Design and Prototyping of the Full Feeder: An Automatic Feeder for Horses

Helena Carvalho Leal[1,3], Fabricio Monteiro dos Santos[2], Rafael Takeguma Goto[3]
Esthefany Muniz Chagas[2], Lucca Brito Moura[2] Antonio Ramirez Hidalgo[4]

[1]Departamento de Física – Universidade Federal de Sergipe (UFS)
– 49.100-000 – São Cristóvão-SE, Brasil

[2]Núcleo de Computação – Universidade Tiradentes (UNIT)
– 49032-490 – Aracaju-SE, Brasil

[3]Departamento de Computação – Universidade Federal de Sergipe (UFS)
– 49.100-000 – São Cristóvão-SE, Brasil

[4]Departamento de Engenharia Elétrica – Universidade Federal de Sergipe (UFS)
– 49.100-000 – São Cristóvão-SE, Brasil

{helena_leal19, rafaelseto}@academico.ufs.br,

{fabricio.monteiro, esthefany.muniz, lucca.brito}@souunit.com.br,

ahidalgo@ufs.br

Abstract. *This paper presents the prototyping and experimental evaluation of the Full Feeder, an automatic feeding system designed for horses. The system integrates mechanical and electronic components to dispense controlled food portions throughout the day. The results indicate that the feeding and power supply methods were effective, including battery-only operation, power-supply-only operation, and combined operation. In addition, the system presents safety and aesthetic advantages compared to some commercial feeders. The experiments demonstrated that the device operates reliably and is capable of dispensing approximately 50 grams of Benefit biscuits in three seconds.*

Resumo. *Este artigo apresenta a prototipação e a avaliação experimental do Full Feeder, um alimentador automático para cavalos. O sistema integra componentes mecânicos e eletrônicos para dispensar porções controladas de alimento ao longo do dia. Os resultados indicam que os métodos de alimentação e fornecimento de energia foram eficientes, incluindo operação apenas com bateria, apenas com fonte de alimentação e operação combinada. Além disso, o sistema apresenta vantagens de segurança e estética em relação a alguns alimentadores comerciais. Os experimentos demonstraram que o dispositivo opera de forma confiável e é capaz de dispensar aproximadamente 50 gramas do biscoito Benefit em três segundos.*

1. Introduction

In animal care environments, particularly in horse breeding facilities, maintaining regular feeding schedules is essential for ensuring animal health, which makes it crucial for those seeking constant improvements in animal welfare. Horses naturally benefit from frequent feeding with small portions throughout the day, which improves nutrient absorption and reduces the risk of gastrointestinal problems such as ulcers and coic. However, implementing such feeding schedules manually can be challenging for caretakers, as it may require multiple feeding cycles distributed across the day.

With the increasing availability of automation technologies, electronic and mechanical systems have been progressively adopted to assist in routine tasks within agricultural and livestock environments. Automatic feeding systems represent a promising approach to improving animal care while reducing the workload required from human operators. Therefore, with the automatic feeder, the caretaker can focus on other tasks.

This work presents the design, prototyping, and experimental evaluation of Full Feeder, an automatic feeding device developed to dispense controlled food portions for horses. The system integrates mechanical and electronic components that allow programmable feeding cycles and supports different food types, including pellets and treats.

This work aims to develop and experimentally evaluate a functional prototype capable of reliably dispensing food portions multiple times per day. Additionally, the system seeks to improve usability and aesthetics compared with existing commercial feeders, while maintaining safe and reliable operation, positively impacting both animals and their owners with the different charging configurations for the equipment.

2. Related Work

Automatic feeding systems have been developed to support the nutritional management of animals in agricultural and equine environments. These systems typically rely on programmable timers and mechanical dispensing mechanisms that release predefined food portions at scheduled intervals.

The *iFEED* automatic feeder is one example of such systems. According to its documentation, the device distributes small food portions at regular intervals in order to mimic natural feeding behavior. This approach aims to improve nutrient absorption and reduce digestive problems in horses, as their stomachs continuously produce acid. The recommended feeding strategy typically involves distributing approximately 30 to 60 grams of food per cycle across several feeding events per [iFEED 2026].

Another commercially available device is the *Rei dos Alimentadores* automatic feeder, which is designed to accommodate larger food containers and serve different types of animals. These systems commonly employ large storage containers (such as 30-liter reservoirs)[Rei dos Alimentadores 2026].

Despite the availability of these solutions, several limitations can be observed in current commercial products. Some systems lack visual indicators for food levels, while others present limitations in food compatibility or aesthetic design. Furthermore, the integration between mechanical structure and electronic control vary between models.

3. Theoretical Background

Horses benefit from receiving smaller food portions distributed throughout the day, which can support digestive health and reduce the risk of gastrointestinal disorders such as ulcers and colic [Frape 2010]. Offering small food portions in order to promote a more natural feeding pattern and to help prevent and treat ulcers and colic, since horses' stomachs produce acid continuously. As a result, the amount of manure decreases, indicating improved nutrient absorption by the animal. Typically, the recommended portion ranges from 1–2 ounces (approximately 30–60 g), and the manufacturer suggests between 10 and 12 motor activation cycles within a 24-hour period, with a minimum interval of 30 minutes between each portion [iFEED 2026]. Thus, feeding routines can be maintained without constant human supervision, reducing the workload associated with manual feeding.

Many automatic feeding devices rely on programmable timers to control activation cycles. Timer-based control systems are widely used in electromechanical automation because they allow devices to operate at predefined times without continuous human intervention. These systems typically include a timer module connected to a control circuit responsible for activating motors or other actuators according to programmed schedules [Bolton 2015].

Another important component in automated feeding systems is the dispensing mechanism. Helical or screw-based feeders are commonly used in agricultural and livestock applications due to their ability to transport and dispense granular or pelletized materials in controlled quantities. In such systems, the rotation of a helical shaft moves the material along a channel, allowing the dispensed quantity to be regulated by the duration of motor activation [Olanrewaju 2017].

The Full Feeder prototype follows these principles by integrating a timer-controlled electronic circuit with a helical dispensing mechanism, enabling automated and controlled food distribution for horses.

4. Methodology

This study adopts an experimental engineering methodology based on system design, prototyping, and controlled experimental evaluation. Such approaches are widely used in engineering research, where a functional artifact is developed and subsequently evaluated through systematic experiments to assess its performance and operational reliability [Wieringa 2014, Kitchenham et al. 2002]. The research methodology followed three main stages: *system design and prototype development, experimental setup, and performance evaluation*.

4.1. System Design

The *Full Feeder* prototype was developed through the integration of mechanical and electronic subsystems responsible for food storage, portion dispensing, and automated activation. The system was designed to provide controlled food release throughout the day while maintaining operational safety and reliability.

The design process involved selecting appropriate structural materials, assembling the mechanical feeding mechanism, and implementing the electronic control circuit responsible for activating the motor and managing the power supply.

4.1.1. Mechanical System

The mechanical subsystem of the *Full Feeder* prototype is illustrated in Figure 1.

The mechanical subsystem consists of a food reservoir connected to a dispensing mechanism based on a helical feeder. The reservoir is constructed using a 5-liter polypropylene container adapted to support controlled food release. The feeding mechanism rotates a nylon helix that pushes the food through an outlet, enabling portion control according to the motor activation time. This mechanism supports different types of feed, including pelletized food and treats such as Benefit biscuits [SUPRA Alisul 2023].

Figure 1. *Full Feeder* Automatic Feeder.

The reservoir unit together with the feeder, excluding the box containing the electronic components, weighs approximately 2 kg, with an estimated error of ± 0.1 kg due to the scale's measurement uncertainty. The 25 cm support bracket is rated to support up to 30 kg; subtracting the 2 kg weight of the equipment results in a remaining capacity of 28 kg. Therefore, for safety considerations, half of the maximum supported load (14 kg) can be used as feed to fill the reservoir. According to the manufacturer specifications of the Mmamute feeder, the device is compatible with traditional pellets and powdered feed, but it is not suitable for hay. Additionally, it supports Benefit biscuits, as verified in the experiments conducted in this report. It is also important to note that the equipment was designed and tested using a 110 V power outlet.

4.1.2. Electronic System

The electronic subsystem controls the activation of the feeding mechanism and manages the system's power supply.

For didactic purposes, the following are photos, respectively:

- Image of the actual electronic system.
- Image focusing on the back of the board.
- Image of the overall electronic circuit created in Lucidchart[1].
- Image of the circuit implemented on the isolated board and its connections with other components, created in Tinkercad[2].

These electronic architecture of the system is shown in Figures 2, 3, 4 and 5.

[1]Lucidchart. Online diagram creation tool. Available at: `https://www.lucidchart.com`
[2]Autodesk. Tinkercad. Available at: `https://www.tinkercad.com`

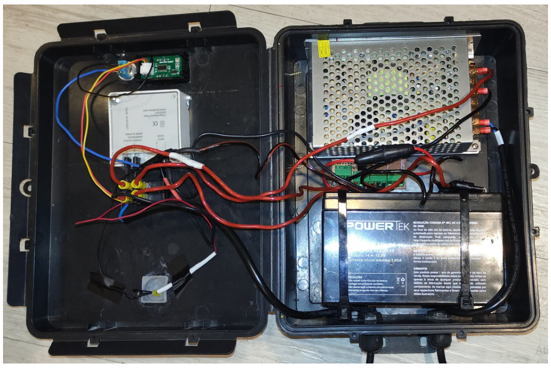

Figure 2. Internal view of the electronic system.

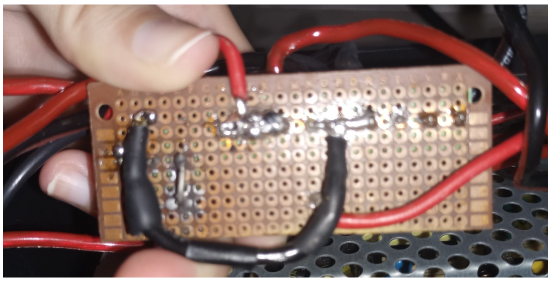

Figure 3. Back view of the perforated board used in the electronic circuit.

The circuit includes a programmable timer, a voltage monitoring module, a 12 V power supply, a rechargeable 12 V battery, control buttons, LED indicators, and a protective fuse. These components are assembled on a perforated board and housed inside a protective enclosure. The programmable timer allows users to define feeding cycles by specifying ac- tivation duration and frequency throughout the day. The system supports three operating configurations: battery-only operation, power supply-only operation or both combined. Voltage monitoring is performed using an integrated voltmeter that displays either the battery voltage or the output voltage of the power supply. A fuse was implemented to protect the circuit against short circuits or electrical faults, improving operational safety.

4.1.3. Components

This section details the electronic and mechanical components of the system. Regarding the hardware elements, a viewing window allows the observation of the food level, while a voltmeter monitors the battery level when connected or, alternatively, measures the output voltage of the power supply. An externally accessible timer avoids the need for frequent opening of the multipurpose enclosure, helping to protect the electronic circuit. Additionally, an LED indicator signals when the main circuit is powered on. In terms of safety, a fuse and an operational indicator LED were implemented, along with other safety measures discussed throughout the report.

Reservoir components: polypropylene container (OU brand, Izy 5L model, or approximately 451 grams capacity); assorted screws, nuts, and washers; two acrylic pieces used as viewing windows; Mmamute automatic feeder with nylon helical screw and anti-rodent outlet with agitation system; 25 cm support bracket (pair); P4 connector attached to a 2×1 mm^2 gauge cable.

Multipurpose box components: voltmeter; 6A 125V push button; Sinotimer timer with second-based function; push button; LED diffuser lens; power cord with 10A 250V plug; wires with gauges of 0.4 mm^2, 1 mm^2, and 2.5 mm^2; 10A 12V power supply; perforated board; terminal blocks; 10A10 diode; fuse; POWERTEK 12V battery.

Additional components: black silicone adhesive; heat shrink tubing (various sizes); electrical insulating tape; female terminal connector; male terminal connector.

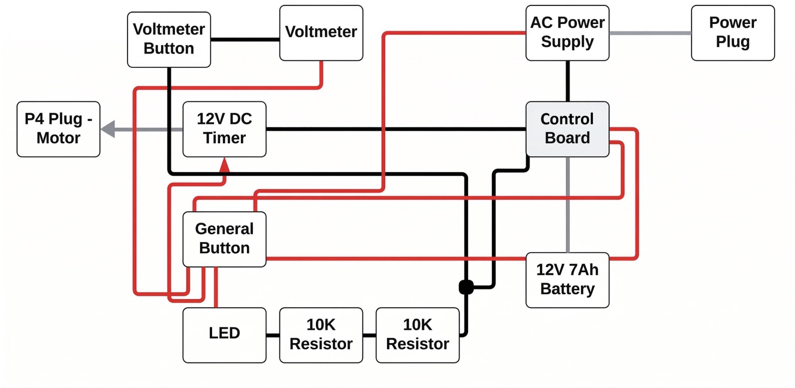

Figure 4. General electronic architecture of the Full Feeder system.

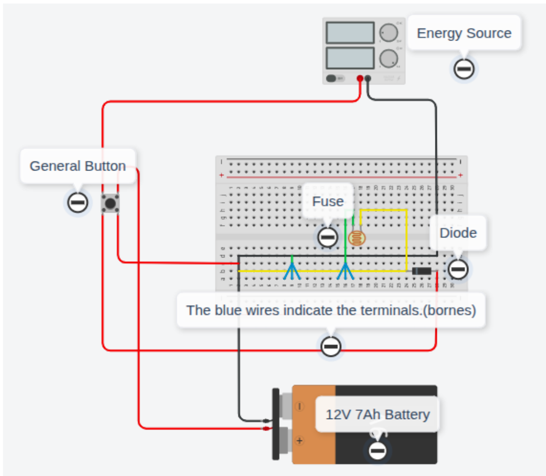

Figure 5. Initial view of the perf-board (Tinkercad).

4.1.4. Safety Considerations

Safety was a primary concern throughout the development of the equipment, and several measures were implemented to ensure safe operation. A fuse was installed so that, in the event of a short circuit, it prevents damage to other components of the system and can be easily replaced if necessary. The LED indicator includes a yellow diffusing lens in order to avoid producing an excessively strong light for the user's eyes. Additionally, it was verified that the battery contains an internal protection circuit designed to ensure safe operation during use.

4.2. Experimental Setup

After assembling the prototype, a series of experiments were conducted to evaluate the operational performance of the system under different conditions. So, the experiments were designed to evaluate three main aspects of system performance:food dispensing performance, energy consumption and battery autonomy and operational stability under different power configurations.

4.3. Testing Procedure

To evaluate dispensing performance, the system was tested using Benefit biscuits, with approximately 450 grams per package. Different activation durations (1–5 seconds) were tested to determine the amount of food released during each activation cycle.

Additional experiments were conducted to analyze energy consumption and operational reliability. In these tests, the system was programmed to perform eight feeding cycles per day, each lasting one minute, across a seven-day testing period. During the experiments, voltage levels and system behavior were monitored to identify possible operational instabilities or failures.

4.4. Evaluation Metrics

The evaluation focused on quantitative and qualitative metrics related to system performance. The main metrics analyzed were:

- **Food dispensing time**, defined as the duration required to release a food portion
- **Dispensed food quantity**, activation time over released feed mass
- **Battery voltage variation**, to evaluate energy consumption and system autonomy
- **Operational stability**, verified by monitoring whether the programmed feeding cycles were completed successfully

This methodology enables the systematic evaluation of the prototype's operational performance and provides experimental evidence regarding the feasibility of the proposed automatic feeding system.

5. Results and Discussion

The experimental evaluation demonstrated that the *Full Feeder* prototype operates reliably under the tested conditions.

The procedure used to collect data was through practical tests on how the electronic equipment would behave together with the entire system that surrounds or feeder.

5.1. Biscuit Dispensing Test

Different times were tested to empty a 450-gram package of Benefit biscuits [SUPRA Alisul 2023].

The initial battery level was 12.5V and the final battery level was 12.4V.

The dispensing experiment showed that a 3-second activation of the feeding mechanism releases approximately 50 grams of biscuits per activation cycle, which corresponds to the recommended feeding portion for horses. Even though, some variability was observed in later trials due to biscuit fragmentation caused by repeated mechanical rotations within the reservoir, this result indicates that the device can effectively control portion sizes by adjusting the activation time of the motor.

5.2. Battery Performance

A total of 8 daily programs were performed over 7 days of the week, with only the battery connected and with the option of having both the battery and the power supply connected.

Table 1. Benefit Biscuit Dispensing Test

Programming (g/s)	1s	2s	3s	4s	5s
1	19	38	57	54	57
2	16	35	51	73	57
3	20	32	50	64	71
4	16	43	34	57	52
5	16	51	56	61	92
6	20	38	60	63	60
7	20	41	34	71	39
8	22	16	48	Refeed 7	Refeed 22
9	25	37	46	–	–
10	Refeed 276	Refeed 119	Refeed 14	–	–

Source: author

Table 2. Battery Performance Test

	1	2	3	4	5	6	7
8 cycles (1 minute each)	OK	OK	OK	OK	X (discharged)	none	none
Battery Level (V)	12.4	12.3	12.2	12.1	–	–	–

Source: author

The initial battery voltage was 12.5V and the final voltage was 12.1V when discharged. The main switch was ON and the voltmeter switch was also ON.

When operating exclusively on battery power, the system successfully executed the programmed feeding cycles during the first four days of the experiment.

5.3. Combined Battery and Power Supply

Table 3. Battery and Power Supply Performance Test

	1	2	3	4	5	6	7
8 cycles (1 minute each)	OK	OK	OK	OK	OK	OK	OK

Source: author

The initial battery voltage was 12.4V and the final voltage was 12.4V. The main switch was ON and the voltmeter switch was also ON.

The evaluation of the power configurations revealed that battery-only operation provides limited autonomy due to the capacity of the battery used in the prototype. However, when combined with an external power supply, the system maintains stable operation over extended periods. Also, a slight increase in temperature was noticeable at the power source when the motor was running. However, the equipment cools down again, and this situation is to be expected.

5.4. Power Supply Operation

The initial battery voltage was 12.5V and the final voltage was 12.5. The main switch was ON and the voltmeter switch was also ON.

When operating exclusively with the external power supply, the system maintained stable operation during the entire testing period without any interruptions.

Table 4. Power Supply Performance Test

	1	2	3	4	5	6	7
8 cycles (1 minute each)	OK	OK	OK	OK	OK	OK	OK

5.5. Comparisons between automatic feeders

Two other feeders currently available on the market were compared with the *Full Feeder*: the feeder manufactured by Rei dos Alimentadores and the one produced by iFEED. Figure 6, Figure 7, and Figure 8 present images of the three devices for comparison.

Figure 6. Full Feeder

Figure 7. iFEED

Figure 8. Rei dos Alimentadores

A comparison was conducted between currently available feeder models on the market, considering the following criteria: feed type, feed size, aesthetic appearance, presence of a food level window, equipment dimensions, and the number of daily portions supported by the system.

Full Feeder: Works with powdered feed, pelletized feed, and molasses feed, but is not recommended for wet feed. Supports feed sizes ranging from powder to the size of Benefit biscuits. Presents very good aesthetic appearance and includes a visual window to monitor the food level. The equipment dimensions are approximately 50 cm $\times$ 23.5 cm $\times$ 32 cm (height, width, depth). The system supports between 1 and 8 daily portions.

iFEED: Compatible with large and small pelletized feed, grains, and sweet feed. It is not compatible with hay cubes, wet feed, or hay. The recommended feed size ranges between $1/4$ inch thickness and $3/4$ inch length (approximately 0.635–1.905 cm). The device presents excellent aesthetic design but does not include a food level window. Its dimensions are approximately 21” $\times$ 10” $\times$ 7” (height, width, depth). The system supports between 1 and 48 daily portions.

Rei dos Alimentadores: Works with powdered feed, pelletized feed, and molasses feed, but is not recommended for wet feed. Feed size specifications are not provided by the manufacturer. The device presents limited aesthetic design and does not include a food level window. Equipment dimensions are not specified, but typical models use reservoirs of approximately 30 L or 50 L capacity. The system supports approximately 1 to 16 daily portions.

A comparison with existing commercial feeders highlights design advantages, presence of a viewing window for food-level indicator, which improves usability and reduces the need for frequent manual inspections. It dispenses 8 feedings per day and it can be filled with the same foods as its competitors.

6. Conclusion and Future Work

The experimental results demonstrated that the prototype is capable of reliably dispensing controlled food portions and operating under multiple power configurations. The system introduces usability improvements compared with some existing commercial feeders, including a visual food-level indicator and an integrated electronic monitoring system. The prototype also supports a wide variety of food types, including powdered supplements, although it is advisable to have the feed already present to prevent the dust from falling directly into the trough, and pelletized feed, which increases its versatility for different feeding scenarios.

As future work, the reservoir capacity may be increased to further reduce human intervention. However, this is not a major limitation of the current prototype, since increasing the capacity would mainly require a larger storage container and support bracket. Furthermore, the proposed application focuses on dispensing Benefit biscuits as snacks/rewards, not as the horse's primary feeding source. Experimental results showed that a 3-second activation dispenses approximately 50 g per portion (49.6 g average), which allows the 5-liter reservoir to operate for extended periods without daily replenishment under the intended usage conditions. Also, the project can explore improvements in battery capacity to increase system autonomy, as well as the integration of smart monitoring capabilities such as wireless connectivity or remote control features.

References

Bolton, W. (2015). *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*. Pearson, Harlow, UK, 6 edition.

Frape, D. L. (2010). *Equine Nutrition and Feeding*. Wiley-Blackwell, Oxford, UK, 4 edition.

iFEED (2026). How it works. Accessed: 16 Mar. 2026.

Kitchenham, B., Pfleeger, S. L., Pickard, L., Jones, P., Hoaglin, D., El Emam, K., and Rosenberg, J. (2002). Preliminary guidelines for empirical research in software engineering. *IEEE Transactions on Software Engineering*, 28(8):721–734.

Olanrewaju, T. O. (2017). Design and fabrication of a screw conveyor. *Agricultural Engineering International: CIGR Journal*, 19(3):156–162.

Rei dos Alimentadores (2026). Alimentador automático com bombona recondicionada de 30l. Accessed: 16 Mar. 2026.

SUPRA Alisul (2023). Benefit classic dog biscuit. Accessed: 16 Mar. 2026.

Wieringa, R. (2014). *Design Science Methodology for Information Systems and Software Engineering*. Springer, Berlin, Germany.