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Internet of Things (Iot) To Conference Efficiency and Economy In The Application of Agricultural Supplies

Givaldo Almeida dos Santos*, Franklin Zillmer**, Liária Nunes da Silva***, Robelius De-Bortoli****

*(Postgraduate Program in Intellectual Property, Federal University of Sergipe, Brazil); *(Federal University of Sergipe, Brazil)

*** (Postgraduate Program in Intellectual Property, Federal University of Sergipe, Brazil) – (Federal Institute of Piaui)

****(Postgraduate Program in Intellectual Property, Federal University of Sergipe, Brazil)

Corresponding Author : Givaldo Almeida dos Santos

ABSTRACT

Food production has become a global concern and has attracted the attention of agribusiness producers and entrepreneurs in light of forecasts of rising demand, which is expected to reach 9 billion consumers by 2030. Given this scenario, grain crops gain relevance and boost the development of technologies. In this perspective, the Internet of Things making use of advanced technologies, emerges as a real possibility capable of improving the efficiency in the application of Precision Agriculture techniques and expand food production. The article demonstrates through the simulation the losses that can occur during the planting of soybean in the process of seed deposition if there are inaccuracies, in order to demonstrate the advantages of application of IoT in agriculture. The Internet of Things has a high potential to increase efficiency in the application of precision farming techniques. The attention to the processes of maintenance of the machines is fundamental, since these procedures will impact directly in the performance of the equipment, as well as in the agricultural productivity. The use of technologies in agriculture can avoid losses in the productive process, increase the possibilities of gains and the conditions of exploitation of the areas of planting.

Keywords - Precision agriculture; Agrotechs; Innovation; Internet of Things.

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I. INTRODUCTION

The world population has reached the mark of 7.35 billion people in 2015, and predictions indicate that this number could reach 8.7 billion people by 2030 [1]. This increase of the world population expresses an emergency situation in the production of food, as well as in the economy of the inputs. In this context, the adoption of new technologies has been gaining prominence, especially in the digitization of agricultural processes through Agrotechs, companies that develop cutting-edge products for agribusiness consumption.

In this perspective, the Internet of Things (IoT) has appropriated advanced technologies of microelectronics, embedded systems, connectivity, security, big data and artificial intelligence, and can provide an unprecedented expansion of frontiers for the development of innovation with agricultural technologies. Its use in the digitization of processes in the production of grains may be able to improve the efficiency in the application of Precision Agriculture (AP) techniques and to increase food production.

In this sense, Agrotechs, by combining IoT with Precision Agriculture (AP) techniques to modernize the grain production process, may favor the emergence of new business models capable of empowering farmers, generating new jobs, and increasing agribusiness participation in the economy [2]. With innovation in this market, the possibilities of acquiring intellectual property rights, such as patents, software registration, trademarks, as well as technology transfer, are being expanded.

However, the use of state-of-the-art agricultural machinery to scale production has not yet reached the desired magnitude. According to Filho, and Cunha [3], the main obstacle in this process is still the possible failures that equipment may present during planting or harvesting, consequences of lack of skilled labor for operation, neglect of machinery maintenance or at high cost.

In addition, another variable worthy of note in this process is the accuracy of agricultural machinery during the application variable rate of input. Uhry [4] explains that during automated management, this accuracy becomes the problem to be studied, especially in planting or sowing, a process considered of great importance for success in grain production.

Machado, Alonço, Bellé, and Franck [5] evaluated the possible losses due to problems related to the transition time in the change of the dosages and amount of mass applied through direct methods that measure the amount of input deposited after the application.

Therefore, the article sought to demonstrate through the simulation the losses that can occur during soybean planting in the seed deposition process if there are inaccuracies, in order to demonstrate the advantages of applying IoT in agriculture, a condition that made it indispensable to generate economy and to leverage agribusiness.

The simulation proposed in this research considers that an additional seed unit was deposited in relation to the dose prescribed in the recommendation map and counts the possible losses per hectare in the planted area.

II. CONTEXTUALIZATION

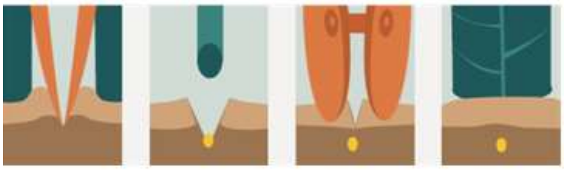
The application of IoT has been strengthened mainly by the use of technologies based on microelectronics, sensor networks and embedded systems, reaching different productive sectors and causing a reduction in the cost of products [6]. These technologies allow you to automate processes and reduce human effort in performing tasks. In the automotive sector, for example, the use of stand-alone technologies and machines has resulted in reduced operating costs, and optimized and accelerated production systems.

In the agricultural sector the automation of handling tasks in the plantations, with the application of precision agriculture techniques combined with the IoT, followed a similar purpose to the automotive. However, in the agricultural sector the purpose was to enable the optimized distribution of inputs in accordance with the spatial variability of soil attributes, nutritional state of the plants, and with that, to increase profitability and productivity, providing greater savings in the application of fertilizers and defensive.

In this context, the assessment of accuracy can follow two methods: direct, when considering the correspondence between prescribed and applied values (measurement of applied mass); indirectly, when they consider the values prescribed and measured by sensors in real time [5].

Accuracy is understood as the difference between the amount of seeds prescribed at the interface of the controller and the actual amount deposited by the seeder-fertilizer machine in the grooves. The grooves are open for deposition of fertilizer and seed, and closed in an automated process by the intelligent machine in several planting lines (Figure 1). Author [4] explains that the longitudinal spacing of the grooves and the parallelism between the lines take into account the characteristics of the cultivar - Plant species - to be implanted and should be standardized in the no-tillage systems - Planting technique -, due to the advantages related to the fuel economy, use of biological material and erosion reduction.

Fig. 1 - Main steps performed by the sowing machine.

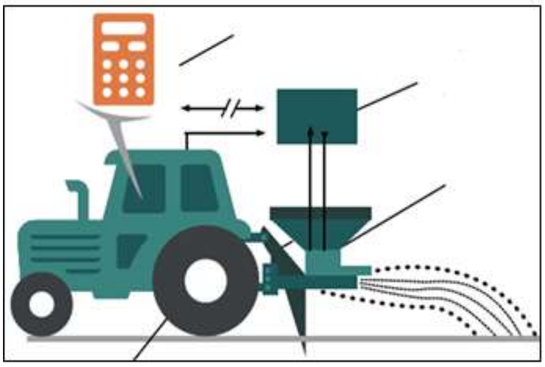


Source: SENAR (2015).

Step 'a' (Figure 1) represents the groove opening discs at a specific depth, step 'b' represents seed deposition, step 'c' represents due closure of the groove, and step 'd' 'represents a slight compaction of the soil to cover the groove. Step 'd' ends the sowing process that is controlled by a network of sensors and actuators, stage 'b', for application of variable rate input through digital recommendation maps.

Sensors properly installed in the seed outlet tube can monitor the amount applied. By recording the product deposition flow through the light beam passing through the tube or the mass quantity of the input, these sensors also play an important role in the possible deposition variation that may occur, as well as informing of possible clogging or emptying of the reservoir. In order to monitor the input depth, the sensors can be connected directly to the cutting discs or hydraulic cylinders that accompany the movement of the rod or platform and indicate the deposition variations through the monitor in the tractor cab [7].

Fig. 2 - Sensing system of the seeding machine – fertilizer.



Source: Adapted from SENAR (2015).

The operating principle of the machine (Figure 2) will consist of the monitoring and correction of the prescribed dosage. This process occurs by controlling and adjusting the number of turns of the dosing mechanism (seed or fertilizer), according to the tractor's displacement and speed indicated by the self-guided satellite system or similar technology. The applied amount adjustment can also be performed from information on the variability map inserted electronically into the central monitor. The signals are sent to the electric or electrohydraulic actuators, which in turn, promote the variation in the flow of descent and the applied dose of the input [4].

In this perspective it is possible with IoT to improve the efficiency of the handling process from the integration of sensors to identify in real time the amount of the input deposited in the furrows opened in the planting line. This procedure can be performed based on computer vision algorithms, artificial intelligence and advanced machine learning techniques. In this way, it is possible to issue information to support the decision-making about failures in the input dosage or for self-correcting actions, in the case of autonomous machines.

In agriculture, one can use sensors that read the spectrum of electromagnetic radiation emitted by the plant, determining its nutritional status and water stress. These results can be obtained through the recorded images and their spectral signatures in in the range of infrared radiation not visible, with the support of geostatistical techniques, such as the Normalized Difference Infrared Index (NDVI).

This is a widely used technique to also determine the presence of pests and weeds in the planted area. In this case, the mapping is done from the segmentation of periodically captured images using Drones or VANT, equipped with RGB (Sensors that capture the emission of electromagnetic radiation from the spectrum Red, Green, Blue) or Hyperespectral (Sensors that capture the emission of electromagnetic radiation from the infrared spectrum) sensors to analyze, from computational algorithms the shape, size, texture and other attributes of the plants.

III. CASE IN ANALYSIS

The techniques for applying Precision Agriculture (AP) in grain production have been presented as an excellent option to raise agricultural productivity. Thus, through seed deposition, irrigation, application of fertilizers and agrochemicals at a variable rate, can provide significant savings in handling, with the use of modern agricultural machinery under favorable conditions, in which the cost / benefit ratio is transparent and advantageous for the farmer.

However, there are still problems to be corrected regarding the accuracy, transition time in the dosage, process of calibration of the sensors and regulation of the mechanisms before the definitive use of the machine in the automated planting process, through digital recommendation maps that allow a partial autonomy or total of the machine in the deposition of the seeds [8].

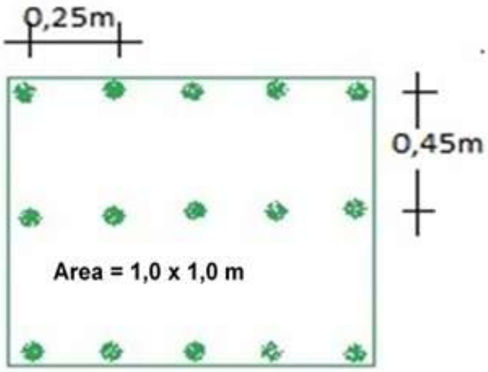
The regulation of the mechanisms is considered a preventive maintenance step that must be carried out with the lubrication of mechanical parts and sensitive electromechanical systems at each operational stop of the machinery. The calibration process consists of adjusting and testing the sensors responsible for recording the velocity of displacement, quantity of seeds deposited, depth of the groove, and is considered a fundamental action to guarantee the accuracy of the application of variable rate input [4]. Regulatory and calibration actions are performed by operators. These actions need to be followed according to the standards defined by the manufacturer, since noncompliance with such recommendations will adversely affect the planting process, causing severe losses for the producer.

In some cases, the short sowing window contributes to neglect related to the regulation or calibration steps of the seeder-fertilizer machine. The attempt to accelerate the planting process by increasing the speed of movement in sowing operations can adversely affect the quality of the longitudinal distribution and the prescribed amount of seed dosage, influencing the plant stand and consequently productivity [8].

In addition, Author [4] adds that the increase of the displacement speed can increase the occurrence of sliding (movement of the wheel without the actual displacement of the mechanism, caused by the lack of contact with the ground or surface) of the driving wheel, responsible for activation the dosing mechanism, negatively influencing the longitudinal spacing between the grooves or seeds.

Simulation of seed loss was calculated considering the distribution of 15 units per square meter in parallel lines of 0.45 meter, which resulted in a longitudinal spacing of 0.25 meter (Figure 3). The number of seeds and the line spacing used in this simulation correspond to those used by author [8], determined according to the characteristics of the seeding machines used in the experiments. The accounting of possible deposition losses with the addition of one unit resulted in 5 seeds per linear meter in each planting line.

Fig. 3 - Area for seed deposition.



Source: Research Data (2018).

Therefore, to cover an area of 1 hectare (100 x 100 meters) by applying the spacings defined in the simulation (Figure 3), with a 25-row planter, it would take just over 9 100-meter steps, with an increase of 12,500 seeds and additional cost of R $ 125.00 per pass (Table 1). According to SENAR [9] the number of paces is defined from the following equation: NP = DE / ((NL – 1) x EL); where NP corresponds to the number of step, DE to the offset, NL to the number of lines, and EL to line spacing.

Table 1 - Displacement and cost of seed addition.

Displacement*	**Seeds****	**Cost**
10	1.250	R$ 12,50
20	2.500	R$ 25,00
30	3.750	R$ 37,50
40	5.000	R$ 50,00
50	6.250	R$ 62,50
60	7.500	R$ 75,00
70	8.750	R$ 87,50
80	10.000	R$ 100,00
90	11.250	R$ 112,50
100	**12.500**	**R$ 125,00**
* linear meter by step of 25 lines		
** price quoted on 10/25/2018		

Source: Research Data (2018).

The financial loss with this failure in planting could reach a total of 115,740 seeds above the predicted density and an additional cost of R $ 1,157.50 per planted hectare (Table 02). This situation will increase competition for nutrients between plants and will negatively impact profitability, considering only the costs of adding seeds.

Table 2 - Negative impacts on profitability.

Planted Hectare	**Seed Additive**	**Additional Cost**
1	**115.740,74**	**R$ 1.157,41**
100	11.574.074,07	R$ 115.740,74
200	23.148.148,15	R$ 231.481,48
300	34.722.222,22	R$ 347.222,22
400	46.296.296,30	R$ 462.962,96
500	**57.870.370,37**	**R$ 578.703,70**
600	69.444.444,44	R$ 694.444,44
700	81.018.518,52	R$ 810.185,19
800	92.592.592,59	R$ 925.925,93
900	104.166.666,67	R$ 1.041.666,67
1000	115.740.740,74	R$ 1.157.407,41

Source: Research Data (2018).

When considering this scenario (Table 2) in a process of planting 500 hectares of soybeans, the loss in profitability calculated from the average net revenue in the main grain producing cities according to CEPEA [10], reached approximately R $ 1,275, 00 per hectare. Thus, there would be a significant negative impact on the income of the producer, which would obtain a net income of only R $ 58,795.00, when it could be R $ 637,500.00, if there was no failure in the process (Figure 4). An extremely high loss, if such a failure is not noticed in a timely manner, during the planting process.

Figure 4. Comparatives of profitability by planted area.

Source: Research Data (2018).

It can be seen from the data shown in the simulation that financial losses due to lack of accuracy in seed deposition can cause significant financial losses to the producer. When using the seeding machine with sensor technology, it is not allowed to neglect the actions related to regulation and calibration of the sensing, electromechanical and pneumatic systems. These systems can be modulated and adjusted in accordance with the parameters defined for the spacings (lines and seeds or grooves), and with this accelerate the sowing process, the variable rate with the lowest risk of failure.

IV. FINAL CONSIDERATIONS

The Internet of Things (IoT) is capable of boosting global agribusiness by enabling Agrotechs to develop technologies to improve efficiency and expand the digitization process of agriculture. These technologies directly reflect the ability to increase the volume of grain crop production, especially in oilseed crops such as corn and soybeans.

Thus, it became clear that IoT has a high potential to increase efficiency in the application of precision farming techniques. Attention to machine maintenance processes, such as sensor calibration and actuator regulation, is fundamental, as these procedures will directly impact on equipment performance as well as agricultural productivity. Practicing these actions can reduce problems with the technology adopted.

Therefore, the article demonstrated that possible failures during the planting process can be quickly corrected or eliminated through monitoring and control with IoT. The adoption of these technologies can avoid prejudice to producers and entrepreneurs in agribusiness, in addition to increasing the possibilities of gains and the conditions of exploitation of the areas of planting.

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REFERENCES

[1]. IPEA (Instituto de Pesquisa Econômica Aplicada) (2015). Megatendências mundiais 2030: contribuição para um debate de longo prazo para o Brasil. Org.: Elaine C. Marcial. Brasília, Ipea, p.175.

[2]. Mélo, B., & Avelar, M. (2017). Inovação tecnológica revoluciona o agronegócio. Sociedade Nacional de Agricultura (SNA). Revista A Lavoura, 120(717), 10-17.

[3]. Filho, R. S., & Cunha, J. P. A. R. (2015). Agricultura de Precisão: Particularidades de Sua Adoção no Sudoeste de Goiás - Brasil. Revista Eng. Agric. 35(4), 689-698.

[4]. Uhry, D. (2013). Avaliação e Critéiro para Utilização de Semeadora com Sistema de Taxa Variável de Sementes na Cultura da Soja. 2013. 141 f. Tese (Doutorado - Programa de Pós-Graduação em Engenharia Agrícola). Universidade Federal de Santa Maria (UFSM). Rio Grande do Sul.

[5]. Machado, O. D. C.; Alonço, A. S.; Bellé, M. P., & Franck, C. J. (2015). Acurácia das semeadoras-adubadoras à taxa variável. Revista Ciência Rural, 45(7), 1205-1213.

[6]. Shiratsuchi, L. S., Brandão, Z. N., Vicente, L. E., Victoria, D. C., Ducati, J. R., Oliveira, R. P., & Vilela, M. F. (2014). Sensoriamento Remoto: conceitos básicos e aplicações na Agricultura de Precisão. In: Agricultura de precisão: resultados de um novo olhar. Empresa Brasileira de Pesquisa Agropecuária. Ministério da Agricultura, Pecuária e Abastecimento. Brasília, 58-70.

[7]. Fraccaroli, E.S. (2018). Alocação de tarefas para coordenação de robôs heterogêneos aplicados na agricultura de precisão. Tese (Doutorado - Programa de Pós-Graduação em Ciências de Computação e Matemática Computacional/USP). Instituto de Ciências Matemáticas e de Computação da Universidade de São Paulo. São Paulo, 2018, 126p.

[8]. Gomes, A. R. A. (2018). Avaliação de sensores ópticos para monitoramento da operação de semeadura em milho e soja. Tese (Doutorado - Faculdade de Ciências Agronômicas/UNESP) Universidade Estadual Paulista. Botucatu, 2018, 82 p.

[9]. SENAR (Serviço Nacional de Aprendizagem Rural) (2015). Agricultura de Precisão na Semeadura (apostila). Programa de Agricultura de Precisão. Goiás.

[10]. CEPEA (Centro de Estudos Avançados em Economia Aplicada). (2018). Custos GRÃOS. Escola Superior de Agricultura Luiz Queiroz - ESALQ/USP. Confederação de Agricultura e Pecuária do Brasil (CNA).

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