HIGHER POLYTECHNIC SCHOOL OF CHIMBORAZO

FACULTY OF LIVESTOCK SCIENCES

ZOOTECHNICS CAREER

"COMPARISON OF PASTURE MANAGEMENT WITH A TRADITIONAL IRRIGATION SYSTEM VERSUS CROP BOOSTER TECHNOLOGY TO OBTAIN BETTER FORAGE PRODUCTION AT THE TUNSHI EXPERIMENTAL STATION"

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DEDICATION

First of all, I dedicate this work to God, for giving me life and wisdom to achieve my goals and fulfill another step in my professional life. To my parents Anita and Fernando, who with their advice and support motivated me to continue despite so many difficulties, have been present giving me their love and with each of their teachings and values that have instilled in me since I was a child to be above all humble in any situation. place than this. To my brothers Diego and Natalia who with their support encouraged me to finish my academic training

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I would like to especially thank God for this degree project, who has given me the strength to continue in the face of difficulties that have arisen along the way, as well as my parents who have supported and helped me at all times. Also to my friend Ángel who from the beginning encouraged me to continue and support me by being present in every problem and joy that came my way. To the Higher Polytechnic School of Chimborazo, Faculty of Livestock Sciences, Zootechnics Career for opening the doors for me and being able to fulfill my goal. To my director of the degree work, Eng. Pablo Andino, who supported me and helped me to complete the investigation, as well as to Eng. Sandra Yambay. And each of the teachers who gave me their knowledge throughout my academic training.

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TABLE OF CONTENTS

CHAPTER II

CHAPTER III

TABLE INDEX

GRAPHICS INDEX

INDEX OF ANNEXES

RESUMEN

El objetivo de la investigación fue comparar el manejo de pastizales con un sistema de riego tradicional frente a la tecnología Crop Booster para obtener mayor producción forrajera. Se realizó en el lote 10.2 B con una mezcla forrajera de Alfalfa (*Medicago sativa*), Ray grass (*Lolium perenne)* y Trébol blanco (*Trifolium repens)*, con una extensión de 50 m de ancho y 178 m de largo con un área total de 8900m^2, el cual se dividió en la mitad quedando así con unas medidas de 50 m de ancho y 89 m de largo cada una, con un área de 4450m^2 en donde se realizó la comparación de los sistemas de riegos, que fue durante un periodo de 30 días el riego 1 día por semana por 40 min. Los datos fueron tomados dos días a la semana para comparar los dos sistemas de riego, donde se determinó la composición botánica %, cobertura basal %, cobertura aérea % y altura cm. Dicho dispositivo que consta de microtransmisores de baja frecuencia los cuales son transportados mediante el agua lo que permitió estimular a las plantas para que exista un mejor desarrollo, mayor absorción de agua y reducir los días de corte del pastizal. Los datos experimentales fueron sometidos mediante la prueba t-student al ($P<0,01$) y ($P> 0.05$). Los mejores resultados se obtuvieron al implementar el dispositivo Crop Booster frente al riego convencional ya que presento diferencias altamente significativas en el porcentaje de proteína de 9,58%, que influye en la dieta, producción de forraje verde 14252 kg/fv/ha/corte, un beneficio/costo de 1,57 USD, se concluyó que el riego con el dispositivo Crop Booster se obtiene mayor producción forrajera, se recomienda que la investigación sirva como base y que se aplique a otras mezclas forrajeras.

Palabras clave: <PRODUCCION FORRAJERA> <MEZCLA FORRAJERA> <MICROTRASMISORES> <ALFALFA (*Medicago sativa*)> <RAYGRASS (*Lolium perenne)*> <TREBOL BLANCO (*Trifolium repens)*> <DISPOSITIVO CROP BOOSTER> <ESTACION EXPERIMENTAL TUNSHI>

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ABSTRACT

The objective of the research was to compare pasture management with a traditional irrigation system versus Crop Booster technology to obtain greater forage production. It was carried out in lot 10.2 B with a forage mixture of Alfalfa (Medicago sativa), Ray grass (Lolium perenne) and White Clover (Trifolium repens), with an extension of 50 m wide and 178 m long with a total area of 8900m2 , which was divided in half, thus remaining with measures of 50 m wide and 89 m long each, with an area of 4450m2 where the comparison of the irrigation systems was made, which was during a period of 30 days' irrigation, 1 day per week for 40 min. The data was taken two days a week to compare the two irrigation systems, where the botanical composition %, basal cover %, aerial cover % and height cm were determined. The device consisted of low-frequency microtransmitters which are transported by water, also allowed to stimulate the plants so that there is a better development, greater water absorption and reducing the days of grassland cutting. The experimental data were submitted using the t-student test at (P<0.01) and (P> 0.05). The best results were obtained when implementing the Crop Booster device compared to conventional irrigation since it presented highly significant differences in the percentage of protein of 9.58%, which influences the diet, green forage production 14252 kg/fv/ha/cut, a benefit/ cost of 1.57 USD, concluding that irrigation with the Crop Booster device results in greater forage production, it is recommended that the research serve as a basis and that it be applied to other forage mixtures. also allowed stimulating the plants so that there is a better development, greater water absorption and reducing the days of grassland cutting. The experimental data were submitted using the t-student test at (P<0.01) and (P> 0.05). The best results were obtained when implementing the Crop Booster device compared to conventional irrigation since it presented highly significant differences in the percentage of protein of 9.58%, which influences the diet, green forage production 14252 kg/fv/ha/cut, a benefit/ cost of 1.57 USD, concluding that irrigation with the Crop Booster device results in greater forage production, it is recommended that the research serve as a basis and that it be applied to other forage mixtures. also allowed stimulating the plants so that there is a better development, greater water absorption and reducing the days of grassland cutting. The experimental data were submitted using the t-student test at (P<0.01) and (P> 0.05). The best results were obtained when implementing the Crop Booster device compared to conventional irrigation since it presented highly significant differences in the percentage of protein of 9.58%, which influences the diet, green forage production 14252 kg/fv/ha/cut, a benefit/ cost of 1.57 USD, concluding that irrigation with the Crop Booster device results in greater forage production, it is recommended that the research serve as a basis and that it be applied to other forage mixtures. greater water absorption and reducing the days of grassland cutting. The experimental data were submitted using the t-student test at (P<0.01) and (P> 0.05). The best results were obtained when implementing the Crop Booster device compared to conventional irrigation since it presented highly significant differences in the percentage of protein of 9.58%, which influences the diet, green forage production 14252 kg/fv/ha/cut, a benefit/ cost of 1.57 USD, concluding that irrigation with the Crop Booster device results in greater forage production, it is recommended that the research serve as a basis and that it be applied to other forage mixtures. greater water absorption and reducing the days of grassland cutting. The experimental data were submitted using the t-student test at (P<0.01) and (P> 0.05). The best results were obtained when implementing the Crop Booster device compared to conventional irrigation since it presented highly significant differences in the percentage of protein of 9.58%, which influences the diet, green forage production 14252 kg/fv/ha/cut, a benefit/ cost of 1.57 USD, concluding that irrigation with the Crop Booster device results in greater forage production, it is recommended that the research serve as a basis and that it be applied to other forage mixtures.

Keywords: <FORAGE PRODUCTION> <ALFALFA> (Medicago sativa)> <RAYGRASS (Lolium perenne) > <WHITE TREBOL (Trifolium repens)> <CROP BOOSTER DEVICE>

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INTRODUCTION

When implementing technology in an irrigation system, the objective is to improve the quality of the plants so that there is a greater production and reduce the cutting time, the type of technology that was implemented in the irrigation of the Tunshi Experimental Station is a Crop Booster device. which helps to increase forage production and have pastures with higher nutritional value. This innovative irrigation system that has obtained good results in the crops because it does not impact the environment and increases a better production, the Crop Booster technology contains low intensity radio frequency microtransmitters that positively influence the metabolism of the plants coming from a more efficient way.

The new Crop Booster technology allows to significantly improve these aspects in the harvested products, which is why it is being tested by producers around the world in a wide variety of crops (Organiko Latam, 2021, p. 2). Crop Booster optimizes both the quantity and quality of yields, improving soil health and nutrient availability, increasing root density and balancing the absorption and use of nutrients by plants (Sánchez, 2020, p. 4) .

Based on the above, it is sought to identify the best alternative for the management and irrigation of pastures, consequently the production and quality of pastures at the Tunshi Experimental Station can be increased. The development of this research can lead to a new irrigation alternative for farmers, which benefits a higher forage production and consequently increases sustainability and profitability.

Due to the benefits obtained when comparing the Crop Booster irrigation system and normal irrigation, the present investigation raised the following objectives:

- Identify the botanical composition of the forage mixture (alfalfa, ryegrass and white clover) when comparing traditional irrigation and the Crop Booster device.
- Evaluate the bromatological composition of the forage mixture (alfalfa, ryegrass and white clover) when comparing traditional irrigation and Crop Booster device.
- Determine the phenological response of the forage mixture (alfalfa, ryegrass and white clover) when comparing the two irrigation systems.
- Evaluate the productive behavior of the grassland with the use of the Crop Booster system and the traditional system
- Determine cost-benefit

CHAPTER I

1. REFERENTIAL THEORETICAL FRAMEWORK.

1.1. Irrigation systems with technology

A technified irrigation system can solve some problems that exist in the field, implementing technological resources can achieve greater efficiency in production and increase product yields, which is why it is beneficial to install technology in irrigation.

It is estimated that in Ecuador only 13.8% of the agricultural area has technical irrigation that allows small farmers in our country to optimize this valuable non-renewable resource in a controlled and efficient manner so as to reduce the waste of irrigation water (Medina , 2017, p. 2).

It is important to highlight that a technical irrigation system has a direct impact on the quality of life of rural families for whom this technology represents a saving of water for agricultural use, resulting in a notable increase in the productivity of their crops (Rizo, 2019).

1.2. Crop Booster Definition

Crop Booster is a technology that is based on the use of a microtransmitter that emits a high number of acoustic frequencies, takes advantage of plot irrigation water to transport the frequencies that the plant species needs to develop, that is, the water acts as a carrier of information whose objective is to deliver to the plants the data stored in the microtransmitters (AGROSITIO, 2020, p. 1).

1.3. Effects of Crop Booster technology on the soil

According to Moreno et al (2015, p. 21), they indicate that the soil is considered a living system because it needs to have available nutrients and an adequate structure where the existence of interaction of all its elements is evidenced: biological, chemical and physical that together they allow to protect the different organisms, it is a factor of crop development that depends directly on the interaction with a fertile soil to have an optimal growth of the plants.

In Ecuador, the use of land for agricultural purposes is seven million hectares, of which cultivated and natural pastures represent 64.56% of the total national productive land (Tenencia de la tierra y usos del piso en el Ecuador, 2016).

The Crop Booster system improves the health of the soil because it promotes the union of its minerals and helps prevent the leaching of the nutrients present in it, which causes an increase in the availability of micronutrients, as well as an increase in the activity of bacteria. nitrogen fixers whose function is to convert the nitrogen present into nitrates and nitrites and prevent excessive evaporation of nitrogen from humid soils, increasing the density of the roots which causes the compaction characteristics of the soil to decrease (Sierra, 2021, p. 10).

1.4. How Crop Booster technology works

Matter is made up of atoms that are made up of protons, neutrons and electrons that are kept in constant motion, this movement translates into vibrational energy where each individual molecule remains fixed, but since they vibrate next to each other, they combine with each other to form their own frequency (PortalFrutícola, 2020 , p. 1).

It is theorized that by exposing plants to frequencies suitable for certain functions, crops with high yields would be obtained because the plants at the molecular level are in harmony with the natural vibratory frequencies, obviously the normal processes of the soil or the crop are not altered. to treat (PortalFrutícola, 2020, p. 1).

In effect, the frequencies transmitted by Crop Booster fit with the natural molecular frequencies of both plants and soils, granting an improvement in their functions, resulting in healthy plants with accelerated growth and higher production, therefore more profitable (Sierra, 2021, p. . 1).

Certainly Crop Booster technology is a non-chemical catalyst whose operation is based on increasing pressure and energy on plant cells by receiving precise acoustic waves in the range of 10 Hz to 150 that exert a direct influence on all components of the plant speeding up processes of metabolism and photosynthesis, as well as enabling the activation of resistance genes (Padilla, 2020, p. 1).

1.5. Transport of low-frequency waves through water

Thanks to its polarity, the water is responsible for efficiently transmitting the information to the plants, using specific frequencies that stimulate them to obtain greater growth and development, the Crop Booster technology uses the irrigation water to transport these frequencies required by the plant to its optimal performance (AGROSITIO, 2020, p. 1).

The Crop Booster microtransmitters will be placed in a metal pipe within the irrigation system, thus a magnetic field is formed consisting of the flow of water that extracts the information stored in the microtransmitters and transports them directly to the crop, finally the water represents the wave of energy that delivers the information stored in the microtransmitters to the plants (PortalFrutícola, 2020, p. 1).

1.6. Installation and use of Crop Booster technology

According to Sánchez (2020 p. 1), the assembly of the system is simple, it is conditioned in a PVC metal pipe to which a cut was previously made and the Crop Booster system is implanted, which has more than 3000 signals of frequency that are programmed in steel alloy disks that are connected to the irrigation system and emit the signals through the water until they reach the soil and the plants. The metal tube has the function of amplifying the waves that are emitted by the microtransmitters to the water destined for the crops. The installation will depend on the type of irrigation system intended for the crop, in any case the installation costs are very low.

It is important to know that if you have a high volume irrigation system it will require larger and more expensive pipes because they must match the irrigation system. It is not necessary to have a power source because the system causes that every time the water flows through the system, it will emit frequencies that will be transported by the water to the plants, delivering all the benefits to the crop (Sanchez, 2020, p. 1).

1.7. Benefits of Crop Booster technology for the plant

Plants benefit by absorbing the frequencies that this system provides them with an improvement in the following aspects: it allows the absorption and use of essential elements such as water, oxygen and carbon dioxide for plant development, it also promotes efficient consumption of light translated into increased photosynthesis (Organiko Latam, 2021, p. 1).

According to (Sierra, 2021), there is also evidence of an increase in: fresh weight, number of harvested fruits classified at higher levels, postharvest life time. In addition, there is an improvement in plant health, increased resistance to pests and diseases.

1.8. Product Advantages

According to Agronoticias (2020, p. 1), the advantages of using Crop Booster technology are the following:

- Economic factor because it represents a saving both in irrigation water and in the purchase of agro-inputs.
- Helps reduce production costs.
- Optimization of water use
- high durability
- easy installation
- Manageable.
- Significantly shortens cultivation time
- Increased quality and quantity of crop yields

1.9. Research on certain crops

In an interview for the VAR 102.9 FM radio station, Sixto Sánchez, Technical Manager of Organiko Latam announced that, in countries such as Peru, Chile, Colombia, Ecuador and Bolivia, there have been increases in production in ranges of 35% to 75% for crops such as: grapes, avocados, blueberries, in the case of tomatoes the increase is 100% increased production (Sánchez, 2021).

1.10. Irrigation methods and systems

Adequate irrigation directly helps crop development, so if there is a water deficiency due to inadequate environmental conditions, moisture must be replenished in the soil so that plants can absorb nutrients. According to Carrasco and Puente (2017, p. 12) they indicate that the irrigation method refers to the way of supplying water within the plot while the irrigation system is a set of equipment, supplies and techniques used for the application of the irrigation system. irrigation water following an established method that considers all the aspects present to make decisions regarding the form of application of irrigation water on the plots.

The choice of irrigation method and system for the plot depends on each particular case, always with the aim of reducing water loss by using it efficiently, where efficiency is the ratio between the amount of water available on the land after irrigation and the total volume of water that was supplied (Demin, 2014, p. 10).

1.10.1. irrigation methods

Irrigation methods have evolved over time from the most rudimentary farmers who were based on the observation of available water from both natural springs and rainwater trying to manage the water resource and the soil for crops, currently there are Fully technified irrigations that are the product of studies in the different branches of agronomy, hydraulics, mechanics and others that complement each other for the automation of irrigation, making better use of parcel irrigation water.

To select the irrigation method, authors such as (Fernández et al., 2010, p. 15) indicate that it is essential to take into account factors such as:

- Topography, shape and orientation of the plot
- Physical characteristics and composition of the soil
- Type of crop
- Quality of irrigation water and availability of irrigation
- Cost of installation, maintenance and execution of irrigation
- Environmental impact that includes runoff and soil erosion

The different irrigation methods are detailed below:

1.10.2. line irrigation

Irrigation method characterized by high water losses, favoring unequal distribution within the plot, resulting in there being flooded sectors and other dry ones. It is recommended that the irrigation water advance slowly through the furrows, obeying the contour lines drawn in the land (Demin, 2014, p. 15).

1.10.3. flood irrigation

It consists of the application of large amounts of water throughout the cultivation area causing a temporary flood (Martínez, 2017, p. 39).

This method has the advantage of low investment costs and the disadvantage is the loss of irrigation water due to infiltration (Carrasco, 2016, p. 26).

1.10.4. furrow irrigation

It is characterized in that the water enters and is distributed through channels or furrows taking advantage of the slope. This irrigation method is adapted to crops sown in rows, therefore, as it works according to the slope of the land, the use of irrigation can be less than 40%, so it is necessary to consider the length of the furrows that depend directly from soil texture and infiltration. The dimensions of the furrows depend on the crop, thus they will be wider, deeper and wider furrows in fruit crops and narrower and more superficial in horticultural crops (Demin, 2014, p. 17).

1.10.5. Irrigation by flowerbeds

This method is the most used globally, it consists of irrigating land that is commonly rectangular and with low slopes that favor the infiltration of irrigation water that must have an irrigation duration of 6 to 12 hours. These lands are fenced by ridges or copings whose width must be 75cm to guarantee absorption, its function is to contain the water, preventing it from entering other fields and causing waste. The furrows are generally open at the end so that there is good drainage in case there is an excess of water, which is why this type of irrigation is for row crops (Pereira et al., 2010, p. 129).

1.10.6. Irrigation system

An irrigation system brings together different structures and implements to make it easier for the land to be cultivated with the necessary water for the plants and to avoid waste. Engineer Gregory Calderón indicates that the materials commonly used in irrigation systems are: PVC pipes and accessories, metal supplies, hoses, hydraulic wrenches, air valves, glues and welds (EL UNIVERSO, 2016, p. 1). The most representative irrigation systems are:

1.10.7. sprinkler irrigation system

It is intended to supply a large amount of water that covers large surfaces, falls uniformly as rain on the crop. The sprinkler system is appropriate for all kinds of soil, it has the disadvantage of causing evaporation losses and also uses a lot of electrical energy to activate the necessary pressure for its correct operation (Demin, 2014, p. 15).

Among the spray equipment are: cannon, center pivot and front feed, fixed spray and portable spray. It is also convenient to take into account that the speed at which the drops fall as rain is equal to or less than the speed of infiltration of water in the soil, this observation will help avoid waste by runoff (Demin, 2014, p. 16). According to el Universo (2016, p. 1) this irrigation system can be of the emergent type that was designed to emerge from the ground when the irrigation system is opened and retracts when finished. There is also a mobile sprinkler system that is attached to the end of a hose and is moved within the plot.

1.10.8. microsprinkler

Variant of sprinkler irrigation with the difference that it has less reach and its drops are smaller, this characteristic makes micro-sprinklers recommended for the irrigation of small plants (EL UNIVERSO, 2016).

It is recommended for crops such as nurseries, fruit trees and vegetables. The wetting diameter when using this system can be from three to four meters, the most common micro-sprinklers are used by fixing a support on the ground and water is supplied through a surface hose. Microjets are generally used in nurseries by placing them so that they hang above the plants connected to a hose that is responsible for irrigating water (Demin, 2014, p.16).

1.10.9. drip irrigation

This system allows the plant to be irrigated drop by drop, reducing water waste, since only the areas where it is necessary are moistened and the rest of the land remains dry. The drip has a design that allows pressure to be lost and drops to fall at different flow rates (2; 2.5; 3; 4 litres/hour). There are non-self-compensating and self-compensating drippers, the latter are made up of a diaphragm that makes it possible to maintain the flow rate if the water pressure drops, thus preventing the plant from running out of the necessary humidity (Demin, 2014, p. 16). Obviously the advantages of irrigation systems are: adaptability, labor savings and water economy.

1.11. forage mix

In our country, most of the arable land enjoys suitable conditions for the production of pastures all year round, notably it is an advantage for which we should be excellent producers, and we also have the possibility of doing so at low costs.

Ecuadorian producers have the opportunity to apply technologies for the production of pastures, for which each rancher must interpret the reality of their farms and timely solve the difficulties in an efficient manner, just as farmers-ranchers act in other countries (León, et al. , 2018, p. 37).

The forage mixtures allow greater advantages, among them a longer and more sustainable production, since growth is compensated despite environmental factors, it reduces weeds and favors animal consumption, facilitating a more balanced nutritional value, demonstrating that animals fed with forage mixtures are much healthier (ROCALBA, 2016, p. 2).

According to Formoso (2011, p. 3), it indicates that forage mixtures where more than three species are brought together are more productive compared to simpler mixtures, and also emphasizes the importance of mixing several species of legumes, since they complement each other and produce more than crops. with two species or in pure plantings, that is to say that the diversity of species, being genetically different and sharing space on the same property, are enhanced and complemented because they use more efficiently resources such as: soil, water, light and nutrients compared to forage mixtures with few species.

Pastures are the most economical source of food for the producer to maintain their animals, therefore it is necessary to have adequate management so that the pasture expresses its full potential when consumed by cattle and that they thus develop development functions. , growth, production and reproduction. Obviously, it is necessary to improve the technology of pasture production, since the feeding directly affects the cattle so that the final product is of high quality in terms of milk, wool, meat, etc. In the present study, the forage mixture made up of: rye grass, alfalfa and white clover detailed below was used.

1.12. Rye grass (Lolium perenne)

1.12.1. Morphological description and taxonomy

Plant with long and wide light green leaves, it is formed by sessile inflorescences arranged alternately along the floral rachis. The seeds differ from other ryegrass by having an edge, in the case of commercial seeds it may be absent because in the collection and cleaning operations it breaks and is eliminated along with the impurities (Fertilizadores y Pesticidas Huesca SA, 2014). .

Rye grass reaches a height of 60-90 cm and forms open clumps at the base. The leaves are rolled up, characterized by having an opaque upper face and a shiny lower face, its ribs are marked, and they have cylindrical stems with a whitish base. The inflorescence is a spike 20-40 cm long, its fruiting is a spikelet with 10 to 20 florets and bearded seed (León, et al., 2018, p. 154). Table 1-1 lists the taxonomic classification of ryegrass.

Table 1-1: Taxonomic classification of ryegrass

Kingdom	plant
Division	Magnoliophyta
Class	Liliopsida
Order	Cyperales
Family	Poaceae
Gender	lolium
Species	*L. multiflorum Lam.*
Scientific name	*L. multiflorum L.*

Font:(Martinez, 2020)

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1.12.2. Adaptation

- Climate: Ray grass adapts to humid temperate climates, resists cold well, does not support drought, acclimatizes to altitudes between 2,500 and 3,600 meters above sea level (León, et al., 2018, p. 154).
- Its growth slows down from 25ºC and stops at 35ºC (Hidalgo, 2010).
- Soils: It needs fertile soils to develop, nitrogen is a particularly important element to have adequate productions (Borau Group, 2014).

It requires soils with an intermediate or slightly heavy texture, demanding in fertility, adapting to both loam and clay loam soils and with a pH close to neutrality. It is intolerant to salinity, alkalinity, droughts and floods (León, et al., 2018, p. 154).

1.12.3. Irrigation

Usually the varieties of ray grass are very demanding in terms of humidity, for a normal development they require between 12-25 mm of irrigation per week, it must be considered that they are susceptible to flooded land or with excess humidity (León, et al., 2018, p 154).

According to Salamanca (1996, p. 5), it indicates that the species is not suitable for continuous grazing, since if a lot of grass is lost due to trampling, it is better to implement rotational grazing. Practice shows that when continuously grazed and without any management practice, it can disappear in two or three years. As for irrigation, where it is possible to use water for irrigation in dry seasons, it should be used since this species requires good soil moisture, the lack of soil moisture is reflected by the low forage production and the decrease in quality of these

1.13. Lucerne (Medicago sativa)

1.13.1. Morphological description and taxonomy

Alfalfa is a forage, leguminous and perennial plant that can reach up to a meter in height, has a robust and highly developed pivoting main root (up to 5 m in length) from which many secondary roots emerge, it has a crown that it comes out of the ground, from which the stems are born, these are thin and erect to support the weight of the inflorescences and leaves that are unifoliolate at first and then have three leaflets, each uni or trifoliate leaf has smooth margins with somewhat jagged upper edges. The flowers are almost always purple, although they may have yellow and violet petals (Olguín, 2012; cited in Barriga, 2017, p. 14).

The fruits are spiral pods, depending on the origin of the fertilization: crossed or self-fertilization. If it comes from cross-fertilization it has nine to eleven seeds, if it comes from self-fertilization it will have from one to three seeds, in both cases the seeds are kidney-shaped, shiny olive green in color and become matte when it ages, finally turning brown. dark (León, et al., 2018, p. 165). Table 2-1 lists the taxonomic classification of alfalfa.

Table 2-1: Taxonomic classification of alfalfa

Kingdom	plant
Division	Magnoliophyta
Class	Magnoliopsida
Order	beans
Family	Fabaceae
Gender	medic
Species	Sativa
Scientific name	*medicago sativa*

Font:(Chorus, 2020, p. 7)

Made by: Perez M. 2022.

1.13.2. Management, performance and nutritional value

- Establishment: By botanical seed, broadcast 45-60-75 kg/ha depending on the amount of dry matter to be obtained. It is recommended to associate with 8 kg/ha of red clover (León, et al., 2018, p. 154).
- Use: You can plant it alone in a plot or use it for cutting, haylage (Jaramillo, 2010).
- By associating ray grass with small grain cereals such as oats or barley, it is possible to produce high quality silage. In paddocks made up of slow-growing species, it is recommended that the mixture contain 60-70% perennial species and 30-40% perennial species. hybrid or annual (León, et al., 2018, p. 154).
- Yield: Cuts every 28-30 days; 120 t/ha/year of green forage, corresponding to 18 t/cut, seed production is 600-700 kg/ha (Jaramillo, 2010).
- Nutritional value: diploid varieties 14-15% protein, tetraploid varieties 19 – 20%; ENN 38.04% (Jaramillo, 2010).

1.13.3. Adaptation

- Climate: It is a species that develops optimally in sub-humid climate, it adapts to temperate climate, in arid conditions it prevails with irrigation. Seed production needs dry air to promote the outcome of the flower and therefore fertilization (Maddaloni and Ferrari, 2005; cited in sinavimo.gob.ar).
- Soil: Alfalfa needs to develop in well-drained soils with a wide variability of more than 60cm depth to promote the development of its abundant roots (Coro, 2007, p.12).

Alfalfa is a calcicultural plant that needs soils with 2-3% calcium, phosphorus, potassium and minor elements such as boron, it does not support acidity, the ideal pH is neutral or slightly alkaline (6.2-7.8), supports pH 9 to pH 11, it is limiting for the crop is a pH 4.5-5.5 (León, et al., 2018, p. 166).

1.13.4. Irrigation

It is necessary that the irrigation in this crop be divided because its requirement varies throughout its reproductive cycle, therefore, if the water supply is excessive, the efficiency of the use of irrigation is reduced, it easily adapts to the water deficit for a long time thanks to that its roots can penetrate the soil profile. The total water needs of the vegetative cycle are between 700 and 900 mm of water (AZUD, 2019).

1.13.5. Management, performance and nutritional value

Establishment: The planting density depends on several factors and must be between 6 and 12 kg/ha to achieve an adequate distribution of the plants (Coro, 2007, p.13).

The recommended planting depth is one to two point five centimeters, soil moisture influences implantation. For a rapid development and establishment of the crop it is necessary to have an adequate level of phosphorus in the soil that determines root growth, potassium helps to increase tolerance to cold, increases resistance to diseases and helps persistence (Agroindustrial Magazine of the NOA , 2007; cited in Coro, 2007, p.13).

- Use: Alfalfa is used to make different feed options for livestock such as flour, pellets and haylage, it is also tolerant to grazing (León, et al., 2018, p. 171).

It can also be granulated as indicated (Barriga, 2017, p.17), for which the raw material must be dehydrated and converted into flour, then granulated, the size of the granule is 5mm to 10mm in diameter. The latter is not recommended for small ruminants because it can cause choking when consumed. As a granule it retains its nutritional properties, but loses the effect of effective fiber to stimulate rumination.

- Yield: Altitude is the most important factor that directly influences the number of cuts in the inter-Andean region, it has a yield of 40 to 80 tons of green fodder / hectare / year, in 4 to 8 cuts (Barriga, 2017, p. 14).

Other authors such as (León, et al., 2018, p. 171), emphasize that the time of establishment of the crop depends on the yield, which is low at the beginning, but with the passage of time and with good management, the strengthening occurs. of the crowns and as a result the yield is increased, on average 18 t /MV/cut up to 22 t/MV/cut.

- Nutritional value: Alfalfa is known as the "queen of forages" due to its high quality nutritional content, adaptability, production and persistence. It has high values of proteins, minerals and vitamins, its energy value is high, directly related to the nitrogen content, it also has minerals (Ca, Mg, S, etc.) and beta carotenes, precursors of vitamin A that influence bovine production (Coro, 2007, p. 21).

The dry matter values are approximately 23% CP (León, et al., 2018, p. 172).

1.14. White clover (Trifolium repens)

1.14.1. Morphological description and taxonomy

White clover is a perennial plant, with a creeping habit, its stems are horizontal, so it develops at ground level where the stolons are buried in the ground by trampling or by the action of the worms that facilitate the nodes of the stolons to generate roots. (Demanet, 2012, p.127; cited in Spain, 2015, p.14).

White clover has trifoliate leaves that may or may not have a white "V"-shaped spot on the upper side. The leaves are variable in size and shape, since they can be wide, oval or almost heart-shaped. The inflorescence has a relatively long peduncle, with white or pink flowers, each flower produces pods that contain from one to seven seeds that are small, heart-shaped and yellow, but turn dark brown over time (León, et al., 2018, page 175).

It is a plant with a short cycle and low yield, but once established it is very persistent as it tolerates grazing and resists drought (León, et al., 2018, p. 175).

According to the website (sinavimo.gob.ar, 2014), the varieties are classified by the size of the leaves in:

- Small leaves of low height; with highly branched stolons
- Medium-sized leaves, with long petioles, less stoloniferous and less branched.
- Large leaves with erect growth, thick and robust stolons
- Very large leaves or giant clover, have higher forage production during the first years of the pasture, with time the persistence decreases. Table 3-1 lists the taxonomic classification of white clover.

1.14.2. Adaptation

- Climate: White clover grows in cold and humid temperate climates (León, et al., 2018, p. 176)
  indicate that in the Himalayas it grows from sea level to 6,000 meters of altitude.

White clover develops well in areas with high temperatures from 10 to 20ºC, it also tolerates high cloud conditions, withstands annual rainfall between 800-1,600 mm and heights of 2,000-3,000 meters above sea level (Martinez, 2020).

- Soil: Requires superficial, medium to heavy soils as long as they are very fertile and well drained, it is necessary to have a pH between 5.0 - 7.5 (Martinez, 2020).

When the "V"-shaped spot present on the upper leaf is brown, it is due to soil deficiencies (León, et al., 2018, p. 175). Table 3-1 details the taxonomic classification of white clover.

Table 3-1: Taxonomic classification of white clover

Kingdom	plant
Division	Magnoliophyta
Class	Magnoliopsida
Order	beans
Family	Fabaceae
Gender	trifolium
Species	repens
Scientific name	*Trifolium repens*

Font:(Martinez, 2020)

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1.14.3. Irrigation

White clover is sensitive to water deficit, therefore soil moisture is an essential requirement for white clover, because its roots are superficial, it is not efficient in controlling water loss, this factor together with high temperatures, result in little or no forage input. On the other hand, in poorly drained soils, it tolerates excess moisture and is less sensitive than other legumes (sinavimo.gob.ar, 2014).

1.14.4. Management, performance and nutritional value

- Establishment: this crop is established by asexual seed when dispersed by stolons, if it is associated with other forage species, around 3 kg/ha will be used, where white clover represents 10% of the total seed used (León, et al., 2018, page 176).

If sexual seed is used it can be sown broadcast and associated with grass seeds, in cold weather the amount of clover seed should not exceed two kilos per hectare because it presents spontaneous growth (Marinez, 2020).

It cannot be kept in mixtures that are for cutting only because the grass would disadvantage white clover with its early shade, especially if nitrogenous fertilizers are applied in cover. Consequently, it is advisable that there be intense grazing at the beginning of the season and when it is necessary to supply fertilizers with phosphorus and potassium to favor the legume, avoid nitrogen fertilizers (Rivera, 2015; cited in Barriga, 2017, p.11).

It resists trampling very well because it does not affect regrowth because the growth points are not damaged, its ideal percentage of white clover in paddocks is 25-30% (León, et al., 2018, p. 176).

- Use: Ideal crop for grazing in association with grasses, it is also used for making hay, especially using very large or ladino white clover (Hidalgo, 2010; cited in Barriga, 2017, p.10).

It is also suitable for silage as a source of breath in the critical season:

- Yield: It is possible to obtain harvests between eight to ten tons of green fodder per hectare. The association with legumes should not exceed 30%, in addition, it is necessary to take precautions when grazing in paddocks, because if the percentage mentioned is exceeded, poisoning of the animals can be evidenced due to its high nitrate content (Martínez, 2020).

Fuster (2005), states that the best form of exploitation is through grazing. White clover can be cut continuous or rotational, if it is cut to a height of 3 cm it will not cause damage to the clover, however, early cuts should allow the clover to recover, when it reaches a height of about 25 cm. Excessive competition due to mixed pastures should encourage white clover defoliation, so saturating the field is not recommended.

CHAPTER II

2. METHODOLOGICAL FRAMEWORK

2.1. Location and duration of the project

The investigation was carried out in the province of Chimborazo in the Riobamba canton at kilometer 12 via Licto at the Tunshi experimental station, with coordinates 1°44'54.8"s 78°37'30.8"w (- 1.748567, -78.625209), the same that lasted 60 days distributed in the fertilization of the organic fertilizer batch, testing irrigation systems and data collection. The meteorological conditions of the place are detailed in table 4-2 below:

Table 1-2: Meteorological conditions of the Experimental Station "Tunshi"

Parameters	averages
Temperature, °C	14.92
RH, %	76.2
Annual Rainfall, mm/year	842
Altitude, masl	2,712
Winds, km/h	15

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2.2. Unitsexperimental

The experimental units that made up the present investigative work were constituted by half of the lot with dimensions of 50 m wide and 89 m long, with a total area of 8900 m2, which compared two irrigation systems which were: the Traditional irrigation versus Crop Booster technology to obtain higher forage production at the Tunshi Experimental Station.

2.3. Materials, equipment and facilities

2.3.1. field

- Hoe
- notebook and pen
- overalls

- Boots
- Quadrant

2.3.2. Equipment

- crop booster
- PVC metal pipe

2.4. Treatments and experimental design

The following investigation was carried out in lot 10.2 B composed of a forage mixture of Medicago sativa (alfalfa), Lolium perenne (ray grass) and Trifolium repens (white clover) to compare two irrigation systems that were; traditional irrigation versus Crop Booster technology, which was carried out, irrigation 1 day per week for a month using the t-students test to be compared.

2.5. Measurementsexperimental

- Botanical composition (Gramineae (%), Legumes (%), (Weeds (%))
- Plant height (cm)
- Air coverage (%)
- Baseline coverage (%)
- Green forage production (kg/ha)
- Dry matter production (kg/ha)
- Benefit/cost analysis

2.6. Statistical analyzes and significance tests

The experimental results were evaluated using the following statistical process:

- Hypothesis test for continuous variables, according to t-Student al ($P<0.01$) and ($P> 0.05$).

2.7. Experimental procedure

For the experimental work, the following was carried out:

2.7.1. Soil sampling

With the use of the drill, random samples were taken from the lot prior to the investigation, the sample must be free of roots and up to 1 kg, which was placed in a plastic bag to be transferred to the laboratory for analysis.

2.7.2. Sampling of the grass

The sample was randomly taken from the pasture in lot 10.2 B where the forage mixture is found until a 1 kg sample was obtained, which was placed in plastic bags to be transferred to the laboratory for the bromatological analysis prior to the investigation.

2.7.3. ground measurement

The measurement of the land was carried out with an extension of 50 m wide and 178 m long with a total area of 8900 m2, which was divided in half, leaving measures of 50 m wide and 89 m long each, leaving with an area of 4450m2.

2.7.4. Installation of the Crop Booster device

Installation of the Crop Booster system which consisted in making a cut to the pipe to install the system, which are magnets that transport waves of frequency through the water that help the plants to have a stimulus for greater growth, the other irrigation system that will be used is through flood

2.7.5. Irrigation

Irrigation was carried out 1 day per week for a month to obtain results.

2.8. Evaluation methodology

2.8.1. Baseline coverage (%)

To determine the basal cover, the Canfield line method was used, under the following procedure; the area occupied by the plant on the ground was measured, the total number of plants present in the transept was added and the percentage of basal cover was obtained by ratio (Jimenez, 2005).

$$\%BC= \frac{\text{Sum of Total Basal Coverage Intercepted}}{\text{Total Line Length}}$$

2.8.2. Air coverage (%)

To determine the basal cover, the Canfield line method was used, the area occupied by the plant in its middle part of the foliage was measured, the total number of plants present in the transept was added, and the percentage of cover was obtained by ratio. aerial (Quezada, 2019).

$$\%AC= \frac{\text{Sum of the total air coverage intercepted}}{\text{Total line length}}$$

2.8.3. Plant height (cm)

It consists of measuring the height of the plant in the different phenological stages, expressed in cm. Taking the same from the soil surface, to the terminal half of the highest leaf.

2.8.4. Production of green forage and dry matter (kg/ha)

It is evaluated by applying the quadrant method, a sample is cut from each plot, in 1 m2 making random launches, cut at a height of 5 cm, the weight obtained is in relation to 100% of the plot and the production of tons/ha. The dry matter production of the grass is obtained by determining the percentage of dry matter (Chugñay, 2015, p.25).

2.8.5. botanical composition

It consists of counting the number of plants of each species found in the meadows, taking a significant sample with the quadrant, to see if any increases or decreases its persistence, and it is expressed as a percentage (Riva, 2014, p.24).

2.8.6. Cost benefit analysis

The economic parameter was evaluated through the cost benefit indicator in which it is related.

$$\mathbf{B/C=}\frac{\text{Total Income(\$)}}{\text{Total Expenses (\$)}}$$

CHAPTER III

3. FRAMEWORK AND DISCUSSION OF THE RESULTS

Comparison of pasture management with a traditional irrigation system versus Crop Booster technology to obtain better forage production at the Tunshi Experimental Station.

For data analysis, the variables between both irrigation systems were compared to determine which is the best irrigation and with a higher forage production. The following variables were taken into account

3.1. Evaluation of the botanical composition

From the forage mixture (Medicago Sativa, Trifolium repens and Lolium perenne) at the Tunshi Experimental Station. In table 1-3, you can see the botanical composition of the forage mixture

Table 1-3: Botanical composition of the forage mixture

variables	Treatments				try	Next.
	Crop Booster (gr/m^2)	**~~%~~**	**Normal irrigation (gr/m^2)**	**%**		
% grasses	355.4	24.94	119	21.56	0.01081	**
% legumes	902.8	63.35	346.4	62.75	0.00052	**
% weeds	167	11.72	86.6	15.69	0.08645	ns

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3.1.1. Grasses (%)

When evaluating the variable botanical composition of the forage mixture consisting of alfalfa, ryegrass and white clover, highly significant differences were present ($P<0.01$), reaching a higher percentage with the Crop Booster irrigation system, 24.9% was obtained and with the normal irrigation system obtained 21.6%. This is because there is an increase in grass development and growth when irrigated with the Crop Booster system.

The key elements of the forage mixtures are the knowledge of this composition and its dynamics in different climatic seasons to evaluate the forage capacity of the species to interact with the weeds in a way that affects and ensures an excellent nutritional quality that is offered to the animals. (Prieto, 2004).

3.1.2. Legumes (%)

When evaluating the variable botanical composition of the forage mixture consisting of alfalfa, ryegrass and white clover, highly significant differences were present (P<0.01), showing only numerical differences, reaching a higher percentage with the Crop Booster irrigation system, 63 were obtained, 3% and with normal irrigation 62.8% was obtained.

With the Crop Booster system there is an increase in the growth and development of grasses because the device emits low-frequency radio waves which helps improve the efficiency and development of plants.

The results are supported by Cabezas (2015, p. 25), who pointed out that the best grasslands are grasslands related to grasses, where legume root nodules bind atmospheric nitrogen in the soil and, ultimately, they provide grass. The same with juicy growth.

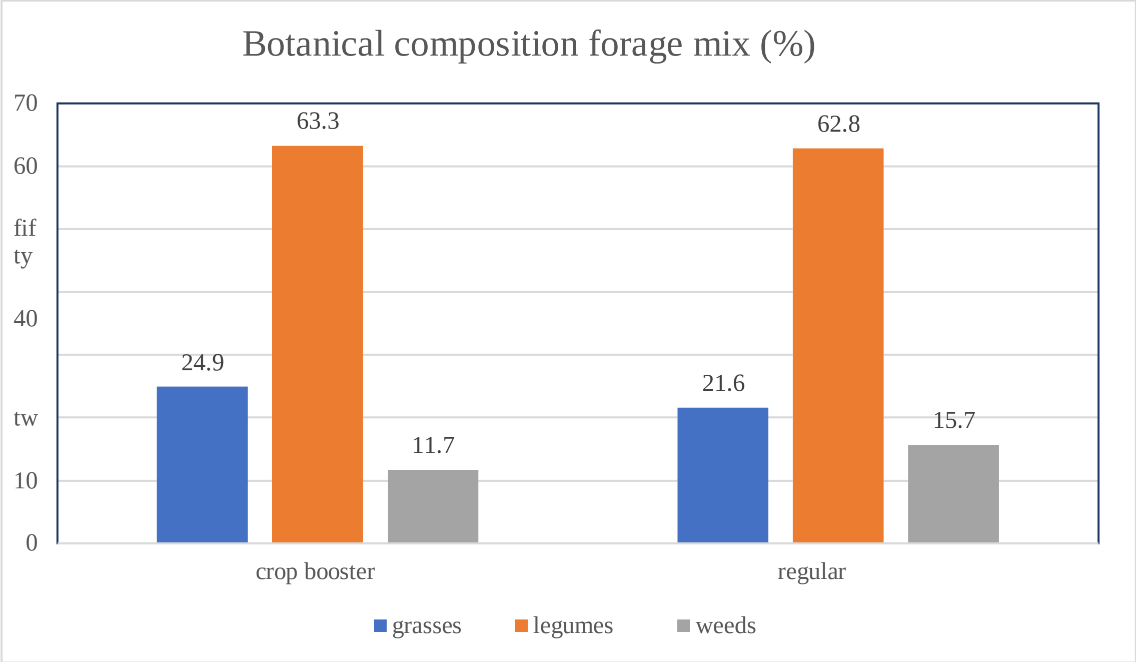
It also has a low carbon to nitrogen ratio (13 to 9), which, when used, prevents competition for nutrients (nitrogen) between soil microorganisms and the plants they grow on.

3.1.3. Weeds (%)

When evaluating the variable botanical composition of the forage mixture consisting of alfalfa, ryegrass and white clover, no statistical differences were present (P>0.05), showing only numerical differences, reaching a percentage with the Crop Booster irrigation system, 11.7 was obtained. % and with the normal irrigation system 15.7% was obtained. This is because with the device there will also be a greater development in the weeds since they also take advantage of the low frequency waves that are emitted to the plants.

The forage mixture must contain 5% to 10% weeds, so it can be seen that these grasses are nutritionally balanced for cattle due to their high mineral content (Jimenez, 2005).

Graph 1-3 shows the botanical composition of the forage mixture (%), with Crop Booster and normal irrigation.



Graph 1-3. Botanical composition forage mix %

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3.2. Phenological response

3.2.1. Height of the forage mixture (cm)

The results with the height variable in cm when compared with the Crop Booster device and normal irrigation present the following results:

When analyzing the variable height of the production of a forage mixture made up of alfalfa, white clover and ryegrass, they reported highly significant differences ($P<0.01$), registering that with the Crop Booster device an average of 49.6 cm was obtained while with normal irrigation an average of 35.04 cm. By using this type of technology in irrigation, this helps to have a greater height in the pastures because the low-frequency waves emitted by the device allow the plant to have a better absorption and metabolism of nutrients to have greater production and growth.

According to Pirela (2009. p. 25), this suggests that grasslands have their own physiological and morphological characteristics that provide specific adaptations for their growth and quality. However, as climatic conditions change, its yields and quality undergo morphological changes, the most influential components being temperature, solar radiation, precipitation and their decomposition, while Gaibor. The role of humus as organic fertilizer is an essential part of crop nutrition, while irrigation and proper management can help improve forage yield. Table 6-3 shows the phenological response of the forage mixture.

Table 2-3: Phenological response of the forage mixture when comparing two systems

variables	Treatments		try	Nex t.
	crop booster	regular irrigation		
Height (cm)	49.67	35.04	0.00295555	**
Air coverage (%)	77.8	57	0.00827478	**
Baseline coverage (%)	74.8	54	0.00448373	**

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3.2.2. Aerial cover of the forage mixture (%)

When analyzing the aerial cover variable of the forage mixture consisting of alfalfa, white clover and ryegrass, they reported highly significant differences (P<0.01), registering that with the Crop Booster device a percentage of 77.8% while with irrigation normal a percentage of 57%. By installing the Crop Booster device in the irrigation system, this allows greater production and development of pastures because the device has low-frequency waves that allow greater aerial coverage in the forage mixture.

According to León (2003, p. 10), he reported that ryegrass adapted to medium to high fertility soils, silty or silty with good drainage, is classified as a forage that prefers moist high altitude soils and is suitable for well-drained and poorly drained soils. drained. It also tolerates acid and alkaline soils (pH 5.0 to 7.8).

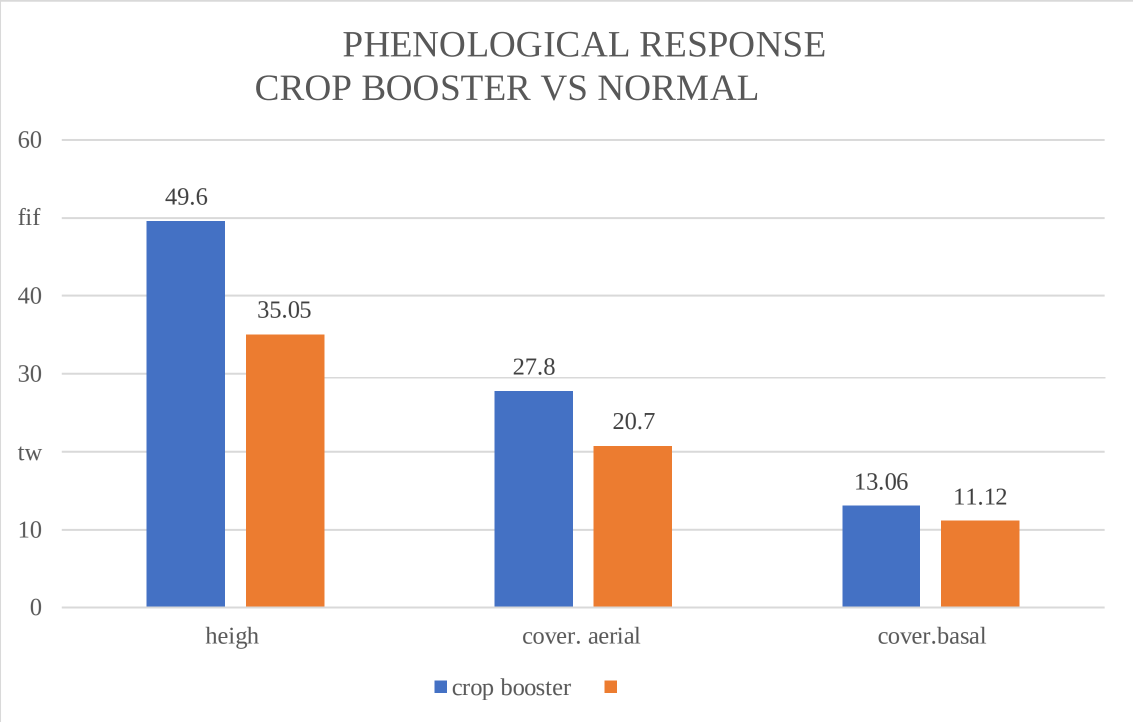
Below pH 5.0, aluminum toxicity can be a problem, while Hidalgo (2010, p. 52) found that compound feeds treated with vermicompost represented 86.00% of the air coverage, which is an important factor in the formation of grasslands due to the air space, the larger it is, the more sunlight can penetrate the surface - the substrate contributes to the photosynthesis process of plants.

3.2.3. Basal coverage of the forage mixture (%)

When analyzing the basal cover variable with a forage mixture of alfalfa, white clover and ryegrass reported highly significant differences (P<0.01), registering with the Crop Booster device a percentage of 74.8% while with normal irrigation a percentage of 54%.

With the Crop Booster device, it helps to have more basal coverage because when irrigation is carried out, the low-frequency waves are transported by the water, which allows greater development and growth of the grass.

In the studies of Rost (2009, p. 29), he pointed out that, through adequate hydration, it facilitates synthesis in organs: roots, stems, leaves, fruits, seeds, etc., facilitating root growth and subsequent growth. of stems. Graph 2-3 indicates the phenological response when comparing the two irrigation systems.



Graph 2-3. Phenological response (Crop Booster vs Normal irrigation)

Made by: Perez M. 2022.

3.3. Green forage of the forage mix (kg/ha)

When analyzing the green forage production of the forage mixture composed of alfalfa, ryegrass and white clover when using the two irrigation systems, which with the Crop Booster device, a production of 14252 fv/kg/ha/cut was obtained at 35 days. and with normal irrigation, a production of 5520 fv/kg/ha/cut was obtained at 45 days, with which it is determined that by implementing the Crop Booster device in irrigation, a better forage production is obtained because it increases growth and plant development.

According to Infoagro (2008, p. 1), in order to protect the layer fertile soil, various cultural tasks are carried out, including: adequate crop rotation, including crops with different nutritional needs, maintenance of humidity, preparation, adequate curing, soil biology and humus, etc. Organic fertilization, where the compound feed is used as a soil regenerator because it alters the ability of the land to be used for livestock production as an artificial grassland for mowing or grazing.

3.4. Dry matter (kg/ha)

When evaluating the dry matter of the forage mixture composed of alfalfa, ryegrass and white clover when using the two irrigation systems, which with the Crop Booster device 4271.32 kg/ms/ha/cut was obtained and with normal irrigation it was obtained 1498.68 kg/ms/ha/cut with which it is determined that by implementing the Crop Booster device in irrigation, greater dry matter is obtained in the forage mixture.

According to Ruiz (2006, p. 25), he mentions that plant growth is basically controlled by environmental factors (mainly temperature, light and water), rainfall remained constant in this study, as well as plant varieties, fertilization techniques, while Rodríguez, G (2010, p. 12), recorded dry matter yields of L.

Perennial that range between 8 tons/ha/year and 11 tons/ha/year, observing differences in the composition of the food mixtures used at different times of the year. Graph 3-3 shows the production of green forage and dry matter.

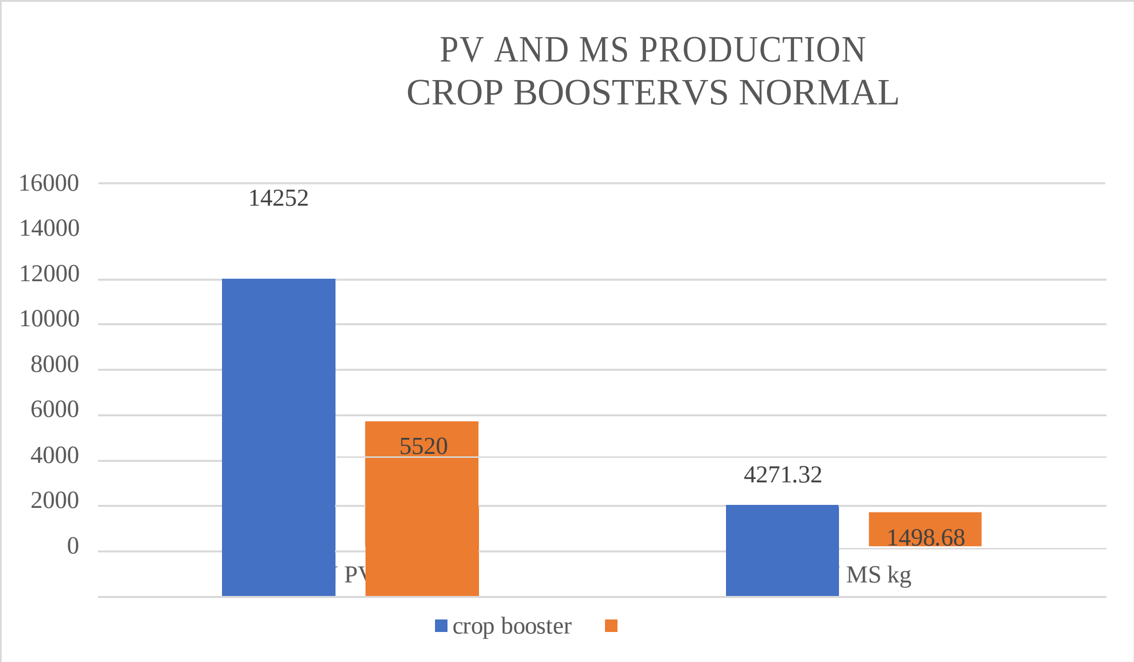
3.5. Proximal analysis

When comparing the two irrigation systems, the following results were obtained according to the bromatological analysis detailed below:

3.5.1. Humidity %

The total moisture content of the forage mixture when using the Crop Booster device, the following result was obtained: 70.03%, while with normal irrigation 72.85%. Irrigation with the Crop Booster device accelerates growth and development in pastures, which is why there is less humidity and accelerates consumption time, unlike the pasture that was irrigated normally, there is higher humidity because the grass is more tender and development is slow.

According to Molina (2010, p. 54), the moisture content of the forage mixture was 71.9% and 71.20%, which can be attributed to climatic factors, harvest age and management of these weeds.



Graph 3-3. Production of green forage and dry matter

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3.5.2. Dry material %

The material content of the forage mixture when using the Crop Booster device was 29.97% and with normal irrigation it was 27.15%. With the Crop Booster device, the dry matter is high due to the state of maturity and handling, which helps to nourish the rumen bacteria to produce meat or milk.

3.5.3. Crude protein %

When evaluating the protein content of the forage mixture when using the Crop Booster device, it was 9.58% and with normal irrigation it was 8.93%, it can indicate that the quality of the forage mixture improved when using the technology in the irrigation because the low frequency waves it emits help to have better metabolism and absorption.

According to Salamanca (1996, p. 36), he found that a balanced combination of grasses and legumes should be used to obtain high yields, palatability and pastures with a good balance of minerals, energy and proteins. The proper distribution for cold weather is: 20% legumes and

80% grasses.

3.5.4. ashes %

When evaluating the ash content in the forage mixture when using the Crop Booster device, it was 1.3% and with normal irrigation it was 1.5%, while Usca (2015, p. 46), showed that the plants that grow in different soils they try to keep their elements in a certain proportion, which mainly affects their chemical composition

Soils rich in calcium, phosphorus, potassium, nitrogen will provide us with a food source rich in these elements and vice versa, as shown by forage analyzes in different cultivation areas. The ash content in grasslands is very important because it determines the proportion of minerals it contains, especially calcium, phosphorus, potassium, nitrogen, etc., which are beneficial for the growth of livestock species.

3.5.5. Crude fiber %

When evaluating the content of crude fiber in the forage mixture when using the Crop Booster device was 16.97% and with normal irrigation it was 16.2%. There is more crude fiber in the grass where the Crop Booster device was installed, this is due to the fact that the cutting and development time was accelerated, unlike with normal irrigation, which time is slow.

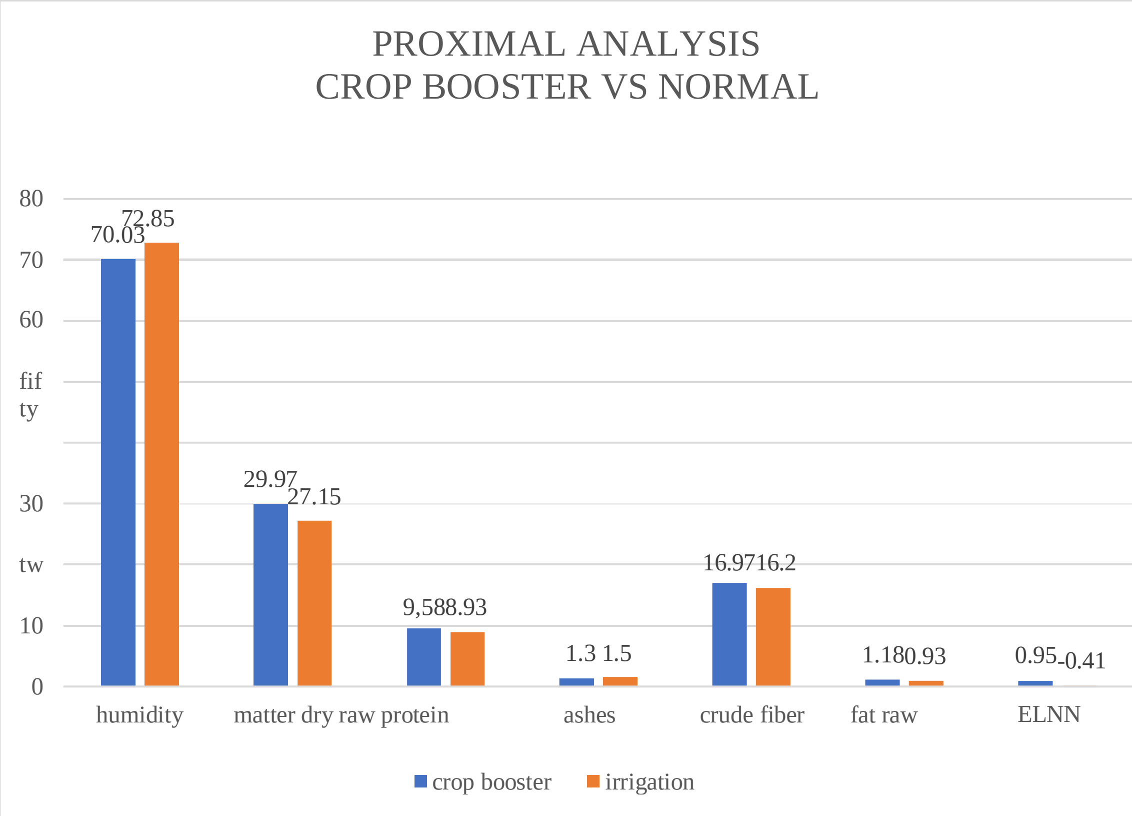
Consequently, Palacios (2010, p.26), showed that fiber is generally a non-digestible substance, but it plays an important role in the metabolism of ruminants, and fiber is very important in this metabolic process of these animals and can improve digestibility and nutrient absorption.

3.5.6. crude fat %

When evaluating the fat content of the forage mixture when using the Crop Booster device it was 1.18% and with normal irrigation it was 0.93%, having a higher percentage of fat in the grass this helps to increase the fat in milk and increased production. In contrast, Rodríguez (2013) found that the fat content in animal diets makes the food more palatable, reduces spoilage and acts as a lubricant when chewing.

3.5.7. Non-nitrogenous free extract %

When evaluating the content of non-nitrogenous free extract of the forage mixture when using the Crop Booster device, it was 0.95% and with normal irrigation 0.41%, because it is a substance that helps heat and energy of movement such as sugar, glucose, starch said component is used in the feeding of ruminants. Graph 4-3 shows the proximal analysis of the forage mixture.



Graph 4-3. Proximal analysis

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3.6. Economic analysis

Performing the analysis of the forage production of the mixture composed of raygrass, alfalfa and white clover that compared two irrigation systems that are: traditional irrigation versus Crop Booster technology, which determined the following results:

The highest profitability in producing forage was obtained when irrigation was carried out with the Crop Booster device, since it presented a benefit/cost of 1.57, which represents that for each dollar invested, a profit of 0.57 cents is obtained; while with traditional irrigation a benefit/cost of 1.29 was obtained, which represents that for every dollar invested there is a profit of 0.29 cents per dollar, as shown below.

The cost-benefit analysis of the production of the forage mixture when comparing the two irrigation systems is shown in table 7-3.

Table 3-3: Economic analysis of production

	items	**crop booster device**	**regular irrigation**
Expenditures (ha/year)			
cb device	1	500	
Irrigation/cutting cost	two		98.88
Tractor	3	1850	450
Fertilizer	4	1300	450
Workforce	5	2190	1095
Gas	6	600	300
Total expenses		6440	2393.88
Pdn fv (tn/ha/cut)		14.25	5.52
Pre-flowering days		35	Four. Five
court number		10.43	8.11
Pdn(ha/year)		148.65	44.77
sale of fodder	7	9908.9	2984.18
Total income		10117.2	3087.58
b/c		**1.57**	**1.29**

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Each item is detailed below:

1. Crop Booster Device: $500 for two years
2. Cost of irrigation/cutting/ha: $98.88
3. Tractor: $40 month
4. Fertilizer: $50qq/50kl
5. Labor: $15/day
6. Fuel: $30/month
7. Forage sale: $66.66

CONCLUSIONS

When evaluating the botanical composition of the forage mixture, the best treatment was with the Crop Booster device, having a percentage of grasses 24.9%, legumes 63.3% and weeds 11.7% compared to traditional irrigation grasses 21.56%, legumes 62.75% and weeds 15.69%

In the nutritional evaluation through a bromatological analysis that was carried out on the forage mixture composed of alfalfa, raygrass, white clover, which was compared with the two irrigation systems, obtaining better results when using the Crop Booster device with a humidity of 70.03%, dry matter 29.97%, protein 9.58%, ash 1.3%, crude fiber 16.97%, fat 1.18%, ELNN 0.95%.

When evaluating the phenological response, the best treatment was to use the Crop Booster device, obtaining a result in a height of 49.6 cm, aerial coverage 77.8%, basal coverage 74.8% compared to traditional irrigation, a height of 35.05 cm., aerial coverage 57%, basal coverage 54%

When evaluating the productive behavior of the forage mixture, the best treatment was irrigation with the Crop Booster device, obtaining a production of green forage at 35 days, a production of 14,252 kg/fv/ha/cut and dry matter of 4,271.32 kg/ms. /ha/cut compared to traditional irrigation that was obtained in green forage at 45 days a production of 5520 kg/fv/ha/cut and dry matter 1498.68 kg/ms/ha/cut.

Through the benefit/cost analysis when using the Crop Booster device in the forage mixture, obtaining an indicator of 1.57 USD.

RECOMMENDATIONS

In order for there to be adequate growth and development of pastures, it is necessary to take into account the type of soil, and environmental conditions, which will influence the existence of greater forage production.

By implementing the Crop Booster technology to the irrigation system, there is an improvement in the nutritional quality of the pastures, which indicates a greater production of forage, which generates greater benefits for the animals they consume.

When irrigating with the device, the phenological responses are superior to traditional irrigation, which indicates that the water that is transported helps the plants to have greater development, which is why it is necessary to carry out more repetitions so that the data is more precise. and without errors.

It is necessary to publicize the Crop Booster device and the advantages it offers, because a higher forage production can be obtained.

Carry out other investigations that allow evaluating the production performance and the benefit/cost generated by the use of the Crop Booster device.

GLOSSARY

Crop Booster: is a new technology that uses waves of low frequency radio to improve plant metabolism, plant and soil health, device that connects to an irrigation system and is activated when water first flows through it. No energy source or maintenance is required (Organiko Latam, 2020).

Catalyst: changes the charge of the mineral particles, adding electrons (negative charge). This causes the minerals to repel each other and separate into small particles, making the water more transparent (Díaz, 2019).

acoustic frequencies: a sound system uses a small electric current to transport specific frequencies to the speakers, the water acts as a carrier wave to bring the information stored in the microtransmitters to the plants (Bermudez, 2020).

Vibrational Frequencies: normal and ideal, improving thus, the health of the plant with the Crop Booster technology positively affects plants with problems (Ariztia, 2020).

microtransmitters: When the Crop Booster microtransmitters are mounted on the metal pipe of an irrigation system, the small magnetic field created by the flow of water passively extracts the information stored in the microtransmitters and carries it to the plants (Ariztia, 2020).

Micronutrients: are the elements that are required in smaller quantities by crops, but this does not mean that they are less important than the rest of the elements; they carry out transcendental functions for the proper growth and development of plants (Intagri, 2021).

micro sprinklers: It is designed to supply water through very fine drops, they have a smaller range and flow rate than conventional sprinklers. They are small in size and some are designed for hanging upside down (NOVAGRIC, 2019).

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ANNEXES

ANNEX A. BOTANICAL COMPOSITION (%).

Of the forage mixture Medicago sativa, Lolium perenne and Trifolium multiflorum, when comparing the traditional irrigation system against the Crop Booster technology.

			REPETITIONS								
PARAMETER	**TREATMENT**	**1**	**2**	**3**	**4**	**5**	**TOTAL PV**	**AVERAGE /m2**	**ADDI TION**	**HALF**	**PERCENTAGE**
GRASSES	CROP BOOSTER	157	351	413	406	450			1777	355.4	24.94
LEGUMES	CROP BOOSTER	970	1120	800	812	812	7126	1425.2	4514	902.8	63.35
WEEDS	CROP BOOSTER	93	168	161	212	201			835	167	11.72
GRASSES	REGULAR IRRIGATION	170	115	100	98	112	2760	552	595	119	21.56
LEGUMES	REGULAR IRRIGATION	367	3. 4. 5	420	313	287			1732	346.4	62.75
WEEDS	REGULAR IRRIGATION	201	75	48	52	57			433	86.6	15.69

- grasses

t-test for means of two paired samples		
grasses	*crop booster*	*regular irrigation*
Average	355.4	119
variance	13552.3	867
Observations	5	5
Pearson correlation coefficient	-0.942294096	
Hypothetical difference of means	0	
Degrees of freedom	4	
t-statistic	3.658259484	
P(T<=t) one tail	0.010806717	
Critical value of t (one tail)	2.131846786	
P(T<=t) two tails	0.021613435	
Critical value of t (two-tailed)	2.776445105	

- legumes

t-test for means of two paired samples		
legumes	*crop booster*	*regular irrigation*
Average	902.8	346.4
variance	19687.2	2621.8
Observations	5	5
Pearson correlation coefficient	0.067521101	
Hypothetical difference of means	0	
Degrees of freedom	4	
t-statistic	8,517009409	
P(T<=t) one tail	0.000521288	
Critical value of t (one tail)	2.131846786	
P(T<=t) two tails	0.001042575	
Critical value of t (two-tailed)	2.776445105	

- weeds

t-test for means of two paired samples		
weeds	*croo booster*	*regular irrigation*
Average	167	86.6
variance	2173.5	4196.3
Observations	5	5
Pearson correlation coefficient	-0.89477211	
Hypothetical difference of means	0	
Degrees of freedom	4	
t-statistic	1.656813034	
P(T<=t) one tail	0.086449063	
Critical value of t (one tail)	2.131846786	
P(T<=t) two tails	0.172898127	
Critical value of t (two-tailed)	2.776445105	

ANNEX B. PHENOLOGICAL RESPONSE OF THE FORAGE MIX

Medicago sativa, Lolium perenne and Trifolium repens, when comparing the traditional irrigation system against the Crop Booster technology.

variables	Treatments	Weeks				Average
	crop booster	1	2	3	4	
Height (cm)		42.84	48.08	50	57.76	49.67
Air coverage (%)		62.5	67.6	70.9	77.8	77.8
Baseline coverage (%)		61.4	61.8	63.2	74.8	74.8
Pdn fv of the mixture (kg/ha)					14252	14252
Pdn plus of the mixture (kg/ha)					4271.32	4271.32
	regular irrigation					
Height (cm)		31.64	34.48	36.96	37.08	35.04
Air coverage (%)		55.2	55.6	56	57	57
Baseline coverage (%)		46	49.4	53.6	54	54
Pdn fv of the mixture (kg/ha)					5520	5520
Pdn plus of the mixture (kg/ha)					1498.68	1498.68

1. **Test t-students variable height (cm)**

	CROP BOOSTER	*REGULAR IRRIGATION*
Average	49.67	35.04
variance	38.24466667	6.573866667
Observations	4	4
Pearson correlation coefficient	0.867166718	
Hypothetical difference of means	0	
Degrees of freedom	3	
t-statistic	7.030972889	
P(T<=t) one tail	0.002955551	
Critical value of t (one tail)	2.353363435	
P(T<=t) two tails	0.005911101	
Critical value of t (two-tailed)	3.182446305	

- **Variable t-student air coverage test (%)**

	CROP BOOSTER	*REGULAR IRRIGATION*
Average	69.7	55.95
variance	41.1	0.596666667
Observations	4	4
Pearson correlation coefficient	0.98948515	
Hypothetical difference of means	0	
Degrees of freedom	3	
t-statistic	4.869227251	
P(T<=t) one tail	0.008274779	
Critical value of t (one tail)	2.353363435	
P(T<=t) two tails	0.016549557	
Critical value of t (two-tailed)	3.182446305	

- **Variable t-student test baseline coverage (%)**

	CROP BOOSTER	*REGULAR IRRIGATION*
Average	65.3	50.75
variance	40.70666667	14.35666667
Observations	4	4
Pearson correlation coefficient	0.663781665	
Hypothetical difference of means	0	
Degrees of freedom	3	
t-statistic	6.071730565	
P(T<=t) one tail	0.004483735	
Critical value of t (one tail)	2.353363435	
P(T<=t) two tails	0.00896747	
Critical value of t (two-tailed)	3.182446305	

ANNEX C. AGRICULTURAL SOIL ANALYSIS LOT 10.2 B

TOX-CHEM	LABORATORIO DE ANÁLISIS QUÍMICO	LTC-SUE-001-20

MATRIZ: SUELOS

Oferta N° 035

Empresa
-

Atención
MARCIA GABRIELA PÉREZ QUISHPE

Dirección
Ciudadela Juan Montalvo

Teléfono
0987594598

Tipo de muestra
Suelo agrícola

Código de la empresa
M-2

Condiciones ambientales de análisis
Tmin: 17,6°C T max: 21,2 °C

Punto de muestreo
Estación Experimental Tunshi-ESPOCH

Fecha de recepción
2020/12/23

Fecha de Ensayo
2020/12/23 - 2020/12/28

Fecha de Emisión
2020/12/28

RESULTADOS ANALÍTICOS

PARÁMETRO	MÉTODO DE ANÁLISIS	UNIDAD	RESULTADO
Humedad	Gravimetría	g/100g	14,00
Materia Orgánica	Gravimetría	g/100g	3,12
Fósforo	Espectrofotometría de Absorción Atómica	mg/Kg	21,10
Nitrógeno	Kjeldahl	g/100g	0,13
Potasio	Espectrofotometría de Absorción Atómica	mg/Kg cmol/Kg mmol/Kg	205,29 0,52 5,25

OBSERVACIONES:

- Muestra tomada por el cliente y receptada en el laboratorio.

BQF. Edwin F. Basantes B. MC.
JLAB

LABORATORIO DE ANÁLISIS QUÍMICO TOX-CHEM DIRECCIÓN RIOBAMBA - ECUADOR

Av. 21 de Abril y Otto Arosemena. RIOBAMBA-ECUADOR
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0998341037

ANNEX D. BROMATOLOGICAL ANALYSIS CROP BOOSTER DEVICE

TOX-CHEM	**LABORATORIO DE ANÁLISIS QUÍMICO**	LTC-ALI-011-21

MATRIZ: ALIMENTOS

Oferta N° 030

Empresa
-

Atención
MARCIA GABRIELA PÉREZ QUISHPE

Dirección
Ciudadela Juan Montalvo

Teléfono
0987594598

Tipo de muestra
Pasto (Disositivo Crop Booster)

Código de la empresa
M-2

Condiciones ambientales de análisis
Tmin: 15 C T max: 25 °C

Punto de muestreo
Estación Experimental Tunshi-ESPOCH

Fecha de recepción
2021/07/08

Fecha de Ensayo
2021/07/08 – 2021/07/13

Fecha de Emisión
2021/07/13

RESULTADOS ANALÍTICOS

PARÁMETRO	MÉTODO DE ANÁLISIS	UNIDAD	RESULTADO
Humedad	Gravimetría	g/100g	70,03
Materia seca	Gravimetría	g/100g	29,97
Proteína Cruda	Kjeldahl	g/100g	9,58
Cenizas	Gravimetría	g/100g	1,30
Fibra Cruda	Gravimetría	g/100g	16,97
Grasa cruda	Gravimetría	g/100g	1,18
Extracto Libre no Nitrogenado	Cálculo	g/100g	0,95

OBSERVACIONES:

- Muestra tomada por el cliente y receptada en el laboratorio.
- Factor utilizado para el cálculo de proteína 6,25

BQF. Edwin F. Basantes B, MSc.
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TOX-CHEM
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ANNEX E. BROMATOLOGICAL ANALYSIS OF TRADITIONAL IRRIGATION

TOX-CHEM	LABORATORIO DE ANÁLISIS QUÍMICO	LTC-ALI-010-21

MATRIZ: ALIMENTOS

Oferta N° 030

Empresa
-

Atención
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Dirección
Ciudadela Juan Montalvo

Teléfono
0987594598

Tipo de muestra
Pasto (Riego normal)

Código de la empresa
M-1

Condiciones ambientales de análisis
Tmin: 15 C T max: 25 °C

Punto de muestreo
Estación Experimental Tunshi-ESPOCH

Fecha de recepción
2021/07/08

Fecha de Ensayo
2021/07/08 – 2021/07/13

Fecha de Emisión
2021/07/13

RESULTADOS ANALÍTICOS

PARÁMETRO	MÉTODO DE ANÁLISIS	UNIDAD	RESULTADO
Humedad	Gravimetría	g/100g	72,85
Materia seca	Gravimetría	g/100g	27,15
Proteína Cruda	Kjeldahl	g/100g	8,93
Cenizas	Gravimetría	g/100g	1,50
Fibra Cruda	Gravimetría	g/100g	16,20
Grasa cruda	Gravimetría	g/100g	0,93
Extracto Libre no Nitrogenado	Cálculo	g/100g	0

OBSERVACIONES:

- Muestra tomada por el cliente y receptada en el laboratorio.
- Factor utilizado para el cálculo de proteína 6,25

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espoch | Dirección de Bibliotecas y Recursos del Aprendizaje

UNIT OF TECHNICAL PROCESSES AND BIBLIOGRAPHICAL AND DOCUMENTARY ANALYSIS

REVIEW OF TECHNICAL STANDARDS, SUMMARY AND BIBLIOGRAPHY

Deadline:06/13/2022

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Faculty: Livestock Sciences
Career: Zootechnics
Title to choose: Zootechnical Engineer
F. responsible: Eng. Cristhian Fernando Castillo Ruiz

1088-DBRA-UTP-2022