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PRECISION AGRICULTURE · REDEFINED

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Case study

Customer: Central Europe

Concluding Report of 2020 Field Trials

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Executive summary

- Data obtained during the growing season was utilised to release two minor updates during the growing season towards improved performance, a major update to facilitate very early stages of an additional crop (maize) and the development of a new version of (NVRA) to be released during the upcoming growing season.
- No limitations due to the AUGIndex were detected.
- Average savings of fertiliser In rapeseed only one application per field has been carried out in February during the early stages of plant growth where the fields are still highly variable. Therefore, as expected the average savings are estimated to be 7.5%. Wheat fields appeared much more uniform which resulted in lower savings (3.5%).
- NVRA resulted in yield increase in rapeseed and winter wheat fields by 1.2% and 10.6% respectively.

For better understanding the A.F.A decision algorithm and results presented in this report, it is suggested that the reader first understands the document “Agronomic Manual v1”.

Goal

The scope of this report is to evaluate Augmenta’s Field Analyzer (A.F.A) performance by estimating the impact of operations carried out on plant growth, development and yielding.

Towards that end yield maps provided by the customer have been correlated with respective AUG Index maps and Fertilizer application maps obtained by A.F.A during field operations (see Fig. 1).

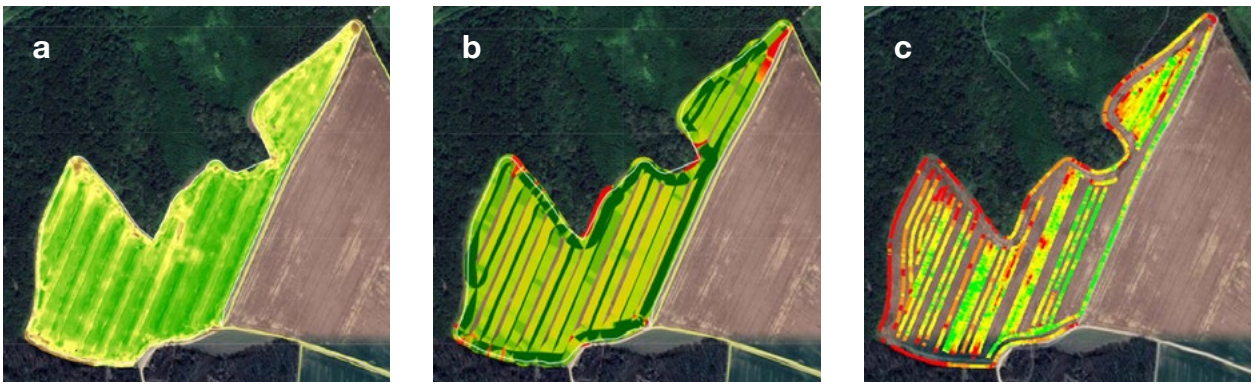


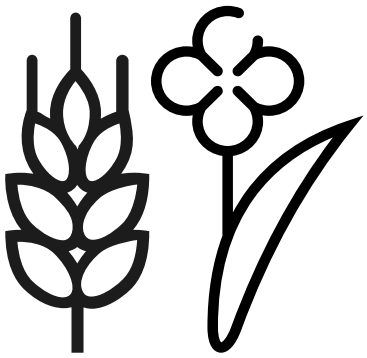
Fig. 1. *(a) AUGIndex, (b) Fertilizer application Map and (c) Yield map of canola field Hardi szőlő (id: 199), Central Europe 2020.*

The total yield of each field has been utilised to calibrate the values monitored by harvesting equipment. Whenever yield maps are not available historic data provided by the customer has been used for comparisons.

Stability of the system

GENERAL STATISTICS

Crop Tested: **wheat, rapeseed**
VRA hectares (total): **564.2 Hectares**
Monitoring (total): **639.1 Hectares**
Fixed Rate Appl. (total): **4.3 Hectares**
Total Fertilizer Used: **94049.2 kg**
Total Sessions: **123**
Total Fields: **40**
Total Working Hours: **78 H, 23 Min**



The A.F.A is being tested over a 4-month period covering different developmental stages of the tested crops. A schematic representation of the spatial operation carried out in each crop is presented on Figure 2.

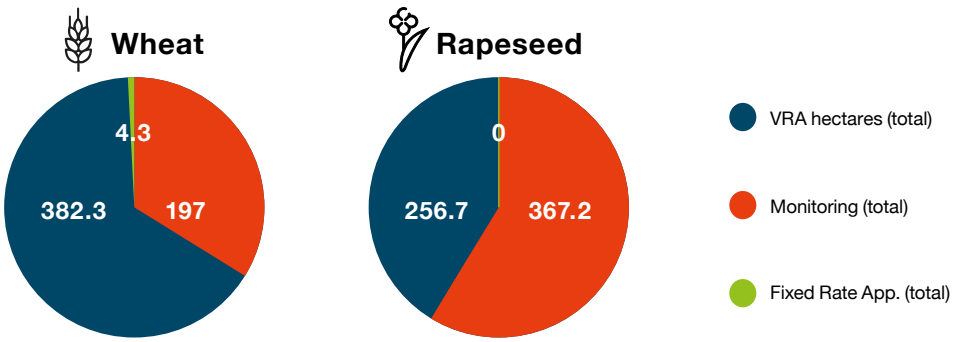


Fig. 2. Operation breakdown in (a) wheat and (b) rapeseed in Central Europe , 2020.

More than 67 sessions were carried out in 21 wheat fields, while 56 sessions were carried out in 19 different fields of rapeseed. Some sessions were duplicates from the same field at a later stage. For example, for the Field “méhes” the 1 st session was carried out on the 18 th of February during which a Variable Rate Application (VRA) of Nitrogen fertilizer was performed and a second Monitoring session was conducted three weeks later, on the 11 th of March. Data obtained during these sessions were utilised to continuously **upgrade the implemented agronomic algorithm** so as to ensure **improved performance** adjusted to monitored field condition. In total, two minor updates occurred during the growing season to improve ad hoc the performance of the algorithm and a major update took place to facilitate very early stages of an additional crop (maize). Moreover, the bulk of data gathered contributed in the development of a new version of the Variable Rate Application Algorithm of Nitrogen Fertilizer (NVRA) to be released during the upcoming growing season.

A.F.A inputs have been constantly compared with current state of the art satellite imagery (US Geological Survey and the Sentinel-2 satellite) in all the sessions mentioned above, to evaluate stability of measurement through the season, time of day and environmental circumstances (e.g. clouds, clear sun). A.F.A autonomous calibration feature performed as planned, providing an accurate representation (both qualitative & quantitative) of the farm no matter the external parameters.

Performance of A.F.A

A.F.A has been tested in fields where variability was negligible (standard deviation=0.01) and the development of the plants was very uniform, as well as in fields of considerable variability (standard deviation=0.18) including plants at different growth stages and possibly arid spots as well. Despite the limitations often encountered by Vegetation Indexes at late developmental stages of a crop, AUGIndex had no problem to detect even minor differentiations on the field (see Table 1).

Table 1. *Vegetation Index monitored during a session performed on the 5th of May in Paperdo field in Central Europe, 2020.*

FIELD NAME	DATE	OPERATION	CROP	MIN(AUG)	AVG(AUG)	MAX(AUG)	STD_AUG
Field5	05/05/2020 14:45:05	NVRA	wheat	0.55	0.58	0.6	0

Thus, even operations carried out late in the growing season were carried out unimpeded (see Fig. 3).

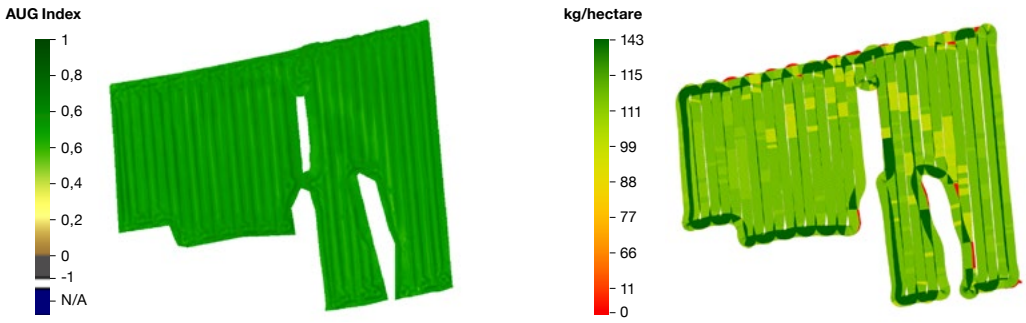


Fig. 3. *(a) AUGIndex and (b) Fertilizer application Map of NVRA operation carried out in Paperdo field on the 5th of May, Central Europe 2020.*

All available sessions were included in the analysis regarding the performance of the NVRA in different crops in terms of fertilizer savings (%). In sessions where VRA was conducted, the fertilizer consumption was compared with the respective consumption had a fixed rate been performed with the respective recommended dose. In sessions where Fixed Fertiliser Application or Monitoring was carried out the data gathered was utilised in simulation models (as described in previous report) so as to estimate Theoretical Savings had the user performed an NVRA in those sessions.

A summary of the results obtained is presented on Table 2 including the savings of fertilizer (% and kg) per crop, the total Number of sessions analysed and the respective acreage (ha).

Table 2. *Summary of results comparing the performance of V.R.A vs fixed dose application of fertilizer in all sessions in Central Europe, 2020.*

CROP	FERTILISER SAVINGS (%)	FERTILISER SAVINGS (kg)	TOTAL SESSIONS	TOTAL AREA (ha)
rapeseed	7.5	11523	36	623.9
wheat	3.1	3756	41	579.7

In order to evaluate the effect of NVRA on yield different sources of data were utilised including yield maps, weighted harvested yield and historic data. Historic data provided was utilised to estimate average Yield per crop. As shown on Table 3 rapeseed yield is relatively stable between the two reference years (2019 and 2020).

Table 3. *Historic data regarding the yield of rapeseed, durum wheat and winter wheat for the years 2019 and 2020.*

	2020		2019	
CROP	**AREA (ha)**	**YIELD (kg/ha)**	**AREA (ha)**	**YIELD (kg/ha)**
rapeseed	324.17	**3476.1**	325.1	**3401.3**
durum wheat	232.47	**5780.0**	248.8	**4888.9**
winter wheat	205.31	**7863.0**	199.3	**5884.8**

On the contrary, as far as wheat is concerned significant differences are observed between the two years. Yield from 2019 is significantly lower compared to 2020. Therefore, it is concluded that historic data of wheat cannot be utilised to conduct meaningful comparisons. The comparison of yield between treatments is presented on Table 4.

Table 4. *Data regarding the yield of rapeseed, durum wheat and winter with different treatments (VRA and Fixed), Central Europe 2020.*

CROP	OPERATION	AREA (ha)	YIELD (kg/ha)
canola	**VRA**	**209.5**	**3446.2**
canola	fixed	30.7	3409.6
winter wheat	**VRA**	**95.1**	**8266.3**
winter wheat	fixed	65.2	7476.9
durum wheat	**VRA**	**NA**	**NA**
durum wheat	fixed	232.5	5780.0

In rapeseed fields where NVRA took place the yield was increased by 1.2% ± 0.1 and this results is consistent between treatments and between years as well. In fields of winter wheat where at least one NVRA operation took place a significant increase in yield was observed equal to 10.6%. Due to inconsistencies in naming of fields no data is available for durum wheat. In order to better understand the results obtained, an evaluation of the NVRA was deemed necessary.

Evaluation of V.R.A

A correlation between Yield maps, AugIndex maps and Fertilizer application maps was deemed necessary to evaluate the effect of the NVRA on different regions of the field so as to understand the consistent yield increase observed despite the reduction of fertilizer added.

Case study teknó, Session 2020-02-19, 09:33:21
In this session the Aug Index values range between 0.24 and 49 with an average of 0.41. It is a 4 relatively uniform field with a standard deviation of 0.06. As previously reported, in this case the implementation of the A.F.A resulted in **5% savings** on **fertilizer**.

Evaluation of V.R.A

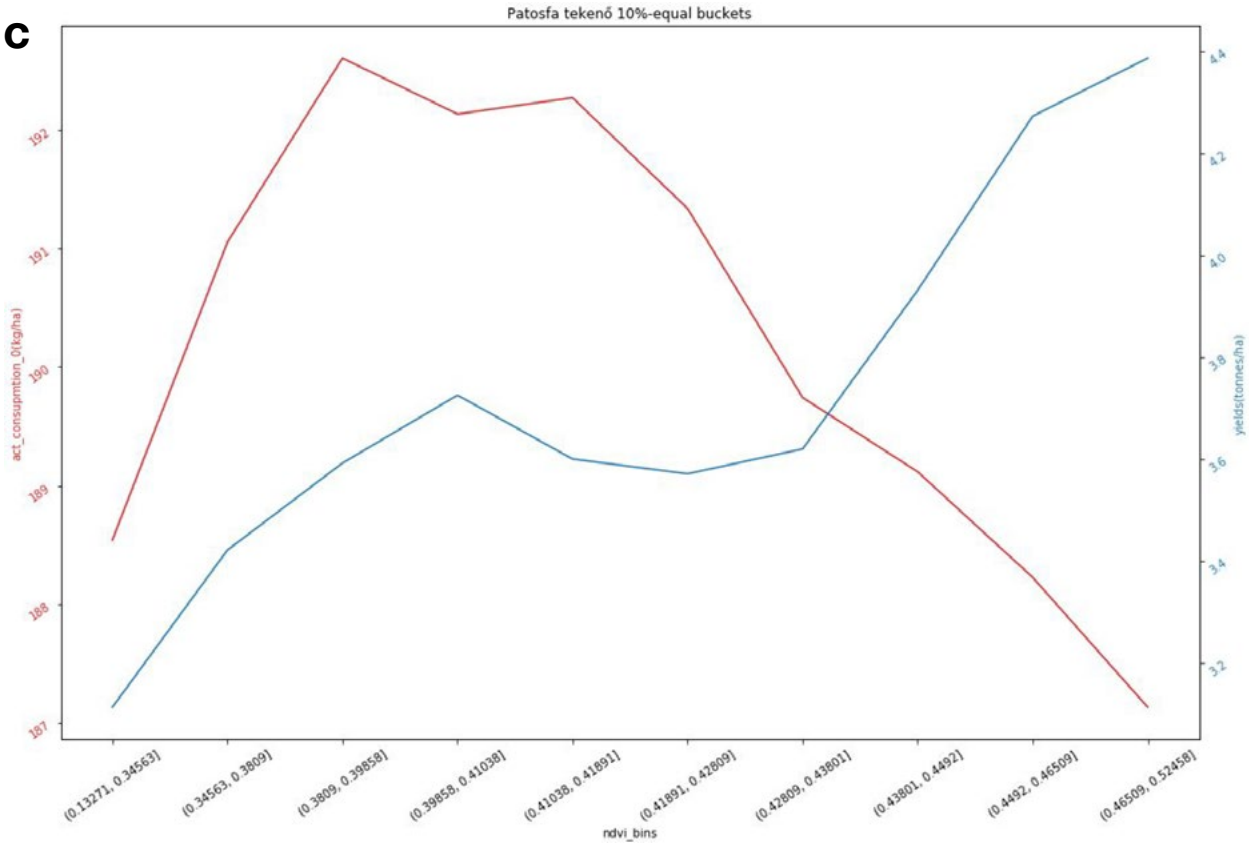


Fig. 4. (a) Aug Index map, (b) fertilization map and (c) correlation between fertiliser added (act-consumption), yield and AUGIndex of the field teknó, Session 2020-02-19, 09:33 performed by the Jankovich Birtok group, Central Europe 2020

As shown on **Figure 4a** and **4b** areas of no potential represent only a minor part of the field. Thus, fertilizer savings occur mostly due to the slight reduction of fertilizer added in the areas of the field that have already reached their potential. However, as it is evident on **Figure 4c** yield monitored increases in the respective areas despite the reduction of fertiliser imposed.

This is a general trend observed between fields supporting Augmenta's decision to **differentiate from competition** and to follow a much more complex, non-linear function for the realization of the agronomic algorithm regarding the Variable Rate Application of N-fertilisation.

Summary

The NVRA related **fertilizer savings equal 7.5%** for rapeseed and are accompanied by a **yield increase of 1.2%**. In wheat fields the respective **fertiliser savings equal 3.1% while yield increase reported was 10.6%**.

The absolute numbers for the above are:

7254.3 kg
of **urea saved** in 2020 using Augmenta system.

13.5 tonnes
of **extra rapeseed** yield gained in 2020 using Augmenta system.

155.5 tonnes
of **extra winter wheat** yield gained in 2020 using Augmenta system

Theoretical benefit if Augmenta was used in the entire farm

Given the acreage fertilised this year (623.9 ha and 583.6 ha of rapeseed and wheat respectively) the total savings of fertiliser would be 15.4 tonnes.

A yield increase of the respective acreage would imply an extra 22.8 tonnes of rapeseed and 460.7 tonnes of wheat

Since, annual yield can significantly vary as indicated by the available historic data the results obtained are to be treated with caution especially in the case of wheat. Different data sets obtained in consecutive years would assist to more accurately determine the percentages reported above.

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