

## Evaluation of drone seeding for pastures, forest species, and cover crops in family farming

Everton Castelão Tetila<sup>74</sup>, Paula Martin de Moraes<sup>1</sup>, Juliana Queiroz da Silva Tetila<sup>75</sup>,  
Josemar Lourenço de Oliveira<sup>76</sup>, Jayme Garcia Arnal Barbedo<sup>77</sup>

### Abstract

According to data from the IBGE Agricultural Census, the state of Mato Grosso do Sul has 71,164 economically active properties, of which 43,223 are family farming establishments. The acquisition of agricultural machinery represents one of the main challenges faced by these small-scale producers. In this context, this work aims to evaluate the use of drones for the seeding of pastures, forest species, and cover crops in family farming systems. The study will be conducted in the community of Assentamento Itamarati 1, located in the municipality of Ponta Porã-MS. An 8-hectare agricultural area will be divided into four quadrants of two hectares each. Using the DJI Agras T30 drone, 100,000 seeds per hectare of each crop will be sown, totaling 10 seeds per square meter. The crops will be distributed as follows: 1st quadrant – Brachiaria grass; 2nd quadrant – forest species; 3rd quadrant – pearl millet; and 4th quadrant – sunn hemp. Thirty days after sowing, aerial monitoring will be carried out using a DJI Phantom 4 drone at an altitude of 10 meters, with the aim of generating productivity maps from the images captured during the flight. Using QGIS software, the average emergence rate of each crop (through plant counts) will be evaluated, and the results will be analyzed based on four metrics: Accuracy, Precision, Recall, and F-Measure. It is expected that new agricultural technologies and intelligent systems will become more efficient and sustainable than current food production methods, in addition to creating new opportunities for specialized employment in drone-based seeding, spraying, and map generation.

**Keywords:** Drone Seeding, Emergence Rate, Family Farming, Itamarati Settlement.

---

<sup>74</sup> Federal University of Grande Dourados. ORCID: 0000-0001-5396-766X. Email: evertontetila@ufgd.edu.br, ORCID: 0000-0001-7479-6716. Email: paulamartin.bio@gmail.com

<sup>75</sup> Faculdade Anhanguera de Dourados. ORCID: 0009-0008-2703-6448. Email: josemarnews@gmail.com

<sup>76</sup> State University of Mato Grosso do Sul. ORCID: 0009-0000-6690-8140. Email: ju@uems.br

<sup>77</sup> Embrapa Digital Agriculture. ORCID: 0000-0002-1156-8270. Email: jayme.barbedo@embrapa.br

## 1. Introduction

According to the 2017 Agricultural Census conducted by the Brazilian Institute of Geography and Statistics (IBGE), the state of Mato Grosso do Sul has 71,164 economically active properties. Of this total, 43,223 properties belong to families engaged in Family Farming, representing 61%. Family Farming plays a fundamental role in the productive chain of Brazilian agribusiness. This sector employs approximately 10.1 million people, or 67% of the agricultural workforce. Moreover, Family Farming forms the economic foundation of 90% of Brazilian municipalities with up to 20,000 inhabitants (IBGE 2017; Borges, 2019).

However, when analyzing agricultural mechanization targeted at Family Farming, it becomes clear that small producers face significant challenges. The main cause of these challenges lies in the limited economic power of Family Farmers. Agricultural mechanization demands a minimum level of resources for the acquisition, operation, and maintenance of equipment necessary for activities such as cultivation, sowing, and harvesting. Additionally, there is a notable scarcity of companies willing to explore and invest in this specific niche. Most companies in the agricultural sector tend to focus on machinery and technologies designed for large-scale farms and agribusiness enterprises, leaving a considerable gap in the market for equipment and technologies better suited to the needs of Family Farming.

As a result, there is a significant disparity between small and large farms, particularly in terms of production efficiency. This creates a cycle in which Family Farming often remains limited to subsistence production, losing the opportunity to integrate into the extensive value chains of Brazilian agribusiness. Investment in research and development aimed at agricultural mechanization for this segment remains incipient. Therefore, investment in research and technological development is crucial to drive innovation and adapt agricultural technologies to the specific needs of small and medium-sized rural producers.

In this work, we plan to evaluate broadcast seeding with drones for pastures, native forest species, and soil cover crops in family farming productions. To achieve this, we will assess the average emergence rate of each crop (plant count) and report the results obtained.

Farmers in various municipalities have been using broadcast seeders for planting operations. The broadcast operation allows the entire planting area to be covered, which

can be done manually, mechanically, or through a combination of both methods. Nevertheless, few studies in the literature address the efficiency of broadcast seeding with drones. The technique can be used in rural properties with different profiles, especially those based on family farming, which often lack the machinery and equipment required for conventional production (Silva, 2024).

It is expected that the adoption of new agricultural technologies and intelligent automation systems will become progressively more common, efficient, and sustainable compared to the methods currently employed in food production. In parallel, these technologies may also drive social development by creating new job opportunities for specialized labor, such as in consulting companies or service providers working in drone-based seeding, spraying, and mapping.

## 2. Methods

We plan to seed an agricultural area of 8 (eight) hectares using the DJI Agras T30 drone, specifically for the execution of this work. The agricultural area shown in Figure 1 is located in Assentamento Itamarati I – Fetagri / Plot 41, municipality of Ponta Porã, Mato Grosso do Sul, Brazil, Latitude: 22°14'42.9"S, Longitude: 55°28'05.8"W.

The agricultural area will be subdivided into a sampling grid consisting of four quadrants, each quadrant measuring 2 (two) hectares. Using the DJI Agras T30 drone, shown in Figure 2, broadcast seeding will be carried out with the solid spreader tank, sowing 100,000 seeds of each crop per hectare, corresponding to 10 seeds per square meter. The aforementioned crops will be distributed as follows: a) 1st quadrant – *Brachiaria* grass; b) 2nd quadrant – forest species; c) 3rd quadrant – pearl millet; and d) 4th quadrant – sunn hemp.



**Figure 1.** (A) Entrance to the Itamarati I Settlement, (B) conversation with producers at the farm headquarters, (C) reconnaissance of the area with the monitoring drone, (D) Aerial view of the headquarters and (E) location of the experimental area.

**Photos:** Everton Castelão Tetila.



**Figure 2.** (A) DJI Agras T30 drone equipped with a solid spreader tank for seeding, (B) seeds of forest species, and (C) seeds for pastures and soil cover.

**Photos:** Everton Castelão Tetila.

After 30 days of sowing, aerial monitoring of the study area will be carried out. For this, we will use the monitoring drone – model DJI Phantom 4 Advanced – at 10 meters above the plantation, in order to create productivity maps in the RGB images obtained with the aerial survey. Using the QGIS software, version 3.36.0, we will evaluate the average emergence rate of each crop (plant count) and report the results obtained for four evaluation metrics: Accuracy (Equation 1), Precision (Equation 2), Recall (Equation 3) and F-measure (Equation 4).

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN} \quad (1)$$

$$Precision = \frac{TP}{TP + FP} \quad (2)$$

$$Recall = \frac{TP}{TP + FN} \quad (3)$$

$$F\text{-Measure} = \frac{2 * (Recall * Precision)}{(Recall + Precision)} \quad (4)$$

We will evaluate the performance of different machine learning algorithms for vegetation mapping. Supervised classification will be applied using the following algorithms: Random Forest, Multilayer Perceptron, Decision Tree, Support Vector Machine (SVM), and deep convolutional neural networks (e.g., AlexNet, GoogleLeNet, ResNet, Xception, and DenseNet). To compare their performance, confusion matrices will be generated to analyze error types, and both parametric (e.g., ANOVA) and non-parametric (e.g., Friedman) hypothesis tests will be applied, followed, when appropriate, by post-hoc tests (e.g., Tukey, Wilcoxon).

After the work is completed, we plan to sow with the DJI Agras T30 drone in different agricultural areas (lots) of the Itamarati I Settlement, as well as in lots of the Rio Feio Settlement, located in the municipality of Guia Lopes da Laguna-MS, which is a DAT of Semear Digital. This planning will take into account the results of the average emergence rate of each crop, ensuring that the positive impact of the research is sustained over time, promoting sustainability.

It is important to highlight that drone seeding is expected to become a widely offered service by consulting firms or service providers, which could generate new job opportunities for specialized labor and boost the Brazilian agribusiness value chain with a low-cost agricultural technology adapted to the specific needs of small and medium-sized farmers, thus making Family Farming products more competitive in the national market.

### **3. Results and Discussion**

The work is currently underway, and as of now, there are no results from the study.

### **4. Conclusion**

The work is in progress, and at this time, the study has not been concluded.

### **Acknowledgements**

The authors would like to thank FAPESP (Processes: 2022/09319-9 and 2023/03870-8) and Fundect (83/029.295/2024 and 83/044.460/2024) for the funding.

### **Referências**

BORGES, S. Z. **Embrapa incentiva agricultura familiar a adotar tecnologias sustentáveis.**

2019. Available at:

<https://www.embrapa.br/busca-de-noticias/-/noticia/48651283/embrapa-incentiva-agricultura-familiar-a-adotar-tecnologias-sustentaveis> Accessed on: July 21, 2025

IBGE. **Censo Agro 2017.** Available at: Disponível em: <https://censoagro2017.ibge.gov.br/> Accessed on: July 21, 2025

SILVA, M. P. da. **Prosa Rural - Plantio direto a lanço na reforma de pastagem [REPRISE].**

2024. Available at:

[https://www.embrapa.br/busca-de-noticias/-/noticia/86931178/prosa-rural---plantio-direto-a-lanco-na-reforma-de-pastagem-reprise?p\\_auth=tcGng1IF](https://www.embrapa.br/busca-de-noticias/-/noticia/86931178/prosa-rural---plantio-direto-a-lanco-na-reforma-de-pastagem-reprise?p_auth=tcGng1IF) Accessed on: July 21, 2025