

Precision Agricultural Equipment in Fertilizer Applications

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Abstract

Argentina has more than 15 million hectares where grasses are planted annually (corn, wheat, barley, sorghum among other crops), which are usually fertilized mostly with nitrogen fertilizers. Therefore, there is a need to know, understand and describe how to improve efficiency according to environments and uniformities in the distribution of fertilizer applications in the field. The latest trends in equipment go through technological developments applied to conventional machinery, which take into account the best moments of application during the cycle of different crops according to the needs of the industry.

This paper analyzes the evolution of precision agriculture (PA) thinking regarding the productive improvement achieved by technological components when they are a complement to soil variability, crop needs by environments according to productive potential, environmental variations during the day (wind, humidity, etc.), applied fertilizer product, how these fertilizers are applied and time of the crop cycle.

On the other hand, the importance of fertilization taking into account the agronomic technical requirements and not only the logistics and capacity of the agricultural machinery destined for the applications. The models of agricultural production and profitability are changing over time, so it is important to be able to understand technological changes quickly.

The robots will be part of the most disruptive process that is coming for conventional agricultural machinery. Companies will surely mutate from producing a seeder, a sprayer, a fertilizer, etc., to produce unique chassis with interchangeable modules that will allow the machinery to be more efficient by more than 80% compared to today. This will allow, among other things, to incorporate very small scale producers back into the production system.

Keywords: Robot; Precision Agriculture; Fertilization Technology

Introduction

After more than 20 years in Argentina with the emergence of precision agricultural equipment (AP) is that many questions arise about what type of fertilizers are applied, in what physical-chemical conditions, how these fertilizers are distributed, with what type of mechanical equipment is distributed, with which electronic equipment, which software are used to make the requirements, that reaction time between reading a prescription or reading information sensors and field application of the product. Other points not less important are the size of the application unit, the smaller definition of the area of characterization, corroboration on whether the number and amount of fertilizers for each area was correct or there was deficit or excess products, etc.

Phrases appeared at the beginning of the AP so that readers understand what this variable application technology was about. One of the explanations mentioned to the Variable rate Technology (VRT) that allowed farmers once known the behavior of the crop in each sector of the batch, calculate the needs of inputs in each smaller homogeneous area or subunit on the ground, and apply them in a site-specific way [1]. This text is still very current and can say much or not say anything about whether zone-variable applications are performed right or wrong. The same thing is still happening today, but more detailed information is available that allows in most cases to start to better understand the operation of this AP system and the response of fertilizer applications to soil and crops.

At the beginning of the variable application of inputs in our country were tried to force the soils towards the characterization of different environments and within the analysis of the areas bring them to the least possible amount, forcing them to behave in the same way, even if they were not. Some fields with expression of microvariability (small sizes, e.g. 5 meters x 4 meters) there were problems with the size of the machinery and the devices that were counted that were not accurate enough. In these fields it was not easy to treat the existing microvariability. Thus, many times the physical and economic results of the variable application did not give as the technicians wished.

Many times, even if the characterization was well done there were also poor results in the field due to applied products or poor conditions of the applied product, poor distributions of fertilizers, applications outside the limits of prescribed environments, or in most fields, the effect of the soil micro-variability exerts an error complicated to isolate in the analysis of performance data.

In 2000, Dr. Terry Roberts [2] mentioned the following to the following about site-specific management (MSE): "MSE is not new, but new high-tech tools make it easier to handle different areas in batches differentially". This phrase still it is very updated only that the size of these areas for our country would be totally changed in relation to what was raised in the year 2000 and what is now beginning to be visualized. Countries like Japan have captured this concept for many years and work in a robotic system obviously because the size of their fields is 5,000m² to no more than 3 hectares [3].

As for the AP technology available in Argentina it can be said that we are using in large part the same as developed countries such as the US. America, Australia, England or Germany, among others. But when it comes to robotization and automation of agricultural machinery, we are below in developments in countries such as Japan, Germany, England, France, Italy and some other country such as Chile in some productions.

Development of the AP in Argentina on fertilization machinery

The model chosen for the application of the AP in our country was originally copied to the US. America. in 1995/96 and always was to adapt the best option proposed by companies, producers or researchers from the universities of that country. Some of the proposed steps as well as the imported equipment were tested in Argentina, being largely successfully implemented. But also, other AP equipment or steps were not applied given their slightest success in terms of their adaptation.

Examples of points for characterizing environments in a field at the start of the AP were the tools that allowed for that better characterization at a lower cost to producers. From there, the comparisons emerged between the data obtained from performance monitors, ground charts, satellite images, aerial photographs, electrical conductivity scrapers, ground radars, soil sampling in grids or directed, among others. The reality was pointing the way at the time and leaving what was most practical and economical for producers.

If we focus on the topic fertilization in AP and it is interesting to note that in principle the realization of variable fertilization was performed with planters, fertilizers with bodies to incorporate solid products, solid product fertilizers to volley or with air-directed descent, with liquid fertilizers injected or by blasting, among others, pero always trying to apply variable by using GPS-directed prescriptions with prior characterization of environments or by real-time response under the reading of sensors such as Green Seeker passive at the beginning and active afterwards, where well-fertilized standard stripes were maintained to be compared to the rest of the crop in the batch.

Currently, the existing model is very similar to what is described in the previous paragraph as to the concept. The improvements were made in the majority of cases due to the experiences of almost 20 years that allowed to improve the analyses and equipment that provide faster responses to change or stabilization of fertilizer doses between environments.

The dose changes many times, between which the environment is detected and the prescribed is applied (necessary for that environment), demanded several seconds and this caused an unwanted dose in that sector of the batch, leaving errors in applications that are then expressed in crop yield. This problem has been solved over time and today we work with very good precision in the world.

Improved action equipment (actuators that receive information from monitors or sensors in real time), whether mechanical, hydraulic and/or electrical, as well as the software used achieving better application of fertilizers in the desired sites. The machinery in turn is more specific and has managed to robotize at the levels of metro to meter control the application and even submetric measurements.

Many factors were and are the cause of poor fertilizer applications. But it is usually always an example of flying fertilizations such as the ones that caused the greatest problems in terms of product distribution in the field. Argentina has been improving these equipment, but Europe is always advancing faster with electronic components connected to devices that measure and in turn can change distributions through changes in machinery in real time. Figure 1 shows poor nitrogen fertilization of maize cultivation due to poor fertiliser regulation.



Figure 1: Views of poor nitrogen applications in corn.

In our country, sprayers have been developed and teams that manage to know and trace an application that provides security to users have been developed and are being developed. The firm Acronex has implemented a real-time monitoring system (weather station) that is connected to sprayer devices to indicate whether there are drift risks or bad applications (<https://www.acronex.com/>). A similar system in Germany several years ago is being used for volley fertilizers where it regulates, in real time, the width of application according to the direction of the winds.

Una weather station mounted above the machine and communicated to an intelligent system that can be combined with a film camera that observes in real time the distribution and in turn controlling a mechanical, electrical or hydraulic system that triggers to make changes in the application width or the angle of output of the fertilizer (in mountainous places), would be the solution for mitigate or eliminate this fairly common and visible problem in the fields of our country.

The latest samples from the agricultural sector in the US. America. and Europe showed equipment with high reaction speeds to vary in contrasting environments in terms of doses applied in a very short time. Control devices were also shown to achieve both highly efficient

and well-distributed solid and liquid fertilizers. These will be the changes that our country must move towards achieving global fertilization efficiency.

Future of fertilization with new AP tools

It is worth starting to discuss the agricultural system and whether you want to improve or go unchanged and do things the same way. One of the points is surely fertilization and how it is currently being performed. Within nitrogen fertilization in grasses is still put on the table if it is done at the right time or if it is done when it is simpler by logistics, even if it is not the right thing from an agronomic point of view. This is surely due to problems in application times because a machine cannot make 1,000 ha in a day for example or by the state of crop development that does not allow the machinery to enter without damaging plants in advanced times of the cycle among other factors.

Another point that is always discussed is usually the diagnostic methods that never finish adjusting after trial and often nor adjust to the reality of what is applied in the field in fertilizers. Together with this the dependence of the year if it is wet or dry and the performance response that this causes. They are all situations of the day to day that with daily information obtained by different methods and applying with robotic equipment could be achieved better.

Today there are some tools that allow a better fit and that allow to more accurately predict the needs of crops in different types of supplies. The combination of satellite images of various satellites, more images obtained from a drone to take it as a comparative sample of adjustment to satellite images, taking data from weather stations there and adjusting to soil elevation models, is achieving an almost perfect fit at an early time in corn and wheat. In addition, they make a mathematical adjustment with climate data to predict after the moment when the images become saturated. In the US. America. some companies provide in satellite imagery virtually every day and it is like watching crops grow, allowing to detect disease problems or nutrition deficiencies many days before the human eye can observe it, for example.

This model starts to have a lot of data that today is possible to analyze with a somewhat simpler logic, because it has managed to have a continuity of points from the same place in time. This helps not only improve the applications of supplies, but also manages to have a traceability of the primary production that will be necessary to achieve prices higher than those listed by commodities in the US. But it's not the first time.

Considering how tools and technological possibilities are progressing, it is that we begin to visualize an interconnected and robotic virtual future in agricultural production. Where a satellite image can be the trigger for a robot to be by air or by land, it comes out to comply with the treatment recommendation indicated to it and then return to its base.

Surely these robots will be able to make agriculture in turn more versatile and with lower maintenance costs than the current machinery. Today rural contractors are going through a very difficult time regarding being able to amortize the working machinery.

Traceability tools exist and as an example we can cite only one company that acquired Trimble (<https://www.harvestmark.com>), which has more than 400 companies as customers. Today the food industry is being transformed by the demands of greater transparency, quality and safety, creating opportunities to provide a meaningful analysis of food from the field to the table. These systems can clearly make price differences for producers as consumers pay for it.

Conclusion

The future of the AP will produce changes that will be very flexible to be able to constantly turn from one production system to another, as long as work begins on the concept of soil micro variability and the correct treatment that this implies.

The advancement in the periodicity and information of satellite imagery, the faster speed of data analysis that previously did not have existing computers, the supply in agricultural machinery that allows changes to be made in a few centimeters and the mental amplitude of those who develop technology and make incredible developments. It is a challenge for all the production sectors of the world.

Today it is necessary that Argentine companies start developing this type of robotic equipment since they are surely the future of agriculture in our country and the world. The company Plantium Gentec of our country has a prototype electric robot that can serve as a platform to place a barrel fertilizer sprayer, fertilizing bodies or fertilizer drops among others.

The Argentine contractor can start mutating from classic machinery to robotic machinery as happens in some countries in Europe where the owner of these equipment travels with his truck and coupled with several robots that are operated from his cell phone.

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