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4R RATE:
Improving the accuracy of potassium rate recommendations

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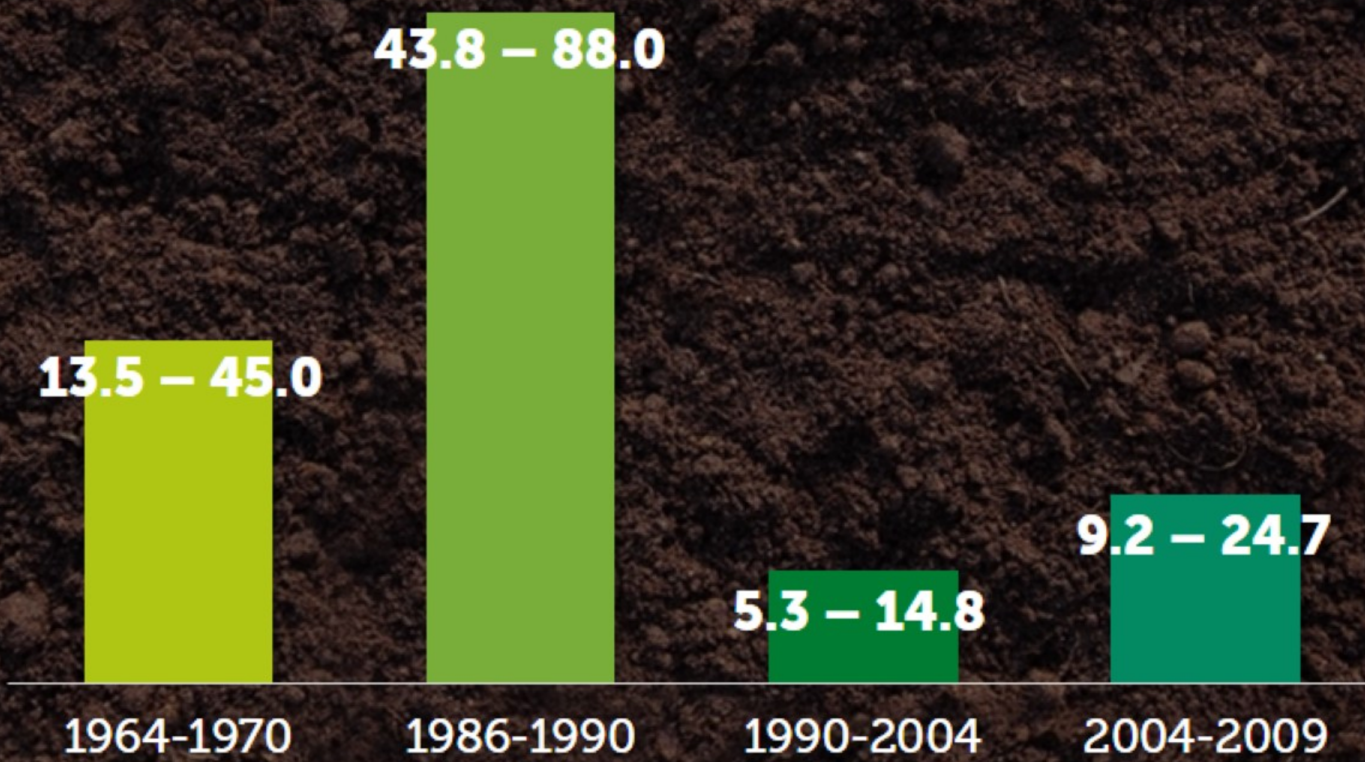
K input in arable soils of Central Russia

kg of K_2O/ha



Improvement of recommendations

on potash fertilizer use and adjustment of currently used soil K test interpretation classes in intensive cropping systems

Project start date

13.09.2012 г.

Duration

2012 - 2017

Partner organizations

- ✓International Plant Nutrition Institute
- ✓Agrochemistry Research Institute
- ✓State centers and stations for agrochemical service (SCAS) of the Ministry of Agriculture of the Russian Federation
- ✓JSC «Uralkali»

Project goals

1

Determine optimal potash fertilizer rates for major crops in crop rotation

2

Evaluate the validity of currently used soil K test interpretation classes for proper assessment of plant potassium requirements

3

Develop proposals on possible fine-tuning of current practice to develop K fertilizers recommendations

Objects

Locations of field experiments

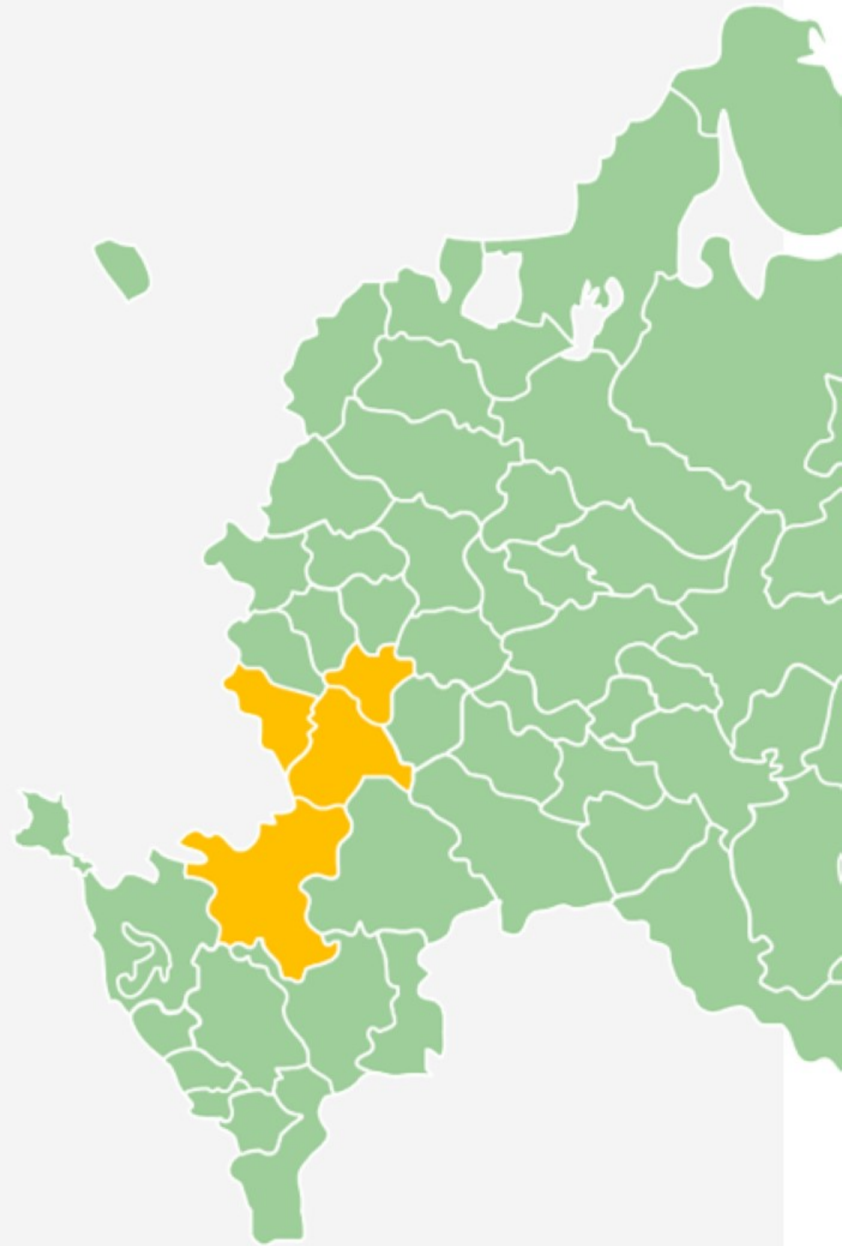
Russia - Lipetsk, Voronezh, Belgorod, and Rostov Oblasts

Soil types

Chernozem soils with medium and "increased" (higher that medium) content of routinely extracted potassium

Crops

Sugar beet, grain maize, rapeseed, soybean



On-farm experiments with K

24 — Direct effect of applied K

42 — Residual effect of applied K

4 — Increasing KCl rates

TREATMENTS

Experiments with sugar beet

▪ absolute control	▪ +K140 (K2)
▪ NP	▪ +K210 (K3)
▪ +K70 (K1)	▪ +K280 (K4)

Experiments with grain maize

▪ absolute control	▪ +K120 (K2)
▪ NP	▪ +K180 (K3)
▪ +K60 (K1)	▪ +K240 (K4)

Soil K test methods

Soil K test interpretation classes
(mg K_2O/kg of soil)

Soil K level	Chirikov	Machigin	Maslova
Very low	<20	<100	<50
Low	21-40	101-200	51-100
Medium	41-80	201-300	101-150
Increased	81-120	301-400	151-200
High	121-180	401-600	201-300
Very high	>180	>600	>300

Mobile soil K

- Chirikov method (0.5 M CH_3COOH) and Machigin method (1% $(NH_4)_2CO_3$)

Exchangeable soil K

- Maslova method (1M CH_3COONH_4)

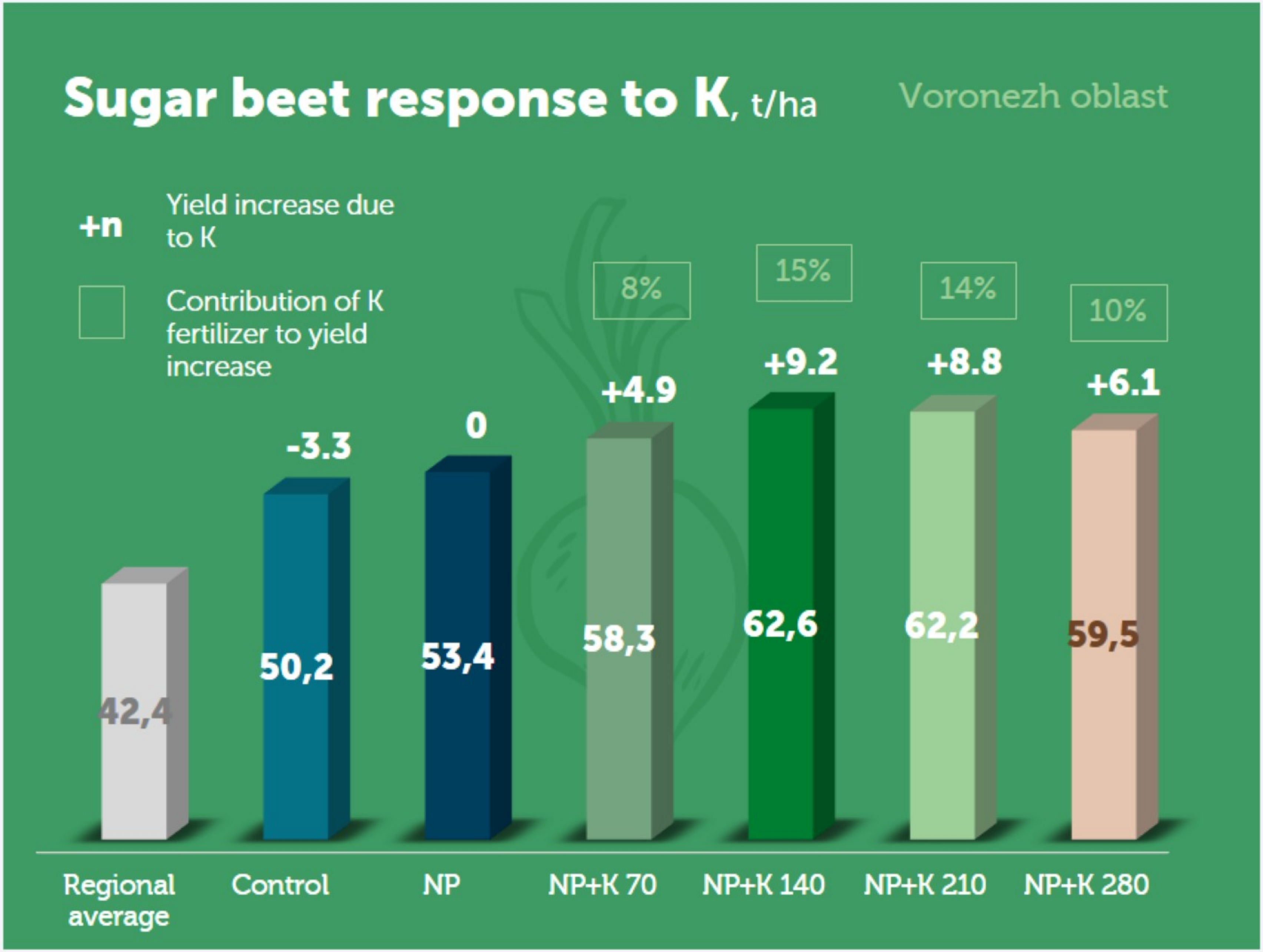
Easily exchangeable soil K

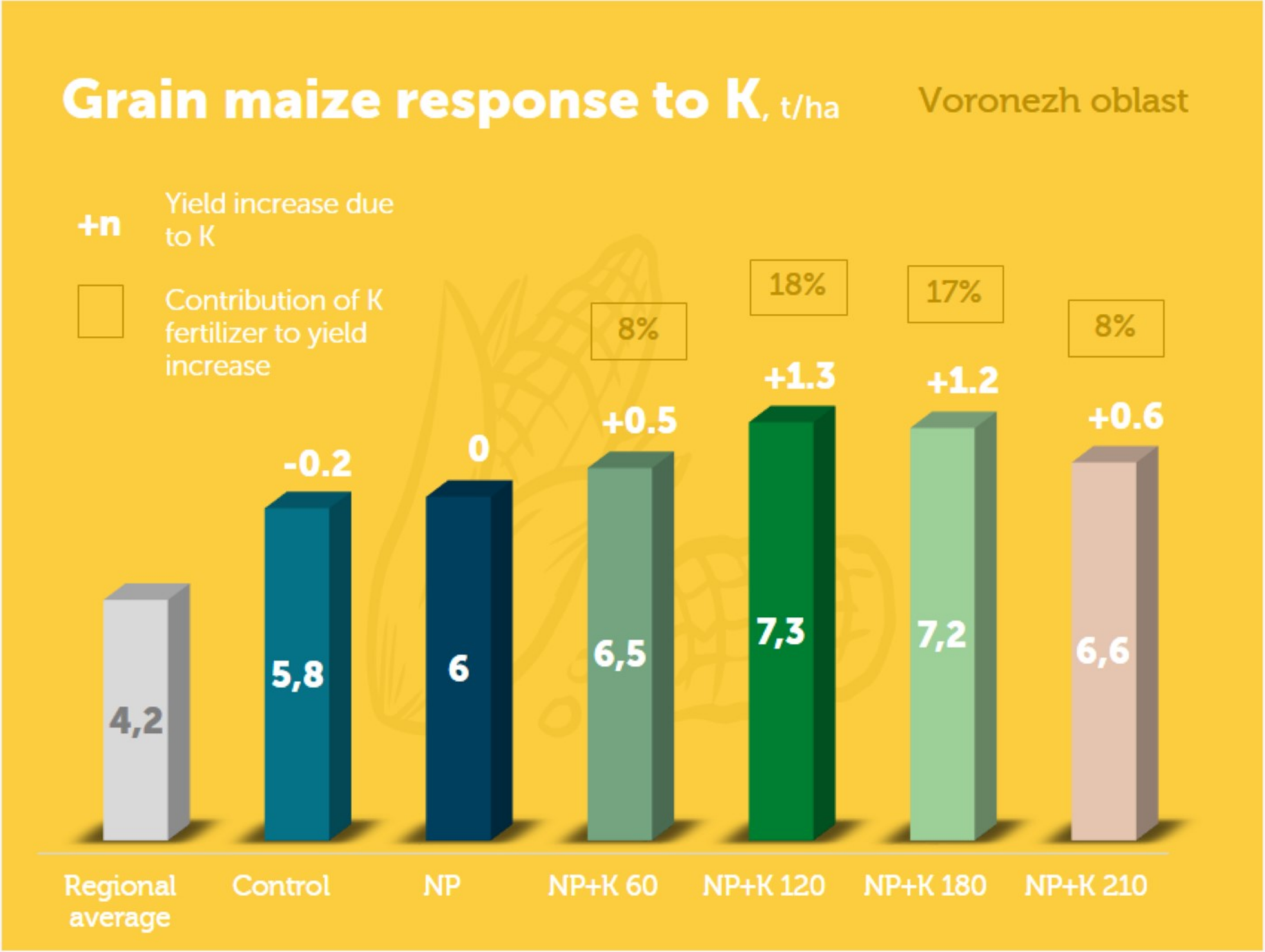
- 0.01 M $CaCl_2$

Crop response to direct K application

average data for 3 years

	Maximum yield increase due to K (t/ha)	Contribution of K to the yield increase
GRAIN MAIZE	1.3	18%
SUGAR BEET	7.5 – 9.2	15%
SPRING RAPESEED	0.2	13%
SOYBEAN	0.1	6%

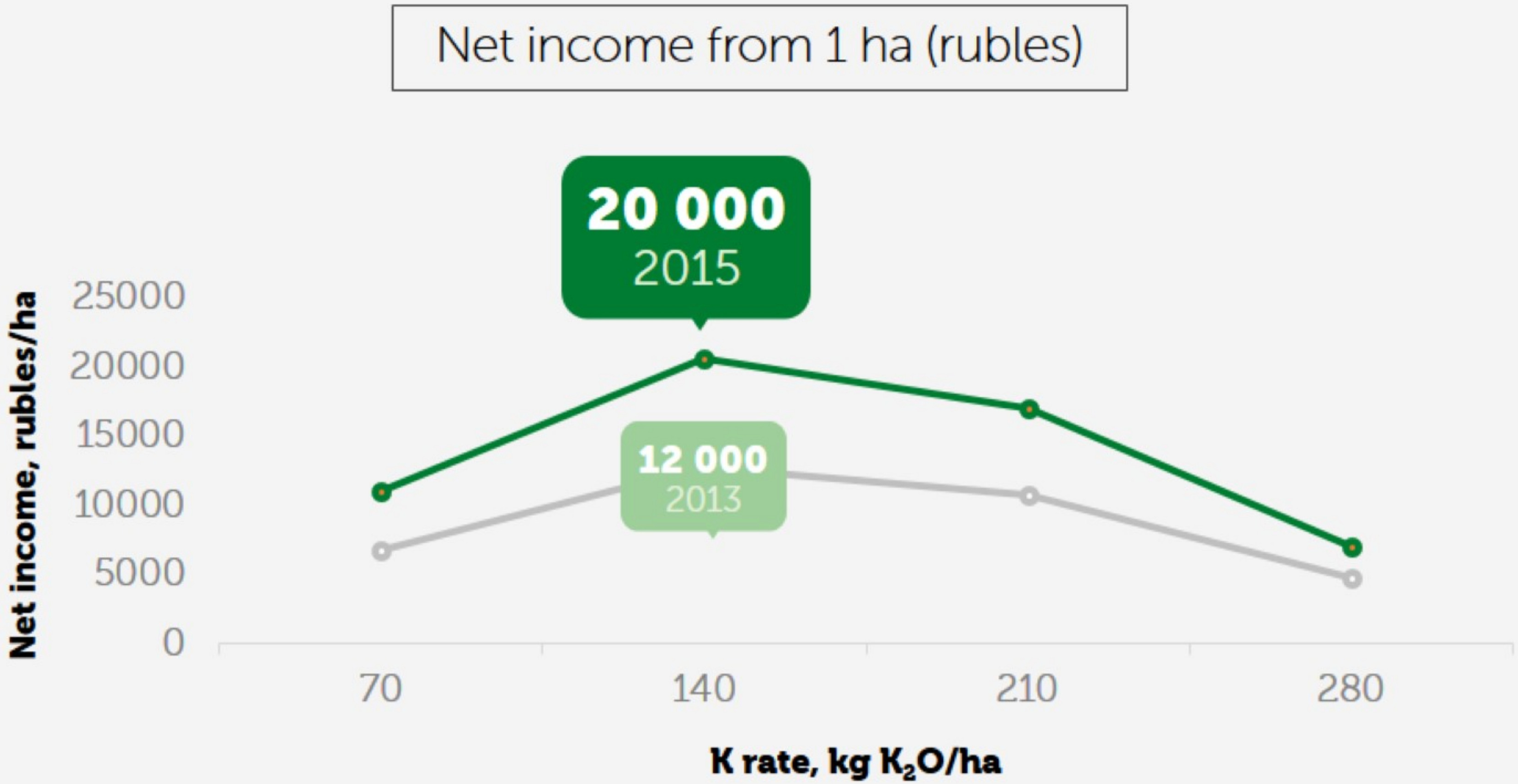

Sugar beet response to K, t/ha
Voronezh oblast
+n
Yield increase due to K
Contribution of K fertilizer to yield increase
42,4
50,2
-3.3
53,4
0
58,3
+4.9
8%
62,6
+9.2
15%
62,2
+8.8
14%
59,5
+6.1
10%
Regional average
Control
NP
NP+K 70
NP+K 140
NP+K 210
NP+K 280



Grain maize response to K, t/ha
Voronezh oblast
+n
Yield increase due to K
Contribution of K fertilizer to yield increase
8%
18%
17%
8%
-0.2
0
+0.5
+1.3
+1.2
+0.6
4,2
5,8
6
6,5
7,3
7,2
6,6
Regional average
Control
NP
NP+K 60
NP+K 120
NP+K 180
NP+K 210

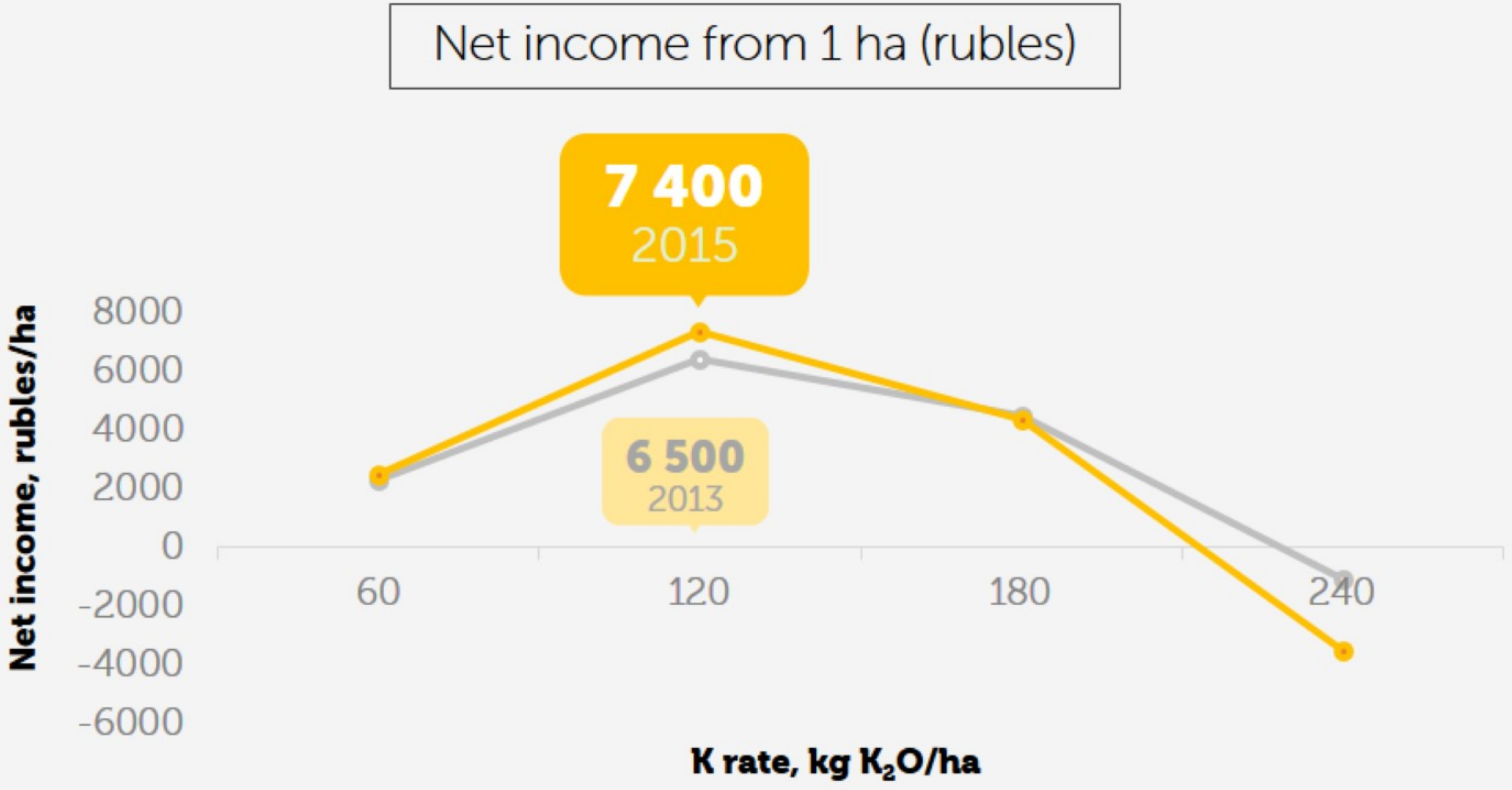
Profitability of potassium fertilizers applications for sugar beet

Voronezh oblast



Profitability of potassium fertilizers applications for grain maize

Voronezh oblast



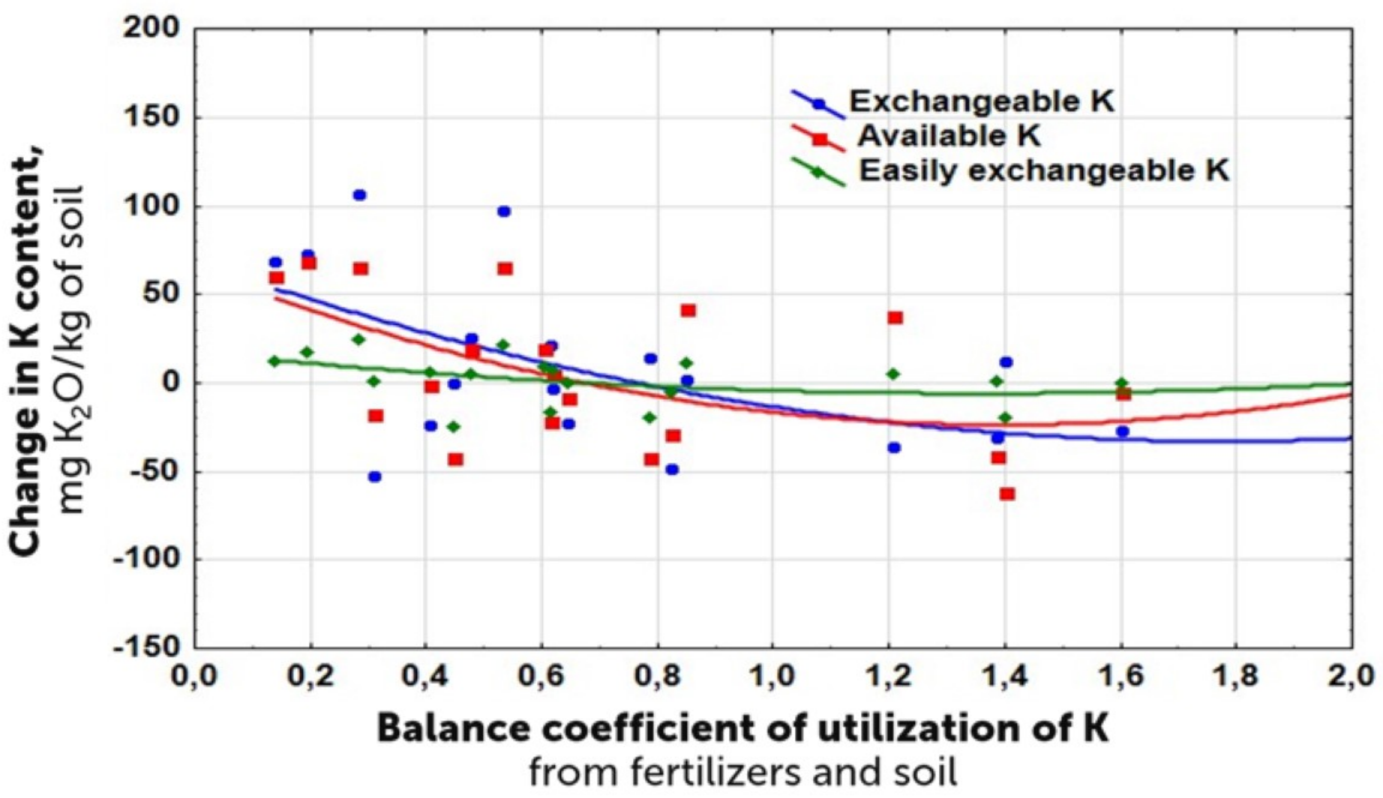
Multi-criteria estimations of optimal K rates

(kg K2O/ha)

Maximum yield increase due to K	Maximum yield increase with account for residual effect of K	Maximum yield of sugar (beet) or protein (maize)	Positive potassium balance	Maximum agronomy efficiency with account for residual effect of K	Maximum net income
Voronezh oblast, sugar beet					
140-210	**140**	**140**	**210**	**70**	**140**
Lipetsk oblast, sugar beet					
280	**280**	**280**	**280**	**70**	**140-280**
Voronezh oblast, grain maize					
120	**120**	**120**	**120**	**120**	**120**

Changes in the contents of different soil K forms during the vegetation period versus the balance coefficient

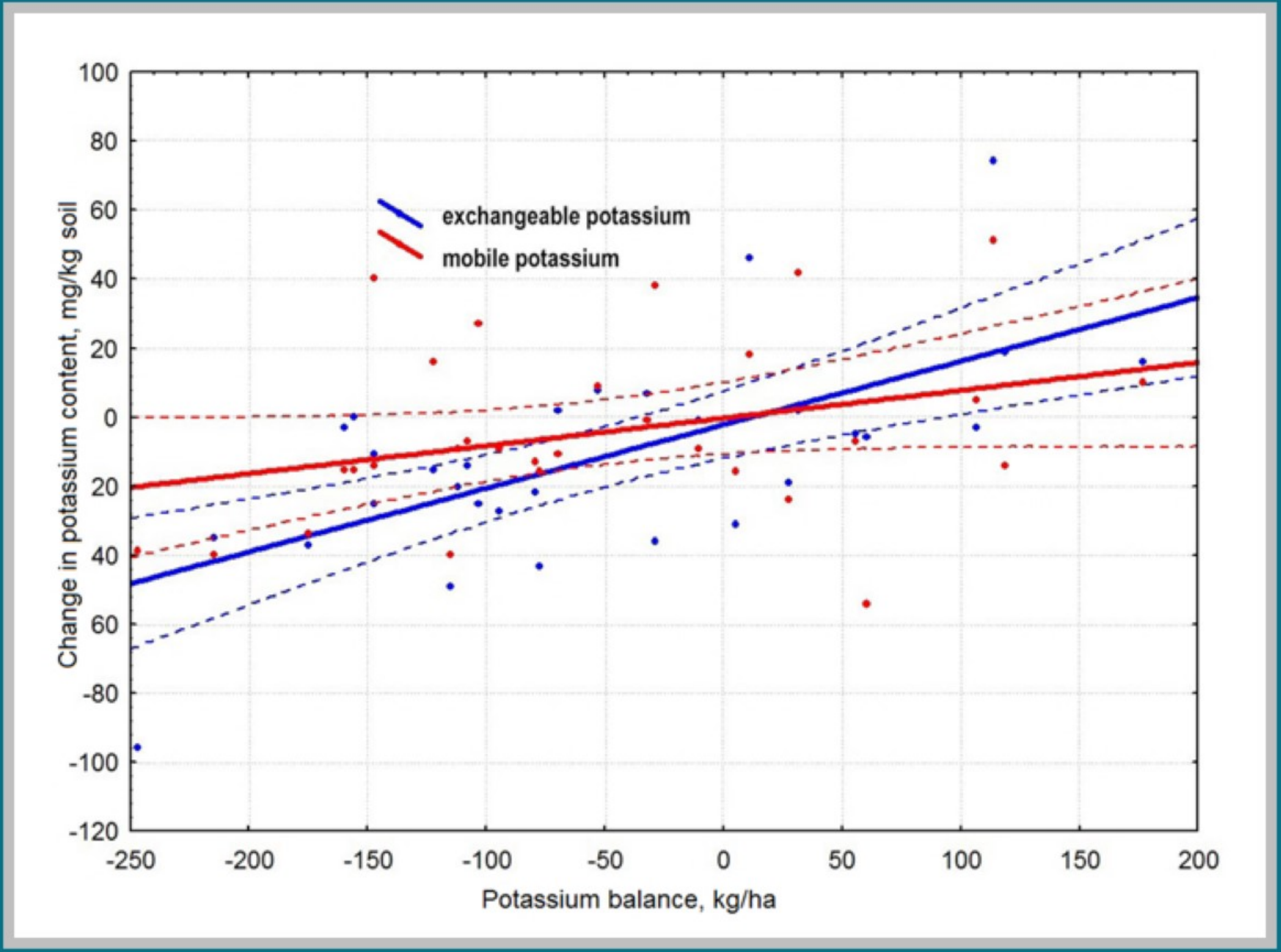
$$BCUFS = \frac{Rf}{F} \cdot 100\%$$



Rf –
K removal with the main and side crop in the treatment with fertilizer application, kg K_2O/ha

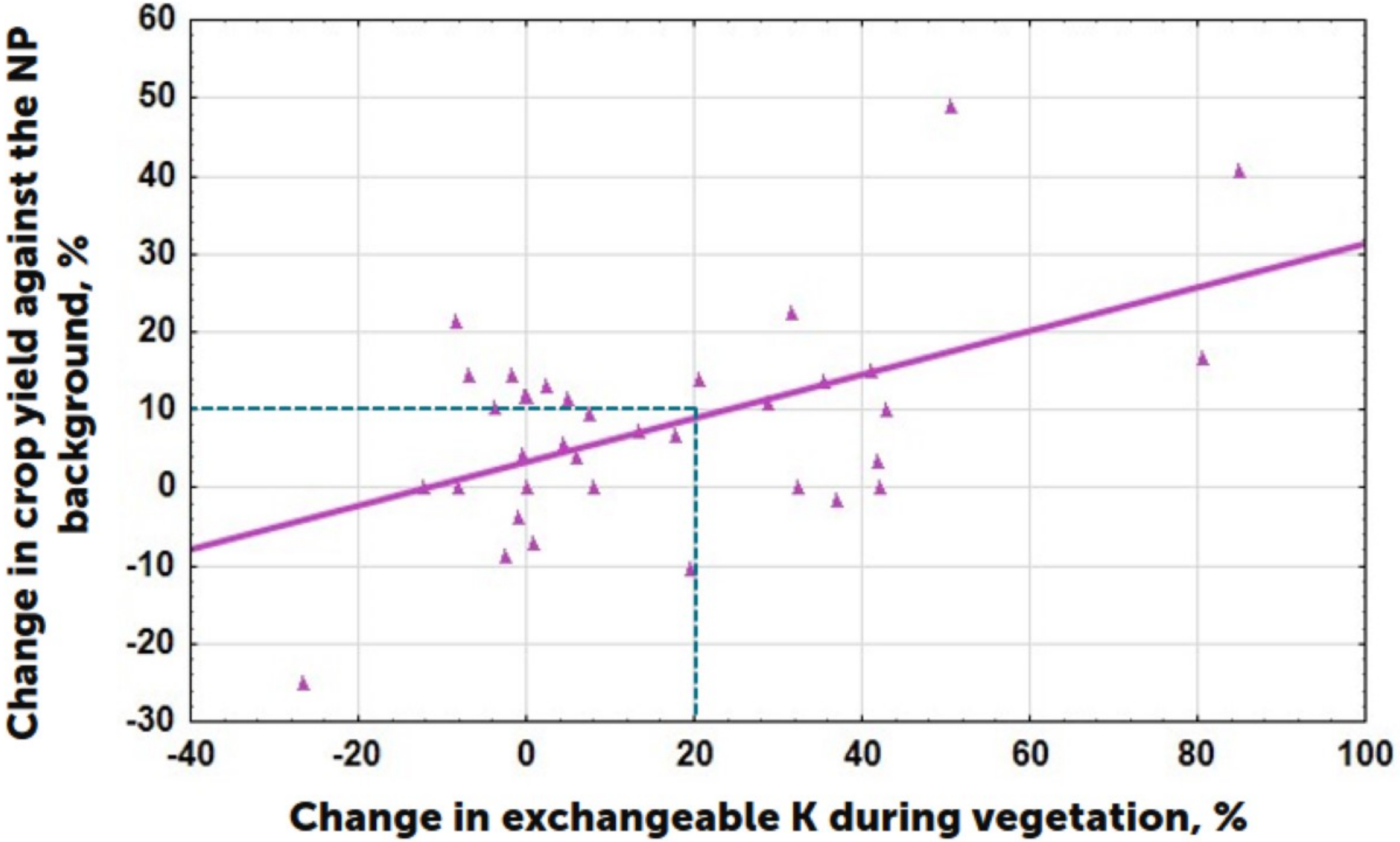
F –
Fertilizer rate, kg K_2O/ha

Relationship between changes in exchangeable and mobile soil K



Effect of the increase in the content of exchangeable K on the change in the yield of sugar beet and grain maize

for the set of treatments with the contents of exchangeable K higher than 250 mg K_2O/kg



Conclusions

1

In Central Russia a substantial yield increase due to K application indicates a significant yield loss which take place without K fertilization even on soils with relatively high content of plant available K

2

In Central Russia region for sugar beet and grain maize grown on chernozems Maslova soil K test method (1M CH_3COONH_4) is the most sensitive to predict crop response to application of K fertilizers

Optimal K application rates, kg K_2O/ha

Voronezh oblast

SUGAR BEET	140
GRAIN MAIZE	120

Lipetsk oblast

SUGAR BEET	210-280

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THANK YOU