Roll-Out of Online Application for N Sidedress Recommendations in Potato.

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ABSTRACT

In the Netherlands the soil nitrogen supply and the crop nitrogen requirement varies widely from year to year and from field to field. For potato farmers sidedress systems based on physical measurements are available, however these systems neglect the spatial variation within fields. Based on 20 years of research we developed a crop reflectance based N sidedress system for potatoes which overcomes this problem. Recently we implemented this system online as an application on a web-based portal called Akkerweb, which allows for safe and easy storage of spatial and temporal soil, crop, climate and management data. Since 2014 we made a small group of farmers acquainted with this application. In participative projects we organized an entire workflow from measuring with tractor mounted sensors (a Yara-N-Sensor) to a N sidedress recommendation. The experiences from the farmers were divers, mainly due to two seasons of irregular weather patterns. Overall the application is appreciated by the farmers as an easy-to-use tool which provides good indications of the N-uptake and guidelines to deal with the natural variation in nitrogen uptake. In 2016 field experiments were done to fine-tune the recommendation system, to enable recommendations on the basis of UAV-images and to estimate the usefulness of several other near-by sensors. Recommendations by the user group enabled us to improve the user interface of the app.

Keywords: N sidedress application, precision agriculture, crop sensing, web-application, Akkerweb, The Netherlands

1. INTRODUCTION

In the Netherlands the soil nitrogen supply and the crop nitrogen requirement varies widely from year to year and from field to field. Figure 1 shows the amount of nitrogen in the crop (requirement) and in the soil (supply) in a typical potato crop as a function of time (Day of Year, 1 January is 1). The nitrogen requirement of the crop varies yearly depending for example on planting date, temperature, radiation, water availability, etc. This variation is indicated by the grey area behind the curve. The nitrogen supply of the soil comes available from decomposition of soil organic matter. The decomposition varies yearly as a function of temperature and moisture, as well with the use of green manure crops, manure and organic fertilizers. The difference between the soils supply and the crops requirement has to be made up by fertilizers. The amount of fertilizers may be fairly small or it may be very large, as can be seen in figure 1.

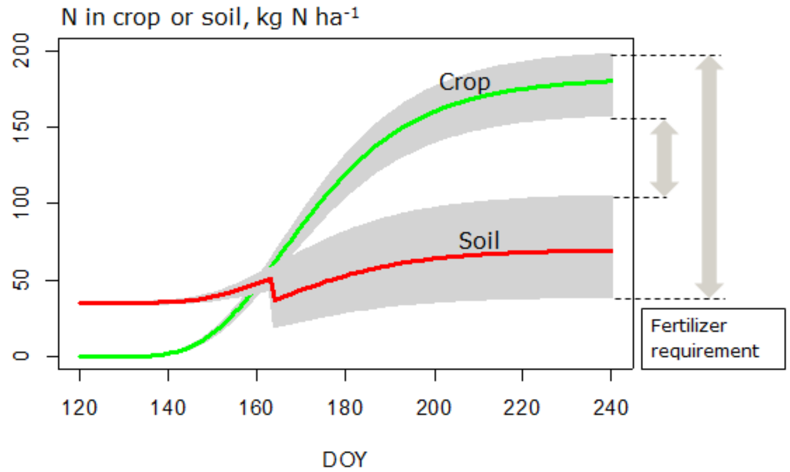

Figure 1. Variation in nitrogen requirement of the crop and supply by the soil.

There are several services available to support farmers with N sidedress recommendations in potato to cope with the variation in fertilizer requirement. Past research has shown that splitting the N recommendation give better results in terms of nitrogen uptake by the plant (Geel et al., 2014). Typically 2/3 of the recommended rate is given at planting. In late June the crop and/or soil is monitored to determine a sidedress nitrogen application.

Since 2010 we developed a crop reflectance based N sidedress system for potatoes based on twenty years of research (Evert et al., 2012, 2013; Schans et al. 2012). This system translates sensing data in combination with farm management data into site specific nitrogen recommendations. Section 2 provides an overview of this sidedress system.

Since 2014 we developed a web-based portal called Akkerweb (www.akkerweb.nl). Akkerweb is a platform where spatial and temporal soil, crop, climate and management data are easily and safely stored. Akkerweb functions as a platform, providing the building blocks (connected data) to develop online applications and decision support modules. As Akkerweb provides a solid basis, it was logically for us to implement our crop reflectance based N sidedress system into an online application on this platform. Section 3 provides an overview of the application.

2. N SIDEDRESS SYSTEM

The crop reflection based N sidedress system consists of three parts. In the first part the crop reflection is translated into a nitrogen uptake by the crop. In past research we found that a weighted difference vegetation index (WDVI) measured with a Cropscan MSR has a strong relation with the aboveground and total N-uptake of potatoes. In figure 2 the relation between WDVI and total N-uptake of the plant is shown, following a broken-stick-model (Evert et al. 2012a, 2013).

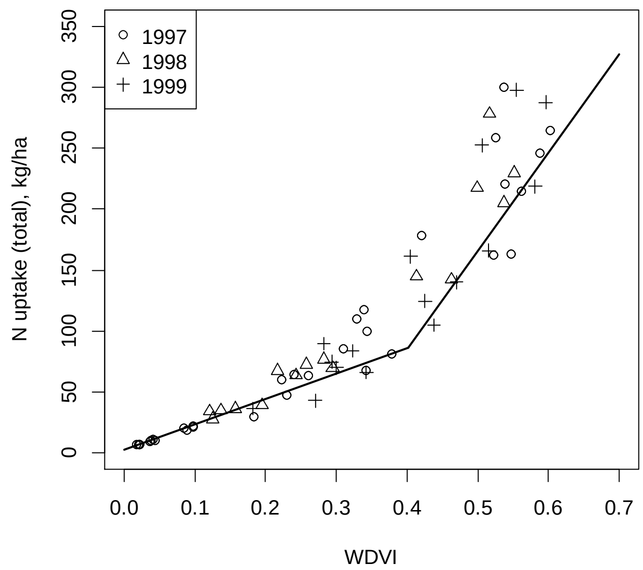

Figure 2. Correlation between N uptake of potatoes (total uptake) and the WDVI, from Evert et al. (2012).

The WDVI is calculated as follows (Clevers, 1989):

$WDVIg = R810 - c \cdot R560$
With R810 is the reflectance at near infrared wavelength 810 nm,
R560 is the reflectance at green wavelength 560 nm and
c is the correction factor for bare soil. For clay a value of 1.3 is assumed and for sand 1.7.

Similar for a Yara-N-Sensor, which is a tractor mounted reflectance sensor, a S1 or SN index is used. S1 has a strong relation with WDVI (Evert et al. 2012b). In Vona and Malda (2011) a relation between S1 and N-uptake has been found. SN is a calibrated value which has a strong relation with aboveground N-uptake.

The second part consists of a model which estimates the theoretical N requirement of the crop based on temperature (temperature sum), planting date, expected yield and the scouting date. Originally the model is derived from Steltenpool and Van Erp (1995) and adapted according to Geel and Wijnholds (2003):
$Ntarget = Nmax \cdot EXP(-EXP(-0.00494 \cdot Tsum - 544))$
Where $Nmax = 1.188 \cdot expected\ yield\ (ton/ha) \cdot Ncontent\ tubers.$
The Nmax depends on the expected yield (input from farmer) and the N-content of the tubers. The N-content is a factor which differs for starch potatoes respectively consumption potatoes. The Tsum is the temperature sum between planting date and scouting date.

In the last part a recommendation is derived from the estimated total N-uptake of the crop and the estimated N-target.

3 APPLICATION ON AKKERWEB

Akkerweb is a platform consisting of several applications. Akkerweb focusses on field data, meaning that it connects several data sources to provide public and private data for each crop field in the Netherlands. Applications are offered to the farmer, which use the available data on the platform and from other applications and translate the data into practical and usable information. The N sidedress application is such an application.

Figure 3 shows a schematic overview of the N sidedress application.

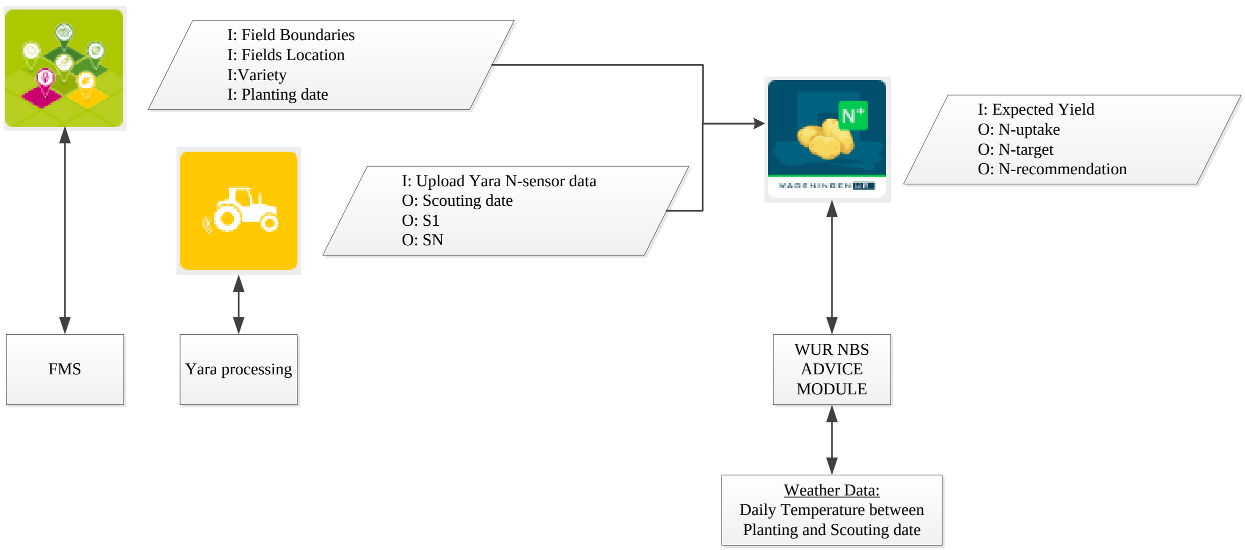

Figure 3. Overview of interactions between N sidedress application and other applications.

In a Cropping Scheme application the farmer registers his potato fields, cultivar and planting date. He also has the possibility of importing these data from his Farm Management System. Second, in a Sensordata application the farmer uploads his Yara-N-sensor data. In the background the app connects with a module to process the raw data and translates the data into usable values as scouting date, S1 and SN. The application also interpolates the measurements using Inverse Distance Weighting. Other possible inputs are satellite data (WDVI) or UAV-images (Multispec4C, Chlorophyll Index; Evert et al, 2016). The outputs are interpolated maps for the different vegetation indices.

Last the farmer uses the N sidedress application. The application imports the data from the Cropping Scheme and the Sensordata application. The farmer adds information about the expected yield for his field. The N-sidedress application combines the data and communicates the data to an advice module (the N sidedress module; NBS). The advice module contains the algorithms to translate the vegetation indices to a N-uptake, to estimate a N-target and to calculate a N-recommendation. The advice module uses the geographic location of the field to download temperature data of the nearest public weather station. The module estimate the N-target from the expected yield and the temperature sum between planting date and crop sensing date using the logarithmic model described in section 2. The output of the module is a N-uptake map, a N-target value and a N-recommendation map. The N sidedress application visualizes these maps and values and gives the farmer the opportunity to download a Variable Rate Application (VRA) Task map.

4. PRACTICAL USE

Since 2015 we organized an entire workflow in participative projects from measuring with crop sensors to applying N recommendations. Contractors are measuring with tractor mounted Yara-N-sensors. They upload the data on Akkerweb and share these data with their customers (farmers). Farmers use the N sidedress application as a decision support tool to decide about applying a sidedress application (yes or no) and the amount of fertilizer (recommended rates).

Figure 4 shows an example of the N-uptake and N-target of a field in the south of the Netherlands in 2016. The cultivar is Fontane. The crop is planted at 8th of May and emerged at 25th of May. The expected yield is 65 ton/ha. The farmer applied 120 kg N/ha at the base. Figure 4 shows that especially at the second measurement the actual uptake is lower than expected. Therefore the farmer decided to apply 41 kg N/ha (VRA) at 28th of June. During July the farmer expected decomposition of organic matter. Therefore he waited applying more fertilizer. The 4th measurement shows that the N-uptake of the crop increased with about 60 kg N/ha, mainly due to decomposition process. At 21^{h} of July the farmer applied one more recommendation (VRA) of 50 kg N/ha on average and a range of 0 – 110 kg N/ha. The realized yield was estimated on 55 ton/ha. This example shows the necessity and advantages of site specific recommendations.

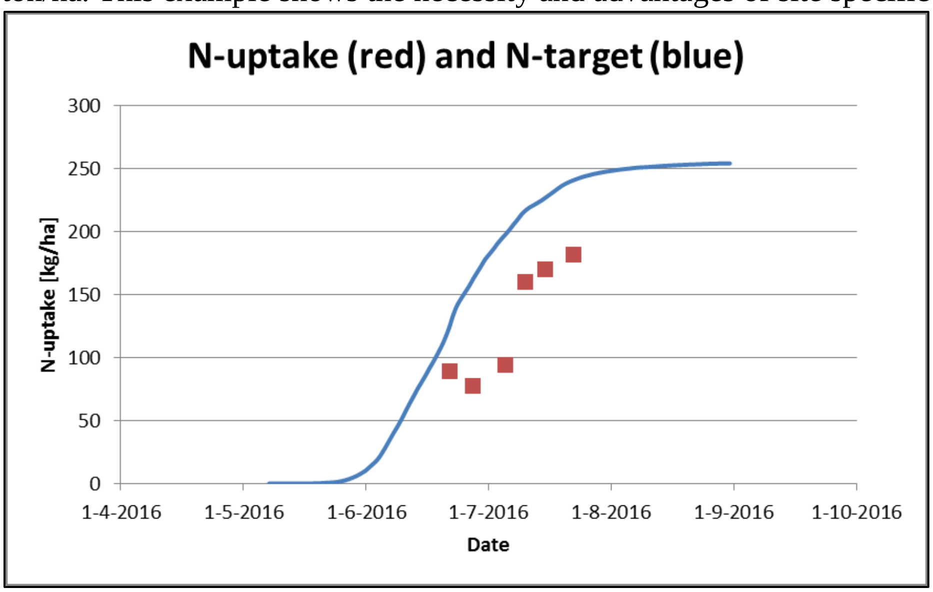

Figure 4. N-uptake (red dots) and N-target (blue curve) of a field in the south of the Netherlands.

5. PRESENTATION

In the presentation we shortly summarized the background information described in this paper. Furthermore we showed some results of the relation between vegetation indices derived from UAV-images (Multispec4C) with the aboveground N-uptake from experiments in 2016. Last we elaborate more on some results from the participative groups derived in 2015 and 2016, a quick glance of the online application itself and our lessons learned for future work.

6. REFERENCES

Clevers J.G.P.W. (1989), ‘The application of a weighted infrared-red vegetation index for estimating leaf-area index by correcting for soil-moisture’, *Remote Sensing of Environment*, Volume 29, July 1989, Pages 25-37, ISSN 0034-4257, http://dx.doi.org/10.1016/0034-4257(89)90076-X. (http://www.sciencedirect.com/science/article/pii/003442578990076X)

Evert, F.K. van; Booij, R., Jukema, J.N.; Berge, H.F.M. ten; Uenk, D.; Meurs, B.E.J.J.; Geel, W.C.A. van ; Wijnholds, K.H. ; Slabbekoorn, H.J.J. (2012a), ‘Using crop reflectance to determine sidedress N rate in potato saves N and maintains yield’, *European Journal of Agronomy*, Volume 43, November 2012, Pages 58-67, ISSN 1161-0301, http://dx.doi.org/10.1016/j.eja.2012.05.005. (http://www.sciencedirect.com/science/article/pii/S1161030112000767)

Evert, F.K. van; Voet, P. van; Valkengoed, E. van; Kooistra, L.; Kempenaar, C. (2012b) ‘Satellite-based herbicide rate recommendation for potato haulm killing’, *European Journal of Agronomy*, Volume 43, November 2012, Pages 49-57, ISSN 1161-0301, https://doi.org/10.1016/j.eja.2012.05.004. (http://www.sciencedirect.com/science/article/pii/S1161030112000755)

Evert, F.K. van; Schans, D.A. van der; Geel, W.C.A. van; Malda, J.T. ; Vona, V. (2013), ‘From theory to practice: using canopy reflectance to determine sidedress N rate in potatoes’, Refereed book chapter in: *Precision Agriculture '13 / Stafford, J.V.*, Wageningen : Wageningen Academic Publishers, - p. 119 - 127.

Evert, F.K. van; Meurs, B.E.J.J. ; Schans, D.A. van der; Booij, J.A.; Geel, W.C.A. van; Kempenaar, C. (2016), ‘Using Aerial Imaging in a Large-Scale Roll-out of N Sidedress Recommendations for Potato’, *Proceedings of the 2016 ASA/CSSA/SSSA Annual Meetings*, Phoenix, AZ, USA . [9 November 2016]

Geel, W.C.A. van; Wijnholds, K.H. (2003); ‘Ontwikkeling van geleide bemestingssystemen bij de teelt van zetmeelaardappelen’. (Development of guided sidedress systems in starch potatoes). Report 510168, PPO, Lelystad, The Netherlands.

Geel, W.C.A. van; Kroonen-Backbier, B.M.A.; Schans, D.A. van der; Malda, J.T. (2014), ‘Nieuwe bijmestsystemen en –strategieën voor aardappel op zand- en lössgrond; Deel 2: resultaten veldproeven 2012 en 2013’. (New sidedress systems and strategies for potatoes on sand and loess soil.), Report 615, PPO, Lelystad, The Netherlands.

Schans, D.A. van der; Evert, F.K. van; Malda, J.T., Dorka-Vona, V. (2012), ‘Sensorgestuurde advisering van stikstof bijbemesting in aardappel: implementatie en integratie.’ (Sensor-based N sidedress system in potatoes: integration and implementation). *Masterplan Mineralenmanagement*, Report 520, PPO, Lelystad, The Netherlands.

Steltenpool, J.A.N.; Erp, P.J. van (1995), ‘Schatting van de actuele N-opname door aardappelen.’ (Estimation of the actual N-uptake by potatoes). *Meststoffen 1995 p.45-50*.

Vona, V.; Malda, J.T. (2011), ‘027 PPL: Bemesting van praktijkpercelen tafelaardappelen en implementatie van een ijklijn voor de Yara N-sensor’ (Fertilizer application in common fields with consumption potatoes and implementation of a calibration curve for the Yara N-sensor), ALTIC, Dronten, the Netherlands.