Variable Rate Application of Fertilizer in a Permanent Pasture - An Account of the First Year of Experimental Tests in Portugal

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Abstract

Alto Alentejo is a southern province of Portugal with over 200,000 ha under permanent pasture. It came natural for the mechanisation group of the University of Évora, localised in the region, to pursue the objective of demonstrating new technology for fertiliser application in permanent pastures. This paper describes the major steps required to accomplish the objective. A description of the equipment gathering, methodology followed as well as the preliminary results of the first year will be presented. A tractor was equipped with a commercially available, DGPS based, precision farming package to interact with the electronic control system of the fertilizer spreader. This system enables the application plan to be transferred to the tractor terminal and spreading to be done accordingly.

Key words: Precision farming, fertilizer spreading, permanent pasture

1 Introduction

In Portugal, various researchers have demonstrated a willingness to follow the path of Precision Agriculture. However, limitations imposed by the low level of investment in this field linked to structural questions have prevented such a move. This study is the first project carried out in Portugal to demonstrate Precision Agriculture techniques and technology.

The advantage of transferring state-of-the-art technology, traditionally used for cereal crops, to pastureland may be an incentive for extensive livestock farming and the maintenance of montado pastureland (cork-tree groves and forage pasture). In the Alto Alentejo region, a high proportion of soils place limitations for farming: the layer of soil suitable for plant growing is usually very thin, with many rocky outcrops at the soil surface and there are also drainage problems. The level of organic matter is low and acid soils are predominant. The quality of such land has deteriorated due to its use over a period of several decades for the production of cereals, thus rendering the use of intensive production systems impracticable. However, there is now a demand for a strategy aiming the recuperation of this land over the medium- and long-term, based on the proven aptness of the region for the raising of native breeds of cattle and sheep in an extensive farming regime. Part of this strategy will be the establishment and maintenance of permanent pastureland as an integral part of the montado ecosystem.

The biodiversity of montado pastureland is well recognized and encouraged. Farmers are also aware of the variability of their farmland. What they normally lack is the knowledge of technical means to adequate farming inputs to such variability; their response is usually dependent on the available technology, and solutions are uniformly applied to the field. Thus, a vicious circle is created: technology for variable rate application is not widely used because farmers do not express a demand for it; and farmers do not seek out the technology because they are ignorant of its existence.
2 Materials and Methods

With the financial support from the programme AGRO of the Ministry of Agriculture, a three year project was established. In this study, the following equipment was used for carrying out field work (Fig. 1):
- a Massey-Ferguson, 6130 Datatronic 2 agricultural tractor (63kW);
- a Fieldstar precision farming system;
- a Garmin GPS/DGPS 16 receiver, mounted on the tractor;
- a Vicon- RS-EDW fertiliser spreader with its Ferticontrol standard controller;

The following 4 major steps were required to accomplish the objective:

- Step 1: the fertilizer spreader was calibrated and its spread pattern evaluated. This step involved the assessment of the lateral uniformity of distribution in order to establish the working width. This was carried out by placing a set of trays perpendicularly to the line to be followed by the tractor in which the fertiliser distributed was collected, enabling the distribution curve to be obtained. A set of trays placed along the line followed by the spreader was used to determine the transition zone between different application rates.

- Step 2: the FieldStar package was used to draw the field map, to draw a sampling plan and to guide the operator to the actual sample location.

The tractor, equipped with the FieldStar system was driven along the edges of the plot, and reference contour points were recorded as well as the presence of trees, rocky outcrops and other natural obstacles. Data recorded on a memory card was then transferred to a PC in which appropriate software was installed to build up the field map. A survey grid, based on the value of the spreader working with was drawn on the field map.

Geo-referenced soil samples and pasture samples were collected for the analysis of the physical (texture) and chemical composition (nitrogen, phosphorus, potassium, pH and organic matter) and to evaluate the floristic composition (balance between vegetal species; evaluation of dry matter).

- Step 3: the results from soil physical properties, pH and nutrients analysis, as well as from the botanical components of the pasture were plotted onto the sample plan map.

- Step 4: the maps were presented to agronomists for interpretation and a fertiliser recommendations plan was tailored to suit the pasture.

![Diagram of Technology to variable application of fertiliser](image-url)
3 Results

Figure 2 illustrates the transversal distribution curve for 18% Super phosphate fertiliser, which led to an effective working width of 28 meters, with a coefficient of variation of 15%.

The distribution of phosphorus and dry matter on the field are shown in figures 3 and 4, respectively.

![Transversal distribution curve for the Vicon RS-EDW distributor with 18% Super phosphate fertiliser](image1)

Fig. 2 Transversal distribution curve for the Vicon RS-EDW distributor with 18% Super phosphate fertiliser

![Phosphorus distribution map (P2O5, in p. p. m.)](image2)

Fig. 3 Phosphorus distribution map (P2O5, in p. p. m.)
Figure 4 shows the dry material production map (Total DM, in kg/ha).

Figure 5 shows the first set of fertiliser recommendations to be applied in each field location.

Figure 5 shows the fertiliser recommendations map (18% Super phosphate fertiliser, in kg/ha).
4 A Major Constrain

Due to the lack of free DGPS signal (EGNOS) at the time of fertilizer application, it was found that the spreader was not following the application plan previously established, but instead, it was automatically set by the system to apply a constant rate of fertilizer. As the lack of free DGPS signal became persistent, it was decided to override the system and to use a high-precision RTK-GPS, available in the University, to drive the tractor to the exact spot and to vary manually the application rate on the spreader control (Ferticontrol), according to the application map.

5 The Future of the Project

Intra-plot management is a process in which knowledge is acquired cumulatively. Several years of observations are required for the identification of the principal factors explaining reported variability. A new set of analysis to the soil and to the composition of the pasture will be held later in the spring of 2005, as a starting point for a second cycle for fertilizer application planning to that field.

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