



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

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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

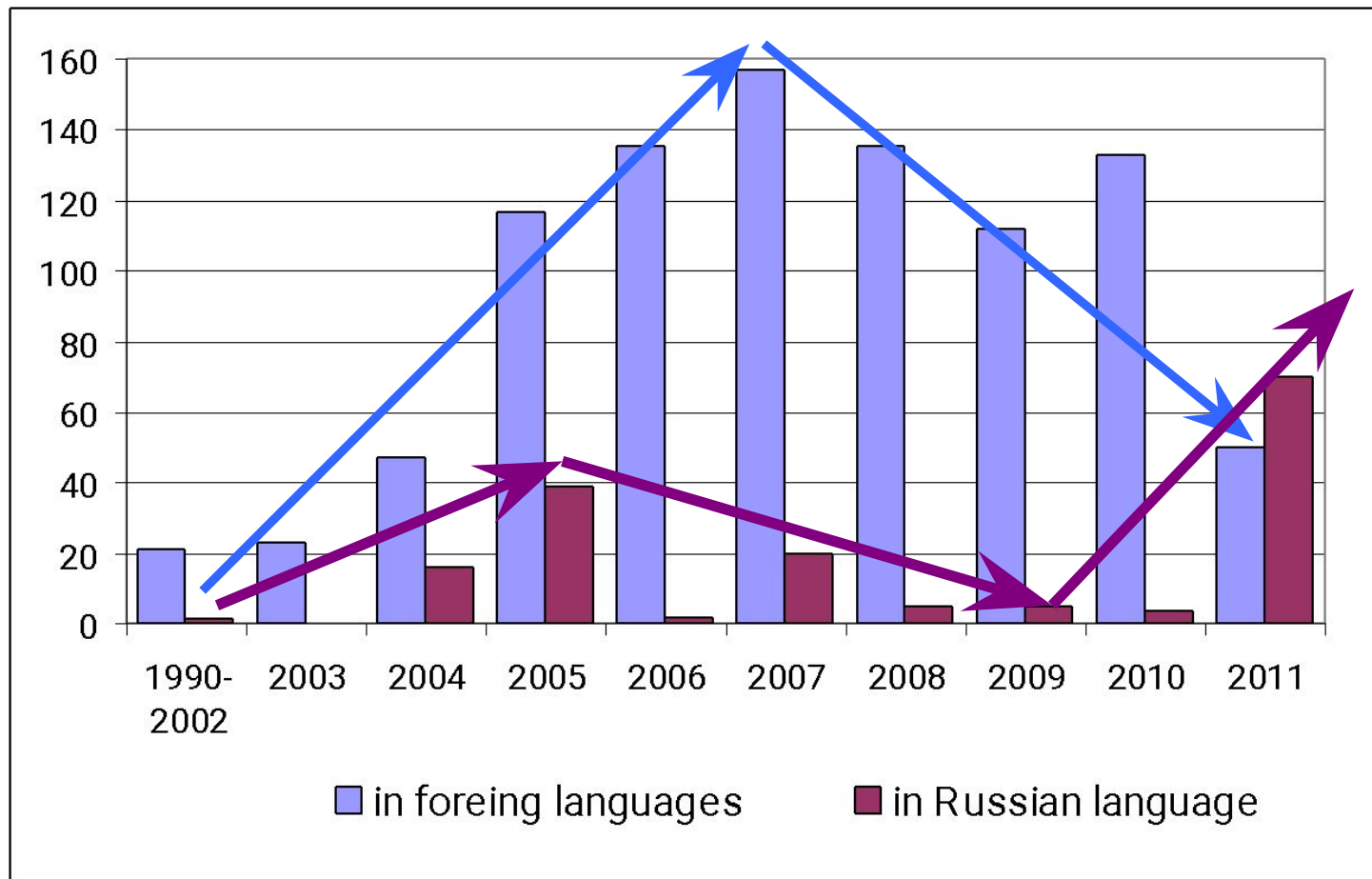
○ **Techniques**

- 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 device**
AMAZONE
- **Fertilizers spreader and pesticide 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)

4. Vetch-oat
forage mixture

3. Barley

2. Potatoes

1. Winter wheat
for forage



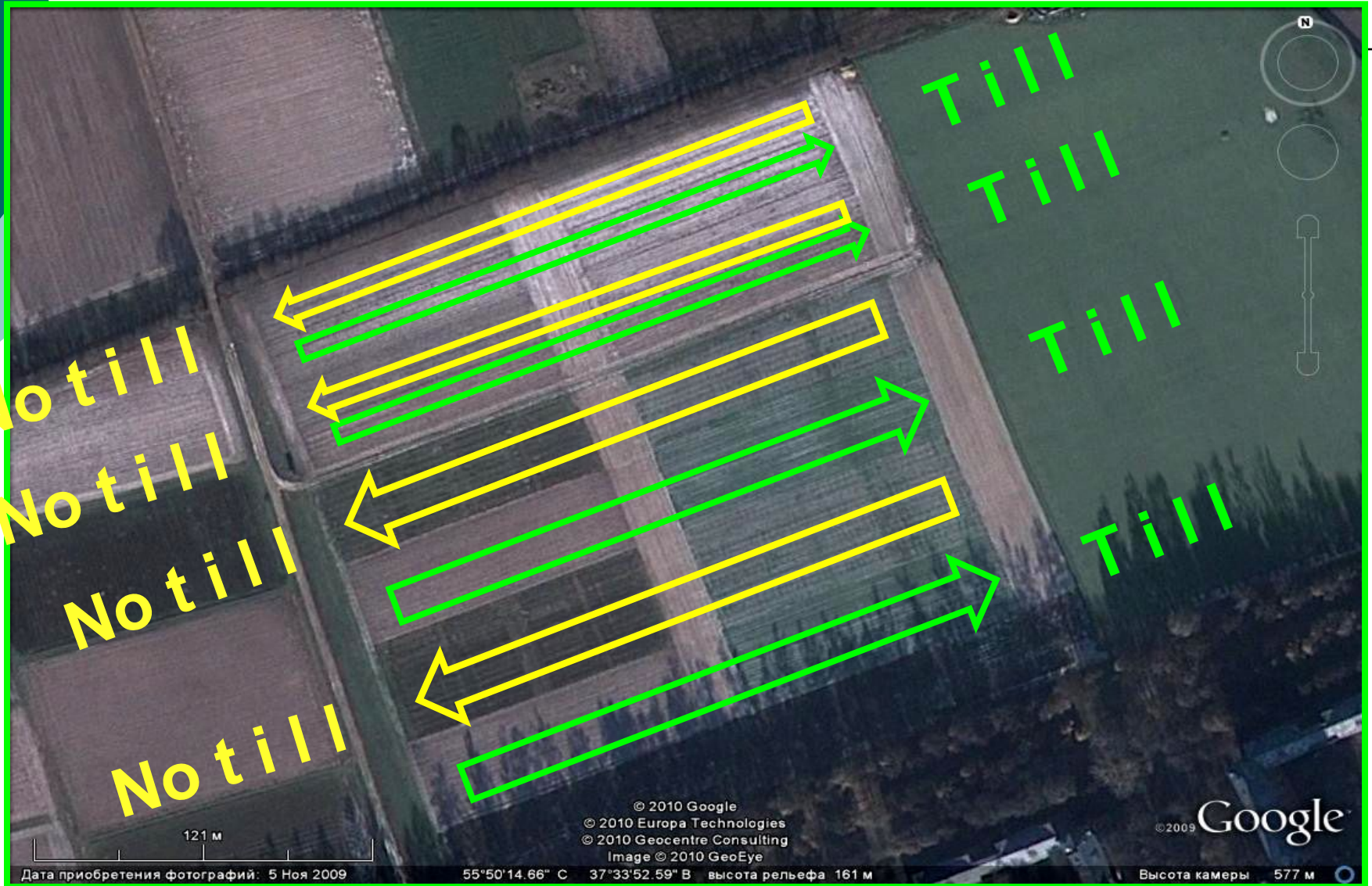
Precision and Traditional Agriculture Plots (Factor A)



Precision

Traditional

Soil Treatment (Factor B)



No-till: sod seeder AMAZONE D-3001

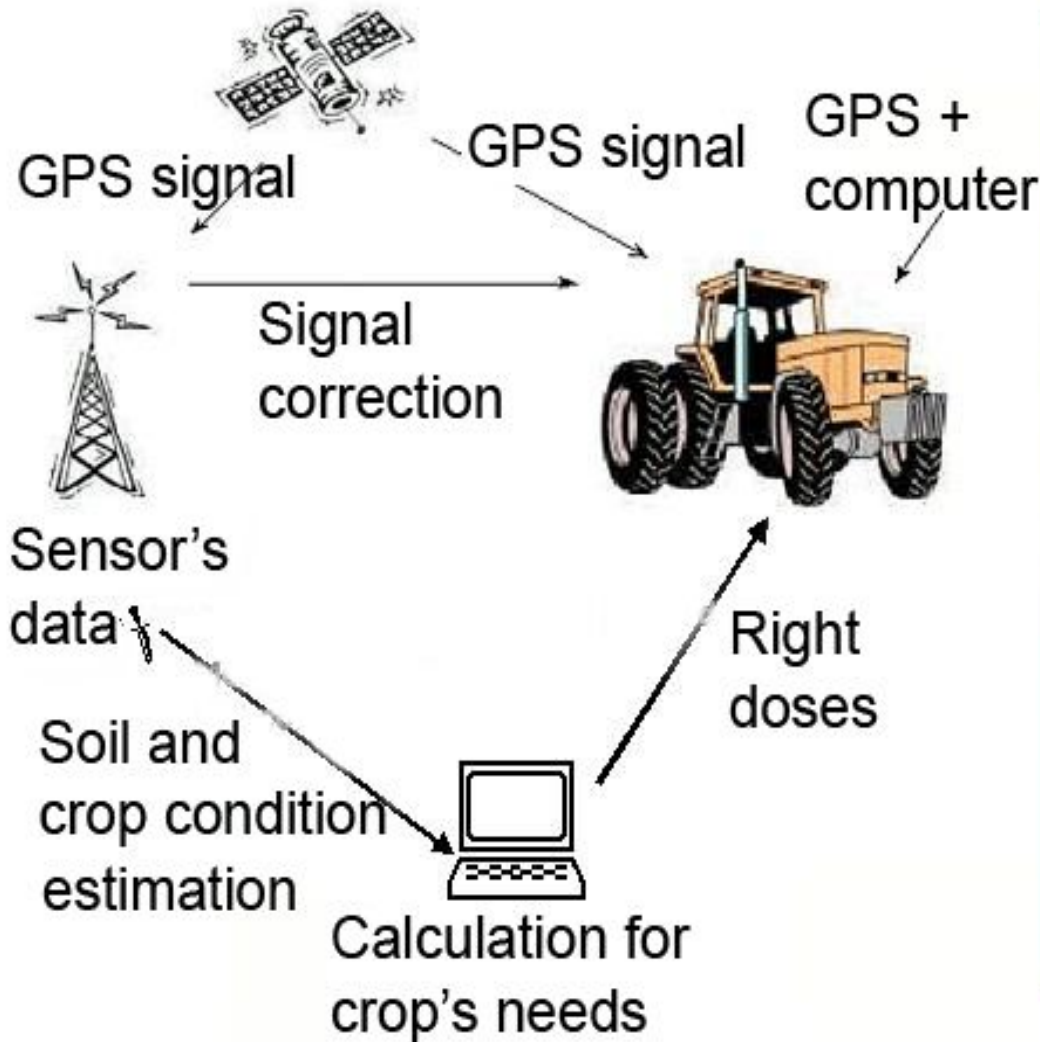




Next steps

- 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**



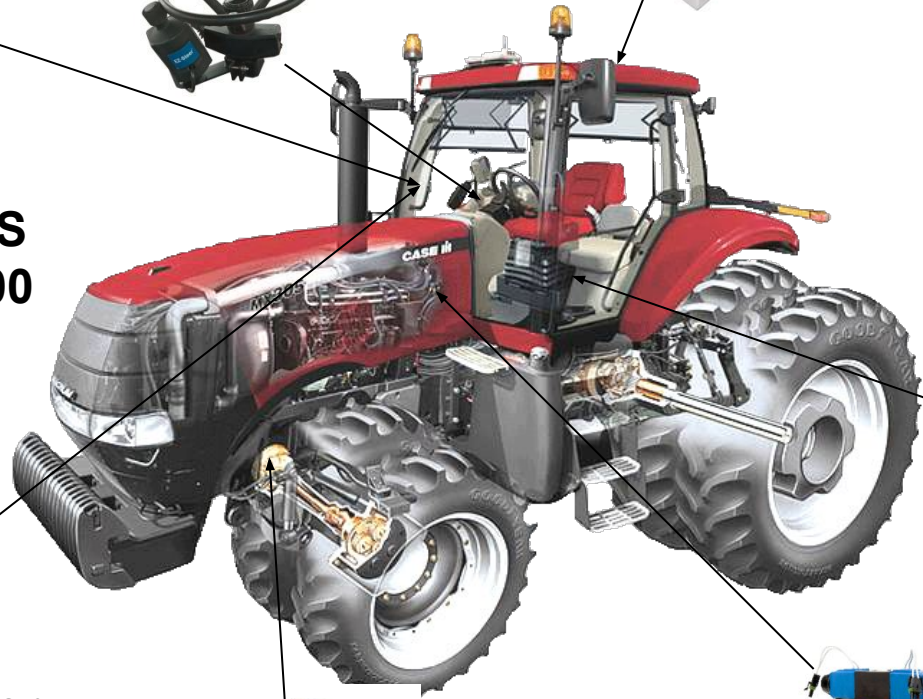
Base station



**Controller AgGPS
NAVCONTROLLER II**



**Control
valve**



**Wheel
alignment
sensor**



**Light emitting
diode panel
AgGPS
EZ-GUIDE PLUS
or EZ-GUIDE 500**

or



Field computer

Benefits of Autopilot system for Precision Agriculture

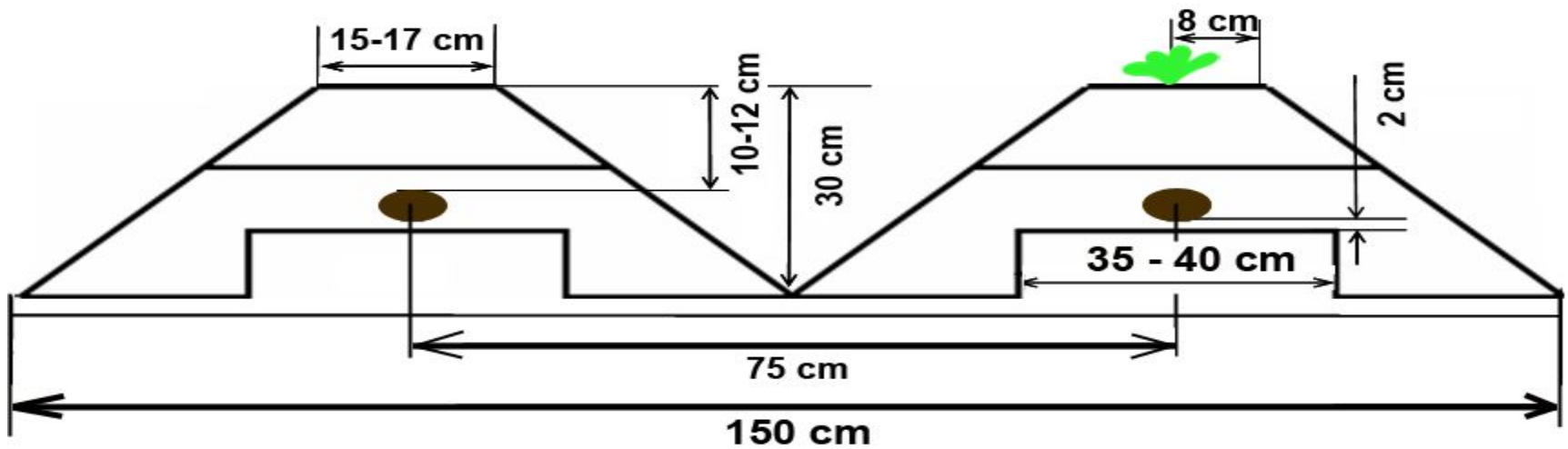
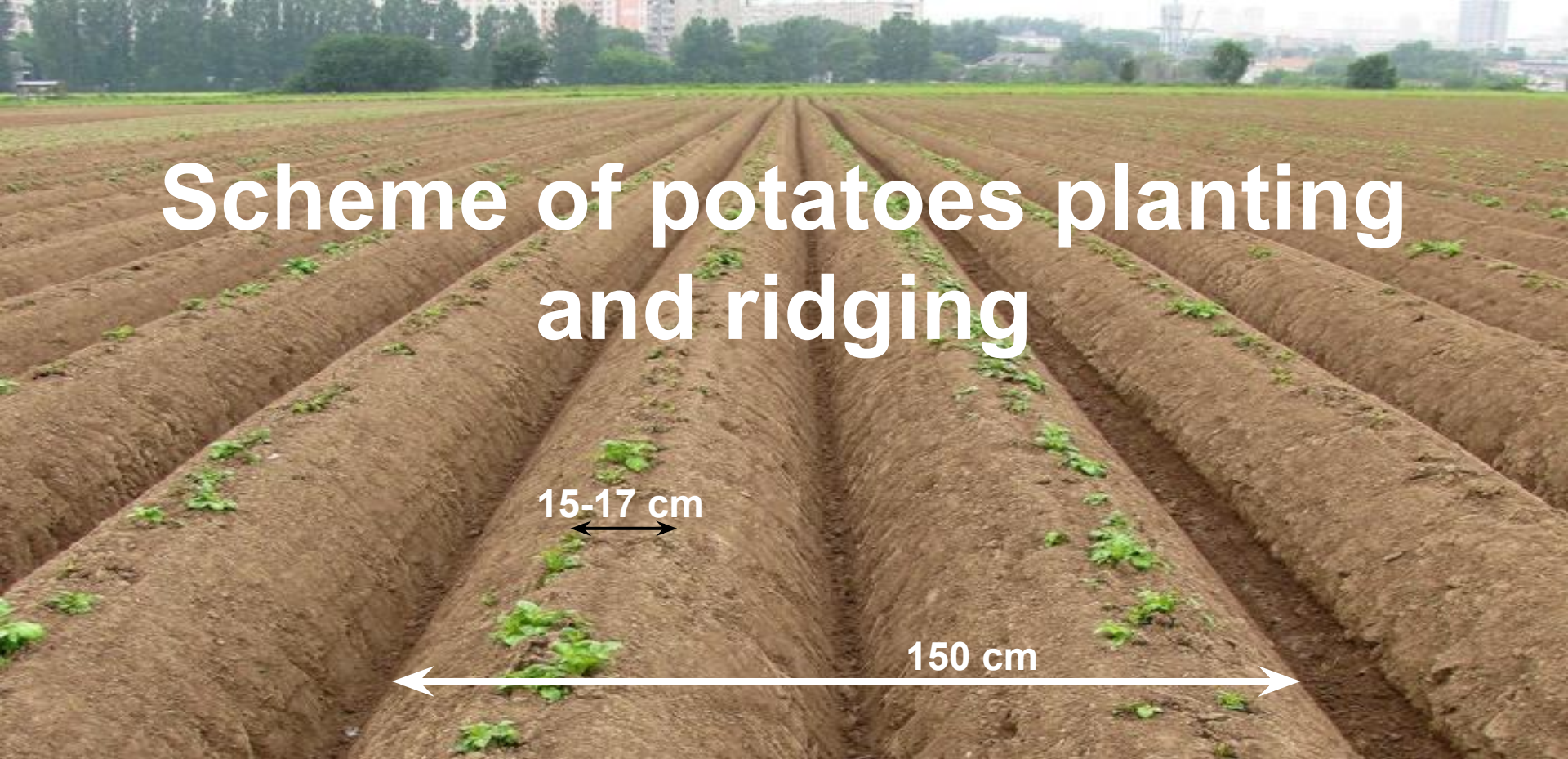
- Tractor operator works hard, he can't work for a long time without breaks, he will become tired and make faults
- Autopilot system helps to do your routine task without faults
- The results of field work will be excellent: no gaps, no blank-spots, no weeds, no waste of yield

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

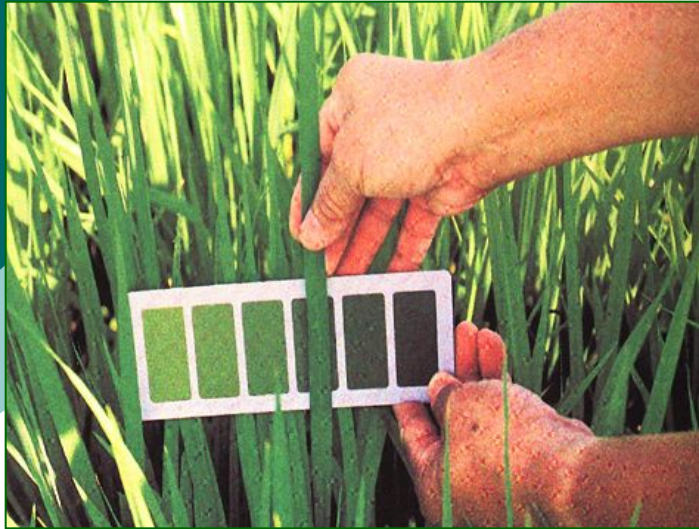
Different aims – different equipment



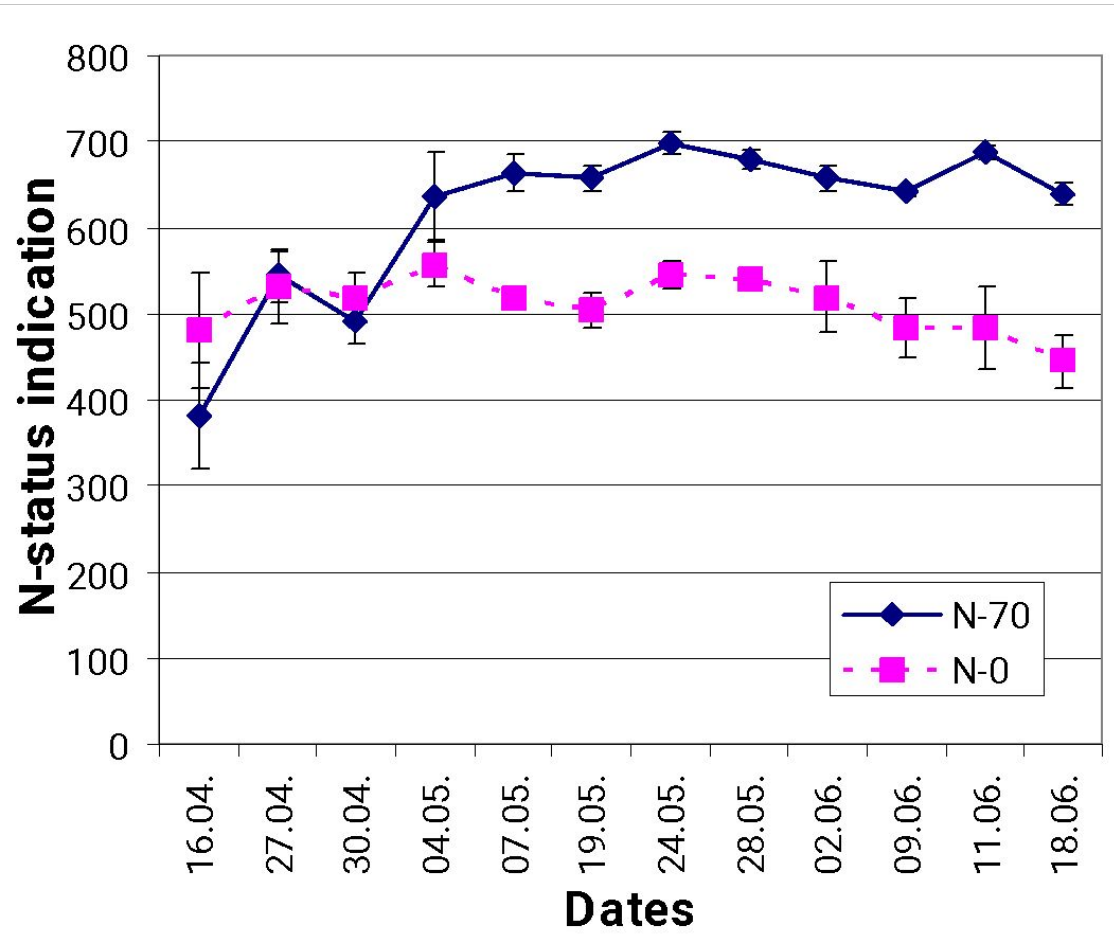
- N-tester® Yara
- GreenSeeker® RT220
- N-sensor ALS® Yara



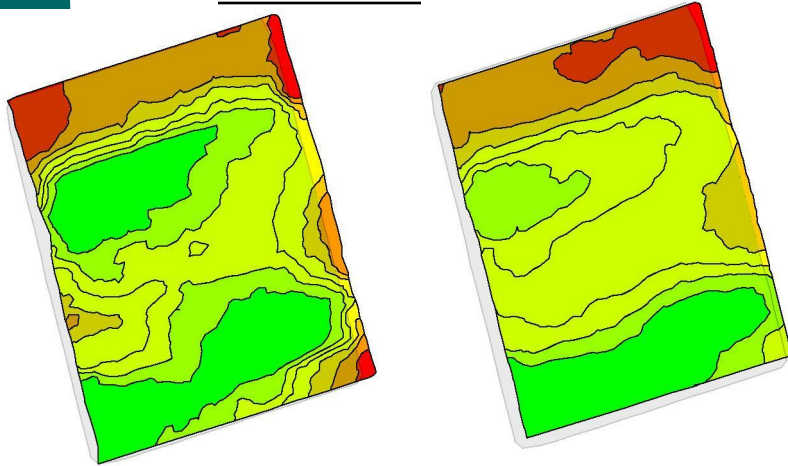
N-tester on Winter Wheat



**Nitrogen balance
under different N doses**



Maps of wheat biomass - NDVI measurement by GreenSeeker

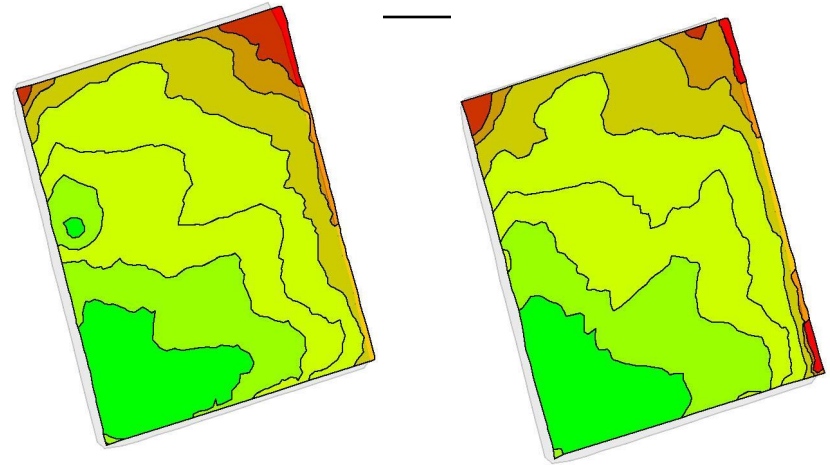


26 April

3 May

Beginning of season:

**Difference between
technologies**



7 June

24 June

The second half of season:

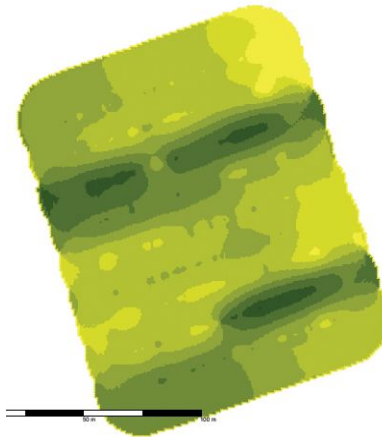
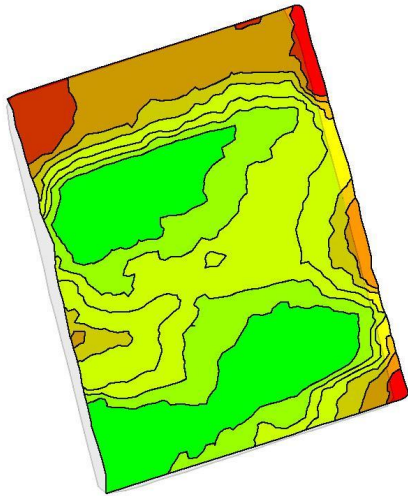
**Difference between field
segments**

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

Different width of working beam

1–1,5 m

12–15 m

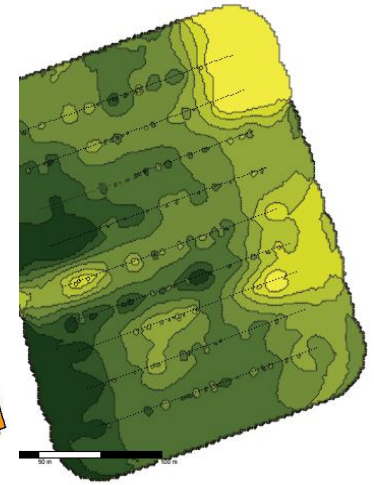
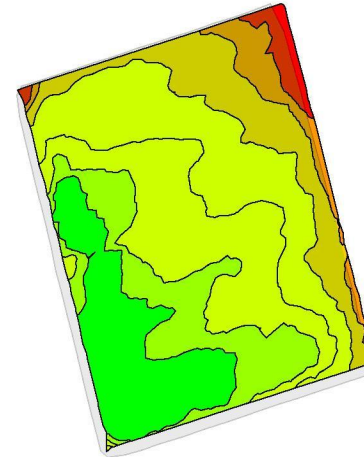


GreenSeeker N-sensor

26-28 April

1–1,5 m

12–15 m

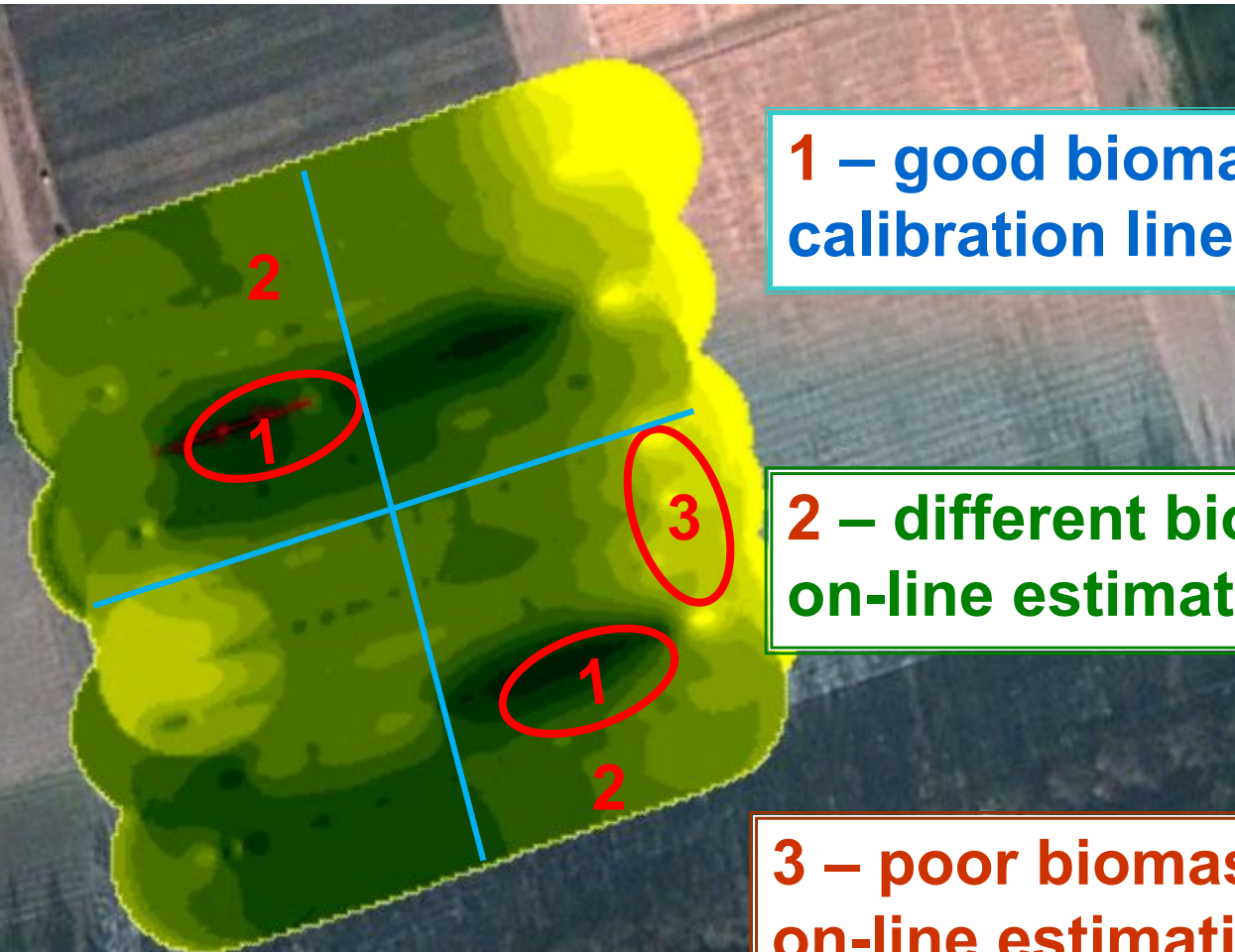


GreenSeeker N-sensor

1-2 June

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

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



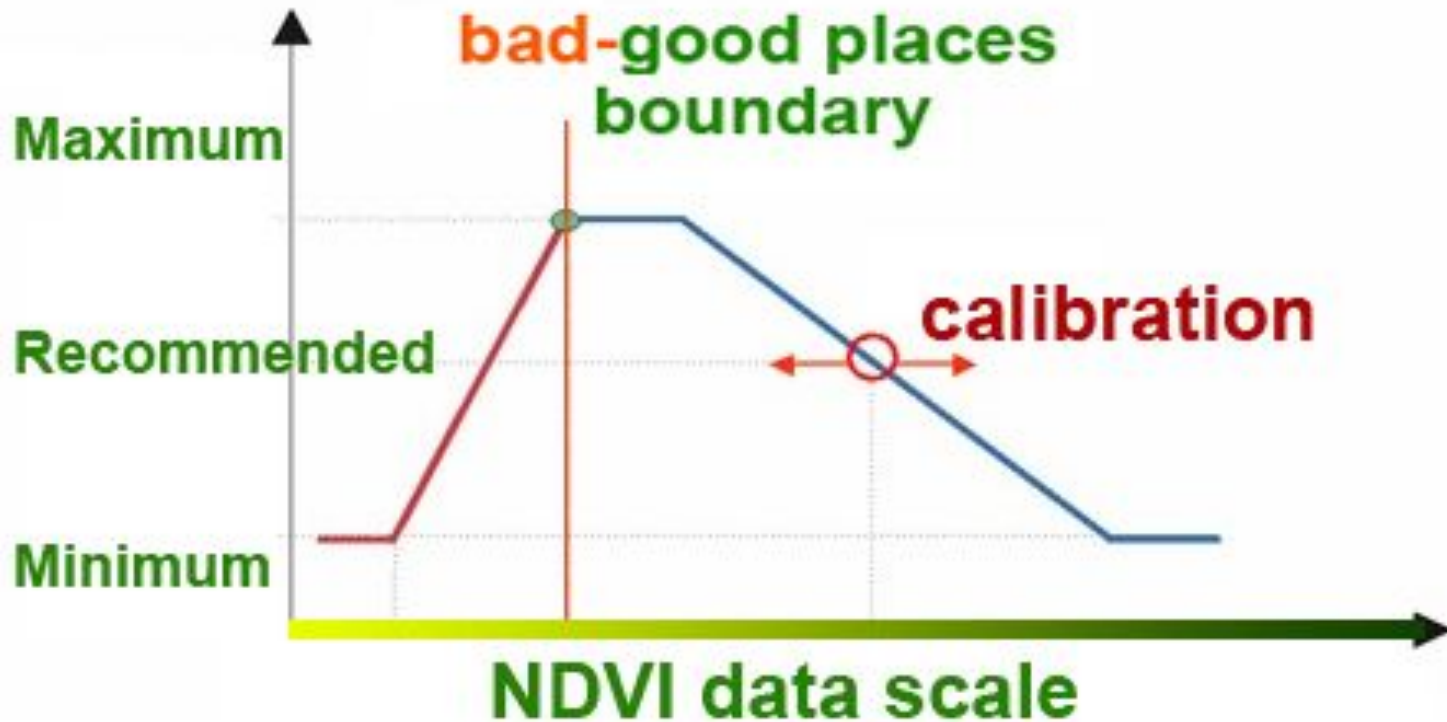
**1 – good biomass =>
calibration line**

**2 – different biomass =>
on-line estimation**

**3 – poor biomass =>
on-line estimation**

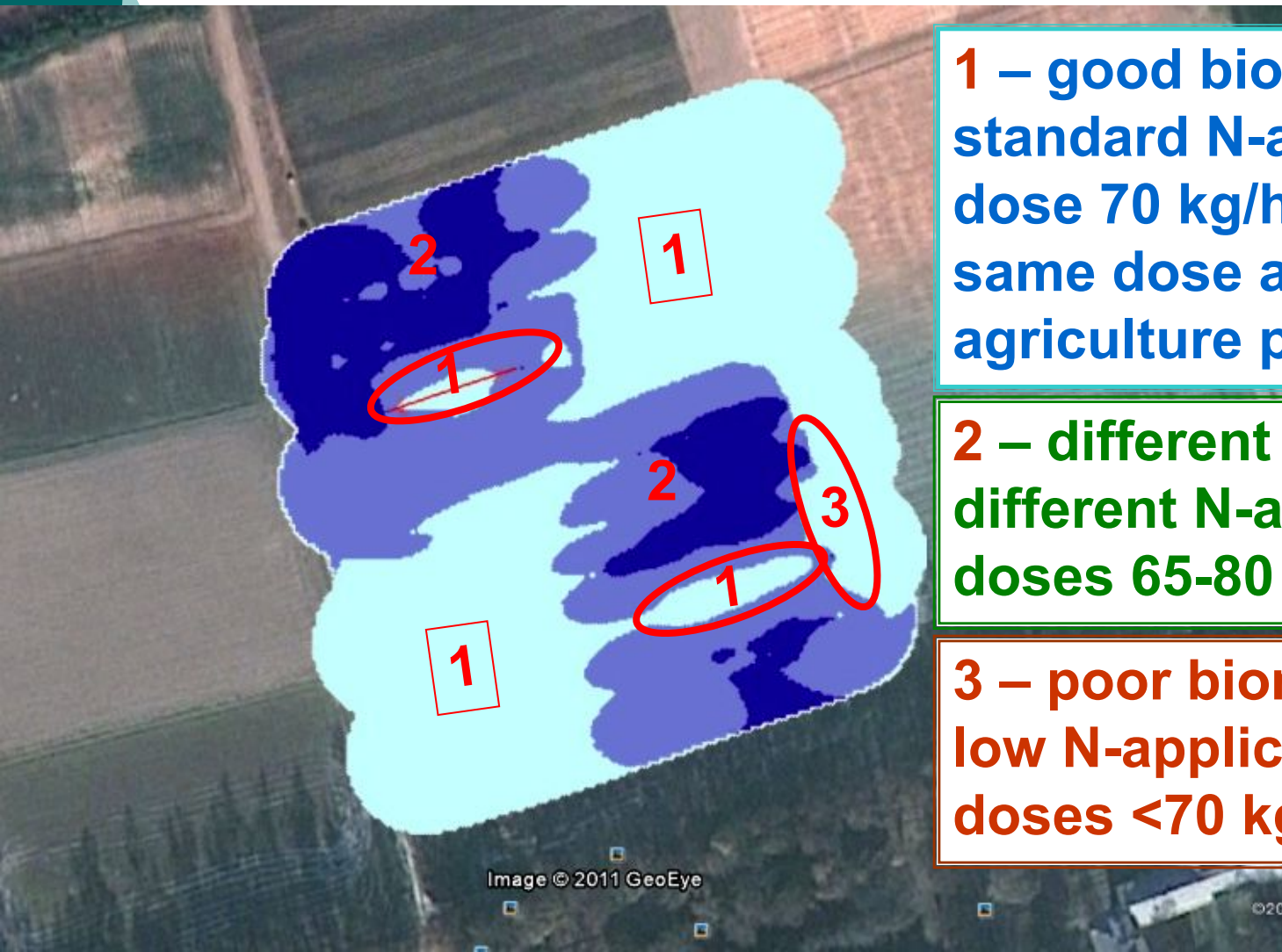
N application at tillering stage (EC 30 – 36)

N doses



poor biomass **good biomass** **over-biomass**

On-line N-application prescription, application map

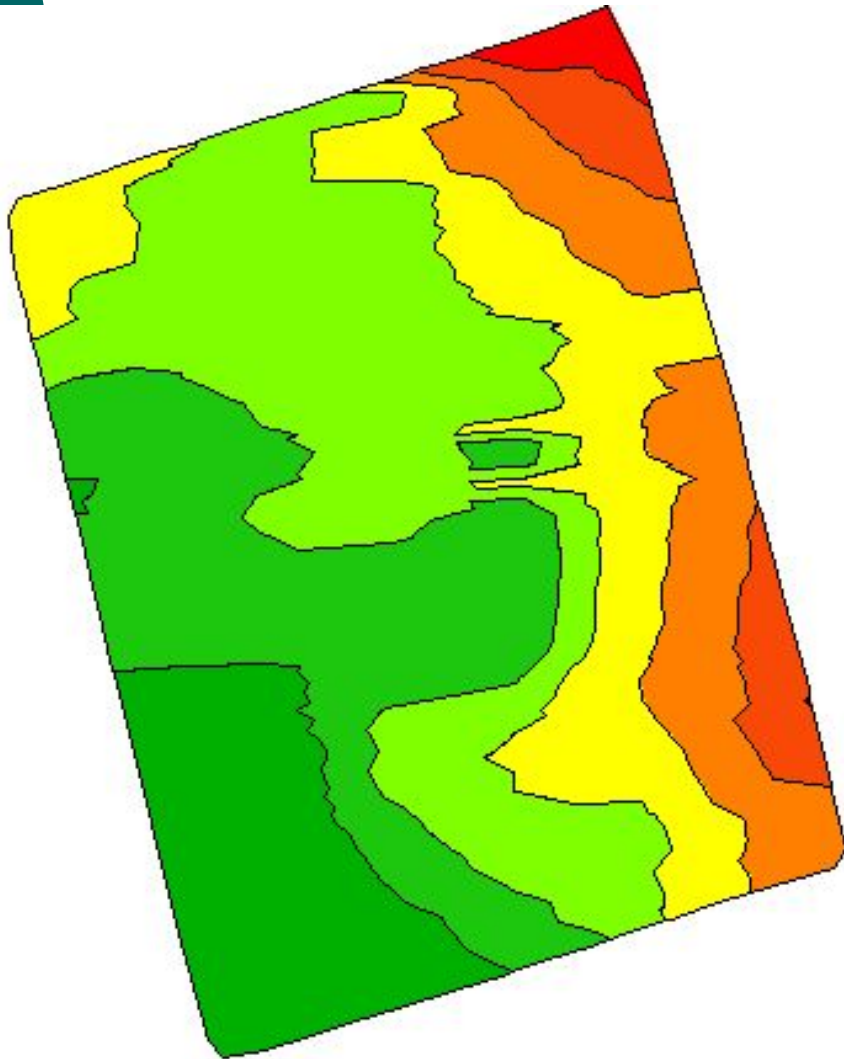


1 – good biomass =>
standard N-application,
dose 70 kg/ha and the
same dose at traditional
agriculture plots – [1]

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

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

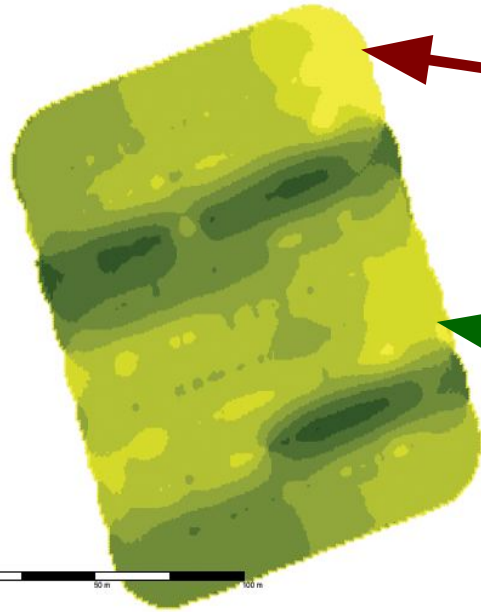
Wheat Yield Map



Yield, tonne/ha

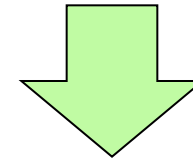
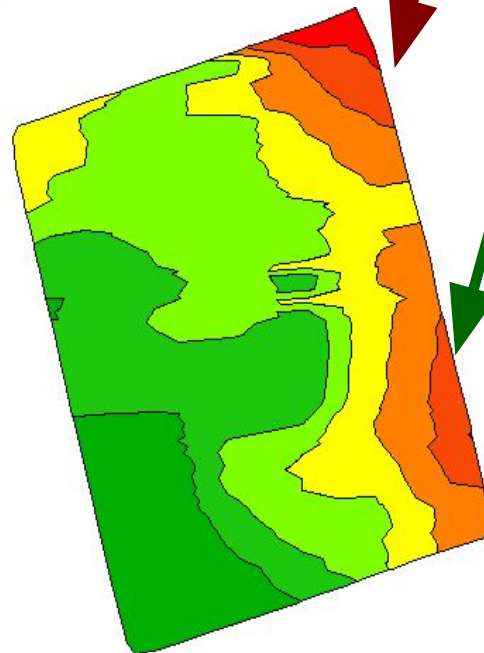
■	3,98 - 4,40	(0,19 ha)
■	3,82 - 3,98	(0,30 ha)
■	3,67 - 3,82	(0,42 ha)
■	3,43 - 3,67	(0,26 ha)
■	3,18 - 3,43	(0,17 ha)
■	2,90 - 3,18	(0,07 ha)
■	1,83 - 2,90	(0,02 ha)

Biomass and Yield Maps



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

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



=> Profitability of N
application is different

Yield, tonne/ha

■	3,98 - 4,40	(0,19 ha)
■	3,82 - 3,98	(0,30 ha)
■	3,67 - 3,82	(0,42 ha)
■	3,43 - 3,67	(0,26 ha)
■	3,18 - 3,43	(0,17 ha)
■	2,90 - 3,18	(0,07 ha)
■	1,83 - 2,90	(0,02 ha)

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	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	
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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- **Researches carried out at the Scientific Centre on Precision Agriculture of Russian State Agrarian University-Moscow Timiryazev Agricultural Academy and presented in the above report were done within the support of Grant of the Government of the RF № 11.g. 34.31.0079**

Thank You for Your attention!



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