Implementation of Precision Agriculture Technology at Russian State Agrarian University – Moscow Timiryazev Agricultural Academy

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Turkey, Side, 2014

Precision Agriculture
- Idea & Concept

- Precision Agriculture
  - Sustainable agriculture
  - Connected problems of Economy, Community and Environment

Precision Agriculture
- Ideas & Modern Techniques Use

Main ideas

Field mapping - detailed soil maps of fields

- Crop &Biomass mapping
- Crop management – use of fertilizers and pesticides according to the soil properties and crop needs

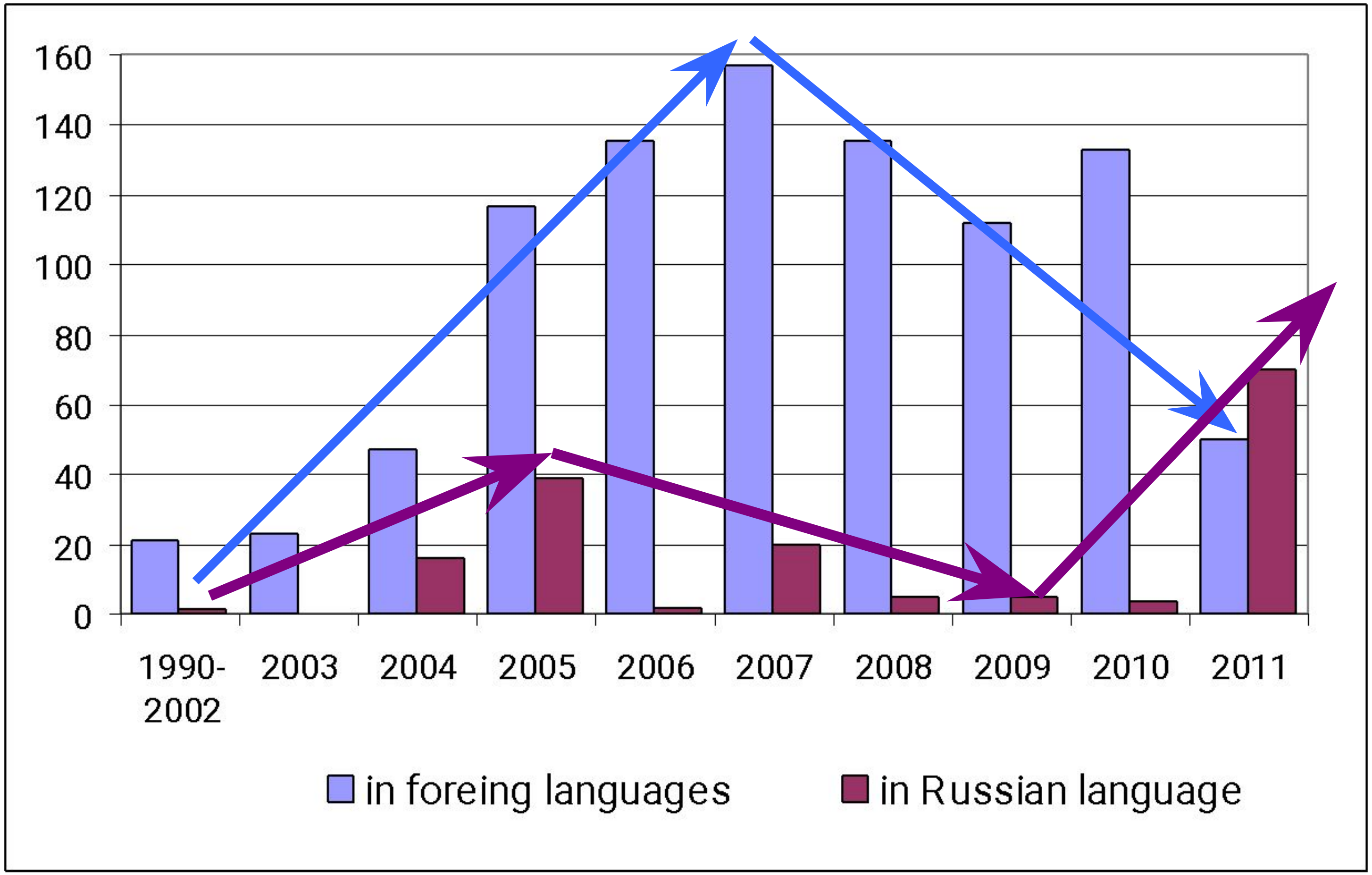
Techniques

- global positioning systems (GPS); sampling machine; soil sensors
- remote sensing; NDVI-sensors; crop-meters
- variable rate applicators, spreaders and sprayers

Precision Agriculture – Actual History

- The 1990th – start of precision agriculture implementations in the world;
- The 2000th – wide spreading of this technology in the world: Europe, North America, Asia
- The first steps in Russia, Ukraine and Kazakhstan – 2005-2007

The number of articles on Precision Agriculture in World press*



* - according to the Central Russian Agrarian Library

Modern situation in Russia

- **The main centers of Precision Agriculture in Russia**
  - AgroPhysics Soil Institute, St.-Petersburg
  - LLC “Eurotechnika”, Samara
  - Russian State Agrarian University – Moscow Timiryazev Agricultural Academy

Precision Agriculture at Russian State Agrarian University – MTAA

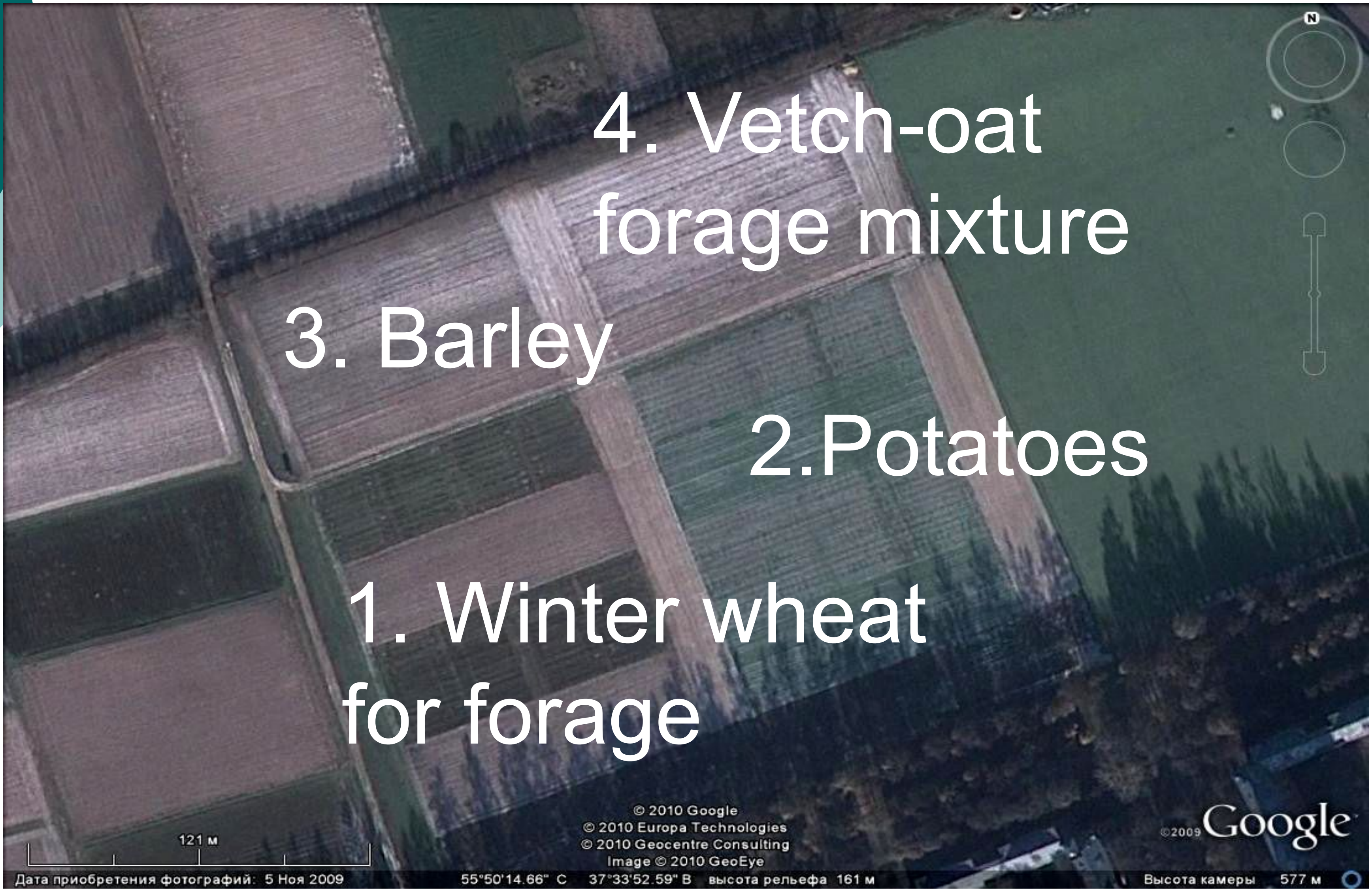
- **2007** – creation of Scientific Center of Precision Agriculture
- **2008** – beginning of field experiment on adaptation of Precision Agriculture technologies

Technical device and equipment

- Navigation system
  - GPS; Trimble
- Parallel guidance system Autopilot
- Soil-tilling and seed-drilling devi
  - AMAZONE
- Fertilizers spreader and pesticid sprayers with dosing device
  - AMAZONE
- NDVI-testers and sensors
  - N-tester
  - GreenSeeker
  - N-sensor

Scientific Center of Precision Agriculture at Russian State Agrarian University - MTAA

Experimental field (6 ha)



Precision and Traditional Agriculture Plots (Factor A)

Precision

Traditional

Soil Treatment (Factor B)

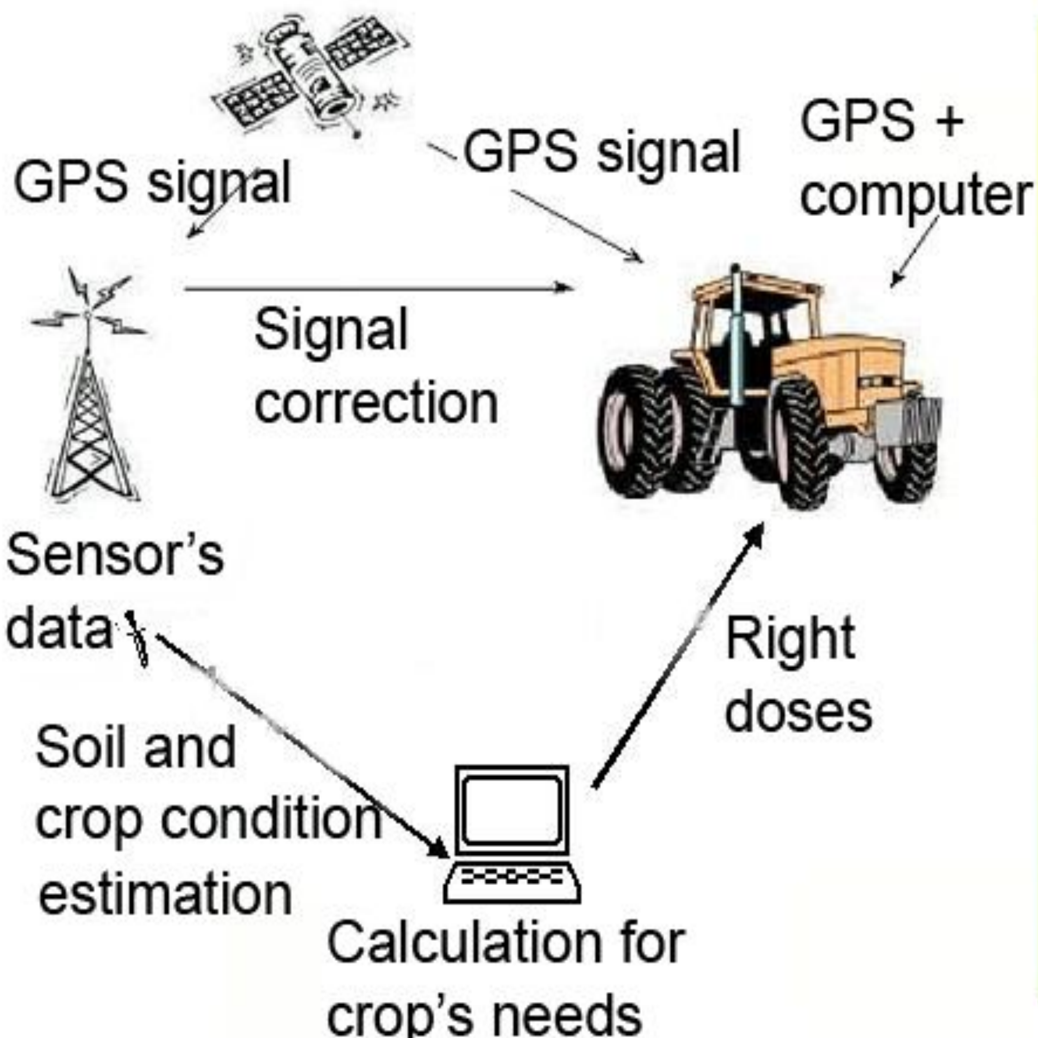
No-till:
sod seeder AMAZONE D-3001

Next steps

- Recommended treatments for the certain areas on the basis of completed maps and data of soil and crop conditions

- Recommendations are downloaded to the board computer of tractor and machine

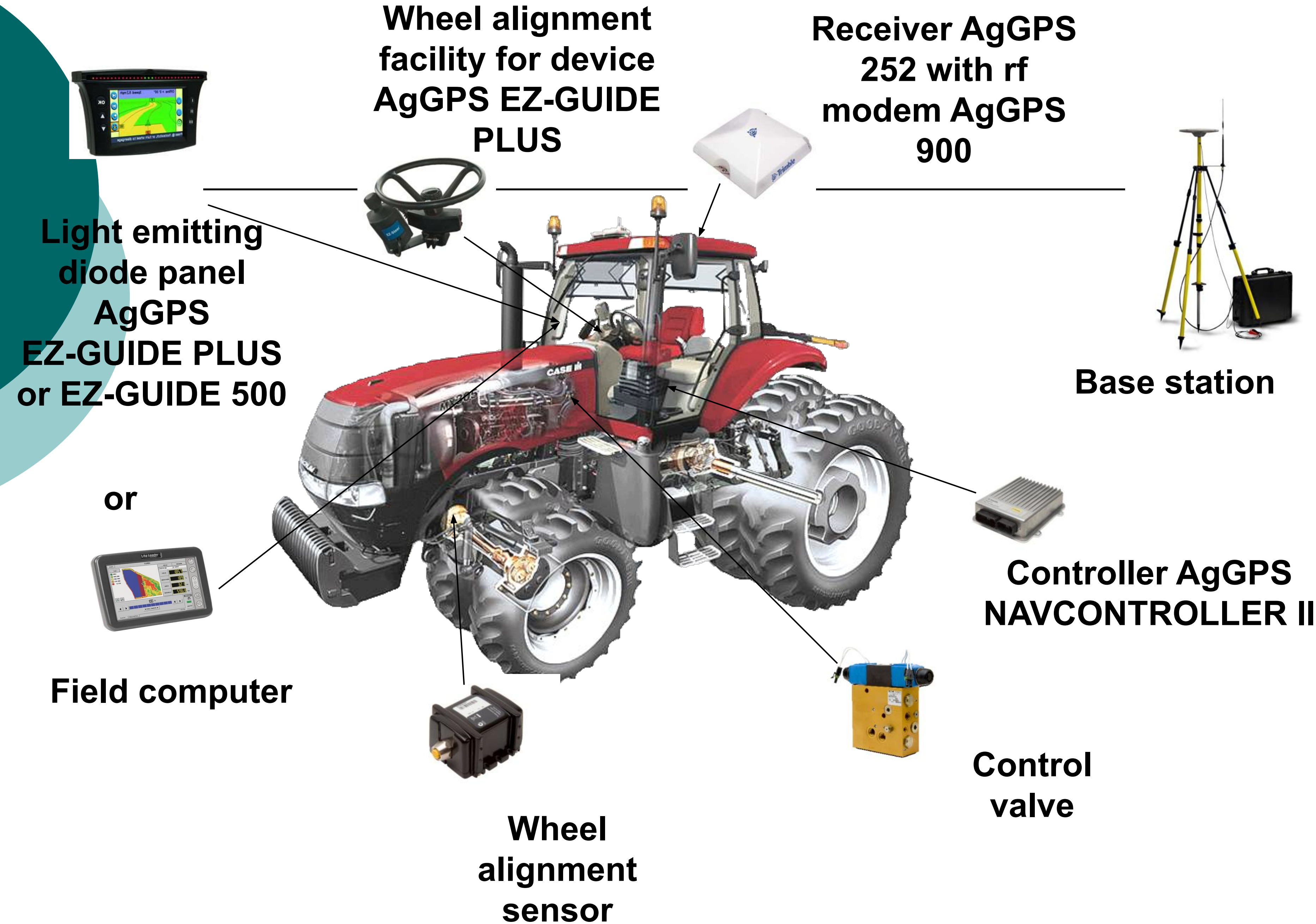
Tractor's task



First step;
field drive by received directory

Second step:
applying the right doses
on the right spot
on a small scale

Navigation System at operator's cab


Wheel alignment facility for device AgGPS EZ-GUIDE PLUS
Receiver AgGPS 252 with rf modem AgGPS 900
Light emitting diode panel AgGPS EZ-GUIDE PLUS or EZ-GUIDE 500
or
Field computer
Base station
Controller AgGPS NAVCONTROLLER II
Control valve
Wheel alignment sensor

Benefits of Autopilot system for Precision Agriculture

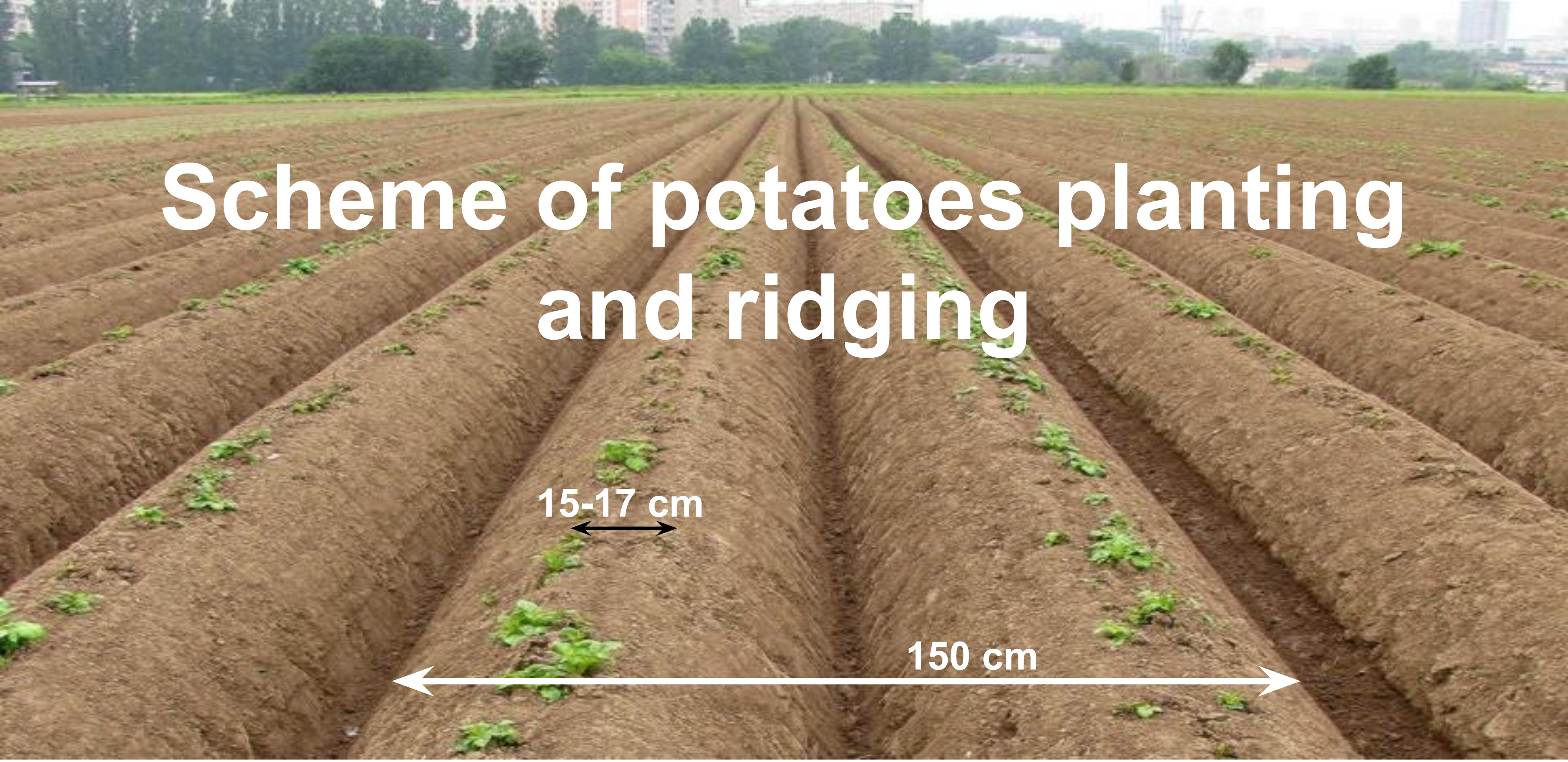
- Tractor operator works hard, he can’t work for a long time without breaks, he will become tired and make faults
- Autopilot system helps to do your routine task without faults
- The results of field work will be excellent: no gaps, no blank-spots, no weeds, no waste of yield

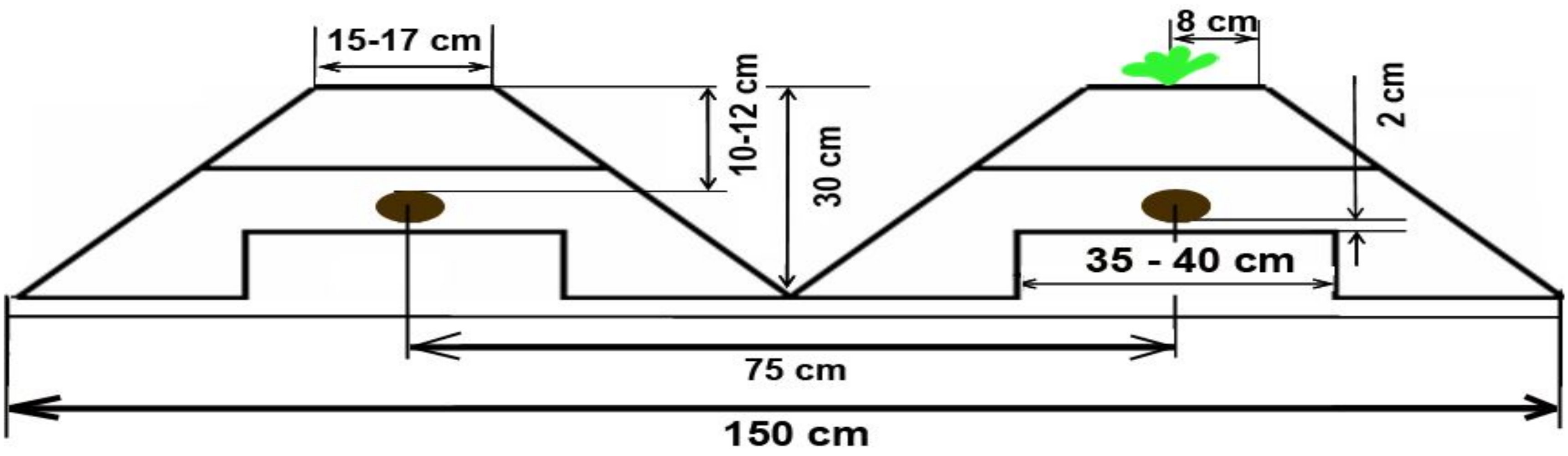
INTER ROW DISTANCE AND DEVIATION FROM INTER ROW DISTANCE OF SAWING MACHINES (2009-2013)*

* - inter row distance for D-9-30 – 12,0 cm, DMS – 18,8 cm

Crop	Sawing machine D-9-30 (ploughing)				DMC (minimum soil treatment)	
	marker		autopilot		autopilot	
	inter row distance, cm	deviation, cm	inter row distance, cm	deviation, cm	inter row distance, cm	deviation, cm
Vetch-oat mixture	-	-	13,3	+1,3	19,1	+0,3
Winter wheat	16,8	+4,8	13,8	+1,8	19,2	+0,4
Barley	15,2	+3,2	13,4	+1,4	18,7	-0,1

Scheme of potatoes planting and ridging





INTER ROW DISTANCE AND POSITION OF POTATOES PLANTS ON THE RIDGES IN CONNECTION WITH DIFFERENT PLANTING TECHNOLOGIES

*- inter row distance – 75 cm

Year	Inter row distance, cm		Position on the ridge, cm	
	marker	autopilot	marker	autopilot
2009	65…81	75 +_ 2,8	from center +_6…10	from center +2,8
2010	60…80	75 +_ 3,3	from center +_5…15	from center +3,3
2011	70…90	75 +_ 2,5	from center +_5…15	from center +1,5
2012	73…88	75 +_ 2,5	from center +_2…13	from center +1,8
2013	70…85	75 +_ 3,1	from center +_5…10	from center +2,3
In average	67…85	75 +_ 2,8	from center +_5…13	from center +2,8

GreenSeeker –

for crops and for weeds

N-sensor ALS® Yara

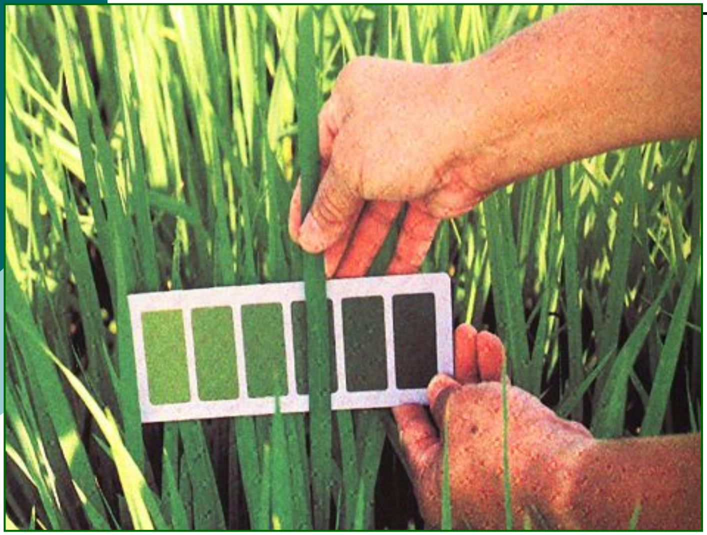
N-Sensor ALS is mounted on a tractor's canopy. This system records light reflection of crops, calculates fertilisation recommendations and then varies the doses of fertilizer spreading

Sensors of Nitrogen in crops

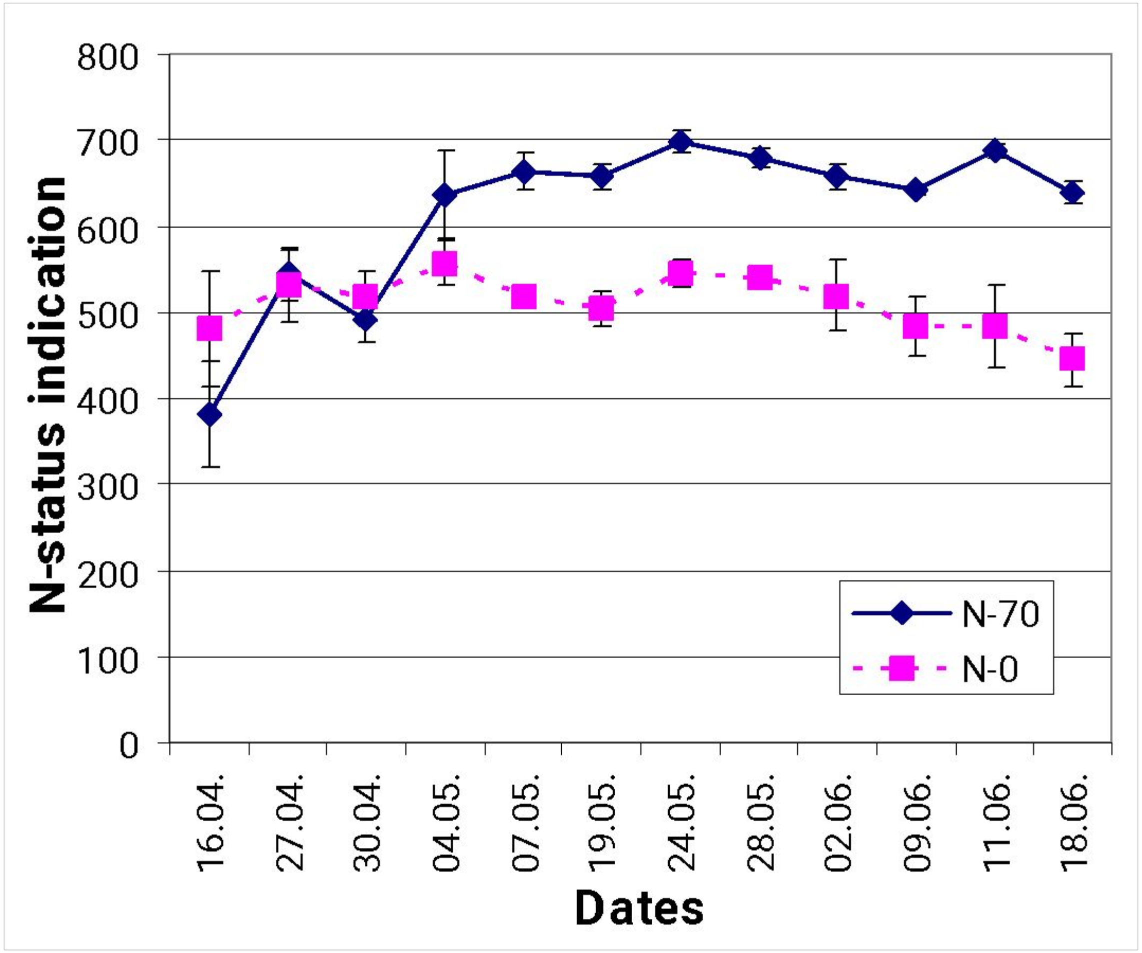
Different aims – different equipment

- N-tester® Yara
- GreenSeeker® RT220
- N-sensor ALS® Yara

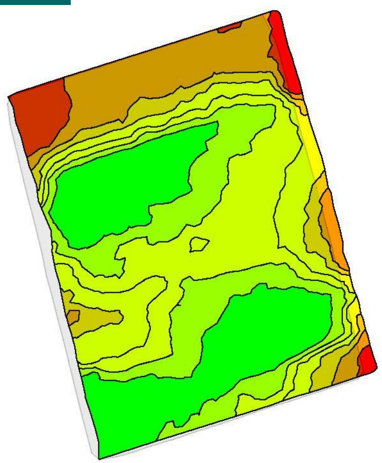
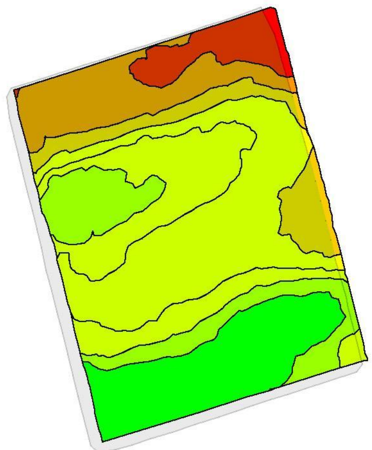
N-tester on Winter Wheat



Nitrogen balance under different N doses



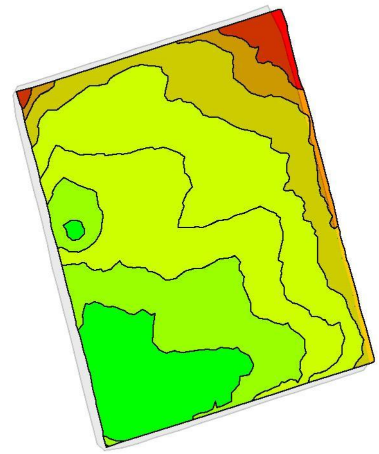
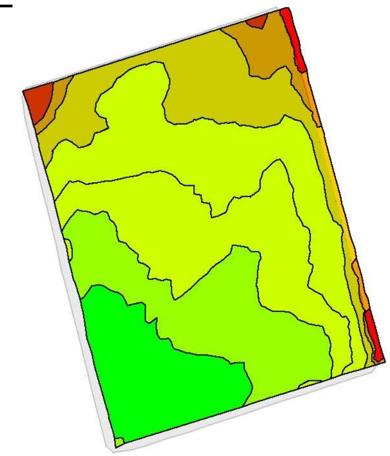
Maps of wheat biomass - NDVI measurement by GreenSeeker

26 April 3 May

Beginning of season:

Difference between technologies

7 June 24 June

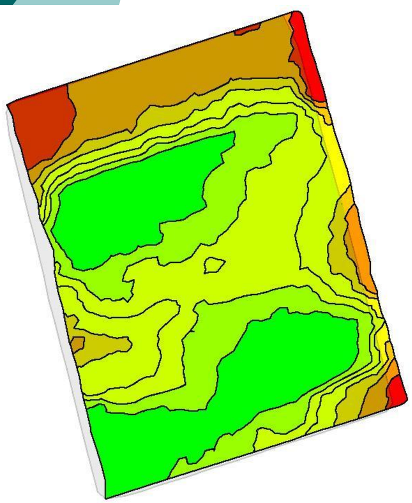
The second half of season:

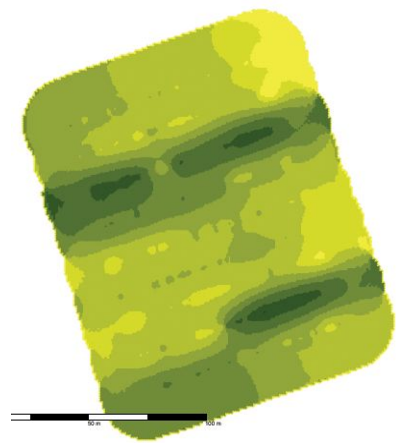
Difference between field segments

Two NDVI-measuring systems comparison (GreenSeeker – N-sensor)

Different width of working beam

1–1,5 m 12–15 m

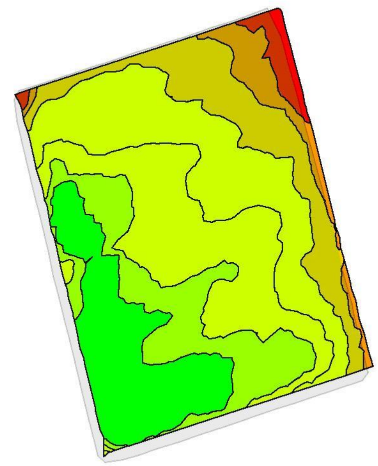


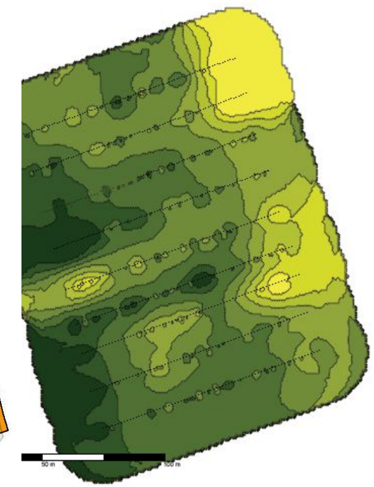


GreenSeeker N-sensor

26-28 April

1–1,5 m 12–15 m



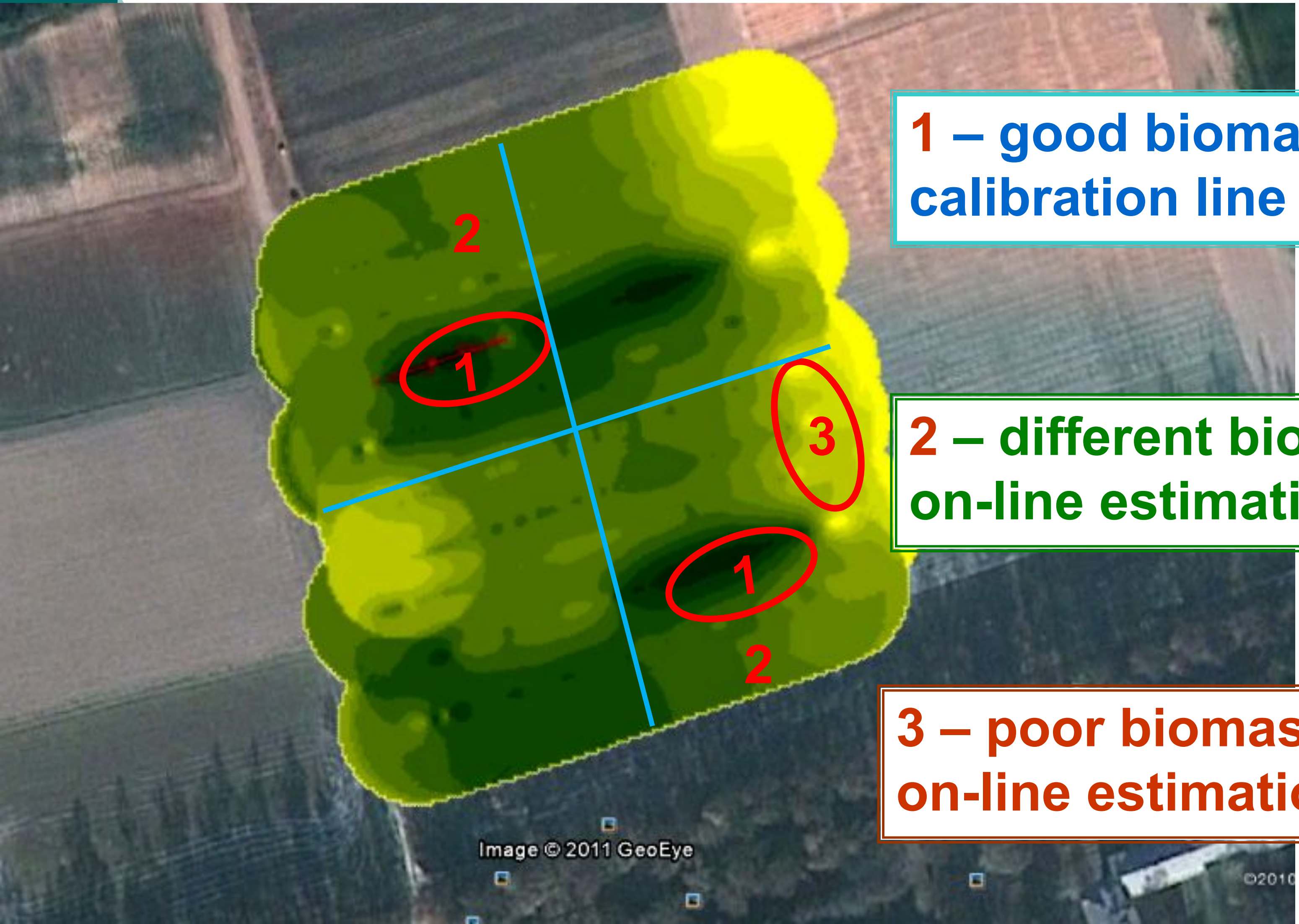


GreenSeeker N-sensor

1-2 June

Independently on NDVI-measure system maps the same data are similar

Wheat biomass map at tillering stage (EC 30 – 36)

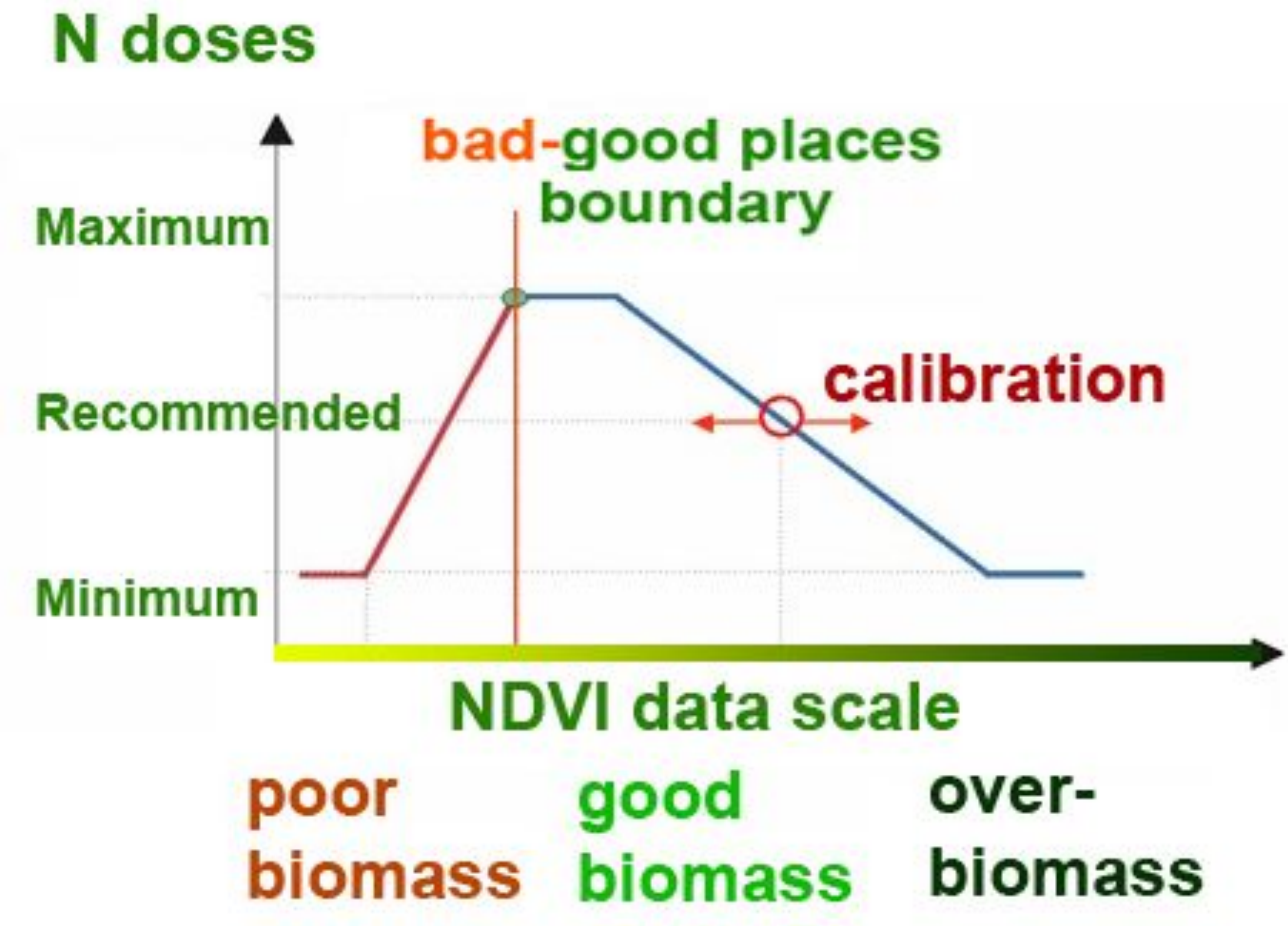


1 – good biomass => calibration line

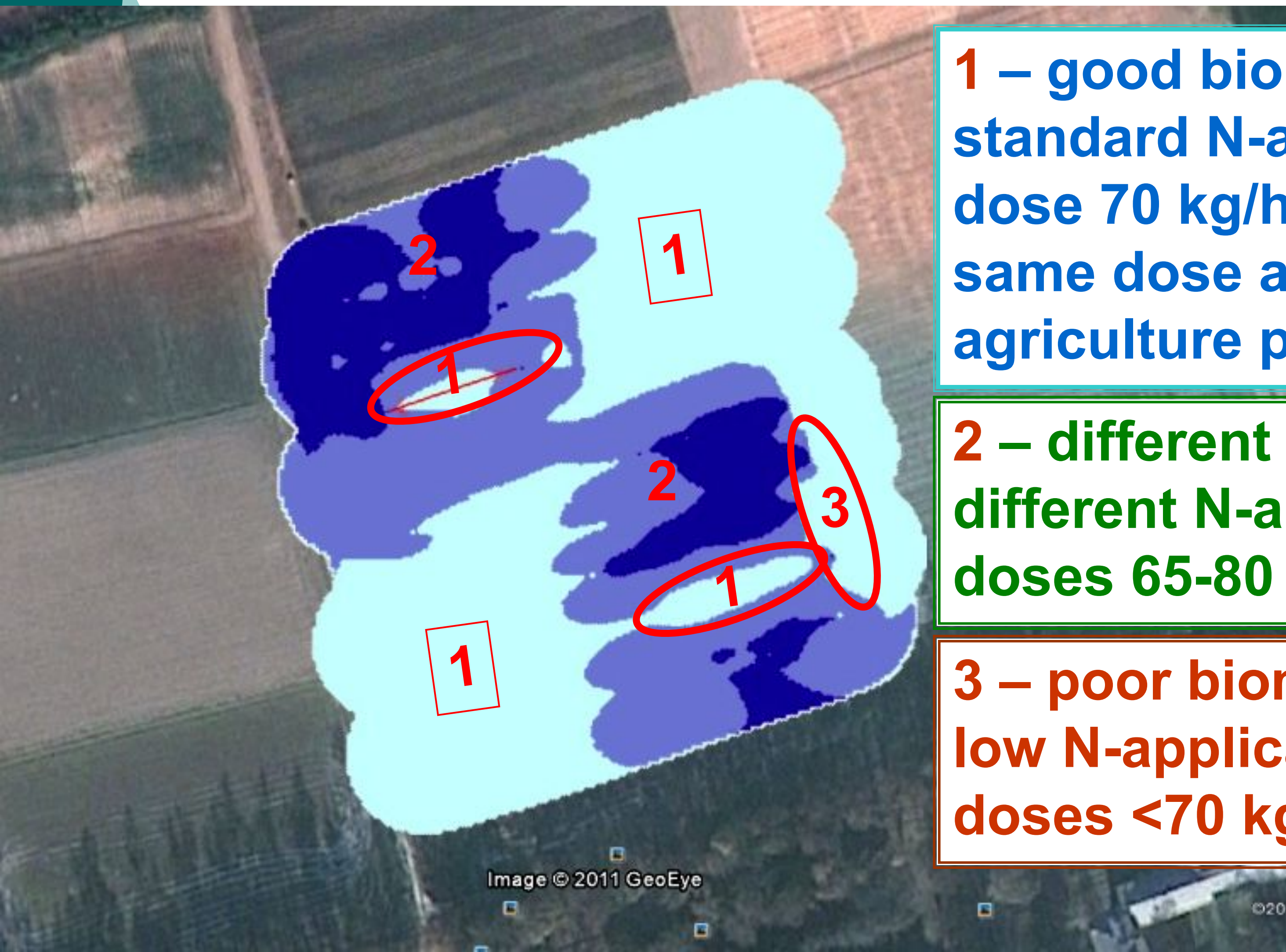
2 – different biomass => on-line estimation

3 – poor biomass => on-line estimation

N application at tillering stage (EC 30 – 36)



On-line N-application prescription, application map

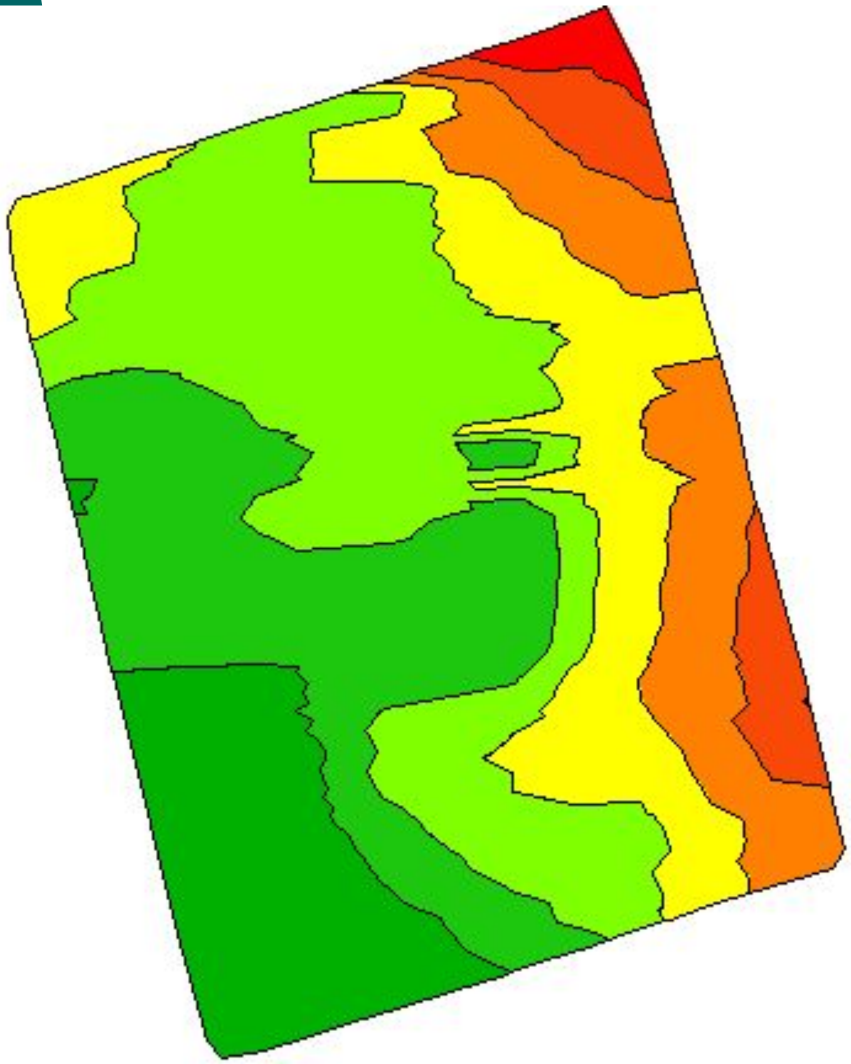


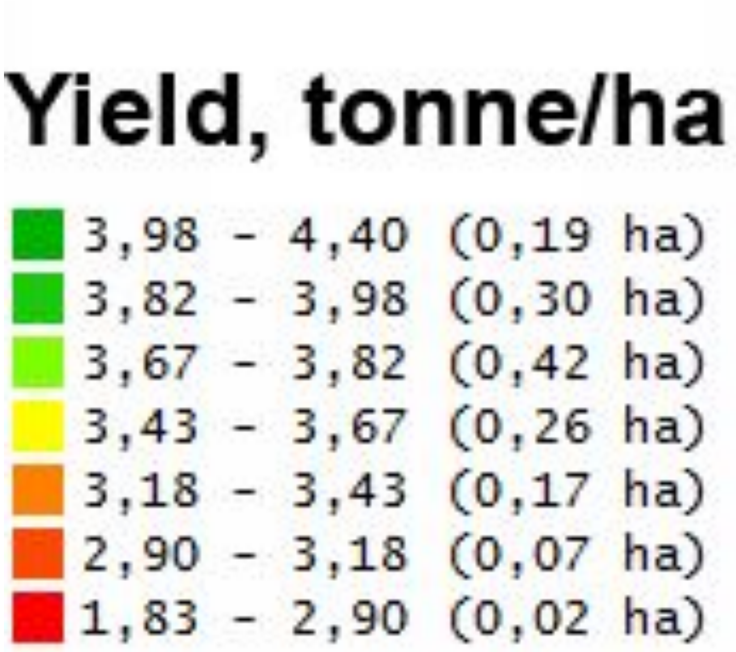
1 – good biomass => standard N-application, dose 70 kg/ha and the same dose at traditional agriculture plots – [1]

2 – different biomass => different N-application, doses 65-80 kg/ha

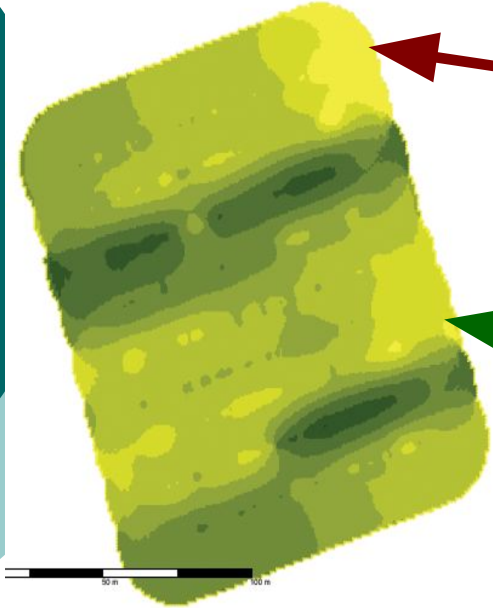
3 – poor biomass => low N-application, doses <70 kg/ha

Wheat Yield Map





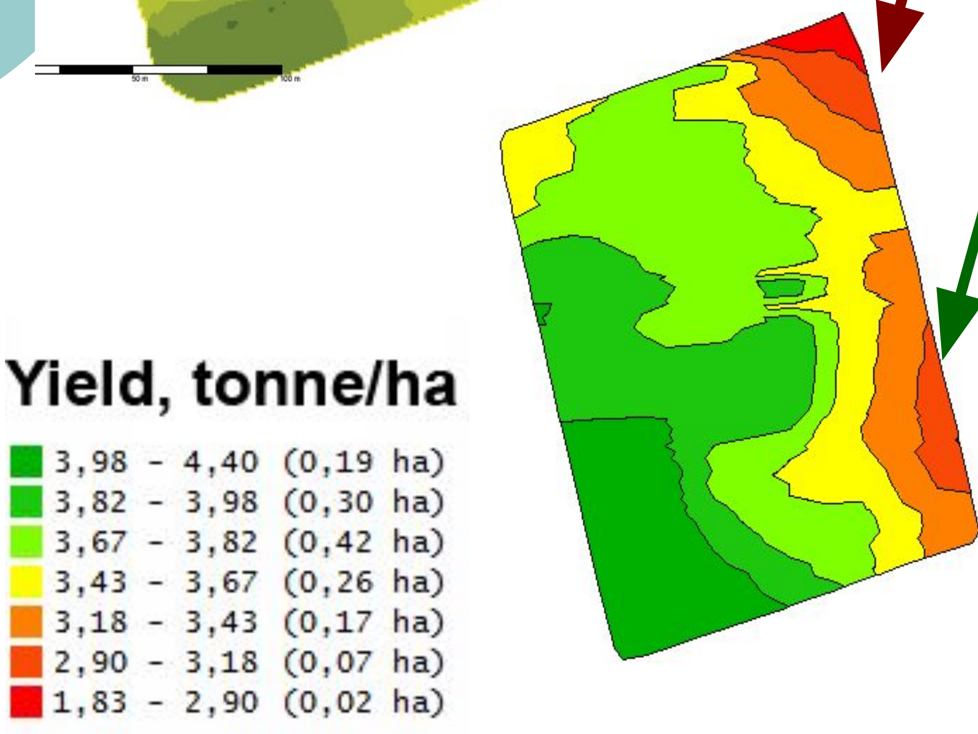
Biomass and Yield Maps



Poor biomass, low yield,
application N 70 kg/ha

Poor boimass, low yield,
application N < 70 kg/ha

=> Profitability of N application is different



DOZES OF HERBIZIDES RELATING NDVI PARAMETERS FOR WINTER WHEAT PLANTS

NDVI	Dozes of herbicides, mg^{-ha}	
	Differential applying	Total applying
0,25…0.35	190	190
0,25…0,45	160	
0,45…0,55	130	

APPLYING DOZES OF HERBICIDE COWBOY RELATING NDI PARAMETERS

NDVI	Dozes of herbicides, l^{-ha}		
	Increasing	Decreasing	Total consumption
> 0,30	290	410	
0,30…0,35	314	386	
0,35…0,40	338	362	
0,40…0,45	362	338	
0,45…0,50	386	314	410
0,50…0,55	410	290	

First step – soil mapping

- Points of soil samples taking (1,4 ha) to demonstrate variability of NPK content

Map of soil fertility was made before beginning of crop-rotation

YIELD OF THE CROPS RELATING THE VARIANTS OF SOIL TREATMENT (2009-2013)

Crop	Technology	Soil treatment	Yield, t-ha					
			2009	2010	2011	2012	2013	in average
Vetch-oat mixture	precision	ploughing	21,3	20,5	10,8	20,6	12,1	17,1
		“null”	25,0	19,4	9,4	27,3	14,3	19,1
Winter wheat	precision	ploughing	4,23	4,63	3,70	6,31	6,12	5,00
		“null”	5,09	4,11	3,55	6,15	5,87	4,95
	traditional	ploughing	4,28	4,50	3,65	6,52	5,80	4,95
		“null”	5,18	3,85	3,53	6,35	5,62	4,91
Potatoes	precision	ploughing	41,5	31,7	24,4	19,9	28,6	27,2
		minimal	37,5	20,7	23,2	18,3	25,9	25,1
	traditional	ploughing	38,9	24,2	24,0	19,1	27,6	26,8
		minimal	36,3	19,2	22,9	17,5	26,2	24,4
Barley	precision	ploughing	5,40	3,35	2,64	4,33	5,18	4,18
		minimal	5,78	2,99	2,83	4,20	5,00	4,16
	traditional	ploughing	5,0	3,47	2,76	4,26	5,20	4,16
		minimal	5,39	3,06	3,08	4,18	4,95	4,13

Conclusions

- The researches of five-year duration demonstrate the preference of precision agricultural technology in planting cereal crops and potatoes in the Central Region of Russia at loamy-sandy sod-podzol soils.
- The following elements and methods of precision agriculture were examined: soil characteristics mapping, autopilot for sowing and crop-tending operations, green biomass mapping with N-sensors.
- The using of optical N-sensors is effective for application of different doses of fertilizers and improving yield quality.
- Autopilot system for sowing and crop-tending operations is much effective as it allows avoiding the over-sowing and gaps.

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Thank You for Your attention!

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