Assessment of nutrients and organic matter balance response to fertilization and programmed crop yield
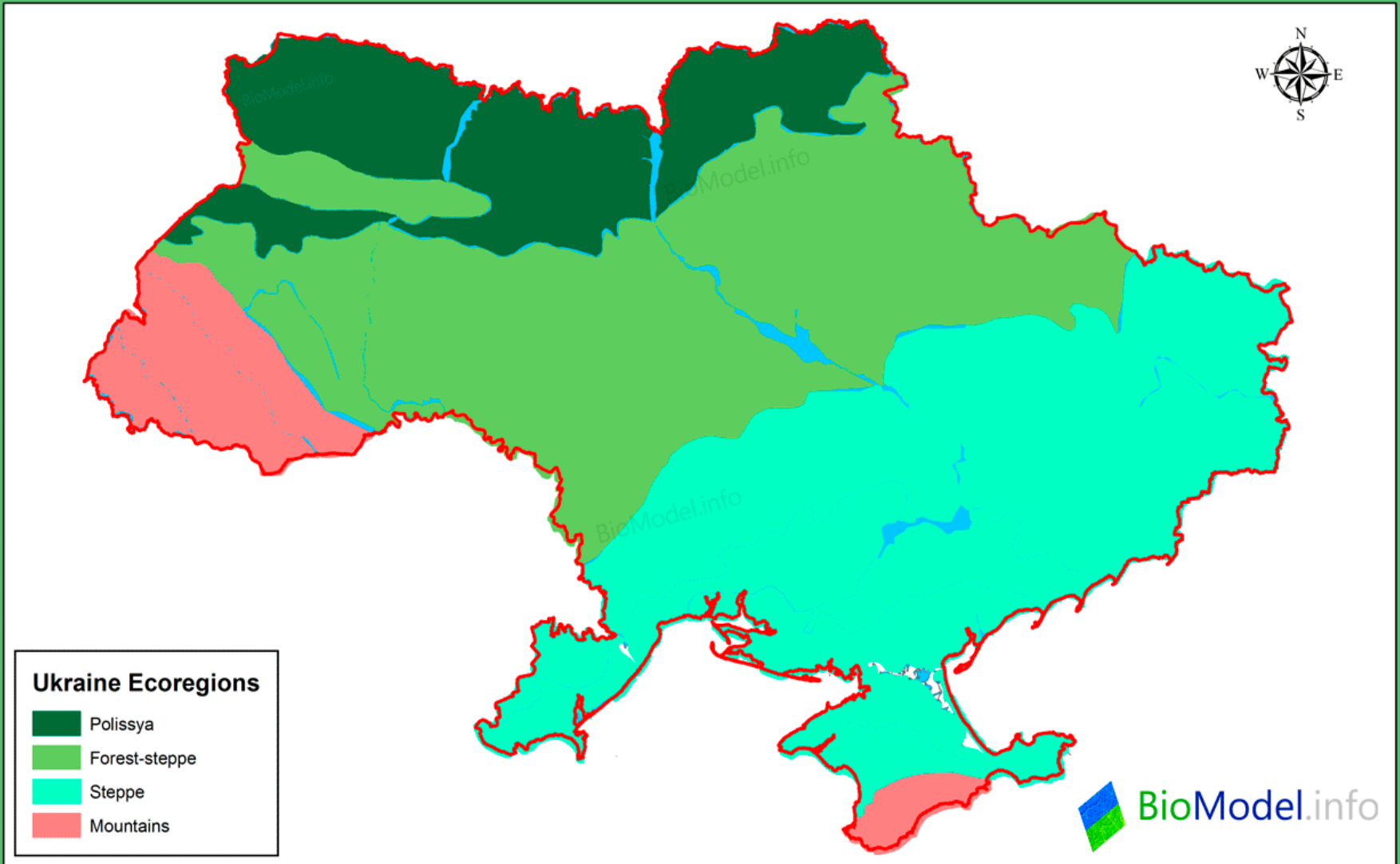
Elina Zakharchenko

Sumy National Agrarian University, Ukraine
Department of Arable Farming, Soil Science and Agrochemistry
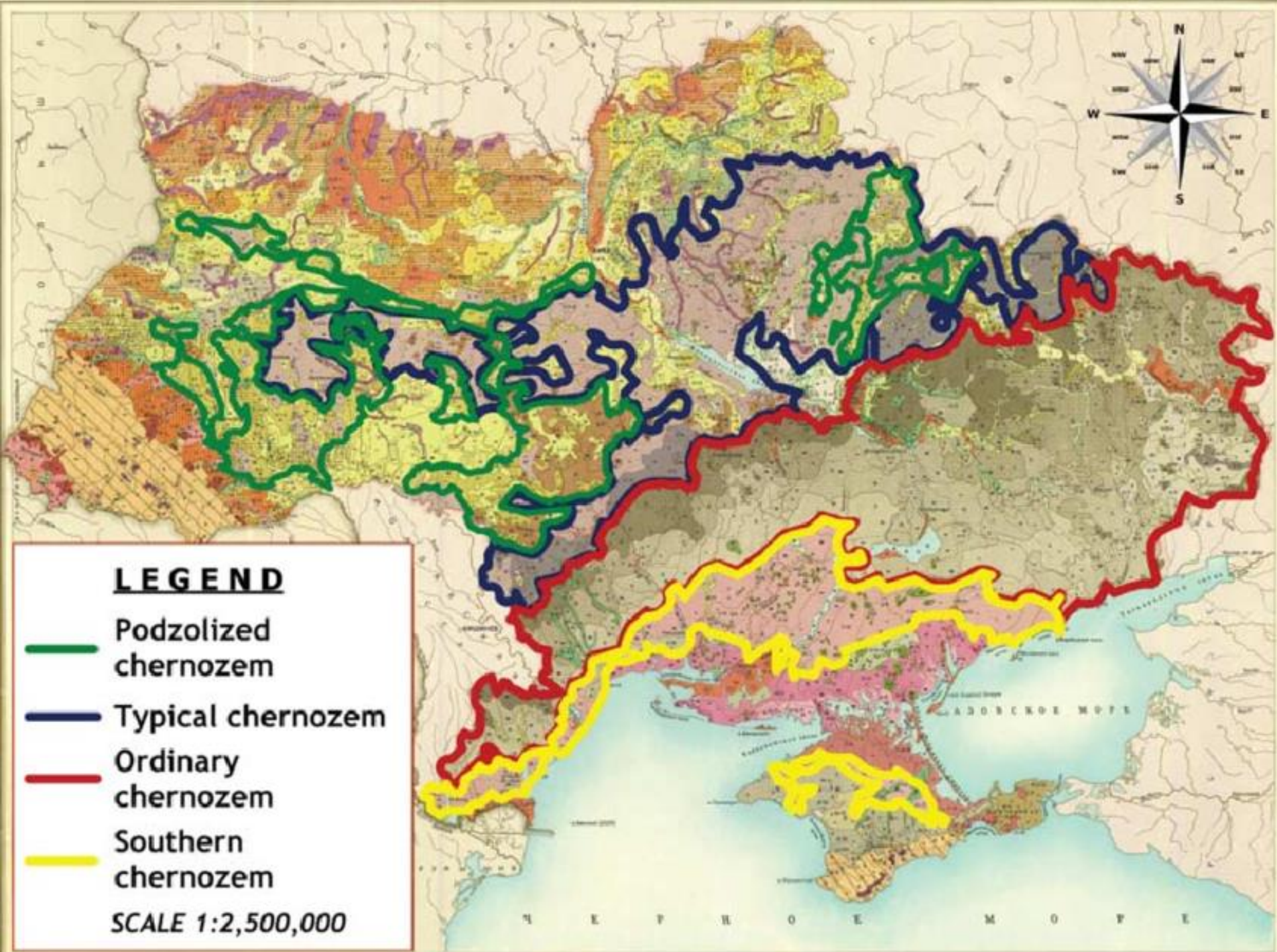**Faculty of Agrotechnologies and Environmental Management**

Nature-Agricultural Zoning of Ukraine

Ukraine Ecoregions

- Polissya
- Forest-steppe
- Steppe
- Mountains

- The total area of Ukraine is 60.35 mln.ha, area of lands - 57.93 mln.ha.
- Land Fund of Ukraine is divided as follows agricultural lands - 42.74 mln.ha (arable lands - 32.53; hayfields and pastures - 7.86; fallow lands - 0.25; gardens - 0.89); forest lands - 10.62; wetlands - 0.98; built-up lands - 2.54 mln.ha.
- Soil cover of Ukraine is very diverse and has up to 1000 kinds of soil. On 2/3 it consists of chernozems soils (about 25.3 ml.ha). At the same time chernozems ordinary cover an area of 10.5 mln.ha, typical - 5.8, southern - 3.6, podzolized - 3.4 and chernozem-meadow soils - 2.0 mln.ha. Also, significant areas are occupied by fertile grey forest soils (4.3 mln.ha), the sod-podzolic soils (up to 3.9 mln.ha), chestnut soils (1.4 mln.ha), brown soils (1.1 mln.ha) and meadow-marsh soils (about 1 mln.ha).
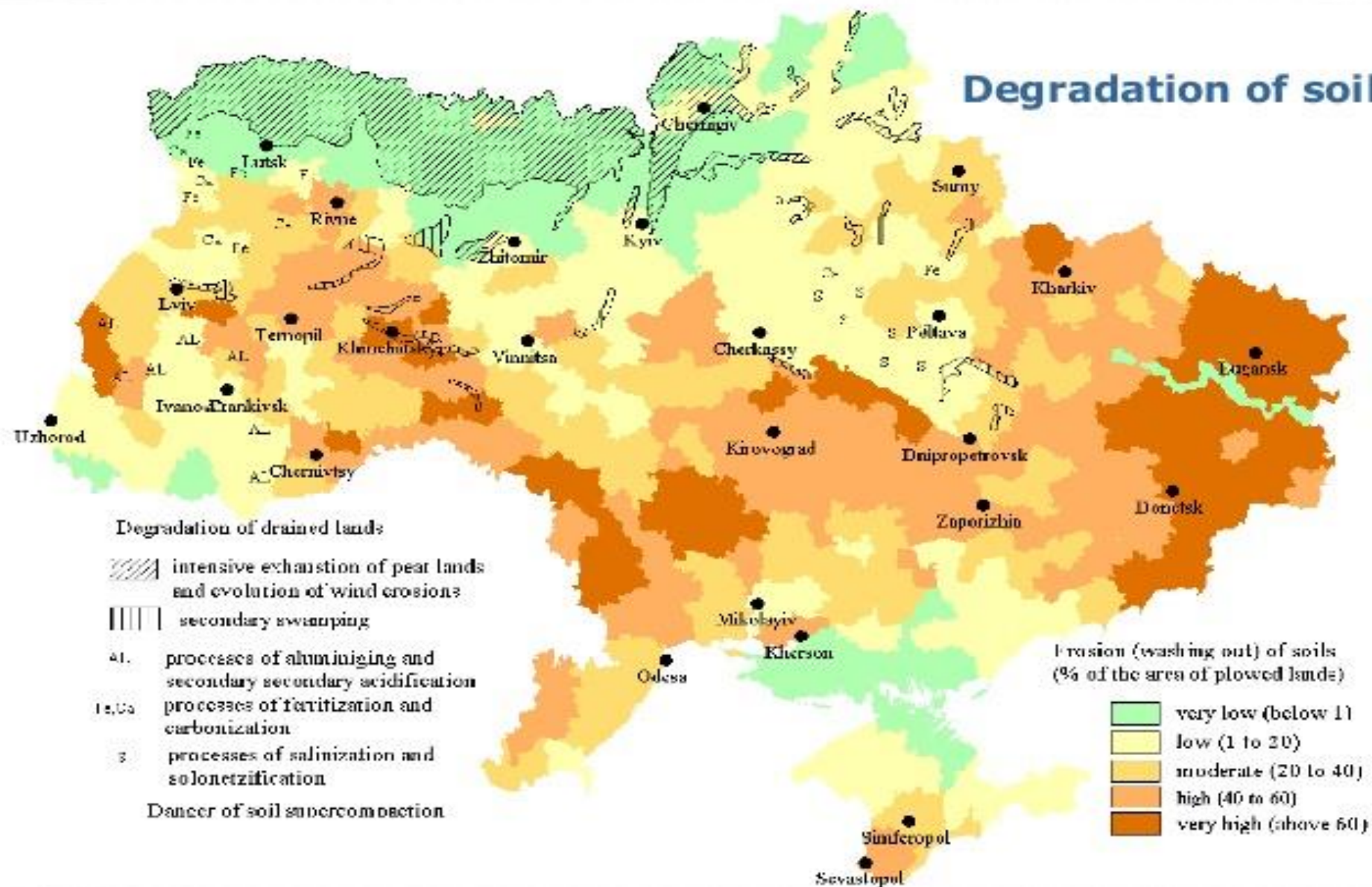- Area of chernozems in Sumy region is 65% of all arable soils in it.

LEGEND

Podzolized chernozem

Typical chernozem

Ordinary chernozem

Southern chernozem

SCALE 1:2,500,000

Chernozem profile (University field)

Source: Balayev, 2013

Degradation of soil

Degradation of drained lands

- ▨ intensive exhaustion of peat lands and evolution of wind erosions
- ▥ secondary swamping
- Al. processes of aluminiging and secondary secondary acidification
- Fe,Ca processes of feritization and carbonization
- s processes of salinization and solonetzification

Danger of soil supercompaction

Erosion (washing out) of soils (% of the area of plowed lands)

- very low (below 1)
- low (1 to 20)
- moderate (20 to 40)
- high (40 to 60)
- very high (above 60)
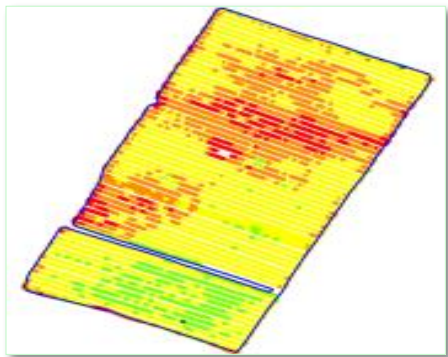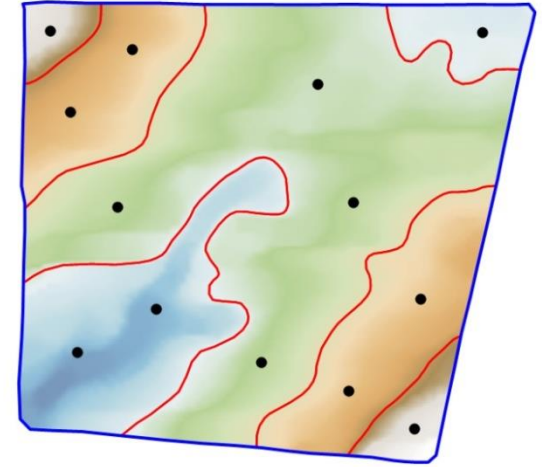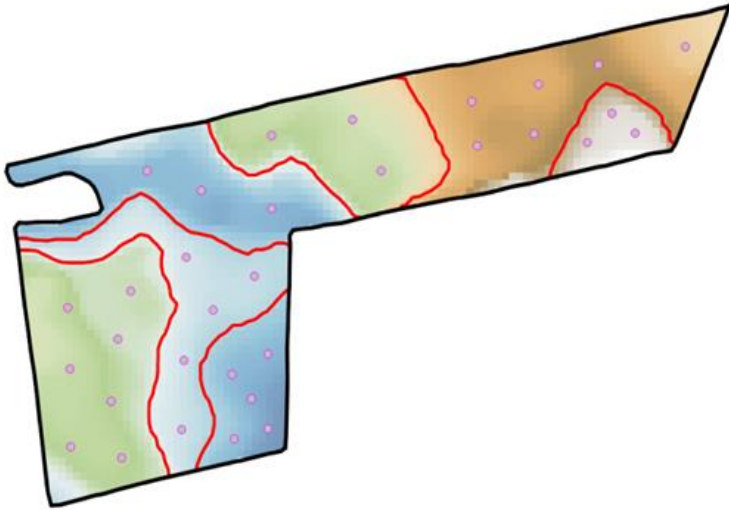
Soil sampling and mapping

- *Mapping of conductivity of soil*
- *Mapping of relief*
- *Soil kinds determination and grouping*
- *Data of crop yield on each field*
- *Using of space data:*
  - *Remote sensing*
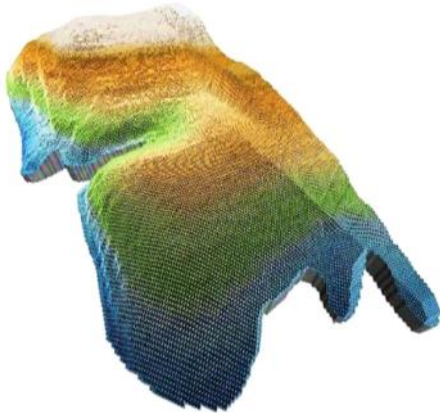 - *Geospatial data*

KERNEL

Measurement of soil conductivity by Dualem 1-S (source – Kernel)
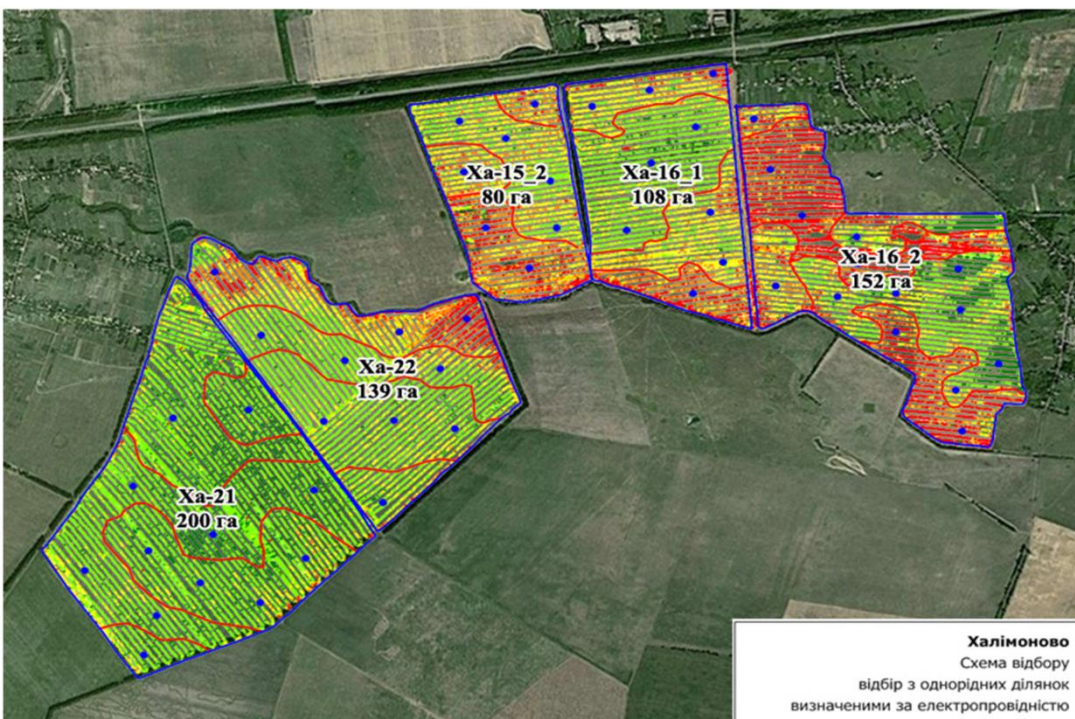
Grouped zones by relief

- *Used for further planning of fertilization depends on field moisture, crop*

  Mapping of relief are made during harvesting on the base of satellites photos

KERNEL

Technology of using remote sensing for zoning

Photo of field (satellite photo)

Scheme of soil sampling

Поле 1010604
Площа 352 га
Пшениця озима, 2012 рік
Індекс біомаси (NDVI)

0,3

0

-0,4
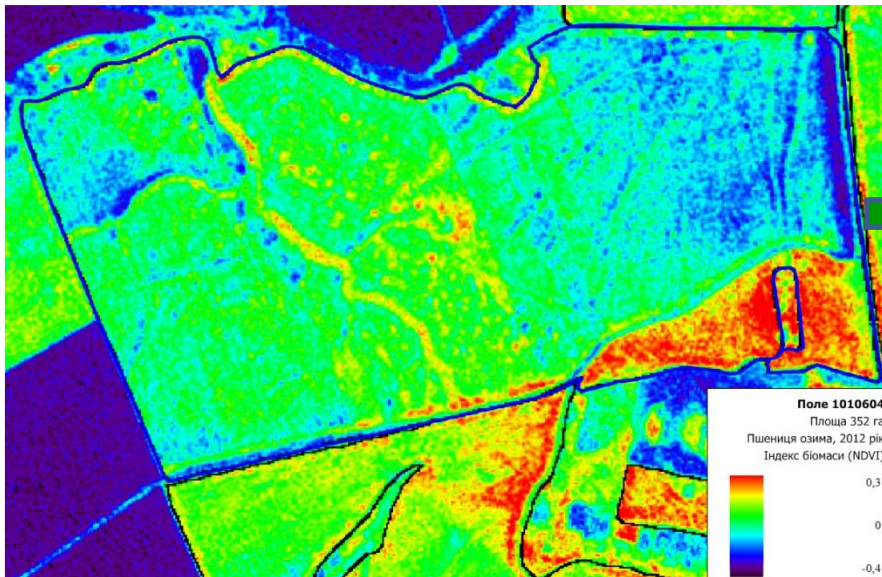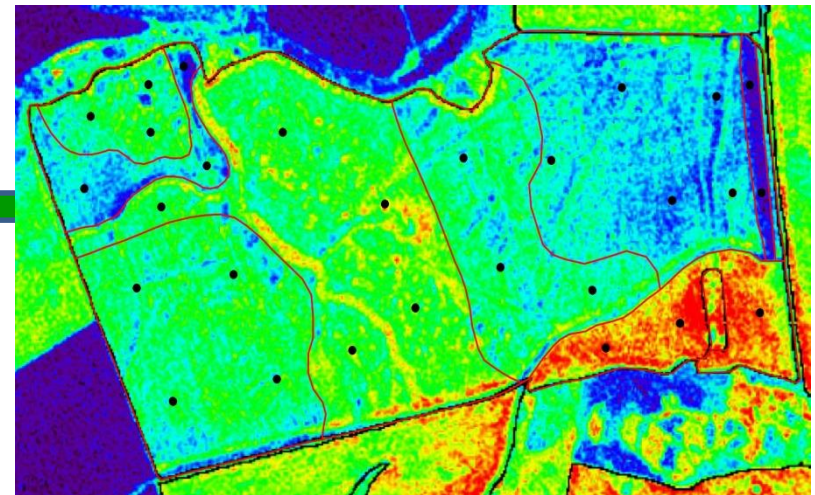
Example of using of space technology for diagnostic of nutrients

Remote sensing is applied for determination of actual value of plant biomass during planning the soil sampling and determination of nutrient content

KERNEL

Electronic map of fields (source – Panorama Agro)

Creating of borders of fields

E-map pf fields
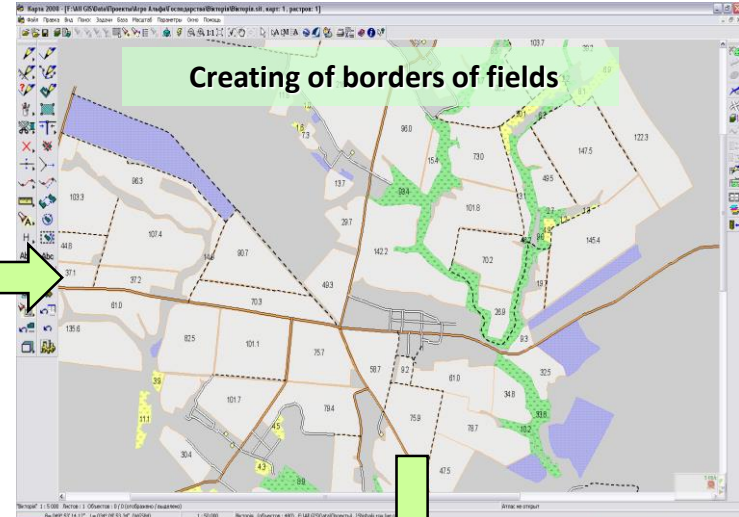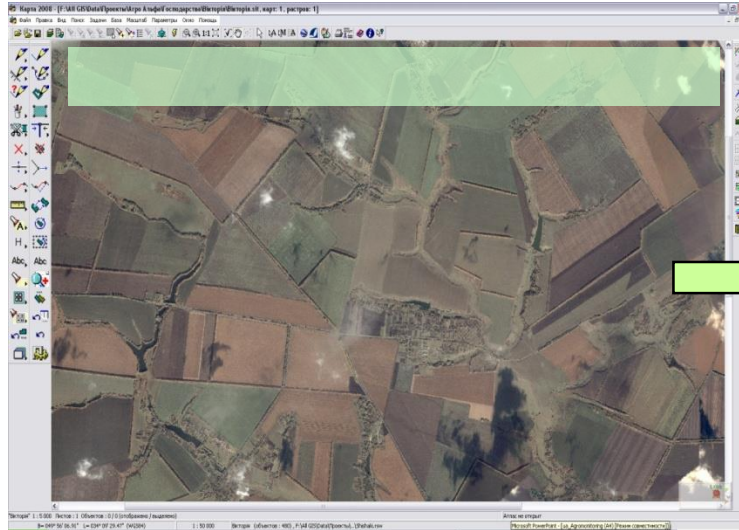
✓ GeoEye-1, WorldView-1/2, QuickBird, IKONOS and others – to 1 m);
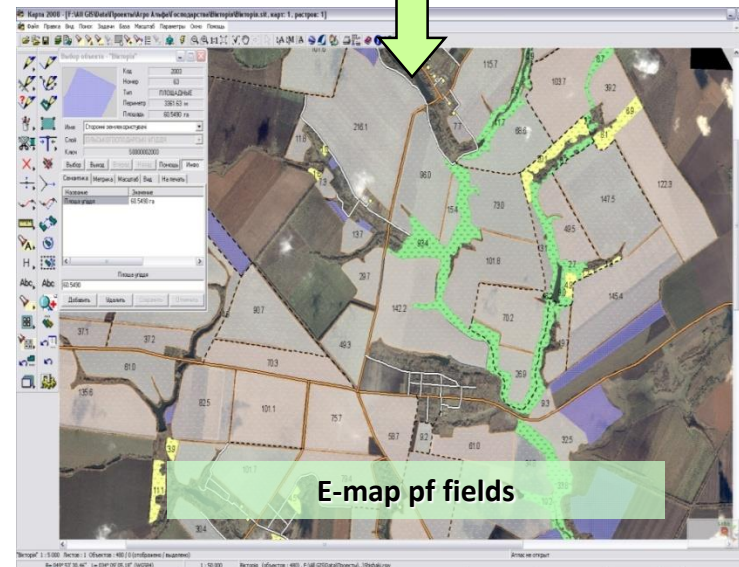
Monitoring of plant growth dynamics

Report of farmers

✓ **Connection objects of map with photos – estimation of soils, plant growth etc.)**
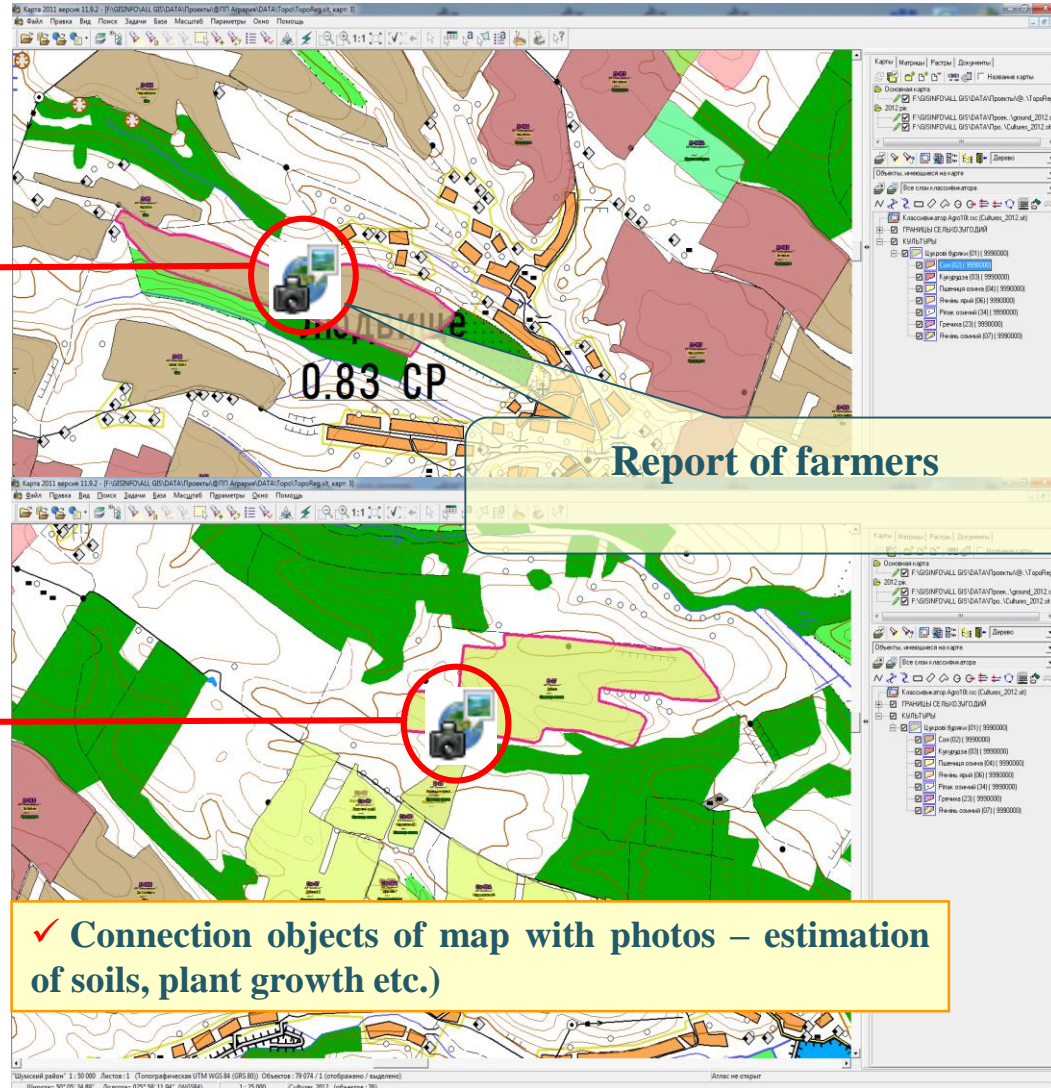
Dynamics of humus content and applied of manure in Sumy region

Indexes	Years						
	I (1965-1969)	III (1977-1980 pp.)	V (1986-1990)	VI (1991-1996)	VII (1997-2001)	IX (2006-2010)	X (2010-2015)
Observed area, thousands hectares	1232.2	1297.5	1298.1	1213	1155.9	836.1	830
Applied manure, t/ha	4.4	7.4	8.8	7.4	2.6	0.97	0.5
Humus content, %	3.5	3.46	3.35	3.36	3.4	3.58	3.6

Sowing area in Sumy region of main crops
thousands of hectares

	Winter grain cr.	Barley	Oat	Peas	Millet	Buck wheat	Corn	Other grain cr.	Oilrape seed	Soya	Sun-flower
2011	231,4	107,4	21,8	7,4	5,8	28,5	231,2	28,4	22,8	42,6	115,3
2017	207	36,2	10,7	9,7	0,8	21,5	319,7	4,57	13,3	147,1	201,7
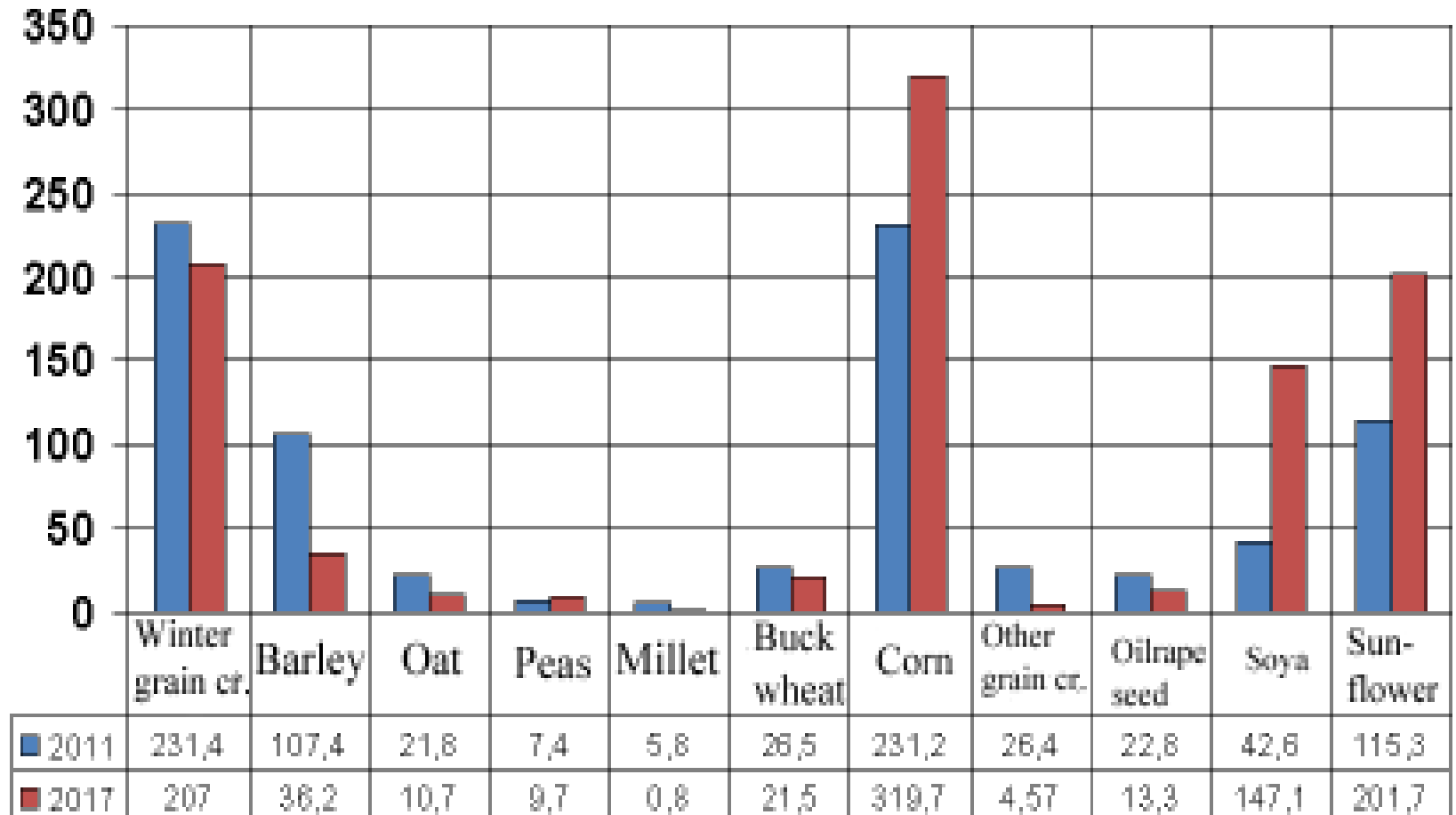
Yield crops in Sumy region

	Winter grain cr.	Barley	Oat	Peas	Millet	Buck-wheat	Corn	Other grain cr.	Oil rape	Soya	Sun-flower
2011	2,78	2,12	1,67	1,53	1,79	1,09	6	1,71	1,25	1,65	1,82
2017	5,08	3,88	2,59	3,35	2,29	1,15	7,47	1,93	3,49	1,85	2,56
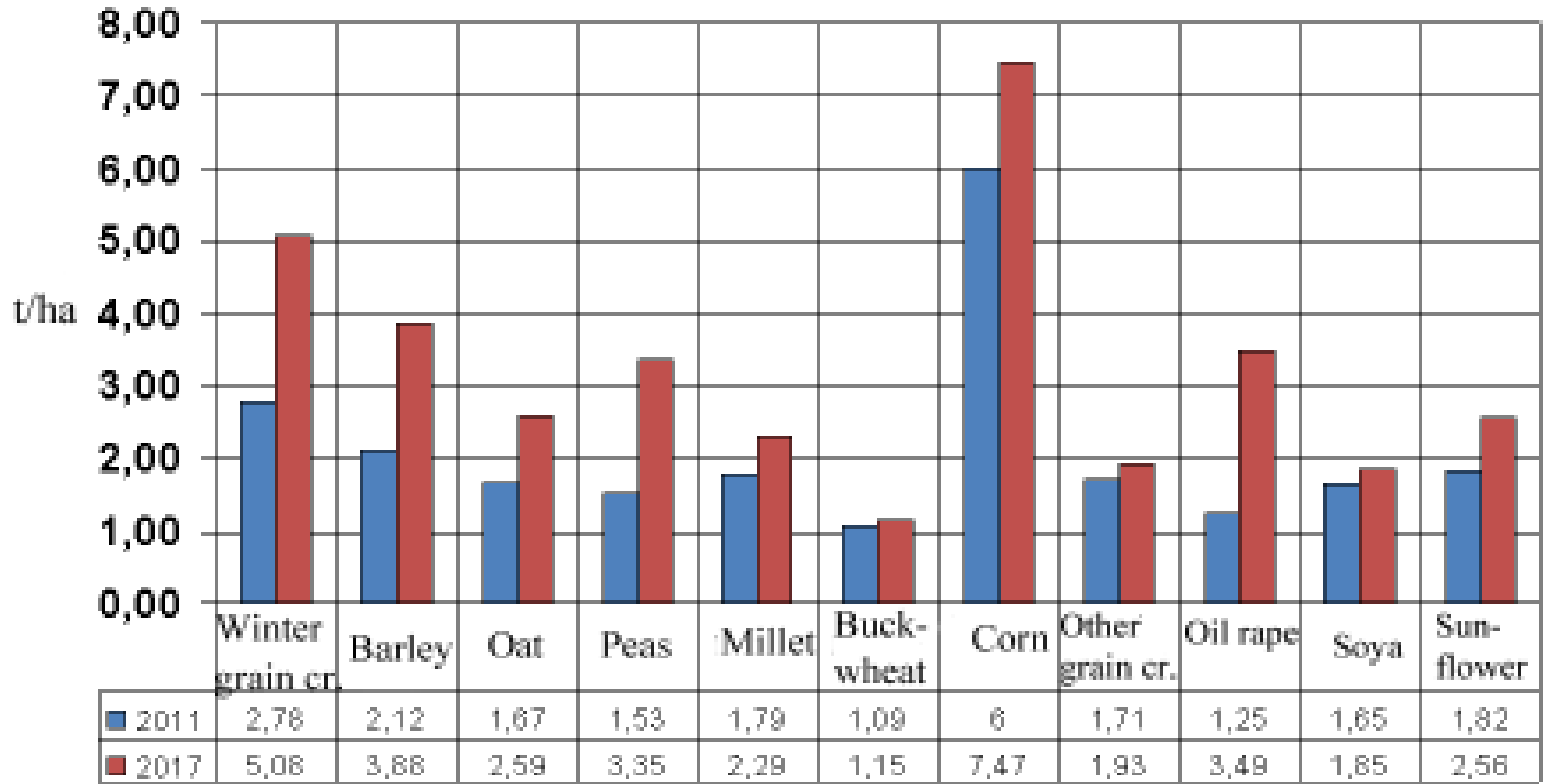
Crops

Humus balance (arable lands, Sumy region)

| Cros	Area, thous. hec-tares	Coeff. of minerali zation of hu-mus,t/ha	Humus minerali zed, ths. t	Yield of main prod., t/ha	Yield by-product (straw, roots, etc), t/ha	Yield by-product (straw, roots, etc) per sowed area, ths.t	Coeff. humi-fication	Humus from by-product, ths.t	Humus from manure ths.t	Deficit by humus balance, ths. t (t/ha)
Winter grain crops	207,0	1,35	279,45	5,08	7,11	1471,77	0,20	294,35		14,91
Spring barley	36,2	1,23	44,53	3,88	4,26	154,21	0,22	33,93		10,6
Oat	10,7	1,20	12,84	2,59	2,17	23,22	0,21	4,88		7,96
Peas	9,7	1,50	14,55	3,35	5,03	48,79	0,23	11,22		3,33
Millet	0,8	1,10	0,88	2,29	3,44	2,75	0,22	0,61		0,27
Buckwheat	21,5	1,10	23,65	1,15	1,73	37,19	0,20	7,44		16,21
Corn	319,7	1,56	498,73	7,47	11,21	3583,84	0,20	716,77		**+218,04**
Other grain crops	4,57	1,20	5,48	1,93	2,51	11,47	0,20	2,29		3,19
Oil rape seed	13,3	1,39	18,49	3,49	4,52	60,12	0,23	13,83		4,66
Soya	147,1	1,50	220,65	1,85	2,78	408,94	0,20	81,79		138,86
Sunflower	201,7	1,39	280,36	2,56	5,12	1032,70	0,14	144,56		135,8
Total	**971,7**	**-**	**1399,61**					**1311,66**	**36,72**	**51,23**
Per 1 ha			**1,44**					**1,34**	**0,038**	**0,05**

Crop yields and total harvests of grain under different weather conditions and rates of applying fertilizers
(sowing area of grain crops – 14 mln. ha)

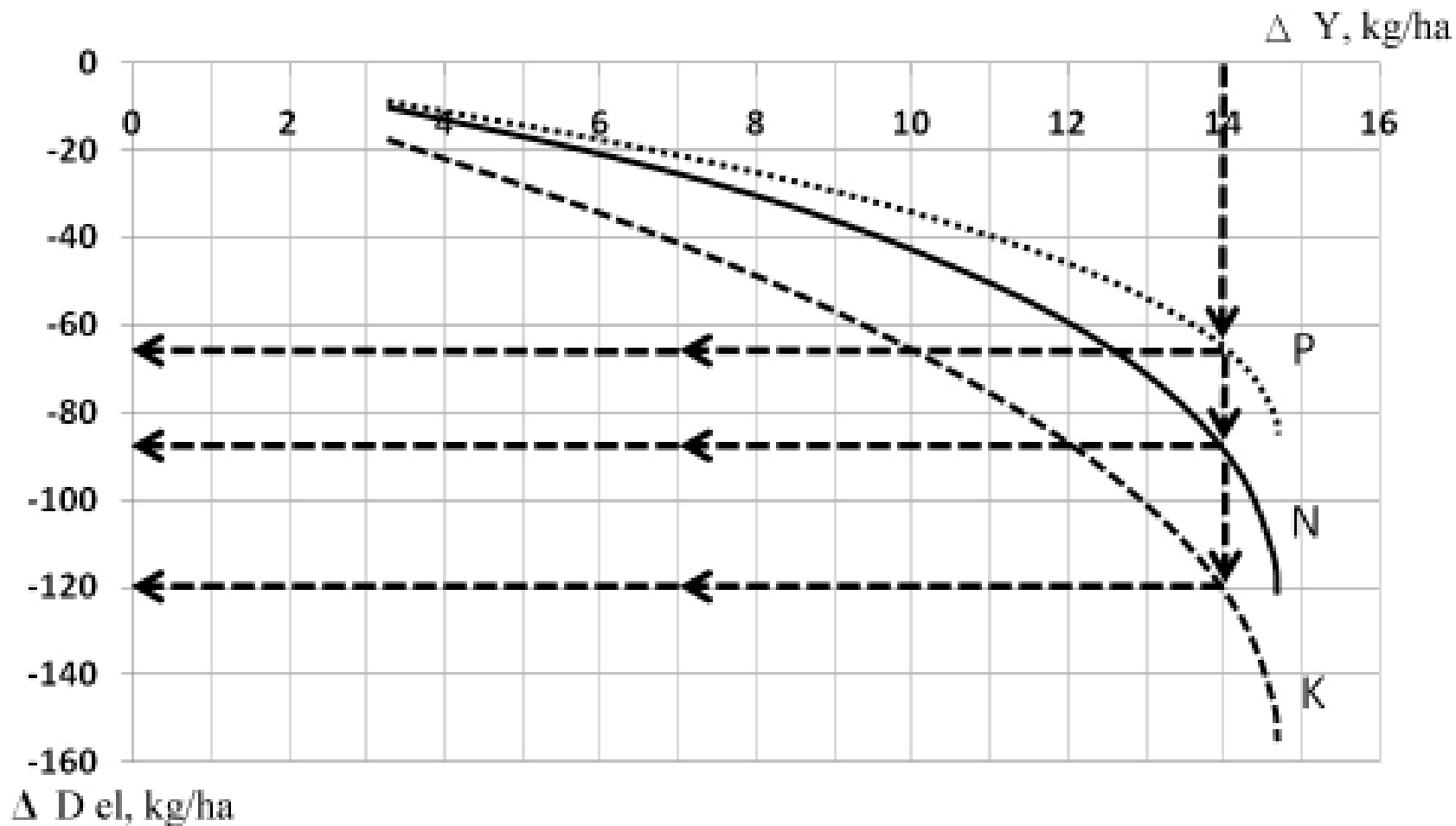| Experimental plots	Weather conditions			
	bad		average	
	Average yield, t/ha	Total harvests of grain, mln. t	Average yield, t/ha	Total harvests of grain, mln. t
No fertilization (Control)	1,77	24,8	29,7	41,6
$N_{40-60}P_{40-60}K_{40-60}$	2,25	31,5	34,5	48,3
$N_{90-120}P_{90-120}K_{90-120}$	2,58	36,1	41,8	58,5

Graphs for determination of critical yield of winter wheat (no deficiency of humus) 1 i 2 – humus formaion under incorporated of straw and output it for livestock; 3 – loss (mineralization) of humus.
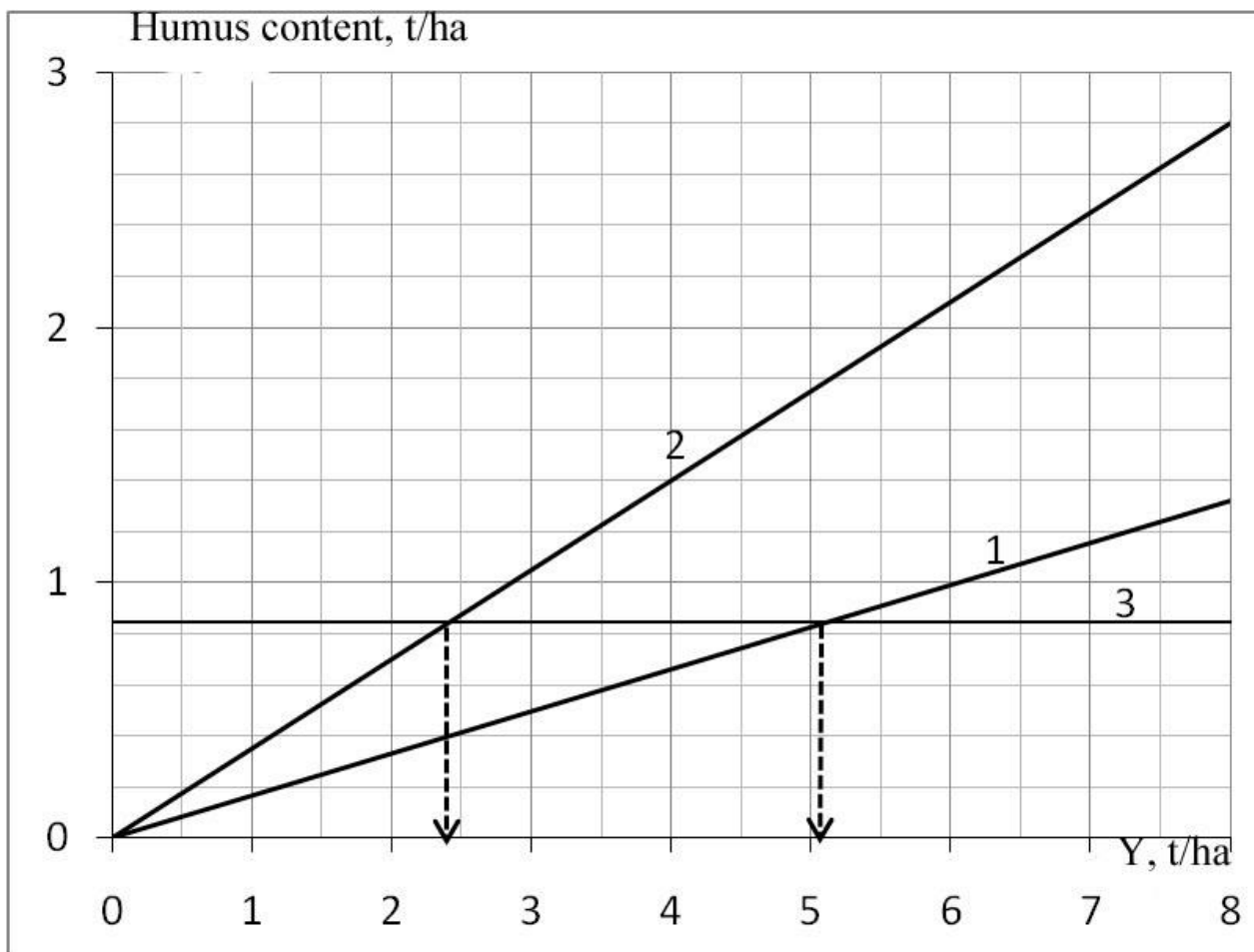
Results of calculations of the main soil nutrients with applied mineral fertilizer and incorporated straw

Ferrtilizer rates, kg/ha (X)	Additional yield, cwt/ha (ΔY)	Fertilizer rates separately on nutrients, kh/ha			Deficiency of main nutrients from applied fertilizers, kg/ha		
		X_N	X_P	X_K	ΔD_N	ΔD_P	ΔD_K
50	3,26	19,2	11,6	19,2	-10,1	-8,8	-17,6
100	6,12	38,4	23,2	38,4	-21,3	-18,0	-35,3
150	8,57	57,6	34,8	57,6	-33,4	-27,5	-53,3
200	10,60	76,8	46,4	76,8	-47,1	-37,4	-71,5
250	12,23	96,0	58,0	96,0	-61,6	-47,6	-89,9
300	13,44	115,2	69,6	115,2	-77,6	-58,2	-108,5
350	14,24	134,4	81,2	134,4	-94,5	-69,1	-127,3
400	14,64	153,6	92,8	153,6	-112,6	-80,4	-146,3
423	14,69	162,7	97,6	162,7	-121,6	-85,1	-155,2

Deficiency of main nutrients under applying mineral fertilizers with additional yields

Thanks for your attention!

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