upon cattle despite the technological advancements, especially in the native market of the country and the industry seems promising without a second doubt to tap resources and exploit gains.

Waste generation

Fruits production in India = 97.4 million tonnes (2018-19)

CAGR fruit production = 3%

Fruit production in 2023 ≈ 109.6 million tonnes

Vegetables production in India = 187.36 million tonnes (2018-19)

CAGR vegetable production = 3.8%

Vegetable production in 2023 ≈ 217.5 million tonnes

Total fruit and vegetable production in 2023 ≈ 327.1 million tonnes

Estimated losses fruit and vegetable waste is around 40% p.a.

Quantitative loss = 130.4 million tonnes / year

According to Economic Time in 2013, Rs. 13000 crore worth fruits and vegetables was wasted.

Considering these values, waste management is not just a big issue but a necessity.

As per data of Assam Urban Solid Waste Management Policy, 2018, waste generated in North Guwahati is 4 million tonnes per day in 2011. Thus, the fruit and vegetable waste is about 40% of total, which accounts to almost 4.8 lakh tonnes per day.

From this data and considering the population ratio of Guwahati city to that of India, it can be assumed that the fruit and vegetable waste generated per day from Gorchuk market is almost 500 kg /day which is hazardous for both humans and environment if left as it ease. Any

form of possible treatment will not just help protect the human environment, but also generate good amount of revenue from the waste.

Besides, the cattle fodder available in market ranges from Rs 2/kg to Rs. 20/kg differing in brand and nutritional value. But, the nutritional value of the feed is not standardised. Considering that the vegetable and fruit waste being used as cattle feed, the nutritional aspect will certainly be more pronounced and healthier for the cattle. So, utilising the fruit and vegetable waste as cattle feed meets both the demand of cattle feed and waste management.

Waste segregation

Waste segregation is the first step in waste management. In order to facilitate waste management, waste needs to be segregated into bio-degradable or non-biodegradable waste. Alternatively, waste can also be divided into plastics, glass and organic or food waste. However, very few households divide their waste.

A part of the problem emerges from the fact that specialized bins are not available in the market that can help households divide their waste into color-coded bins. That is why the Sheetal Group has introduced a range of coloured plastic storage bins, such as blue, green and white dustbins, to help people segregate their waste products. Segregation of waste leads to better waste management.

The segregation will take place in multiple stages.

First, the fruits and vegetable wastes have to be separated from the other types of wastes in the market such as cardboard, paper, plastics and others. Next, fruits have to be segregated on basis of type like citrus, non-citrus, rich in carbohydrates, rich in proteins, etc. Similarly, another measure of segregation will be the extent of rotten as that will be deciding factor for pathogen activity and thereby the usability. Those fruits and vegetables which are completely rotten cannot be used as the pathogen count will be very high and may affect the cattle if used. Further, the fruits and vegetables have to be segregated in terms of aesthetic values as not all may be accepted by the people to be fed to the cattle. Fruits and vegetables have to be segregate from each other.

Segregation becomes most important as the rotten fruits and vegetables will affect the fresh or non-rotten ones at a very fast rate and it may lead to destruction of a whole batch of fruits and vegetables. Once removed from the pack, though pathogen activity will be there, that won’t affect the fresh ones.

Competitive analysis

For this product, the main competitors are grass and rice husk which are generally used as cattle feed. But the thing is always availability of these and the nutritional content of the same. The cattle feed made from fruits and vegetables will be more as supplement rather than main diet thereby its competitors will be the supplementary medicines or complements given to cattle which are much greater in price.

PROCESS FLOW OF CONVERSION OF FRUIT AND VEGETABLE WASTE TO CATTLE FEED

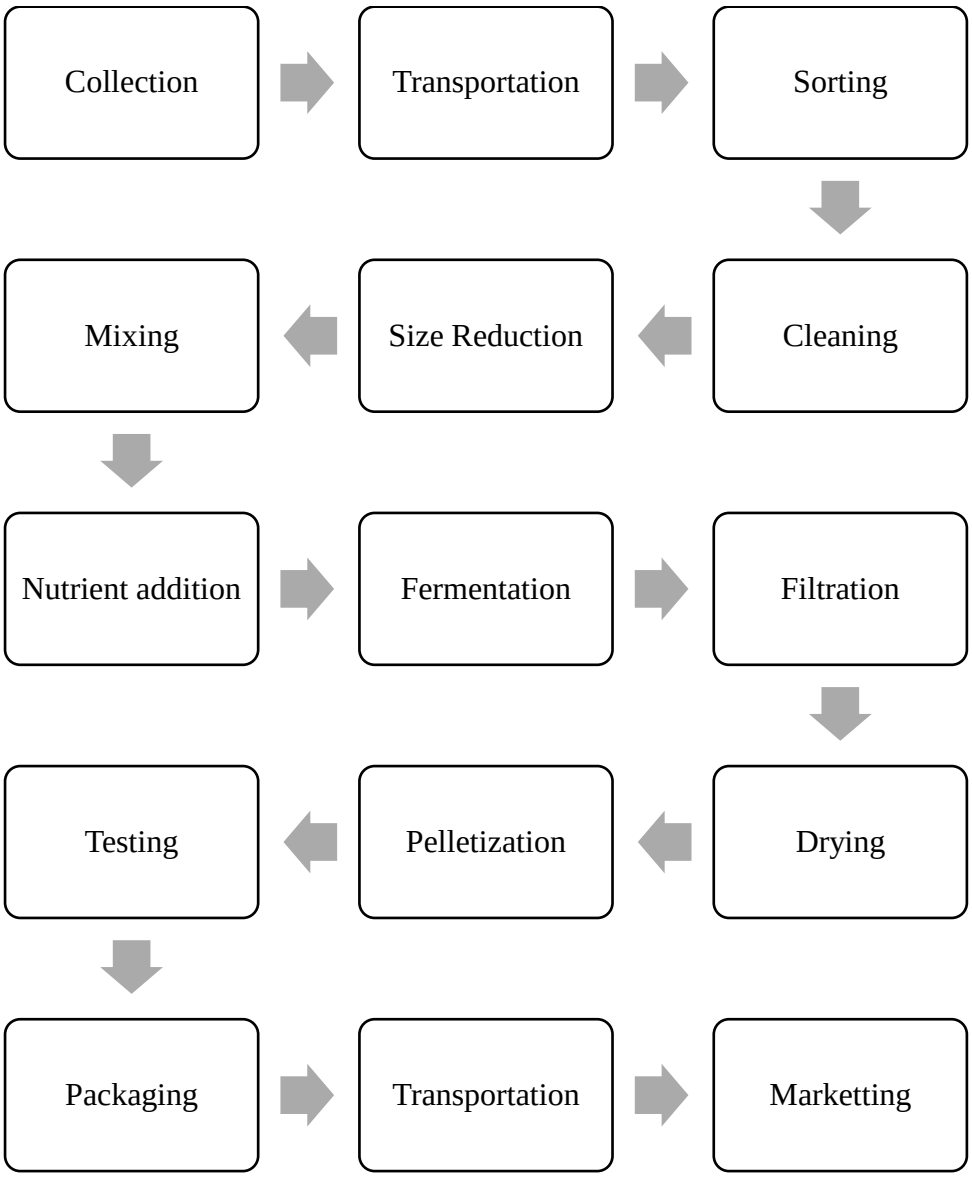

Fig. 2 Process flow of fruit and vegetable waste to cattle fodder

- Collection of fruit and vegetable waste: The collection of waste materials from various sources represents the first step in adding value to the process. By rescuing these materials from landfills or other disposal sites, the waste can be repurposed into a useful product, reducing waste and helping to promote a circular economy.
- Sorting and cleaning of the waste: Sorting and cleaning the waste ensures that only organic materials are used in the process, avoiding contamination by non-organic materials that could harm the cattle or reduce the nutritional value of the fodder.

- Shredding or chopping the waste: By shredding or chopping the waste, the surface area of the materials is increased, making it easier to extract the nutrients and enzymes in subsequent steps.
- Mixing the shredded waste with water and enzymes: Adding water and enzymes to the waste helps to break down the cell walls and release the nutrients, increasing the bioavailability of the fodder.
- Adding a source of nitrogen: Nitrogen is a key component of protein, and by adding a nitrogen source to the mixture, the microbial growth and protein synthesis are promoted, which increases the nutritional value of the fodder.
- Fermenting the mixture: Fermenting the mixture helps to reduce the pH, kill any pathogens, and improve the digestibility of the fodder, making it easier for cattle to extract the nutrients.
- Draining the liquid portion and separating the solids: Separating the solids from the liquid helps to concentrate the nutrients and increase the protein and fiber content of the fodder, which further enhances its nutritional value.
- Drying the solids: Drying the solids helps to reduce the moisture content and increase the shelf life of the fodder, making it easier to store and transport.
- Pelletizing or compacting the dried solids: Pelletizing or compacting the dried solids into convenient forms makes it easier for farmers to handle and distribute the fodder, which increases its market value.
- Testing the quality of the fodder: Testing the nutritional composition and safety standards of the fodder ensures that it meets the required quality standards, which adds value by increasing consumer confidence and demand for the product.
- Distributing the fodder: Finally, distributing the fodder to local farmers or ranchers ensures that they have access to a high-quality, nutritious, and affordable feed for their cattle, which improves the health and productivity of the animals and increases the profitability of the farming operation.

BUSINESS PROSPECT

Financial Analysis:

Collection and transportation of waste = Rs. 500/tonne

Waste generation = 5000 kg/day = 5 tonne per day

Annual collection and transportation charge = Rs. 500*5*365 = Rs. 9,12,500

Shredder machine (500 kg/hr capacity) (2 nos.) = Rs. 25,000

Mixing and fermentation tank (2 nos.) = Rs. 80,000

Solar dryer (2 nos.) = Rs. 85,000

Pelletizer (2 nos.) = Rs. 70,000

Weighing machine (2 nos.) = Rs. 10,000

Gunny bag sealing machine (2 nos.) = Rs. 5,000

Fixed Capital:

Sl. No.	Item	Cost (in Rs.)
1	Land, setup, and storage	1200000
2	Shredder machine	50000
3	Mixing and fermentation tank	160000
4	Solar dryer	170000
5	Pelletizer	140000
6	Consultant	100000
7	Weighing machine	20000
8	Gunny bag sealing machine	10000
9	Misc. charges	100000
10	Collection and transportation	1000000
11	Electrification and installation costs	30000
	Total	**2980000**

Table 1. Fixed capitals

Working Capital:

Sl. No.	Item	Cost (in Rs.) pa
1	Supervisor (1 No.)	400000
2	Skilled worker (3 Nos.)	900000
3	Unskilled worker (6 Nos.)	1500000
4	Cashier (1 No.)	200000
5	Watchman (2 Nos.)	300000
6	Power	100000
7	Water	80000
8	Utilities	20000
9	Testing (2 test/month)	240000
10	Transportation (factory to market)	400000
11	Marketing cost	50000
12	Insurance	1000000
13	Safety and maintenance	300000
	Total	**5490000**

Table 2. Variable capitals

Break even analysis:

Assuming 70-80% moisture content in the raw materials, 1.2 tonnes fodder can be produced from 5 tonnes of fruit and vegetable waste per day.

This accounts to 430 tonnes per annum.

Total fixed cost = Rs. 29,80,000

Fixed cost per kg = Rs. 6.93

Total variable cost = Rs. 54,90,000

Variable cost per kg = Rs. 12.77

Profit percentage = 20%

$$Selling\ price\ =\ (Fixed\ cost/kg\ +\ Variable\ cost/kg)(1\ +\ Profit\ \%)$$

Selling price per kg = Rs. 23.64 ≈ Rs. 24.00

$$Breakeven\ point\ (BEP)\ =\ Total\ fixed\ costs\ /\ Contribution\ margin\ per\ unit$$

$$Contribution\ margin\ per\ unit\ =\ Selling\ price\ per\ unit\ -\ Variable\ cost\ per\ unit$$

Breakeven point = 2980000/11.23 = 265360.64 kg

Breakeven price (BEP) = (Total fixed costs / Total volume) + Variable cost per unit

Breakeven price = 2980000/265360.64 + 12.77 = Rs. 24.00

Cash flow analysis:

Initial investment = Rs. 29,80,000

Annual operating cost = Rs. 54,90,000

Depreciation = Rs. 2,00,000 (worst case scenario)

Let the cost of cattle feed is Rs. 600/ gunny bag where capacity of each gunny bag is 25 kg.

Total revenue generated = Rs. 1,03,20,000

Project life = 3 years Discount rate = 15%

Year	Initial Investment	Annual working cost	Depreciation	Revenue generated	Depreciated revenue	Discounted value	Present value factor	NPV
0	29.8						-29.8	-29.8
1		54.9	2.0	103.2	101.2	88.0	33.1	33.00
2		54.9	2.0	103.2	101.2	76.52	21.62	24.92
3		54.9	2.0	103.2	101.2	66.54	11.64	36.56

Table 3. NPV Estimation (values in lakhs)

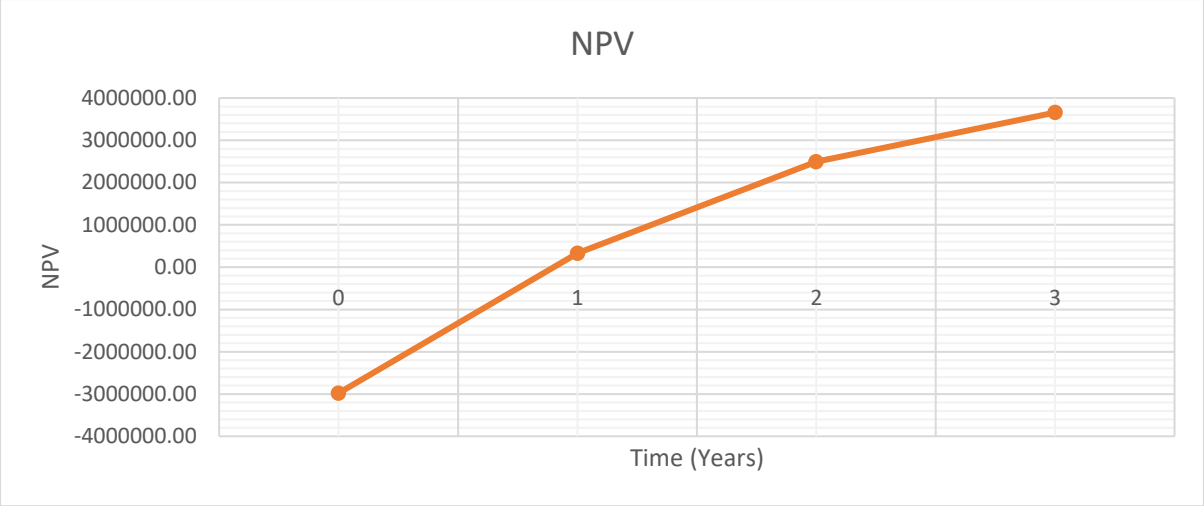

Fig. 3 NPV Curve

RISK ANALYSIS

There are various risks associated with this project, such as market demand, raw material availability and price volatility, production efficiency, and regulatory compliance. Some of the key risks and mitigation strategies are:

- **Market demand risk:** Conducting a thorough market research to identify the demand and supply dynamics, and diversifying the product portfolio to cater to different market segments.
- **Raw material risk:** Building a strong supplier network and entering into long-term contracts to ensure consistent supply and price stability.
- **Production efficiency risk:** Investing in modern and efficient machinery and equipment, and implementing quality control and process improvement measures.
- **Regulatory compliance risk:** Obtaining necessary licenses and permits, and complying with environmental, safety, and health regulations.
- **Health and safety risks:** Processing plants can pose risks to the health and safety of workers, such as exposure to hazardous chemicals, accidents involving heavy machinery, and exposure to high levels of noise or heat.
- **Environmental risks:** Processing plants can generate large amounts of waste and emissions that can have negative impacts on the environment. These can include air pollution, water pollution, and the release of greenhouse gases.
- **Supply chain risks:** The processing industry is often part of a complex global supply chain that can be impacted by various factors, such as changes in commodity prices, political instability, or natural disasters. These can disrupt supply chains and impact production and profitability.

SWOT ANALYSIS OF FRUITS AND VEGETABLES WASTE AS CATTLE FEED

Strengths	Weaknesses
1. Value addition to fruit and vegetable waste. 2. Reduces feed costs for livestock farmers. 3. Improves animal health and productivity due to the high nutrient and fibre content. 4. Reduces the environmental impact of livestock farming 5. Provides a source of income for waste collectors. 6. Highly nutritional feed. 7. Positive environmental impact as waste is not sent to landfills thereby reducing the probability of leachate formation. 8. Waste to energy generation.	1. Quality control can be difficult due to variations in waste composition. 2. Storage and processing can be challenging, particularly for small-scale farmers. 3. Transportation of waste to livestock farms can be difficult and may require specialized equipment. 4. May require additional labour for processing and storage. 5. Palatability may be a concern. 6. Acceptance of this type of feed by the people. 7. Handling and segregation.
Opportunities	**Threats**
1. Can help diversify income sources for farmers. 2. Can improve profitability for farmers by reducing feed costs and increasing animal productivity. 3. Provides an opportunity for waste management and recycling. 4. Can improve soil health and reduce the need for synthetic fertilizers. 5. Can help promote sustainable agriculture practices. 6. Can reduce methane emissions compared to traditional feed sources. 7. Can help promote community-based waste management systems. 8. Can be used to supplement other types of feed sources.	1. Limited availability of fruits and vegetable waste in certain regions. 2. Competition for waste from other industries, such as composting or biofuel production. 3. Potential negative impact on human food systems if waste is diverted from human consumption to animal feed. 4. Risk of contamination if waste is not properly collected and processed. 5. Potential for spoilage if not properly stored and processed. 6. May not be suitable for all types of livestock. 7. Lack of awareness and education among farmers and consumers about the benefits of using waste as feed.

Table 4. SWOT Analysis

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