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Waste managing plan for floriculture plants

León Joaquín
https://orcid.org/0009-0003-8383-3875
joaquin.leon@udla.edu.ec
Universidad de las Américas
Facultad de Ingeniería y Ciencias Aplicadas
Carrera de Ingeniería Industrial
Quito-Ecuador

Pavón Mishel
https://orcid.org/0009-0006-7848-0878
mishel.pavon@udla.edu.ec
Universidad de las Américas
Facultad de Ingeniería y Ciencias Aplicadas
Carrera de Ingeniería Industrial
Quito-Ecuador

Murillo Diego
https://orcid.org/0009-0009-5004-4101
diego.murillo@udla.edu.ec
Universidad de las Américas
Facultad de Ingeniería y Ciencias Aplicadas
Carrera de Ingeniería Industrial
Quito-Ecuador

León Mateo
https://orcid.org/0009-0005-9291-2297
bryan.leon.narvaez@udla.edu.ec
Universidad de las Américas
Facultad de Ingeniería y Ciencias Aplicadas
Carrera de Ingeniería Industrial
Quito-Ecuador

Guatumillo Damaris
https://orcid.org/0009-0001-7236-4263
damaris.guatumillo@udla.edu.ec
Universidad de las Américas
Facultad de Ingeniería y Ciencias Aplicadas
Carrera de Ingeniería Industrial
Quito-Ecuador

Toroshina Joel
https://orcid.org/0009-0000-8351-5445
joel.toroshina@udla.edu.ec
Universidad de Las Américas
Facultad De Ingeniería y Ciencias Aplicadas
Carrera de Ingeniería Industrial
Quito-Ecuador

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Abstract. - Ecuador's Floriculture Industry is essential as one of the biggest flower producers exporting flowers worldwide. However, flower production generates harmful environmental waste, emitting greenhouse gases. Therefore, it is vital to implement sustainable practices. In this document, an analysis of the supply chain will be conducted to provide a cleaner production system and efficiency for the Floriculture Industry. The objective is to reduce the harmful impact on the environment, searching solutions to minimize water use and develop energy-efficient technology. As a result, we look forward to sustainable flower production, protecting the environment and natural resources.

Keywords: Floriculture, cleaner production, waste management.

Plan de utilización de los desperdicios dentro de las florícolas

Resumen: La industria florícola de Ecuador tiene un papel destacado como uno de los principales exportadores a nivel mundial. Sin embargo, esta producción genera desperdicios que perjudican al medio ambiente, como contaminación del agua y suelo, daños a la biodiversidad y emisiones de gases de efecto invernadero. Por tanto, es crucial implementar prácticas sostenibles. En este trabajo se realizará un análisis de la cadena de suministro para proponer un sistema de producción más limpio y eficiente en el sector florícola. El objetivo es reducir el impacto negativo en el medio ambiente, buscando soluciones para minimizar el desperdicio de agua y adoptar tecnologías energéticamente eficientes. Con estas medidas, se busca lograr una producción de flores más sostenible, preservando los recursos naturales y protegiendo el entorno ambiental.

Keywords: Floricultura, producción más limpia, gestión de residuos.

I. INTRODUCTION

The floricultural industry has grown from 2000 to 2020 from $3.7 billion annually to $7.9 billion, representing an annual growth of 3.9% of the market. The global flower market is stocked in 30% of South America, highlighting Colombia and Ecuador providing over 97% of all flowers from the region [1]. In Ecuador in 2022 116 thousand tons of flowers were exported to the market, valued at $638 million [2]. The export of flowers requires a system of transportation and cold storage, which requires adequate infrastructure to preserve their condition and characteristics. In addition, production involves several stages from planting to selling the flowers. It begins with the selection and sowing of seeds or bulbs, followed by cultivation in greenhouses under controlled conditions. During growth, care and management of the plants are conducted, including irrigation, fertilization, and pest control. Once the flowers are at optimum maturity, harvesting occurs, followed by post-harvest processes such as cutting, treatment with preservatives, and proper packaging. The flowers are then transported under refrigerated conditions to maintain freshness and distributed to wholesalers, retailers, or exporters. The following document will analyze the supply chain for the Floriculture sector through simulation to propose a cleaner production system. The inefficient use of water, both through inadequate irrigation systems and excessive irrigation, can deplete local water resources and affect aquatic ecosystems. The intensive use of pesticides, herbicides, and chemical fertilizers can contaminate soil and water, damaging biodiversity. Packaging waste, such as plastics and cardboard, can end up in landfills or the environment, contributing to pollution [3]. Therefore, it is considered crucial to address the problem of waste in flower farms to reduce the negative impact of waste through sustainable practices that optimize the use of waste to create sustainable production and improve the image and reputation of the companies that dedicate their activity to planting flowers.

II. DEVELOPMENT

In the present work, different topics related to the implementation of methodologies within cleaner production will be applied to support us in the development of a proposal that takes advantage of the waste generated in the flower farms Description and diagramming of the production process: Detailed explanation of the different stages and activities in the manufacture of a product [4].

A. Bizagi: Software that uses a BPM approach to help optimize operations and improve organizational efficiency, analyzing processes and identifying areas for improvement by visualizing and managing processes intuitively and collaboratively [5].

B. Flow of materials: Each resource involved in the production process is identified and described to find the efficient and sustainable management of materials within the processes, minimizing the consumption of resources and waste [6].

C. Production process simulation: A technique that uses computer models to mimic and represent the behavior of a production process in a virtual environment. It allows for analyzing and evaluating different scenarios, making informed decisions, and optimizing the operational efficiency of the process[7].

D. FlexSim: 3D simulation software that allows modeling and simulation of complex systems for different industries [8].

E. Identify areas for improvement: Identify and recognize areas or aspects of an organization, process, or system that can be improved to achieve better performance or meet specific objectives.

F. Ishikawa: Visual tool used to identify and explore the potential causes of a problem [9].

G. Improvement proposal: Plan or set of specific actions designed to improve an existing process, product, or system.

H. Cost Analysis: The process of examining and evaluating costs related to production [10].

III. METHODOLOGY

A. Description and layout of the production process:

For the flower industry, the production process description goes from the seeds sowing to their commercialization. This can be summarized as the preparation of the land, which involves leveling and eliminating weeds. Next, the roses are planted in appropriate patterns. During the care and handling of the plants, irrigation, fertilization, and protection against pests are carried out. Harvesting is performed at optimum maturity, followed by post-harvest processing, including sorting, removing leaves and thorns, and treatment with preservative solutions. They are then packed and stored under appropriate conditions (Fig. 1)

The following is the process, which has been mapped and diagrammed using Bizagi software, detailing the activities and phases involved in the production of roses in an Ecuadorian flower farm, which we will analyze during the development of this project.

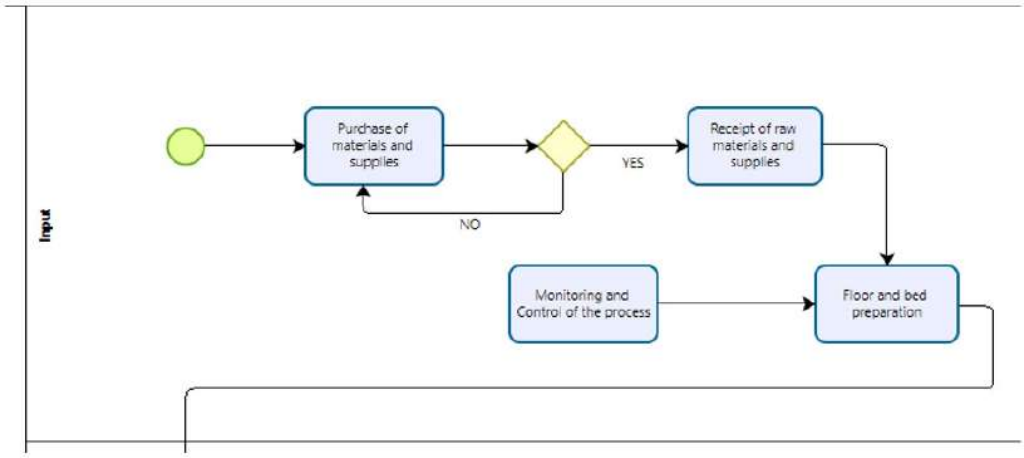

Fig. 1. Entry phase, roses production.

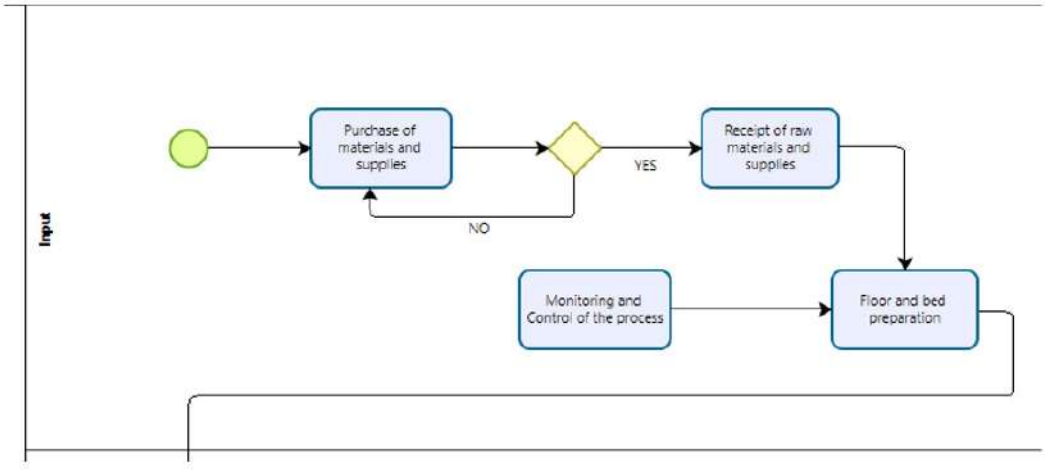

Fig. 2. Rose production.

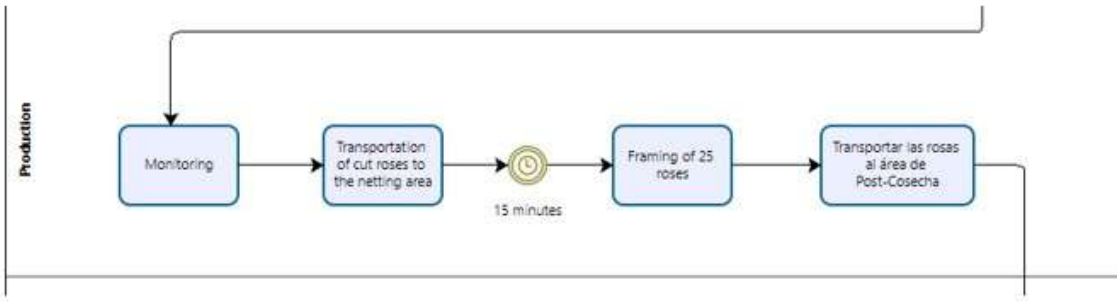

Fig. 3. Rose production two.

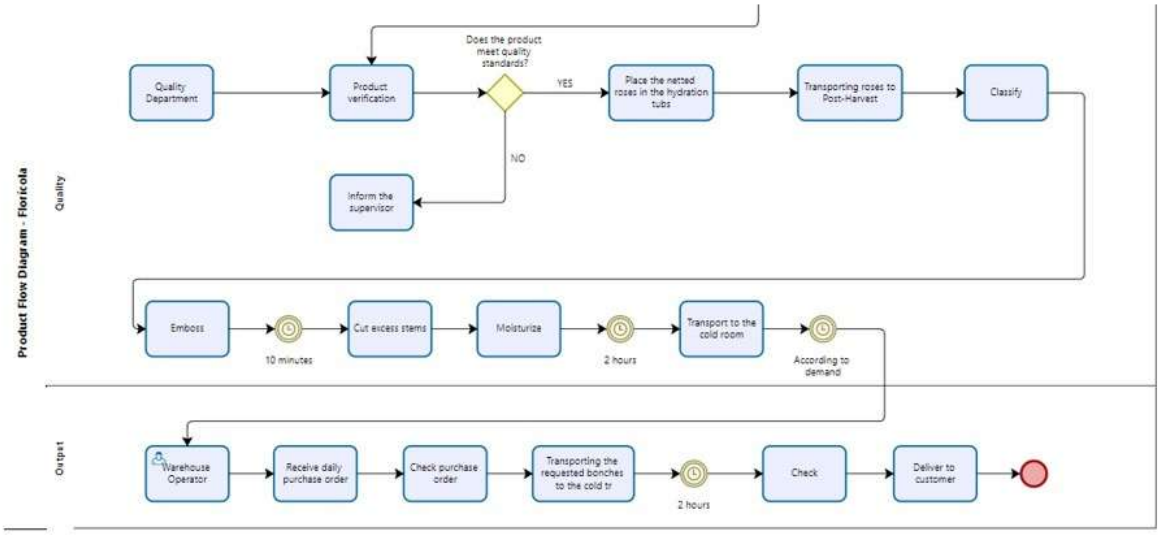

Fig. 4. Quality and output phase.

B. Flow of materials

The flow of materials and quantities wasted based on historical data are detailed below.

Table 1a. Flow of materials.

N°	Input	Quantity Used	Quantity Wasted	Percentage %	Unit	Observation
1	seeds	1000000	50000	5%	units	
2	substrate	300000	30000	10%	liters	
3	water	1560000	312000	20%	m^3	780000 m^3 per month
4	fertilizers	150	22.5	15%	kilograms	
5	insecticides	50	7.5	15%	liters	
6	fungicides	50	7.5	15%	liters	
7	herbicides	50	7.5	15%	liters	

Table 1b. Porducts and waste.

N°	Output	Quantity Used	Quantity Wasted	Percentage %	Unit	Observation
1	flowers	950000	47500	5%	units	
2	Flowers packaged	902500				
3	Water	312000				Storage in tanks

Table 1c. Main supplies.

RAW MATERIAL	INFORMATION
Seeds	Cultivation of one hundred thousand flowers and one million seeds is needed, with an approximate waste of 1 to 5%.
Substrate	Two to five liters of substrate per plant for flower cultivation with an approximate waste of 5 to 10%.
Water	Two to four liters of substrate per plant for flower cultivation with an approximate waste of 10 to 30%.
Fertilizers	One hundred to three hundred grams per square meter of cultivation area with approximately 10 to 20% waste.
Chemicals and Pesticides	One to five liters of insecticides and fungicides, with approximately 10 to 20% waste. One to five liters of herbicides are used with approximately 20 to 50% of waste.
Flowers	For a lot of one hundred thousand flowers, it is considered that there are 5 to 10% of flowers with some defect.

C. Production process simulation

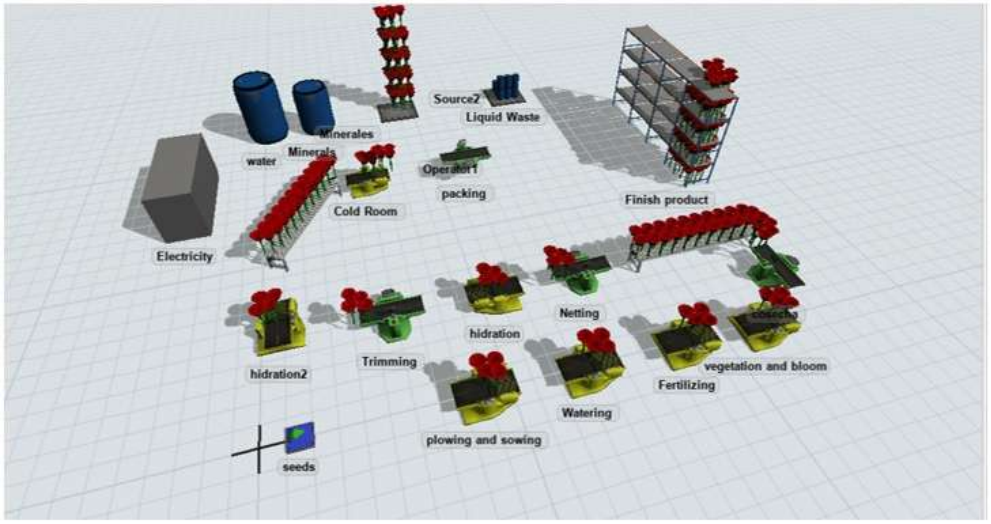

Fig. 5. Process simulation.

The model has detailed the growth of roses as a flow through the processes necessary for healthy and abundant production. It has detailed input flows, such as electric current and water, as well as a representation of both solid and liquid wastes.

D. Identification of areas for improvement

In addressing the problem of water and organic waste on flower farms, it is necessary to identify the root causes. These include more staff awareness and training, efficient irrigation and water conservation systems, and standardized working methods for waste management. By analyzing these causes, strategies can be implemented to optimize resource use, reduce waste, and improve efficiency in flower production. It includes providing adequate training, using advanced irrigation technologies, promoting reuse practices, and establishing clear procedures for waste management. By addressing these areas of improvement, flower farms can reduce their environmental impact and promote more sustainable and responsible production.

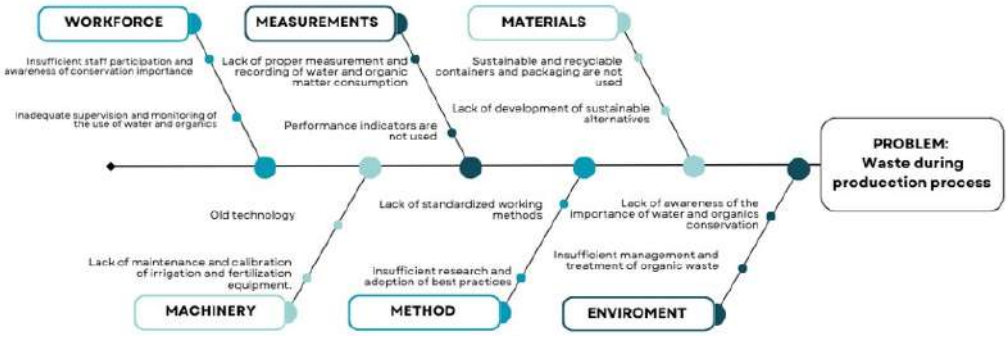

Fig. 6. Ishikawa Waste Production

A.Improvement proposal and cost analysis

A remediation plant is designed to treat waste the floriculture industry generates. The floriculture industry is dedicated to cultivating and producing flowers and can develop distinct types of waste, such as wastewater, used cultivation substrates, packaging, and pesticide residues, among others. However, having data such as the presented waste, which is 100,000 stems every two months, representing 15% of waste, we will focus on designing the remediation plant to reduce and give use to the destruction presented within the floriculture.

According to the data obtained by the public flower company, a remediation plant for about 250 thousand square meters costs about 500 thousand dollars. The purpose of the plant is to reuse the waste, make better use of the waste for the organic part, and generate organic fertilizer, which makes the soils recover their lost nutrients. These fertilizers developed in the remediation plant would be used to treat the ground of the flower farm and sell it. It should be noted that each bag of about 45 kg of compost costs 6 dollars. For each waste that arrives at the plant, there is a transportation cost of $96 to carry 15 cubic meters of plant waste, so it was also proposed to have its dump truck transport the debris from the flower farm to the plant. As a first step to determine the costs of this plant, we searched for a 140 m2 plot of land to establish the plant in a strategic position.

Fig. 7. Area for remediation of plant.

In the design process of the remediation plant, rainwater collection through a tank will be used. The location in La Esperanza, Ecuador, was selected due to the high number of rainy days recorded. With about 214 rainy days per year, representing 58% of the days, it will be possible to benefit from rainwater for the remediation plant while at the same time contributing to the care of the environment., it will be possible to benefit from rainwater for the remediation plant while at the same time contributing to the care of the environment.

Similarly, a rainwater collection tank will be used since the place where the remediation plant will be located in Ecuador has many rainy days during the year, as can be seen in the following graph of the 365 days of the year it rains about 214 days, which means that 58% of the days it rains, so we could benefit from this water for the remediation plant and also help the environment.

Table 2. Rain and humidity.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation (mm)	156	156	193	218	168	128	116	75	80	142	179	173
Humidity	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%
Rainy days (days)	17	16	20	20	20	19	18	15	15	18	18	18

Different machinery is needed to implement the remediation plant, such as a backhoe, extraction pumps, aeration towers, filtration systems, monitoring equipment, and a water collection tank. Also, these costs include the machinery that will be needed for the water treatment plant. a water collection tank. Also, these costs include the machinery that will be needed for the water treatment plant.

Table 3. Costs for the remediation plant

Water Remediation and Treatment Plant		
Machinery/Materials	**Quantity**	**Cost**
Land (140 square meters)	1	$ 50.000,00
Backhoe Loader	1	$ 69.000,00
Water booster pump	1	$ 3.000,00
Aeration tower	1	$ 20.000,00
Filtration System	1	$ 13.000,00
Nutrient and contaminant sensors	2	$ 4.000,00
Water storage tank	1	$ 1.000,00
Tank transports water	per trip	$ 100,00
Dump truck for 15 cubic meters	1	$ 90.000,00
Total		$ 250.100,00

Table 4. Investment Analysis VAN and TIR.

Production Cost	$140.000
Fixed Cost	$10.000
Total Cost	$150.000
Unit cost	$0,15
Sales Revenue	$350.000

Cash Flow	**Investment**	**P1**	**P2**	**P3**	**P4**	**P5**
Utility	$ -250.100	$200.000	$208.000	$192.000	$206.000	$202.560

Investment	
Investment	$ - 250.100
interest rate	15%
Periods	5
VAN	$ 926.023
IRR	76%
Discount rate	13%
The project is viable since the IRR is higher than the discount rate provided by the bank.	

F. Remediation Plant Process.

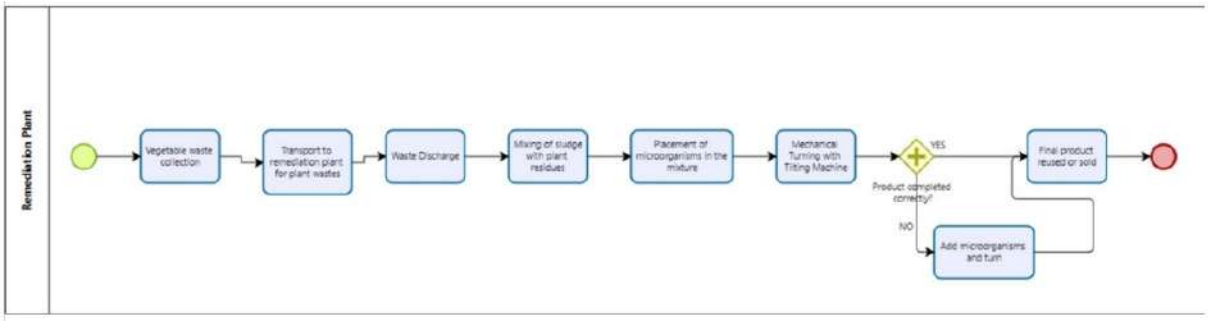

Fig. 8. Remediation plan process.

G. P&ID Blueprint Water treatment plant

The proposed water treatment plant will help us for the use within the remediation plant and for the flower farm itself. By having water stored inside the flower farm, this is transported to the remediation plant where the water treatment plant will be located and thus be able to use that water and reuse it; at the same time, the proposed water plant can also work with rainwater which is a significant amount due to the area where it is located.

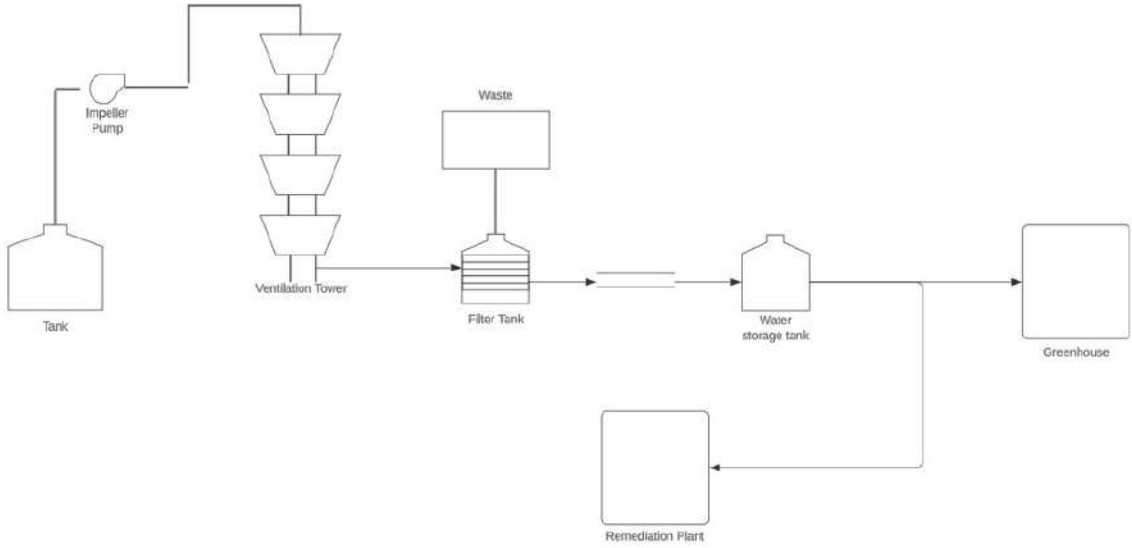

Fig. 9. P&ID map.

IV. RESULTS

Implementing a waste utilization plan within flower farms, especially in rose production, can increase sustainability and reduce environmental impacts. Ordinary wastes in rose production include stems and excessive water use. First, rose stems, usually discarded after harvesting and cutting, can represent a valuable opportunity for utilization. These stems can be collected and used for compost production to regenerate soil nutrients. By integrating a system of proper stem collection and management, floriculture can maximize the value of these residues and reduce the amount of waste sent to landfills. There is also excessive water use in rose production, as roses require irrigation and are often improperly managed, resulting in destruction. To address this problem within this project, the feasibility of implementing the water collection plan and its corresponding treatment to optimize its use in the process and for the proposed compost was evidenced. An adequate waste management plan brings environmental benefits and economic and competitive advantages for flower farms.

CONCLUSIONS

Using simulation programs such as FlexSim within production processes is of utmost importance, as it will allow us to optimize them, increase their efficiency, and reduce costs. Because it helps us identify bottlenecks and problems in the supply chain through data, this will be essential to propose improvement solutions based on results, translating into higher performance and competitiveness for other floriculture companies.
In conclusion, a water treatment plant for a flower farm is a crucial and necessary investment to ensure proper and sustainable management of the water used in the production process, in addition to the fact that it can help with other methods, as in this case for the remediation plant that will help generate new revenue for the company and take advantage of both the waste from the roses and the water.

In short, the remediation plant is a crucial tool for addressing soil and water contamination. It provides an effective solution to restore the environment recover contaminated soils, and all in a natural way, and it is worth highlighting its profitability as it will be a new source of income. Its implementation is essential to achieve responsible and sustainable environmental management.

The flow of materials in a flower shop is essential to ensure product quality, customer satisfaction, and operational efficiency. Proper management of raw materials, from procurement to processing and distribution, is critical to the success of the flower shop and its ability to offer fresh, quality products to its customers.

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