Региональный подход к анализу рынков минеральных удобрений: ГИС как инструмент для выработки рекомендаций по сбалансированному внесению удобрений

Regional approach for analysis of the mineral fertilizer market: GIS as a tool for balanced fertilization recommendations

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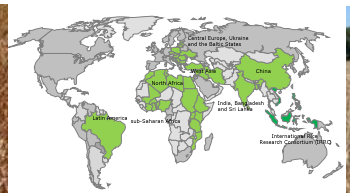
Contents:

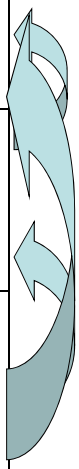
- *Application of GIS in agriculture*
- *GIS as a component of the "Fertilize Brazil" project:*
  - *steps of implementation,*
  - *data sources,*
  - *data bases,*
  - *mapping of nutrients balance (Macro-, Meso- and Micro- levels)*
- *Geo- approach for analysis of mineral fertilizers market in Russia:*
  - *Potash fertilizers markets in Russian regions*



IPI presence map

Application of GIS for specific purposes, related with fertilizers use

Level	Scale	Polygons	Purposes	Users
Micro-	< 1 : 10.000	Fields, plots	Precision agriculture; site-specific management	Farmers
Meso-	1 : 5.000.000 - 1 : 500.000	Counties, landscape contours, soil type areas	Yield forecast, consulting, farm management, fertilizers retail trade	Agronomists consulters, fertilizers dealers, local NPK blenders
Macro-	>1 : 10.000.000	Provinces, states	Regional development assessment, regional targeting of agribusiness strategy	Government, industries, major fertilizers traders



GIS for mapping nutrients balance in Brazilian soils: joint project of IPI and EMBRAPA

- *Brazilian soils are not reach enough in nutrients*
- *Brazilian agriculture strongly depends on mineral fertilizers*
- *Brazil is one of the major N, P and K consumers (4,1%, 10,1 and 11,7% of the world total respectively)**
- *Fertilizing practices in Brazil seek geographical precision, especially in recently developed areas of the Cerrado (savannas), where 17 mi ha were colonized to agriculture after 1980s*
- *Since 2001, IPI cooperates with Brazilian Corporation of Agricultural Research (EMBRAPA)*
- *GIS is a part of IPI-EMBRAPA Project "Fertilize Brazil: Support for Balanced Use of Potassium and other Nutrients in Brazilian Agriculture"*

International Potash Institute

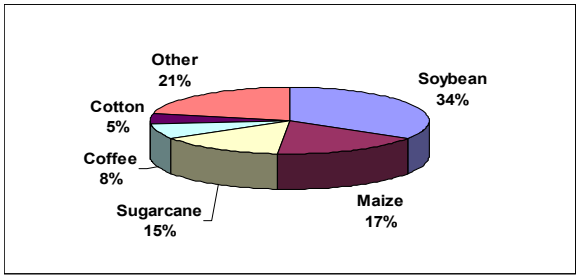
Embrapa Solos

COMIGO

Fesurv Universidade de Rio Verde

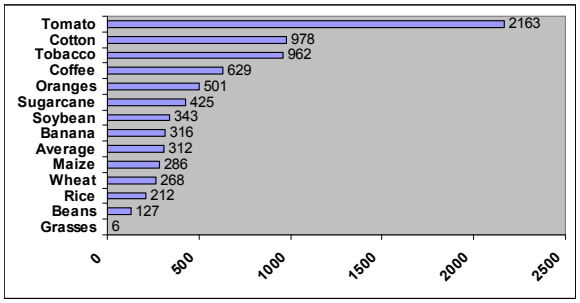
* Faostat (2008)

Brazil: Fertilizers consumption by crop, 2006



Total N, P, and K consumption
(other: rice, beans, oranges, tobacco)

Source: ANDA (2006)



N, P, and K consumption by crop, kg ha^{-1}

Source: ANDA (2006)

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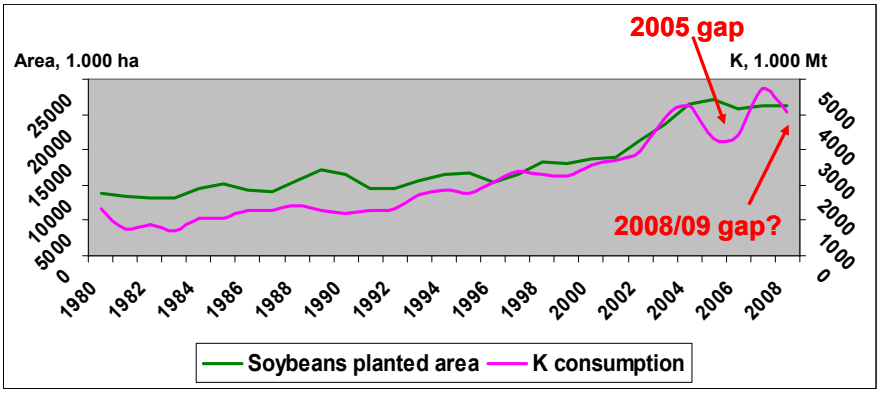
Brazil: K consumption and soybeans planted area,1980-2008



Sources: ANDA, FAO

Correlation (1980-2004):
K consumption and soybeans planted area = 0,9441
K consumption and total agricultural area = 0,8742

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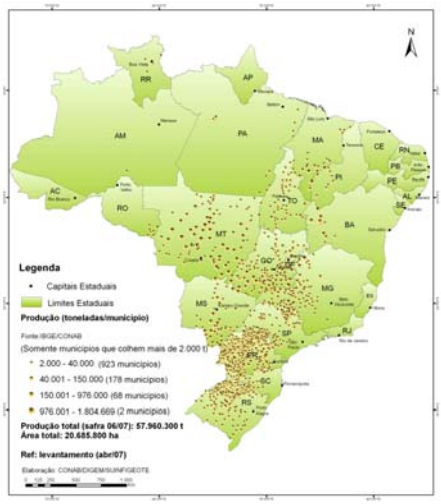
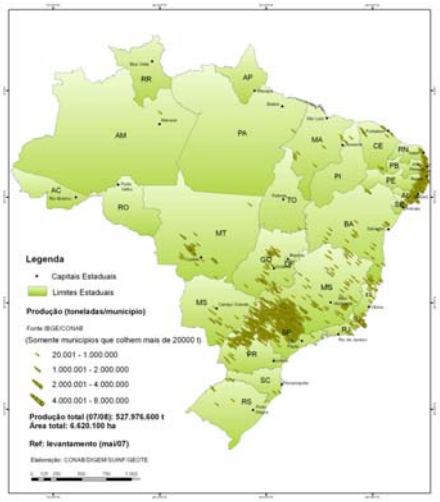
Brazil: regional concentration of commercial crops

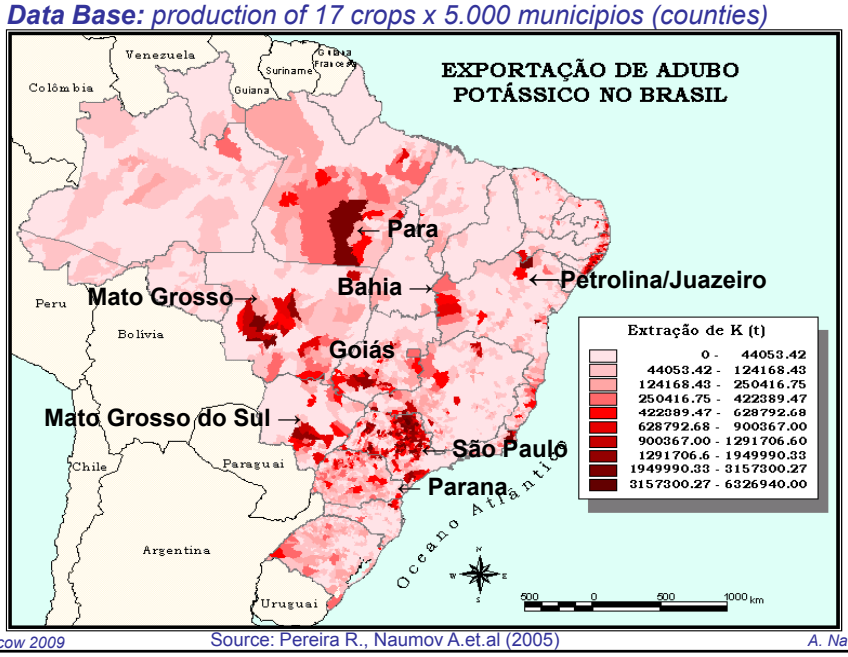
Soybeans production



Sugarcane production



STEP 1 (Macro-level): *mapping K uptake with yield*
Data Source: *IBGE census, CONAB estimates for 2002/2003*
Data Base: *production of 17 crops x 5.000 municipios (counties)*



 Source: Pereira R., Naumov A.et.al (2005)

STEP 1: techniques

PRODUÇÃO AGRÍCOLA MUNICIPAL – LAVOURA PERMANENTE 1999 e 2001

- Algodão arbóreo - área destinada à colheita
- Algodão arbóreo - área colhida
- Algodão arbóreo - quantidade produzida
- Algodão arbóreo - rendimento médio
- Algodão arbóreo - valor
- Azeitona - área destinada à colheita
- Azeitona - área colhida

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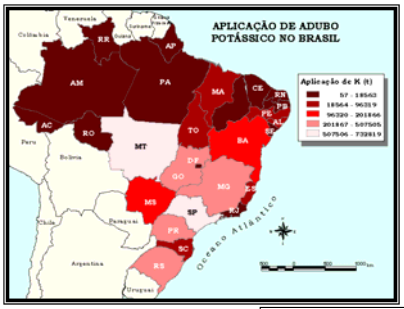
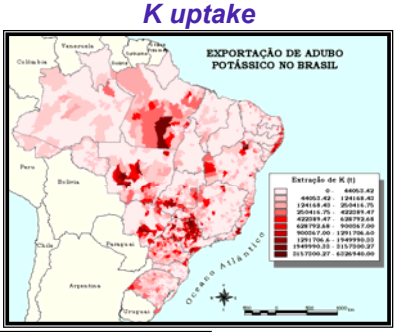
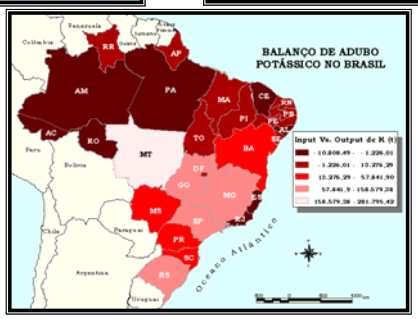
STEP 1 (Macro-level): K balance by state: negative and positive

K fertilization



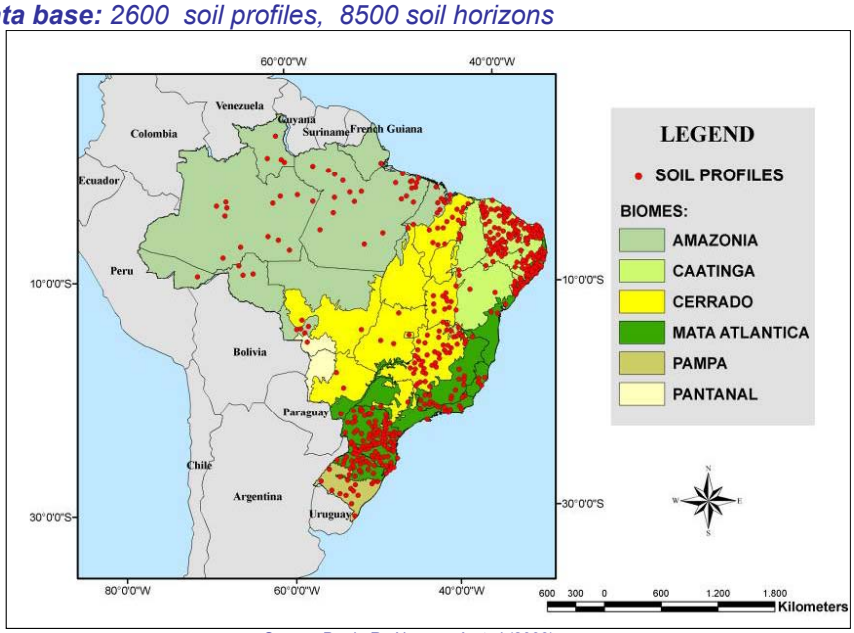
K uptake



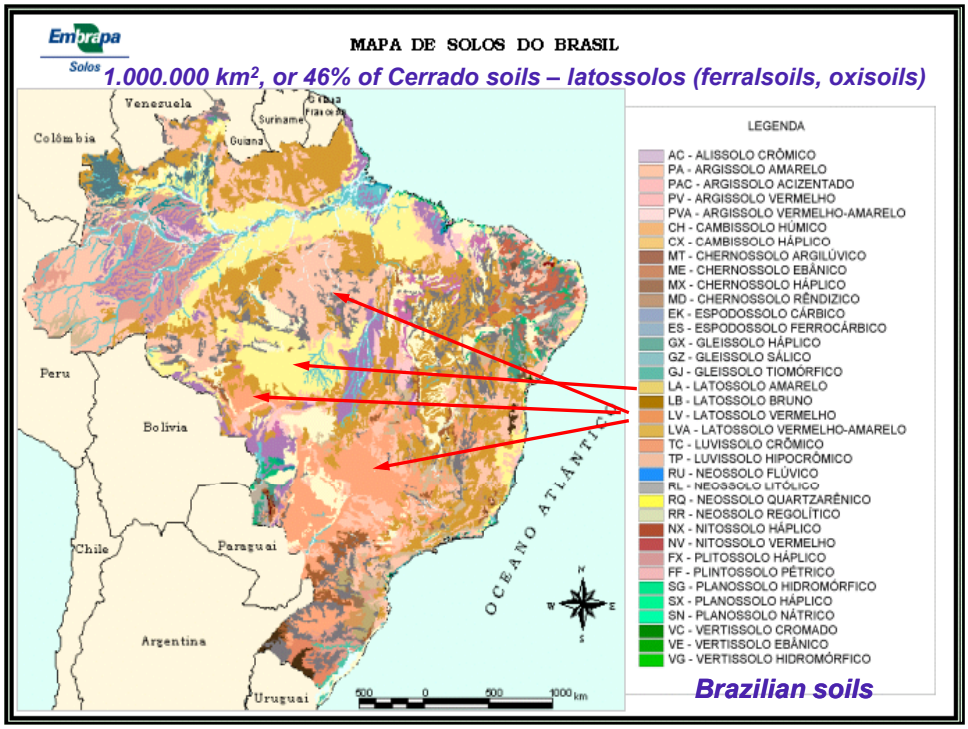


IFA Moscow 2009 Source: Pereira R., Naumov A.et.al (2005) A. Naumov

STEP 1 (Macro-level): *mapping K availability in soil*
Data source: *soil profiles, soil map (EMBRAPA Solos), landscape map (IBGE)*
Data base: *2600 soil profiles, 8500 soil horizons*

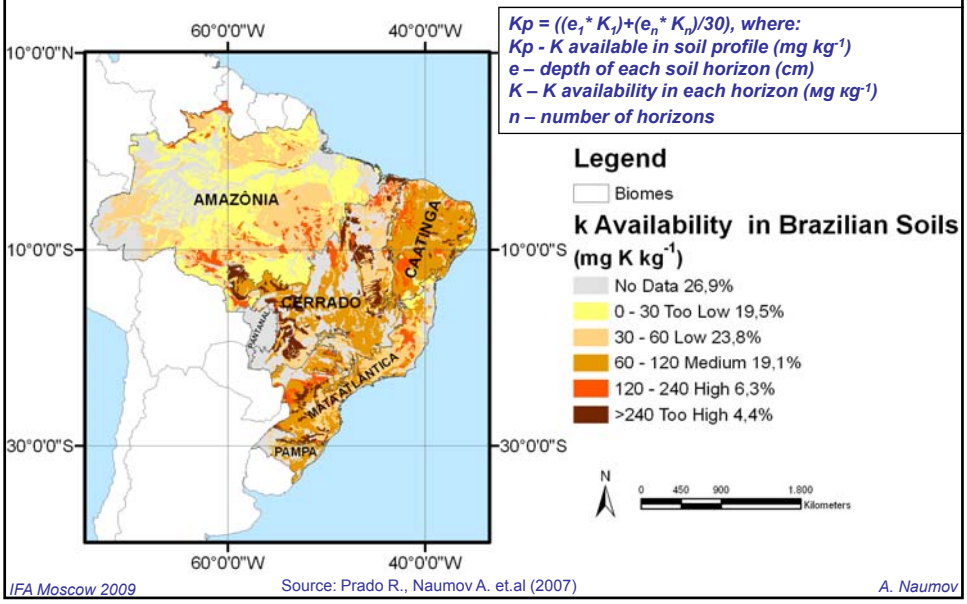


IFA Moscow 2009 Source: Prado R., Naumov A.et.al (2006) *A. Naumov*



Brazilian soils

STEP 1 (Macro-level): *Mapping of availability in Brazilian soils*



Kp = ((e$_1$* K$_1$)+(e$_n$* K$_n$)/30), where:
Kp - K available in soil profile (mg kg^{-1})
e – depth of each soil horizon (cm)
K – K availability in each horizon (мg кг$^{-1}$)
n – number of horizons

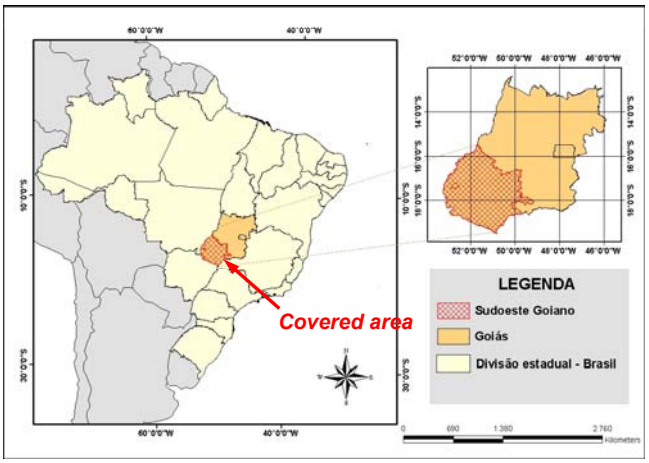
IFA Moscow 2009 Source: Prado R., Naumov A. et.al (2007) *A. Naumov*

STEP 2 (Meso-level): *mapping of K balance in the soils of Goias state*

Location: *SW of the Goias state, Brazil (Cerrado region)*

Data source: *soil database of the COMIGO ag-coop, soil maps, geo-referenced soil sampling, farmers poll*

Data base: *IBGE statistics by 13 crops x 51 municipios (counties); ~ 5.000 soil samples; ~ 200 questionnaires returned by farmers*



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STEP 2: *Soil fertility by-farm DB of the COMIGO ag-coop: organized and completed by EMBRAPA*

Cliente	Nome	Fazenda	NomeProp	Cidade	Estado	Laudo	Amostra	Ph	CaMg	Ca	Mg	RCaMg	Al	HAl1	Ka
1001126	ALVARO MARTINS HENKES	13	FAZ. KAMALA	MONTES CLAROS	GO	123	1	4,10	0,42	0,24	0,18	1,33	0,90	3,70	0,07
1003473	CLAUDIO CESAR TEORO	3	FAZ. RIO DOCE	RIO VERDE	GO	100316	3	5,00	3,83	2,32	1,51	1,54	0,03	2,80	0,26
1001793	ADEMIR ARMANDO BOLDRIN	9	FAZ. PARAISO DO RIO PRE1	RIO VERDE	GO	765	6	4,20	1,39	0,17	1,22	0,14	0,72	3,10	0,07
474	CALLIL JOSE RAHAL	3	FAZ. VALE DO CEDRO	PALESTINA	GO	1	1	4,30	3,34	0,47	2,87	0,16	0,38	3,80	0,24
2238	ENERGETICA SERRANÓPOLIS	8	FAZ. NOSSA SENHORA DA (	SERRANOPOLIS	GO	139	5	4,40	3,25	0,49	2,76	0,18	0,24	2,80	0,04
1004967	MARCOS ANTONIO CASSOL	6	FAZ. ABILIO	RIO VERDE	GO	1830	25	4,60	3,62	0,75	2,87	0,26	0,20	3,20	0,06
1000803	RUI CARLOS FERREIRA	1	FAZ. SANTA TEREZINHA	SERRANÓPOLIS	GO	9640	1	4,20	0,91	0,21	0,70	0,30	0,58	2,40	0,02
1002045	JOSE BENTO BORGES	2	FAZ. SAO JOSE	RIO VERDE	GO	2570	1	4,70	1,59	0,40	1,19	0,34	0,20	3,10	0,08
1002231	JOAO IVAN VILELA LEAO	1	FAZ. RIO PRETO TALHADO	RIO VERDE	GO	2326	2	4,40	2,21	0,57	1,64	0,35	0,35	3,30	0,06
2000678	LIBORIO MANOEL JOAQUIM DI	25	FAZ. ESTRELA DO SUL	ACREÚNA	GO	2845	6	5,50	1,23	0,33	0,90	0,37	0,01	3,50	0,35
2137	JONAS GOMES DE MORAES	1	FAZ. CAMPO ALEGRE	PARAÚNA	GO	9712	7	5,10	11,79	3,39	8,40	0,40	0,04	3,40	0,46
526	VALE DO VERDÃO S/A	131	FAZ. 2 R	MAURILÂNDIA	GO	2976	1	4,30	1,09	0,32	0,77	0,42	0,60	4,00	0,13
1004887	CELSO GOBBI	4	FAZ. CORDILHEIRA	JATAÍ	GO	275	5	5,00	4,30	1,36	2,94	0,46	0,01	2,50	0,06
1944	DESTILARIA CATANDUVA LTD/	2	FAZ. ALVORADA	RIO VERDE	GO	2216	18	4,40	1,65	0,57	1,08	0,53	0,26	2,80	0,06
1001715	ANDREY GUIMARAES MARTIN	4	FAZ. CAÇU	CAÇU	GO	2536	1	4,10	0,46	0,17	0,29	0,59	0,28	2,20	0,04
1005025	WAGNER GUIMARAES NASCIM	2	FAZ. ACANTILHADO	RIO VERDE	GO	2086	1	4,50	1,71	0,64	1,07	0,60	0,40	3,10	0,14
1004684	CARLOS DA SILVA	6	FAZ. SANTA CECÍLIA	CAIAPÔNIA	GO	2896	3	5,50	1,60	0,60	1,00	0,60	0,01	2,80	0,18
1002332	CELINO FERREIRA DA SILVA	1	FAZ. BOA VISTA	RIO VERDE	GO	811	3	5,90	11,54	4,33	7,21	0,60	0,00	2,30	0,18
2113	MARQUES MARTINS CABRAL	2	FAZ. JAMAR	RIO VERDE	GO	9418	4	5,20	1,46	0,55	0,91	0,60	0,03	3,70	0,30
789	ADIMAR M. DE OLIVEIRA	1	FAZ. SÃO TOMAZ CILINDRO	RIO VERDE	GO	1842	1	4,40	0,37	0,14	0,23	0,61	0,32	3,30	0,05
1001503	NIVALDO ISAAC HORBILON	3	FAZ. CABELEIRA MATÃO	RIO VERDE	GO	100673	3	4,90	2,30	0,89	1,41	0,63	0,10	3,90	0,43
1004897	LEONARDO VELOSO DO PRAD	8	FAZ. MONTE ALEGRE	RIO VERDE	GO	2644	1	5,70	0,95	0,37	0,58	0,64	0,02	1,40	0,11
2113	MARQUES MARTINS CABRAL	4	FAZ. RENASCER	ÁGUA BOA	GO	9655	1	5,30	2,91	1,18	1,73	0,68	0,03	1,60	0,80
1003951	ADROALDO GORGEN	3	FAZ. ARIRANHA LUGAR CEF	JATAÍ	GO	2514	2	5,30	1,40	0,58	0,82	0,71	0,02	3,10	0,13
1000294	ROBERTO MARTINS SPADONI	1	FAZ. PARAISO	RIO VERDE	GO	1053	1	5,20	4,70	1,97	2,73	0,72	0,03	3,90	0,10
1000235	CARLOS GUIMARAES DE FREI	2	FAZ. ESPLANADA	RIO VERDE	GO	899	2	4,30	0,59	0,25	0,34	0,74	0,40	2,40	0,08
1847	JEFFERSON JUNIOR DE OLIVE	2	FAZ. COLORADO	PARAÚNA	GO	2048	2	4,60	0,49	0,21	0,28	0,75	0,28	2,30	0,24
1002104	HUMBERTO LEAO GUIMARAES	3	FAZ. MONTE ALEGRE	RIO VERDE	GO	101195	2	4,10	1,18	0,51	0,67	0,76	0,99	7,70	0,11
1944	DESTILARIA CATANDUVA LTD/	1	FAZ. DONA SANTINHA	RIO VERDE	GO	1725	2	4,40	0,83	0,36	0,47	0,77	0,38	2,40	0,03
1001855	ANTONIO PIMENTA MARTINS	7	FAZ. ESCONDIDA	SÃO SIMÃO	GO	100940	2	4,00	1,10	0,48	0,62	0,77	0,96	6,30	0,11
1000675	MARTINHO HUMBERTO LOPES	4	FAZ. RIO CLARO	JATAÍ	GO	482	3	4,70	0,74	0,33	0,41	0,80	0,10	1,90	0,18
1001154	JOSE LUIZ FERRARI	3	FAZ. PARAISO DO RIO PRE1	RIO VERDE	GO	938	1	4,40	0,38	0,17	0,21	0,81	0,35	2,30	0,13

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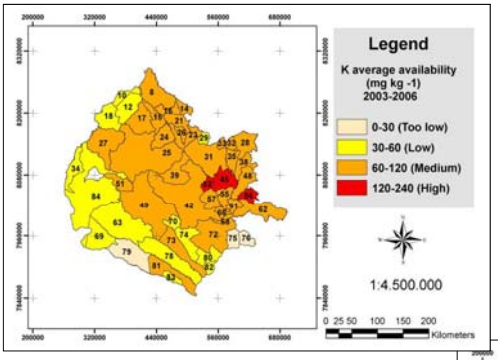
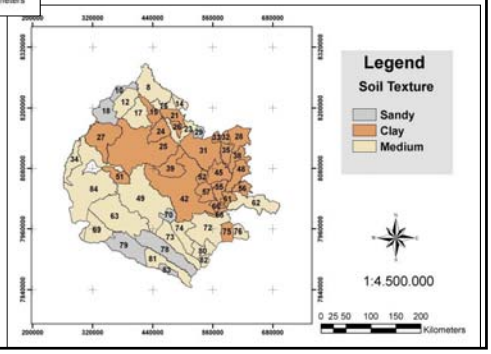
STEP 2



Comparing soil K availability and soil texture classes maps...

...There is a tendency of soil K availability increase in clay soils, whereas sandy soils loose K by leaching.



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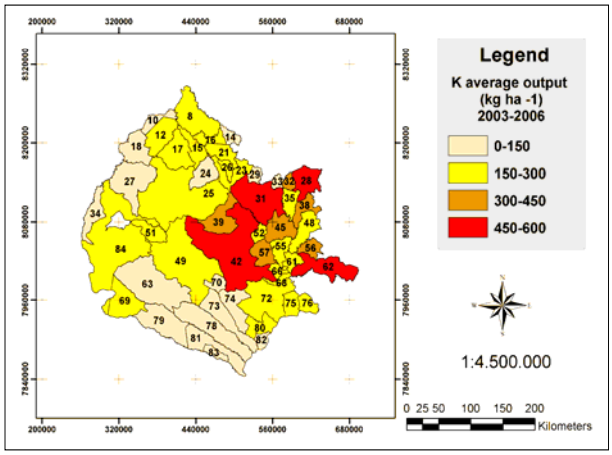
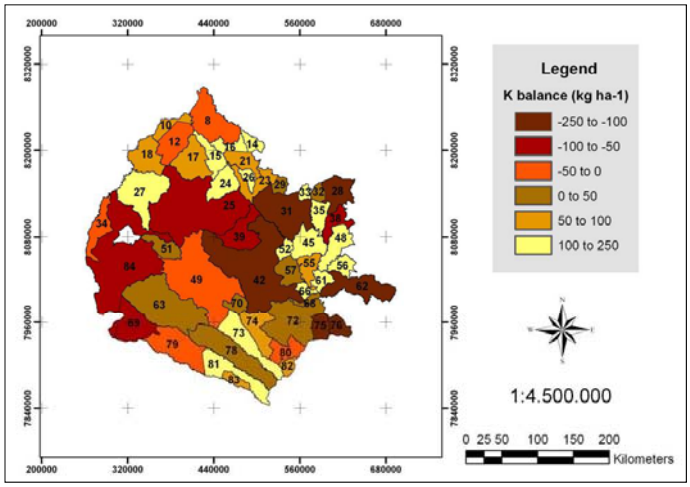
STEP 2

First results of K mapping:
K output (red on the map) depends on yields of soybeans



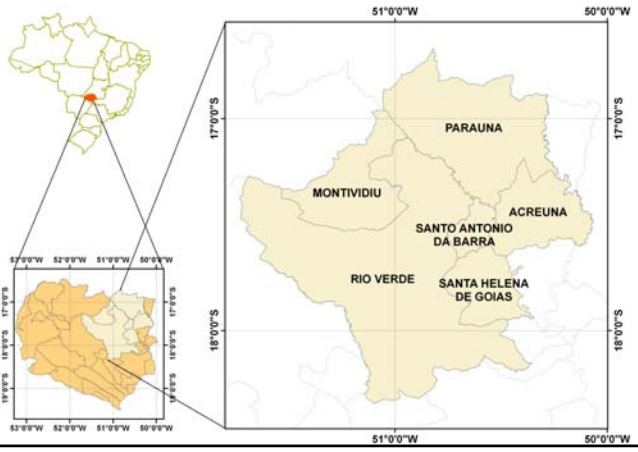
Source: Prado R., Naumov A. et.al (2007)

STEP 2 ***First results of K mapping***: *Negative balance is related with high yields and/or insufficient K applied. Positive balance is related with low yields and/or excess of K applied. "Zero" balance = ideal*



Source: Prado R., Naumov A. et.al (2007)

STEP 3 (Meso-level): *mapping of K balance in the soils of Goias state*
Location: *Rio Verde + 5 nearby counties SW of the Goias state, Brazil*
Data source: *soil map 1 : 250.000, created at the step #2, LANDSAT satellite images 1 : 50.000 for summer (10/02, 05/03/2007) and winter (08/05,17/05/2007) seasons, field trials (54 sites visited)*
Data base: *1 : 500. 000 map, generalized from 1 : 50.000 fragments of deciphered satellite images*



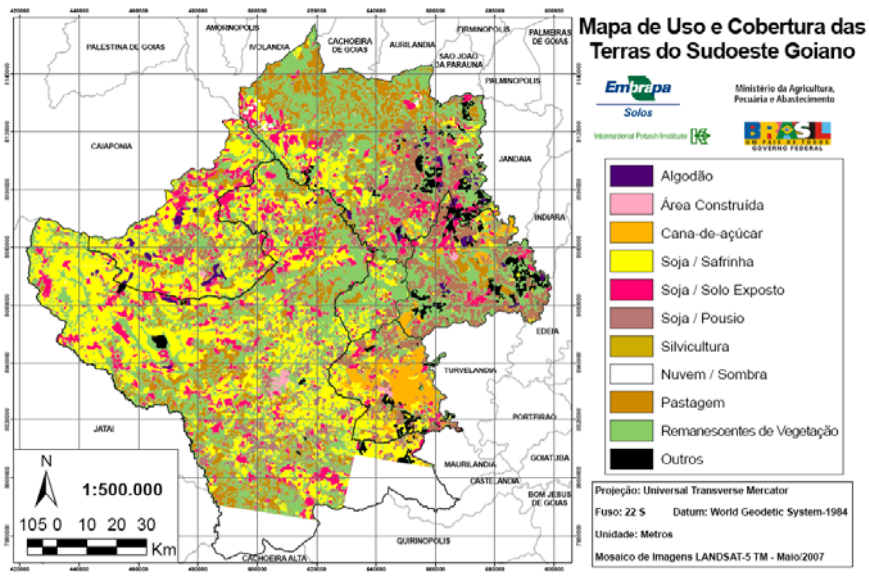
STEP 3 (Meso-level): *LANDSAT images processing and field work*

Results of segmentation of Landsat images (part of study area)

Results of classification of Landsat images (part of study area)

STEP 3 (Meso-level): Results

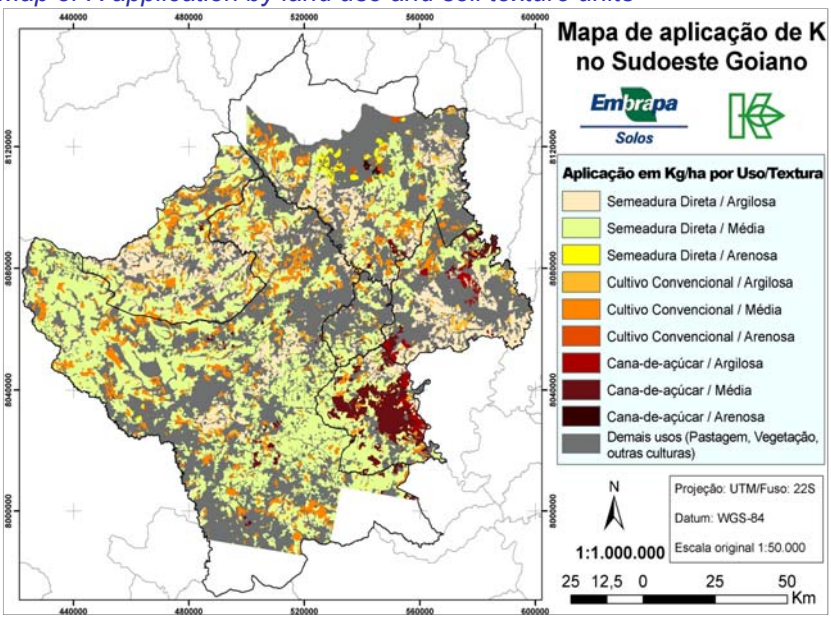
Map of land use and soil cover (cotton, sugarcane, soybean, pasture, etc.)



IFA Moscow 2009 Source: Ferreira E., Prado R., Naumov A. et al (2009) *A. Naumov*

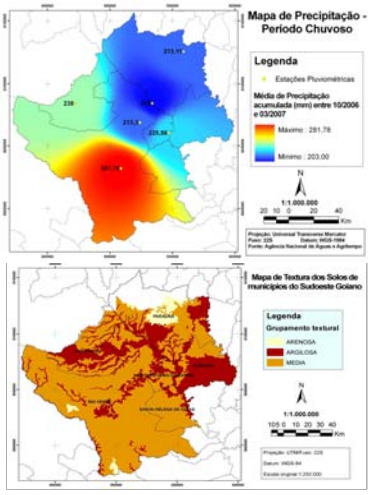
STEP 3 (Meso-level): Results

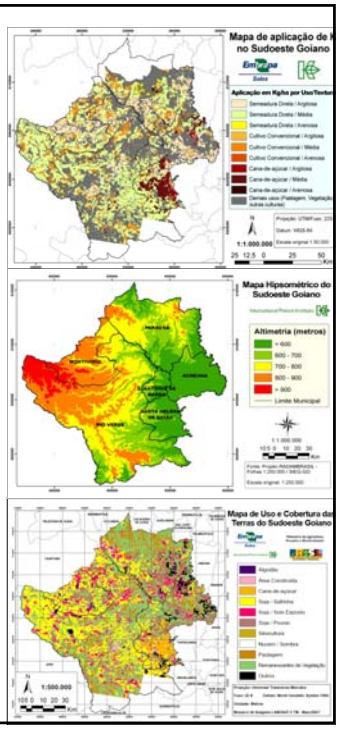
Map of K application by land use and soil texture units



IFA Moscow 2009 Source: Ferreira E., Prado R., Naumov A. et al (2009) *A. Naumov*

Meso-level: Next activities
Comparing: *K application, K soil availability, precipitation, geomorphology, land use*
Scale: *1 : 250.000*





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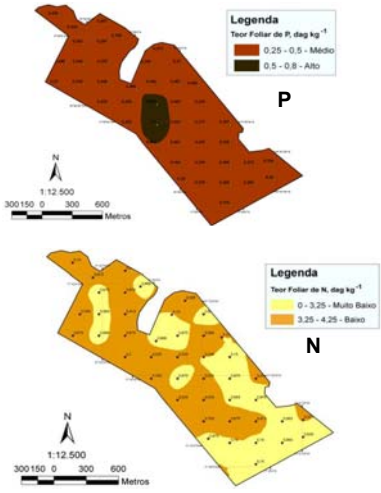
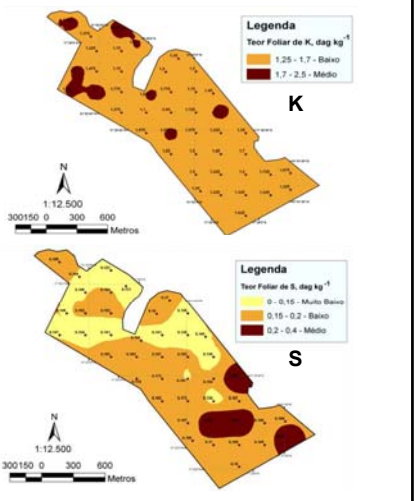
STEP 4 (Micro-level): First approach
Location: *Jataí, Goias state, Brazil*
Data Source: *foliar analysis of N, P, K and S*
Data Base: *1 : 12.500 map*





IFA Moscow 2009 Source: Cabral et al (2009) *A. Naumov*

How GIS enable optimization of fertilizers use?

- ***At MACRO-level:***

  - Helps to understand geographical differences in nutrients balance and fertilizing practices (due to soil and landscape differences, types of agriculture, etc.)

  - Provides tool for analysis of regional fertilizers markets
- ***At MESO-level:***

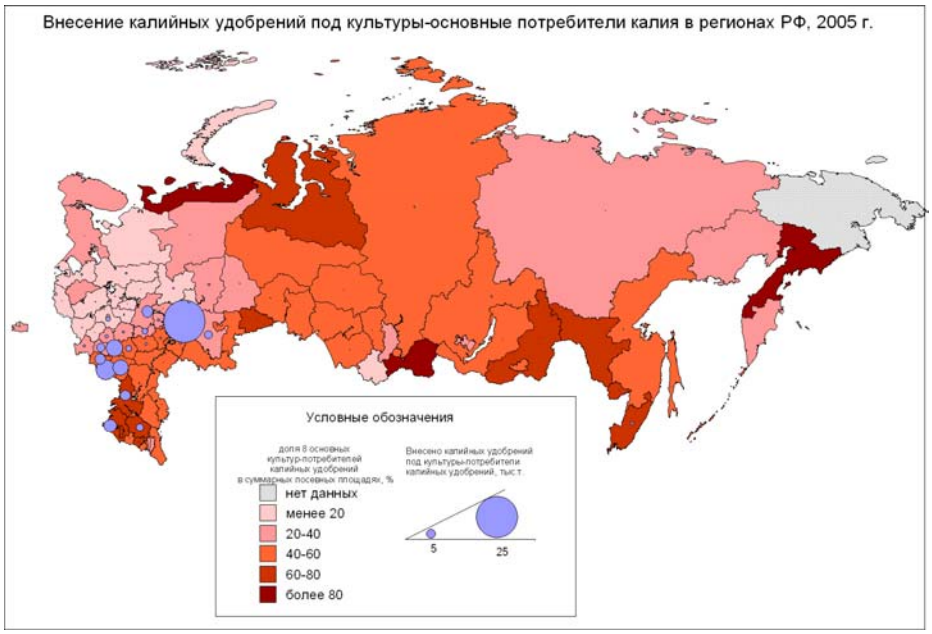
  - Sharpens agronomic recommendations due to regional soil and climate conditions
- ***At MICRO-level:***

  - Helps farmers to adjust their activities to local properties of their fields

  - Protects from inefficient use and losses of fertilizers (via leaching, etc.) and saves farmers' budget

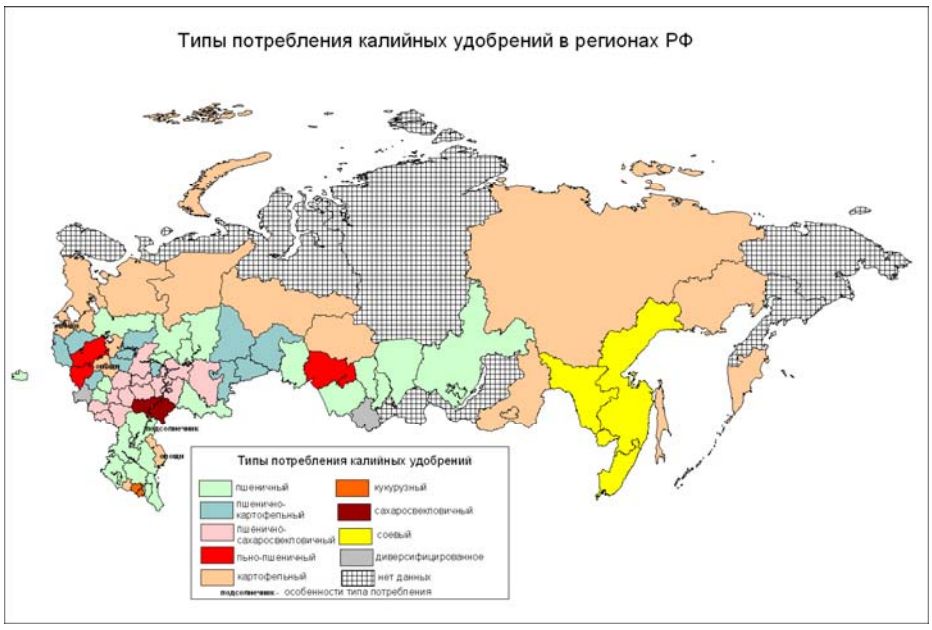
GIS and regional analysis of fertilizers markets in Russian regions: first approach

Application of K fertilizers in Russian regions for 8 crops (% and Mt)



Source: Naumov A., et al (2007)

Types of application of K fertilizers in Russian regions (by crop)



Source: Naumov A., et al. (2007)

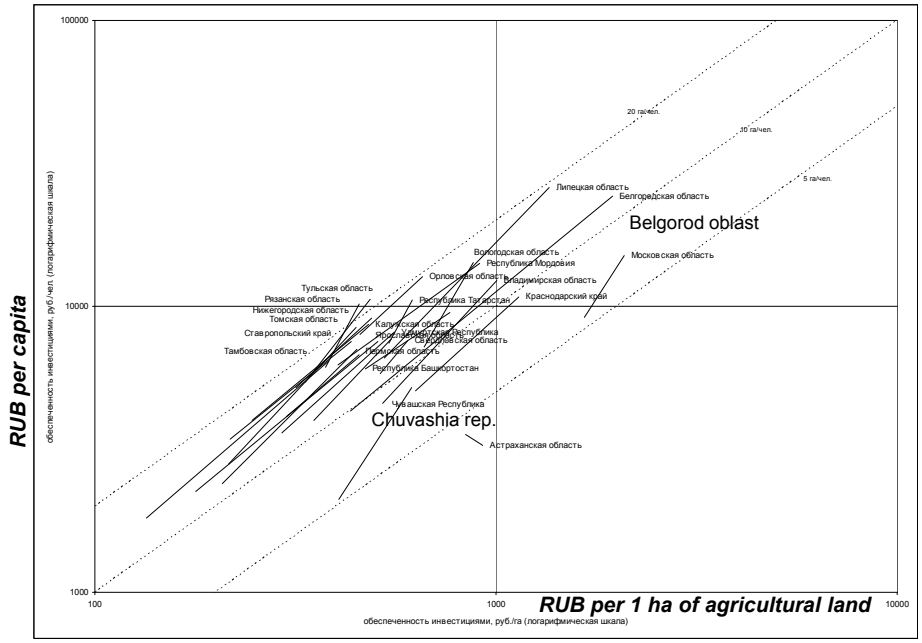
Comparative analysis of application of K fertilizers in Russian regions and their natural analogues in selected foreign countries (2 scenarios: 100% and 50%)

Субъект РФ	K_2O, кг на 1 га (2005)	Потенциальный объем внесения K_2O, тыс. т (сценарий1)	Потенциальный объем внесения K_2O, тыс. т (сценарий 2)	Различия в уровне внесения K_2O (2005 г) и по сценарию1, тыс.т	Различия в уровне внесения K_2O (2005) и по сценарию 2, тыс.т
Татарстан	14,9	62	31	-18,7	12,3
Краснодарский край	2,7	144,9	72,5	-135,2	-62,7
Ростовская обл.	2	136,1	68	-127,5	-59,5
Ставропольский край	1,9	93,6	46,8	-88,4	-41,6
Воронежская обл.	5,2	77,2	38,6	-65,3	-26,6
Белгородская обл.	12,3	49,3	24,7	-32,6	-7,9
Курская обл.	7,4	40,5	20,3	-31,5	-11,3
Респ. Башкортостан	2,3	66,4	33,2	-59,1	-25,9
Нижегородская обл.	8,9	26,8	13,4	-15,7	-2,3
Волгоградская обл.	0,4	90,3	45,1	-89,0	-43,9
Алтайский край	0,1	137,8	68,9	-137,3	-68,4
Оренбургская область	0,1	90,6	45,3	-90,3	-45,0
Саратовская область	0,1	89,6	44,8	-89,2	-44,4

Сценарий 1 – 100%, сценарий 2 – 50% от доз, используемых при интенсивном земледелии

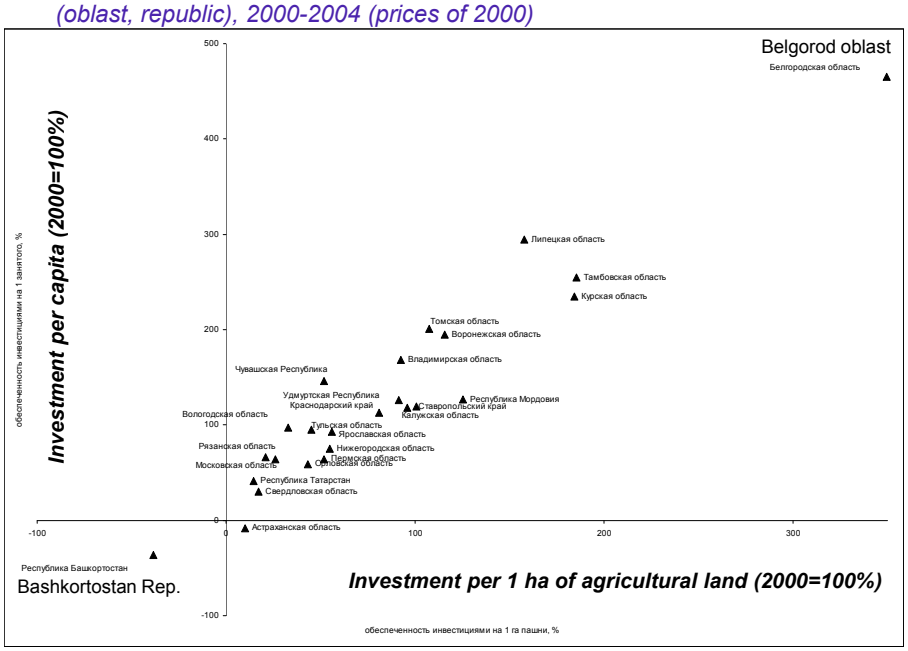
Source: Naumov A., Puchkina A. (2007)

Capital investments in Russian agriculture, by regions (oblast, republic), 2000-2004



Source: Snitko D., 2007

Relative dynamics of capital investments in Russian agriculture, by regions (oblast, republic), 2000-2004 (prices of 2000)



IFA Moscow 2009 Source: Snitko D., 2007 A. Naumov

K fertilizers markets in Russian regions analysis: results of the First Step at MACRO-level

- *Analysis of the current rates of K application, land resources and land use (inc. dynamics of cropped area), capital investment per 1 ha and per capita showed, that:*
- *More important potential markets for K are the plains in the South of European Russia (Krasnodar and Stavropol' kray, Rostov oblast)*
- *Volgograd and Saratov oblast are approaching the previous group*
- *In the Central-Chernozem region, most promising are the markets of Belgorod and Voronezh oblast (mostly because of capital investment flow)*
- *In the Asian part of Russia, huge land resources and very low level of current K doses make the Altay kray a big potential consumer of potash fertilizers*

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K fertilizers markets in Russian regions analysis: conditions for next steps (MESO-level of GIS)

- *Need detailed soil mapping/sampling*

  - Relay on academic institutions, universities (e.g. Geochemistry lab of the Faculty of geography of MSU)
- *Need remote sensing data*

  - Relay on Russia advances in the Space exploration (e.g. Lab of Remote sensing of MSU)
- *Need reliable agricultural statistics*

  - This is a problem, but we can manage it trough polls, field research, etc.
- *Need governmental support*

  - In Brazil, the "Fertilize Brazil" Project is recognized as one of the national priorities in agricultural research.
- *Seek interest from private sector (fertilizers industries, dealers, large-scale ag. companies)*

  - ???

Thank you! Спасибо!

Brazil, Goias state: visiting the farm of Ivanof family