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## **REDUCTION OF MECHANISATION COSTS BY THE APPLICATION OF GPS IN ARABLE CROP PRODUCTION**

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**Abstract:** The development of informatics applications and electronic data transmission, data processing made the establishment of precision agricultural production technologies and their rapid spread possible. This process was accelerated when the civil application of satellites previously used for military purposes was permitted. The accurate performance of the specific work operations within precision crop production by the set operating parameters may significantly improve efficacy. Since very little experience is available in this relation in Hungary the Hungarian Institute of Agricultural Engineering, Gödöllő, as the leader of the consortium, the KITE Agricultural Service and Trade Incorporated, Nádudvar, and Búzakalász Agriculture Service and Trade Incorporated, Kunszentmárton as members of the consortium have initiated a research and development project.

**Key words:** *automatic steering systems, parallel tracing, auto tracing, economical analysis, machine costs.*

### **INTRODUCTION**

One of the most difficult tasks for machine operators in the traditional arable crop production is to lay down a straight trace at the start of the work, which is easier to follow later. The proper joining of production lines may also prove to be problematic.

Agricultural machinery may be manoeuvred more accurately in the fields with the help of the recently available automatic steering systems and satellite navigation based steering systems.

With satellite navigation aid machinery, machinery groups in arable crop production technologies are able to perform their tasks with high cultivation accuracy, without cultivation skips, unreasonable cultivation overlapping, and territorial skips.

In the research phase the preliminary planning of movement maps concerning self-propelled machinery and tractor machinery groups, the optimisation of trace and

cultivation directions, the accurate performance of technological operations and the minimalisation of over cultivation (skips and unnecessary overlapping) were realized. The field measurements have proved that the amount of machinery work and energy expenditure may be decreased while production efficacy may be increased.

Our principal objective is to develop domestic economics and application conditions, the introduction and calculation of economic advantages in terms of parallel, trace following automatic steering systems.

## METHODOLOGY

The economics analysis has been carried out by taking into consideration the arable land of our consortium member, the Búzakalász-Agrár Zrt. along with the available machinery and applied technologies calculating with the actual performance and costs. The crop structure of the incorporation is based on three crops in the following proportion: 900 hectares of wheat, 600 hectares of sunflower, 100 hectares of corn, that is totalling 1600 hectares.

The technological demand of these crops have determined the composition and selection of machinery, machinery systems.

We have analysed:

- the change in field performance in case of machinery operations,
- the change in machinery productivity in case of complex production technology,
- the change in the value of machinery work used for the cultivation of one hectare,
- the performance of power engines in terms of yearly operating hours in the different steering modes,
- the amount of machinery work applied for the cultivation of one hectare.

The assessment of machinery operations has been divided into manual, parallel (trace following) and automatic steering modes.

## RESULTS

### **Increase in field performance and productivity**

In case of the three major operation groups the soil cultivation operations with the application of parallel steering show 3.1%, and 6% plus field performance increase with automatic steering as compared to manual steering. In case of sowing these numbers are 3,4%, and 6,9%, while in case of harvesting the figures are 1,7 and 4,9%.

By adding up the given operations the possible productivity increase within the complex technologies in case of wheat is 19% plus with parallel steering, 42% plus with automatic steering as compared to manually steered power engines. In case of corn production the figures show 7% plus, 18% plus increase, while in case of sunflower these are 6% plus and 14% plus increase.

### **The change of investment demands**

On the basis of calculations done on a 1 hectare territory, the investment demand of machinery able to serve three crops increases costs with 37,5 EUR / hectare in case of parallel steering, while 60 EUR / hectare in case of automatic steering as compared to manual steering. The increase of productivity compensate the higher costs.

### The change of specific machinery cost in terms of different crops

On the basis of the performed analysis the specific (calculated on one hectare) average cost of machinery work as compared to manual steering decreases by 18 EUR/ hectare in case of parallel steering, and by 22,5 EUR/ hectare in case of automatic steering, which means 9,19% and 11.92% savings. The highest savings may be reached within wheat production by the application of automatic steering – that is 12.47%; 22,7 EUR/ hectare. In case of line cultures slightly less, however over 11% cost reduction may be realised (Figure 1).

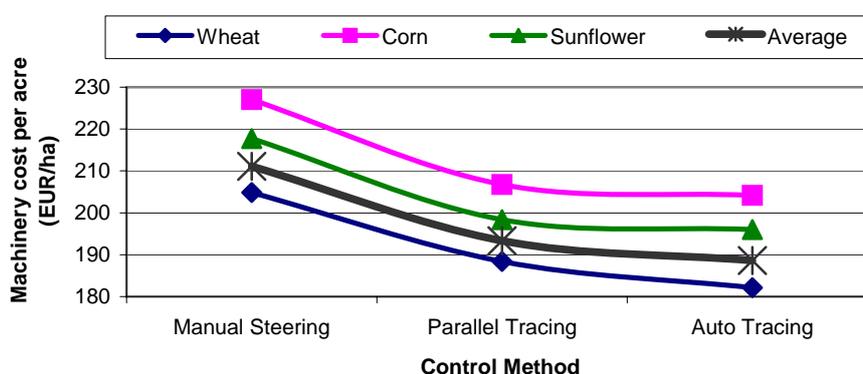


Figure 1: The change of machinery cost per hectare in terms of different crops when manual, parallel and automatic steering methods are applied

### Machinery work savings possibilities

The examined farm applies high capacity machinery and machinery work effective, operation reduced production technologies as compared to the Hungarian average, therefore it uses low, 3.17 operational hours machinery work on average for the cultivation of one hectare.

This specific machinery work volume may be reduced with an additional 7.9% by the application of parallel, and 11,1% by the application of automatic steering systems. This means that when cutting edge technology and machinery are used less than 3 operational hours machinery works is needed for the cultivation of an hectare, which is a rather favourable value even in international comparison.

### Reduction of machinery workload

The annual machinery workload of the power engines used in the farm may be significantly – by 8-11% - decreased as a result of more accurate and effective operations. In favourable cases even 400-500 operational hours may be saved, which may result in the reduction of the number of machines, or the utilisation of machinery in leasing, rental contracts. By parallel steering machinery workload may be decreased with at least 400 operation hours, while automatic steering may result in even 512 hours savings in the 1600 hectare farm.

### PROPOSALS FOR THE UTILIZATION OF THE RESULTS

The widespread application of the results shall be proposed in the plant production sector of agriculture. The results of the farm having contributed in the realisation of the project have proved the benefits, which have encountered in the course of the examinations and measurements.

Primarily automatic steering solutions are to be advised, which ensure higher efficacy and cost reduction, furthermore are less demanding for the operator, who may concentrate better on the quality of work. Advances may be experienced in the quality of work, or possible loss may be reduced.

Remarkable benefits may be indicated particularly in case of bigger farms or more intensive machinery use, where machinery work per hectare expenditures may be decreased, while the efficacy of machinery work is increased, not to mention the better production results to be realised due to precision cultivation. The benefits may be measured in farms of 300-400 hectares, however the result are more notable in 4000-5000 hectares farms.

Another benefit of the automatic steering and machinery control systems is that they may be developed gradually or completed step by step in case of a given machinery fleet. The system may be developed into the direction of work machines from power engines implementing effective and precision production, which is regarded as the most advanced agricultural production technology nowadays.

### REFERENCES

- [1] Földesi I., Hajdú J., Magó L., Fekete, A., Deákvári J., Kovács L.: (2007) Automatic steering with GPS navigation aid. *Agricontrol 2007. 2nd IFAC International Conference on Modelling and Design of Control Systems in Agriculture*. Osijek, Croatia, 03.-05. September 2007. p. 207-210.
- [2] Hajdú J., Kelemen Zs., Magó L.: (2008) Automatikus irányítás alkalmazásával elérhető géphasználati költségcsökkentés vizsgálata a szántóföldi növénytermelésben 32<sup>nd</sup> R&D Conference on Agricultural Engineering, Gödöllő, Hungary, 22. January 2008. No. 1., p. 150-154.
- [3] Hajdú J., Magó L.: (2008) Cost Reduction Analysis of Machinery Use by the Application of Automatic Steering in Arable Crop Production, *Journal of Scientific Society of Power Machines, Tractors and Maintenance "Tractors and Power Machines"*, Novi Sad, Serbia. Vol. 13. No. 1., p. 108-113.
- [4] Hajdú J., Magó L.: (2009) Analysis of the Use of Automatic Steering Systems from an Economical Point of View, *Proceedings of the 37<sup>th</sup> International Symposium "Actual Tasks on Agricultural Engineering"*, Opatija, Croatia, 10-13. February 2009. Proc. p. 303-309.
- [5] Magó L., Hajdú J.: (2009) Reduction of Mechanisation Costs by the Application of GIS in Plant Production, *Abstracts of the International Conference "Synergy and Technical Development in the Agricultural Engineering"*, Gödöllő, Hungary, 31. August - 3. September 2009. p. 102. – Full Paper in CD Issue.

**SMANJENJE TROŠKOVA MEHANIZACIJE SA PRIMENOM *GPS*  
U RATARSKIM PROIZVODNJAMA**

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**Sadržaj:** Razvoj informatike, elektronski prenos i obrada podataka omogućio je uspostavljanje i brzog širenja precizne tehnologije u ratarskom proizvodnju. Korištenjem *GPS* tehnologije efikasnost i preciznost radnih operacija se poboljšava, a troškovi obrade zemljišta se smanjuju.

U radu prikazujemo moguću uštedu u radnom vremenu i u troškovima radnih operacija, naglašavamo i to da primena *GPS* tehnike je više korisno u većim farmama, gde se investicioni troškovi ranije naknađuju.

**Ključne reči:** *automatično upravljanje, paralelna vožnja, automatična vožnja, ekonomska analiza, troškovi mehanizacije*