Agris on-line Papers in Economics and Informatics

Volume I Number 2, 2009

Prefarm Systems and economical analysis of practical experiences

P. Gnip, S. Kafka, J. Čepický, K. Charvát

WIrelessInfo, Help Service Remote Sensing, Litovel, Czech Republic

Abstract

The system of Precision farming guarantees a detail monitoring of data and information necessary for a successful decision in a crop production. The system is designed for a data collection from several sources. The data are collected by a service company and also directly by farmers. The paper also analyses the economical efficiency on the base of Medlov Farm. Next development is currently running under projects Prezem and AgriSensor.

Key words

GPS, GIS, precision farming, economical analysis, monitoring.

Anotace

Systém hospodaření Prefarm zaručuje detail monitorování dat a informací, které jsou nezbytné pro úspěšné rozhodování v rostlinné výrobě. Systém je určen pro sběr dat z různých zdrojů. Údaje jsou shromažďovány servisní organizací, ale i přímo zemědělci. Článek shrnuje praktické zkušenosti na podniku Medlov. Systém je v současné době dále rozvíjen v projektech Prezem a AgriSensor.

Klíčová slova

GPS, GIS, precizní zemědělství, ekonomická analýza, monitoring.

Material and Methods

A technology of Precision farming guarantees a success of this system on the market. Difficulties of technologies, currently and continually involved in this system, argue against its practical use by farmers. In this case, a service company wants to offer a suitable environment not only for data collection, data processing, but also for the high quality of other information related with a farm management and a crop production. The practical distribution of results to customers helps them to ensure a variable application of results on the field. The most important part of services is a technology of data collection, a system of data processing. Remote sensing, crop scanning and soil sampling for management zones classification mean for farmers or other users a simplification of the difficult operations and recommendations including economic calculations.

A professional service in the market in this area uses a follow tools:

- navigation system GPS with or without Differential GPS,
- environment of Geographic information system (GIS),
- internet as a tool for data transport, data presentation,
- map server technology, web mapping services (wms / raster).

The complex advisory and service system on the market is based on results of field trials in different crops and locations. The data for WEB processing are prepared and stored by service organization and farmers. A central database store data is following:

- soil measuring (EM 38 data, soil type data),
- soil sampling (lab analysis for Phosphor, Potash, Magnesium, Calcium, soil pH.…),
- crop scanning (NDVI data created from satellite or airborne pictures),
- yield data from yield monitor created during harvest,
- other remote sensing data (N-sensor scanning),

- agronomy, field management data (crop rotation, variety, data of applications, weather conditions…..).

The main point of system is to collect different data in the easiest way on a field and on a farm, and then to use the collected data for data processing via web tools.

Open source solution Mapserver. Inside of services it was developed a mobile interface for this Open Source solution and also there were implemented OGC standards (WMS) for utilization of data in distributed system. A connection with another open source systems (GRASS, etc), was established. Current solutions are Internet Mobile Systems, including analytical tools. The most successful and currently used application from the service system is „GIS server for precision farming application with mobile access“. It is focused on increase of agricultural profitability and reduction of fertilizer and chemical bad influence on a surrounding environment.

The system provides analysis as follow:

1. Field area calculation – number of hectares for crop rotation, field cutting (Fig. 1, 2)

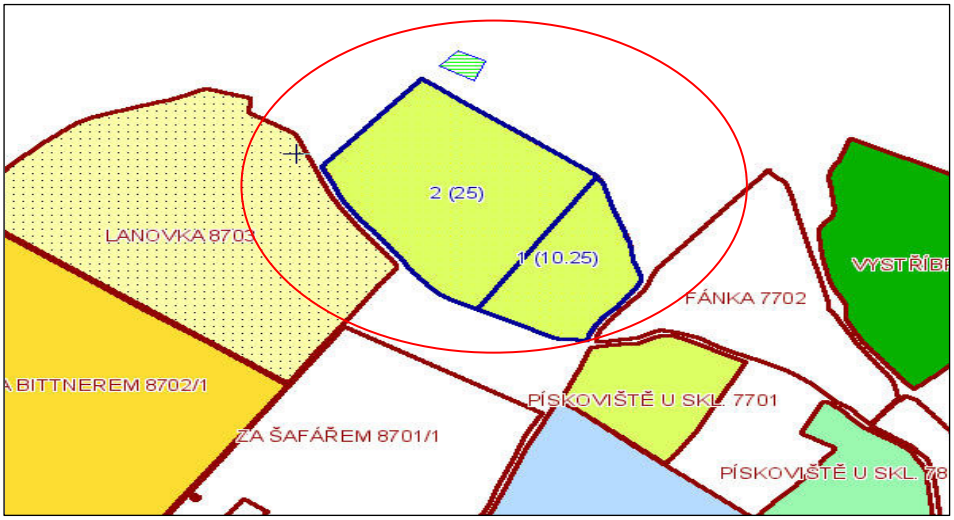


Figure 1.

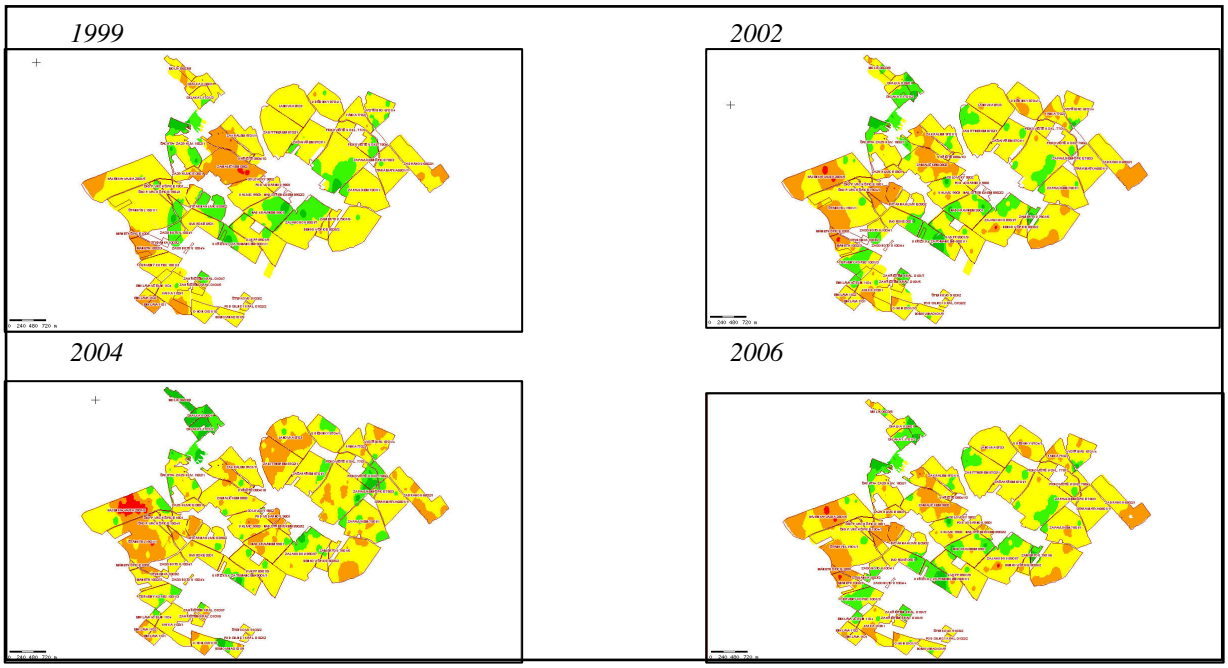


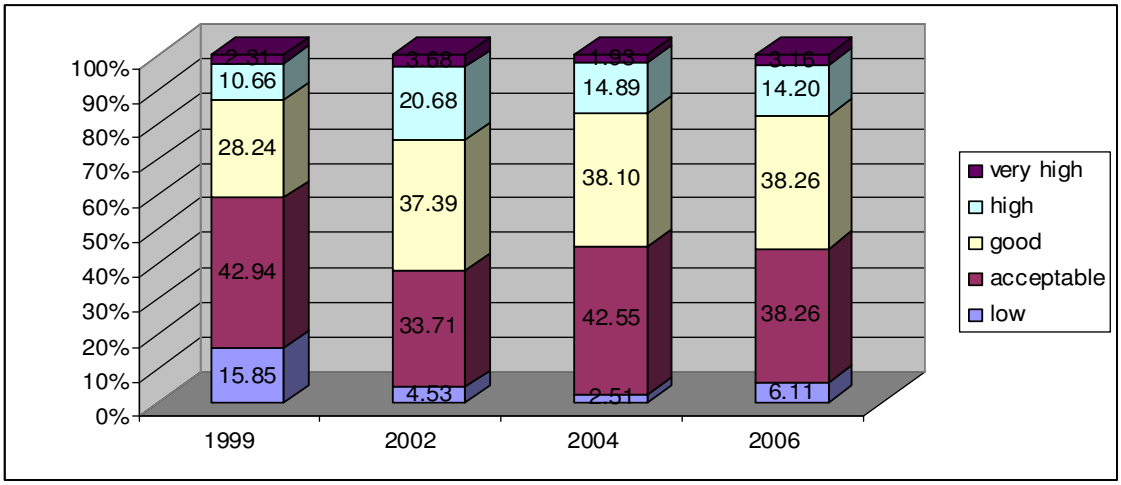
Figure 2.

2. 1999 -2006, Phosphor content in topsoil, % of categories (Graph 1)

4. Variable rate (VRA) and multivariable rate (MVRA) recommendations for basic fertilizer application(P, K, Mg, Ca and Nitrogen). (Fig. 3, Graph 2, 3)

5. History – Traceability (Fig. 4)

Management zones are a result of map analysis to get an optimal amount of each input in crop production founded on variability of soil characteristic and other factors conditioning a crop yield. In this case, the analysis can be done in one time for one field, a group of fields, or a whole farm with the same or similar conditions for the crop planning. In the system a location can be set with a very high resemblance of soil conditions or other elements and monitored characteristic. The GIS in farm management allows us to analyze data and yearly results from the crop production on the farm.



Graph 1.

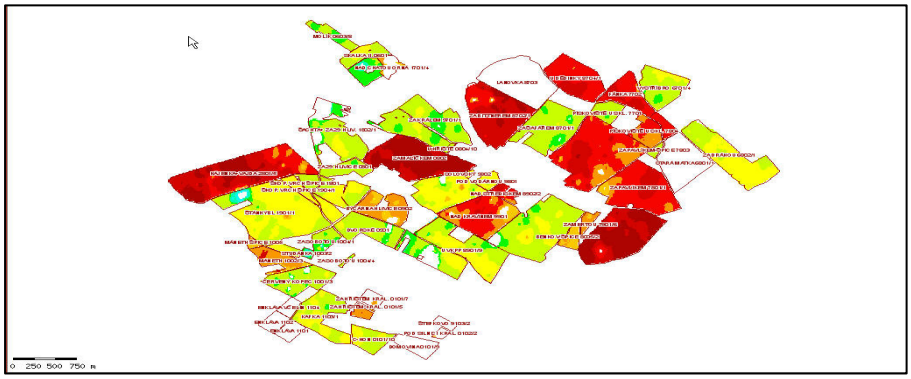
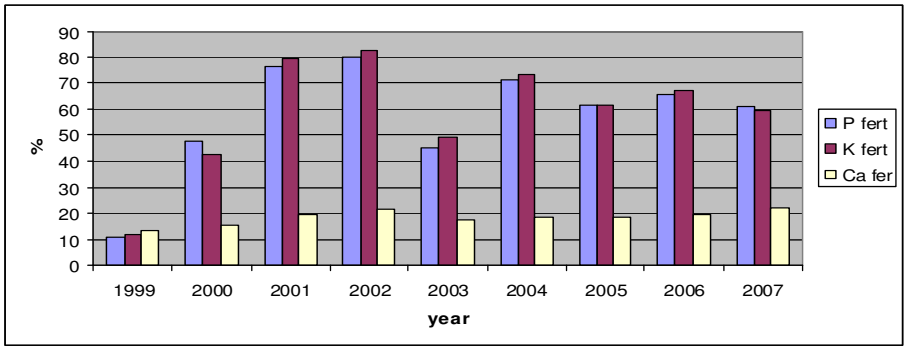
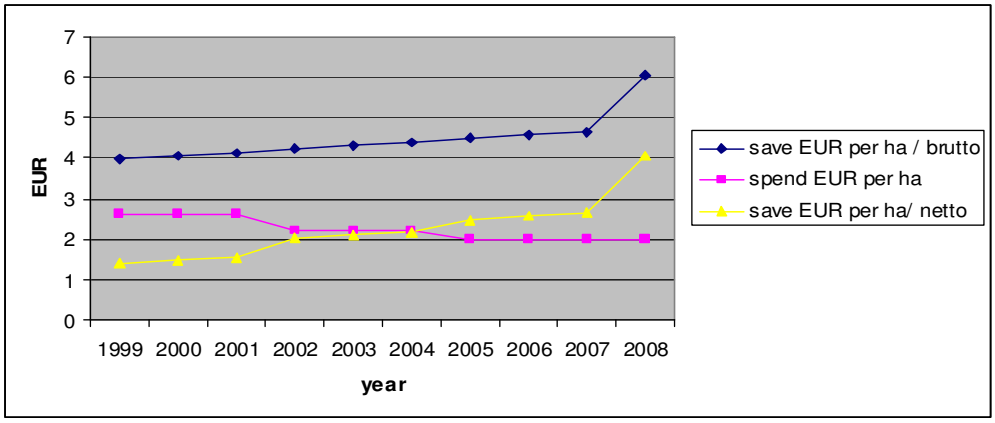


Figure 3.



Graph 2.



Graph 3.

datum	akce	co	detail	množ.	jedn.	poznámka
2007-07-18	Sklizeň-seč	vojteška setá	MORAVA	94.434782608696	q	3.seč
2007-08-02	Plán osevu	pšenice ozimá potravina		0		množení cca 70 ha,zbytek Cubus
2007-08-25	Hnojení	prum. hnojivo	DRASELNA SUL 60%	1.33	q	
2007-08-25	Hnojení	prum. hnojivo	AMOFOS	1.41	q	
2007-09-19	Plán osevu	kukurice na siláž		0		
2007-09-28	Plán osevu	pšenice ozimá potravina		0		
2007-10-10	Setí, sázení	pšenice ozimá krmná	ETELA	2.4	q	Olseed Olomouc
2007-10-10	Setí, sázení	pšenice ozimá potravina	BARROKO	2.1	q	Agro Brno
2007-10-10	Setí, sázení	pšenice ozimá potravina	AKTEUR	2.1	q	Agro Brno
2007-10-10	Setí, sázení	pšenice ozimá potravina	RADUZA	2.1	q	Bzenec
2007-10-11	Setí, sázení	pšenice ozimá potravina	MULAN	2.1	q	běžné pěstování
2007-10-11	Setí, sázení	pšenice ozimá krmná	MLADKA	2.1	q	Mulan,běžné pěstování
2008-01-08	Plán osevu	kukurice na zrno		0		
2008-01-08	Plán osevu	jecmen jarní sladovnický		0		
2008-01-17	Hnojení	prum. hnojivo	LAV	2.5	q	plán na jaro 08
2008-03-02	Hnojení	prum. hnojivo	DUSIČNAN AMONNÝ (34%N)	100	kg	1.regenerační
2008-03-10	Plán osevu	hrách		0		
2008-03-10	Plán osevu	mák		0		
2008-04-10	Ochrana	stimulátor rustu	CYCOCEL 750 SL	1.5	l	TM N Fenol Mix
2008-04-10	Ochrana	stimulátor rustu	N-FENOL-MIX	0.2	l	
2008-05-13	Ochrana	fungicid	JUWEL TOP	0.8	l	s Trendem
2008-05-13	Ochrana	fungicid	ALERT S	0.6	l	TM Talius
2008-05-13	Ochrana	fungicid	TALIUS	0.1	l	TM Alert

Figure 4.

How to start?

A system of adoption and running, described below, was built on the farm by an Advisor Company including a data collection and a field application, so the farmer does not have to be trained on different technique and equipment or a special knowledge. Every step and result is translated to agronomic or farm management language. The system was adopted in the first 3 years periods, than modified in the next 3 years, periodically repeated so far.

First year

1.1. Calculation of system adoption

- Field boundary mapping by GPS. First of all, we have to make a field geographical description in Geographic information system (GIS). We map by GPS a field boundary on the farm and clarify field area in GIS. Foundation of field database in GIS.
- Management zone definition, by analysis of satellite imagery. This is the first data processing and calculation to describe variability of each field.
- Soil sample grid setting - calculating of soil sample control point for soil sampling.
- Agronomic yield data description
- Price calculation of system adoption

1.2. Data collection

- Soil sampling and analysis of samples for phosphorus, potash, magnesium, calcium, soil pH and soil granularity.
- Map analysis of heterogeneity of each monitored element and soil characteristic
- Editing agronomical data to GIS
- Recommendation for variable rate application of lime, phosphor, potash or

magnesium fertilizer independently according to needs.

1.3 Variable rate application of fertilizer
- Variable rate application of P, K, Mg and lime fertilizer

Second year

2.1. Data collection
- Crop monitoring for Nitrogen variable rate application (winter wheat and barley only)
- Yield prediction analysis
- Editing agronomical data to GIS – crop rotation
- Recommendation for variable rate application of lime, phosphorus, potash or magnesium fertilizer independently according to needs.

2.2. Variable rate application of Nitrogen fertilizer (winter wheat and barley only)
- Production and quality variable rate of N fertilizer
- Variable rate application of P, K, Mg and lime fertilizer

Third year

3.1 Data collection
- Crop monitoring for Nitrogen variable rate application (winter wheat and barley only)
- Yield prediction analysis
- Editing agronomical data to GIS – crop rotation
- Recommendation for variable rate application of lime, phosphorus, potash or magnesium fertilizer independently according to needs.

3.2 Variable rate application of Nitrogen fertilizer (winter wheat and barley only)
- Production and quality variable rate of N fertilizer
- Variable rate application of P, K, Mg and lime fertilizer

1. three years period										
Fertilizer	% of farm area	min. rate in kg/ha	max rate in kg/ha	averidge in kg/ha	save in %	save in kg/ha	price for 1 kg of fert	EUR save per ha	extra cost in EUR/ha	profit in EUR/ha
P	136	80	240	180	15	27	0,36	13,22		
K	134	120	350	200	15	30	0,24	9,65		
Ca	47	500	2000	1400	35	490	0,032	7,37		
Total								30,24	14	16,24
Fertilizer	% of farm area	min. rate in kg/ha	max rate in kg/ha	averidge in kg/ha	save in %	save in kg/ha	price for 1 kg of fert	EUR save per ha	extra cost in EUR/ha	profit in EUR/ha
N	21	210	250	240	8	19,2	0,12	2,30	4	
N	19	220	250	240	7	16,8	0,13	2,18	4	
N	24	200	240	230	10	23	0,15	3,45	4	
Total								7,94	12,00	-4,06

Table 2: Cost investment table for 3 x three period in fertilizer saving.

2. three years period										
Fertilizer	% of farm area	min. rate in kg/ha	max rate in kg/ha	averidge in kg/ha	save in %	save in kg/ha	price for 1 kg of fert	EUR save per ha	extra cost in EUR/ha	profit in EUR/ha
P	195	80	240	180	13	23,4	0,37	16,88		
K	204	120	350	200	12	24	0,26	12,73		
Ca	57	500	2000	1350	25	337,5	0,033	6,35		
Total								35,96	9	26,96

Fertilizer	% of farm area	min. rate in kg/ha	max rate in kg/ha	averidge in kg/ha	save in %	save in kg/ha	price for 1 kg of fert	EUR save per ha	extra cost in EUR/ha	profit in EUR/ha
N	22	230	260	245	5	12,25	0,12	1,47	4	
N	21	235	260	250	4	10	0,13	1,30	4	
N	19	230	270	250	8	20	0,15	3,00	4	
Total								5,77	12,00	-6,23

Table 3: Cost investment table for 3 x three period in fertilizer saving.

3. three years period										
Fertilizer	% of farm area	min. rate in kg/ha	max rate in kg/ha	averidge in kg/ha	save in %	save in kg/ha	price for 1 kg of fert	EUR save per ha	extra cost in EUR/ha	profit in EUR/ha
P	187	80	240	180	15	27	0,39	19,69		
K	189	120	350	200	16	32	0,48	29,03		
Ca	61	500	2000	1500	30	450	0,023	6,31		
Total								55,04	9	46,04
Fertilizer	% of farm area	min. rate in kg/ha	max rate in kg/ha	averidge in kg/ha	save in %	save in kg/ha	price for 1 kg of fert	EUR save per ha	extra cost in EUR/ha	profit in EUR/ha
N	22	250	300	270	6	16,2	0,12	1,94	4	
N	21	250	300	270	7	18,9	0,14	2,65	4	
N	24	250	300	270	7	18,9	0,15	2,84	4	
Total								7,43	12	-4,58

Table 4: Cost investment table for 3 x three period in fertilizer saving.

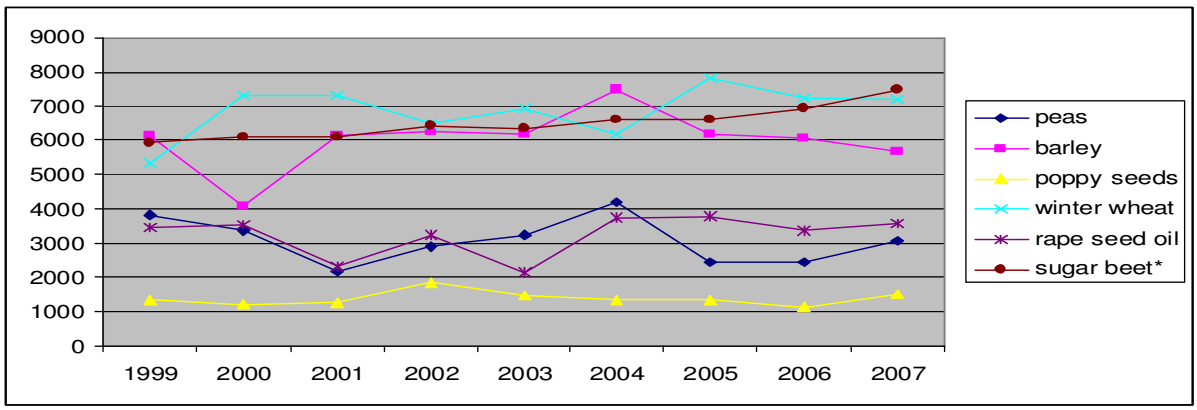
.

The distribution of N fertilize is focused on the yield and the quality of yield, so saving is not on the first place, however, farmer saved also the same fertilizer in the application.

What about yield? (Graph 4)

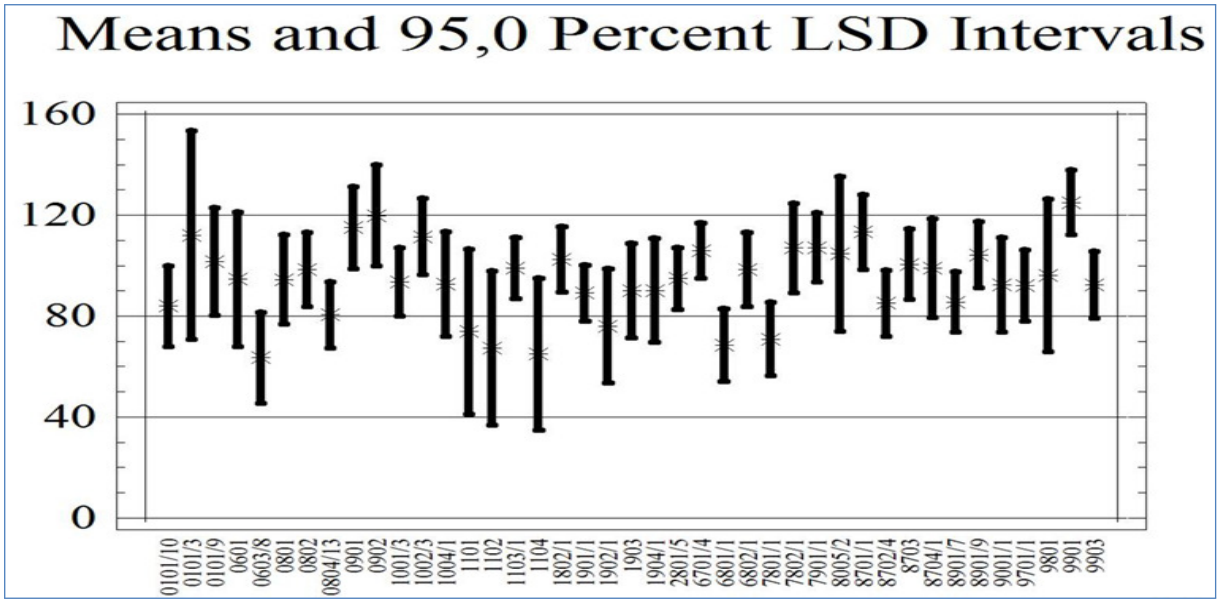
What next?

Variability between each field showed up during a 3 three years period (Graph 5)..



*yield of sugar beet is recalculate on 16 % of sugar contain and divided by 10

Graph 4.



Graph 5.

X = % of yield index in the time, y= fields

According to above mentioned figure, variable rate application and the fertilizer saving does not cause yield homogeneity of each crop, but Theky show up very clear which field is more productive and which less. The farm management continues in next decisions with ideas redistribute more a digger amount of fertilizer on fields with a higher productivity and to change the crop rotation system according to the produktivity of fields.

Discusion

The farm management forms collect necessary tasks which contain the ownership and the renting plan management for soil, the monitoring of seedling plan and plant production for each field. In the European context, one of the most important results is to explain simply the data of results to a final user, and to train him/her, how to work with the system, and what is the benefit from?

First of all, we have to pay attention for the data collection system which is dependent on accuracy, density and repetition in time. An easy work with data in the central database is one of the most important characteristic of the system. The main aim was to prepare a solution accessible from an office and also from a field. Other advantages of the system are following:

- transparent results of data analysis (Maps and tables),
- easy data access (map view, tabs, statistic, new notes),
- multifunction level of use on a farm or company (chairman, lawyer, crop manager, driver),
- traceability – complete notes (crop plan, fertilizer using….),
- possibility of another database connection (WMS, cadastral maps…).

The Precision farming is a system focused on keeping a detail record in farming when each task of operation is recorded to the field as the smallest element, but each task is captured to a specific location (a part of the field). The farmer can achieve a lower cost or to increase a yield of the crop by using this technology. The Precision farming manages a very precise application of chemicals and fertilizers according to really needs on the field, and by these methods the farmer can decrease also the bad influence of use of chemicals in farming, which is very important for the surrounding environment.

The collaborative environment provides a possible area for farmers, EO data providers and other organizations to communicate, share and exchange information. Also, any recent changes can be notified to the coverage and portfolio of related products and services.

The implementation of Web based technologies and OGC is compliant to WMS and WFS to assist the

user in describing the area of interest and in retrieving appropriate product details from the catalogue.

Mainly methodologies, which are based on analyses of satellite or airborne imagery, offer possibilities to start with the precision farming without a small initial investment on the side of farmers. Practically, before the service company start to present collected data and results to farmers, the data must be taken and treated in the central database.

Corresponding author:
Ing Pavel Gnip
WirelessInfo
Cholinská 1048/19, 784 01 Litovel, Czech Republic
e-mail: gnip@wirelessinfo.cz

References

[1] Charvat at all, Precision farming trough Internet and mobile communication, GIS Europe

[2] Charvat, K. at all Premathmod, Third International conference Geospatial information in Agriculture and Forestry, Denver, USA 5.-6.11.2001

[3] Charvat at all. Wireless Communication in the Agri/Food-Industry, Mobile Europe March

[4] Charvat at all E-content agriculture applications using wireless communications ITT Baltic April 2002

[5] Charvat, K. – Gnip, P: GIS server for precision farming application with mobile acces, abstrakt, prezentace IST – 2000-28177 PREMATHMOD, workshop Mobile Information System in Agriculture2002, Keszthely, Maďarsko,18.10.2002, CD

[6] Gnip, P. PREFARM – System of precision farming in Czech Republic.