

# SIG para AP

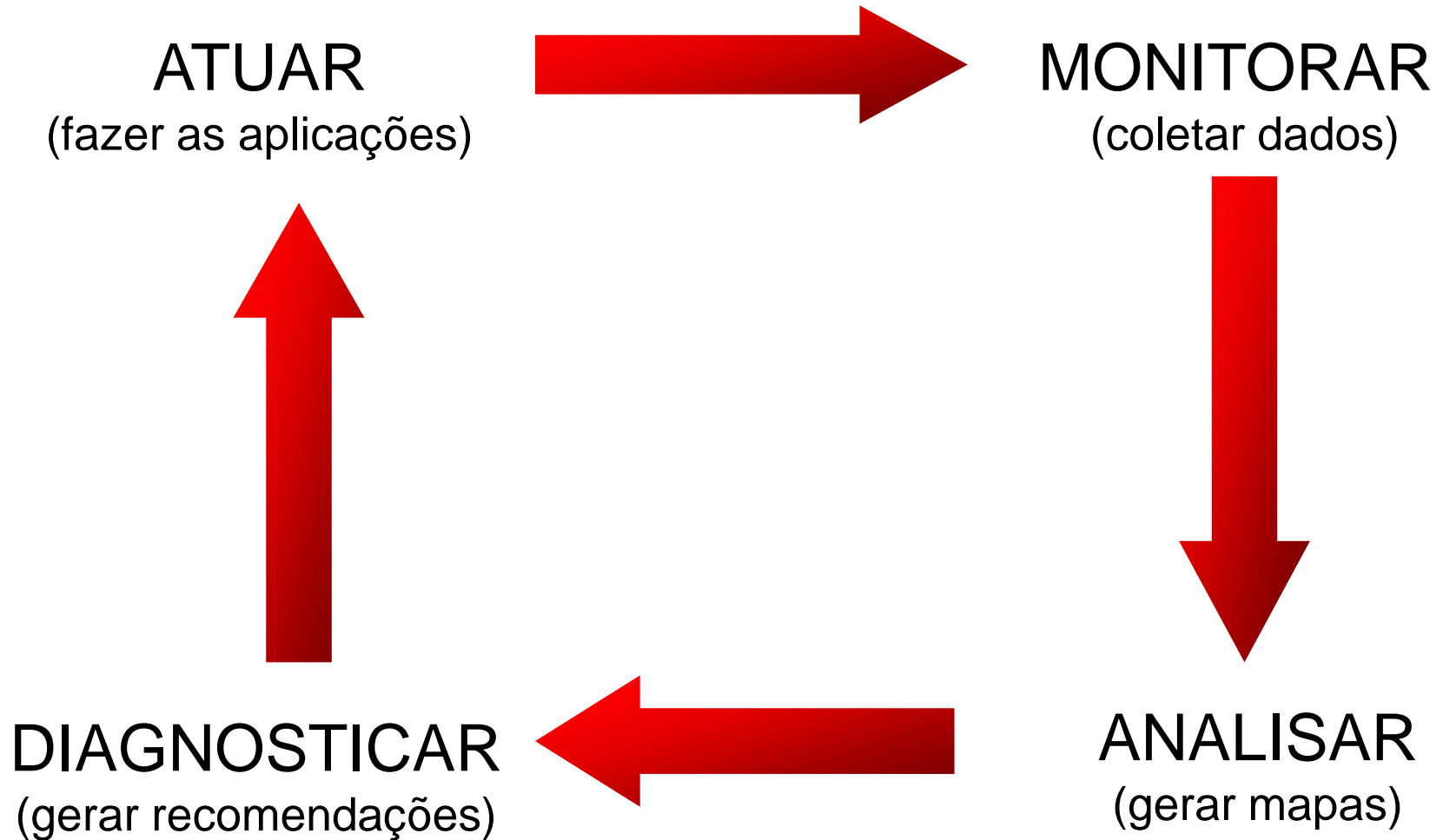
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jpmolin@usp.br



# Objetivo

Abordar conceitos básicos de SIG e  
uma visão de mercado sobre SIG  
dedicados à agricultura de precisão

# Ações

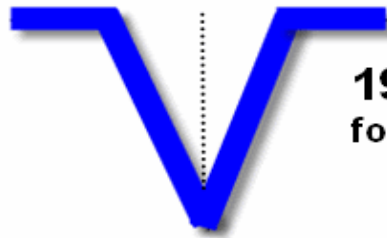




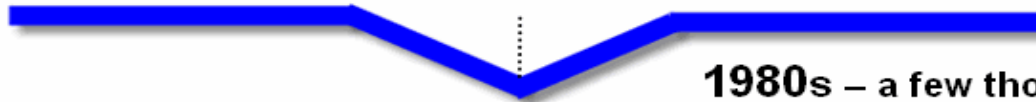
# Sistema de Informação Geográfica – SIG (GIS)

- SIG é software
- Essencialmente permite trabalhar com dados georreferenciados:
  - organização
  - edição
  - análise
  - visualização
  - armazenamento

General Programmers   GIS Developers   System Managers   Data Providers   GIS Specialists   General Users   Public Users



**1970s** – a few hundred innovators establishing the foundation of geotechnology



**1980s** – a few thousand pacesetters applying the technology to a small set of disciplines (RS, GIS)



**1990s** – hundreds of thousands GIS specialists and general users (RS, GIS, GPS)



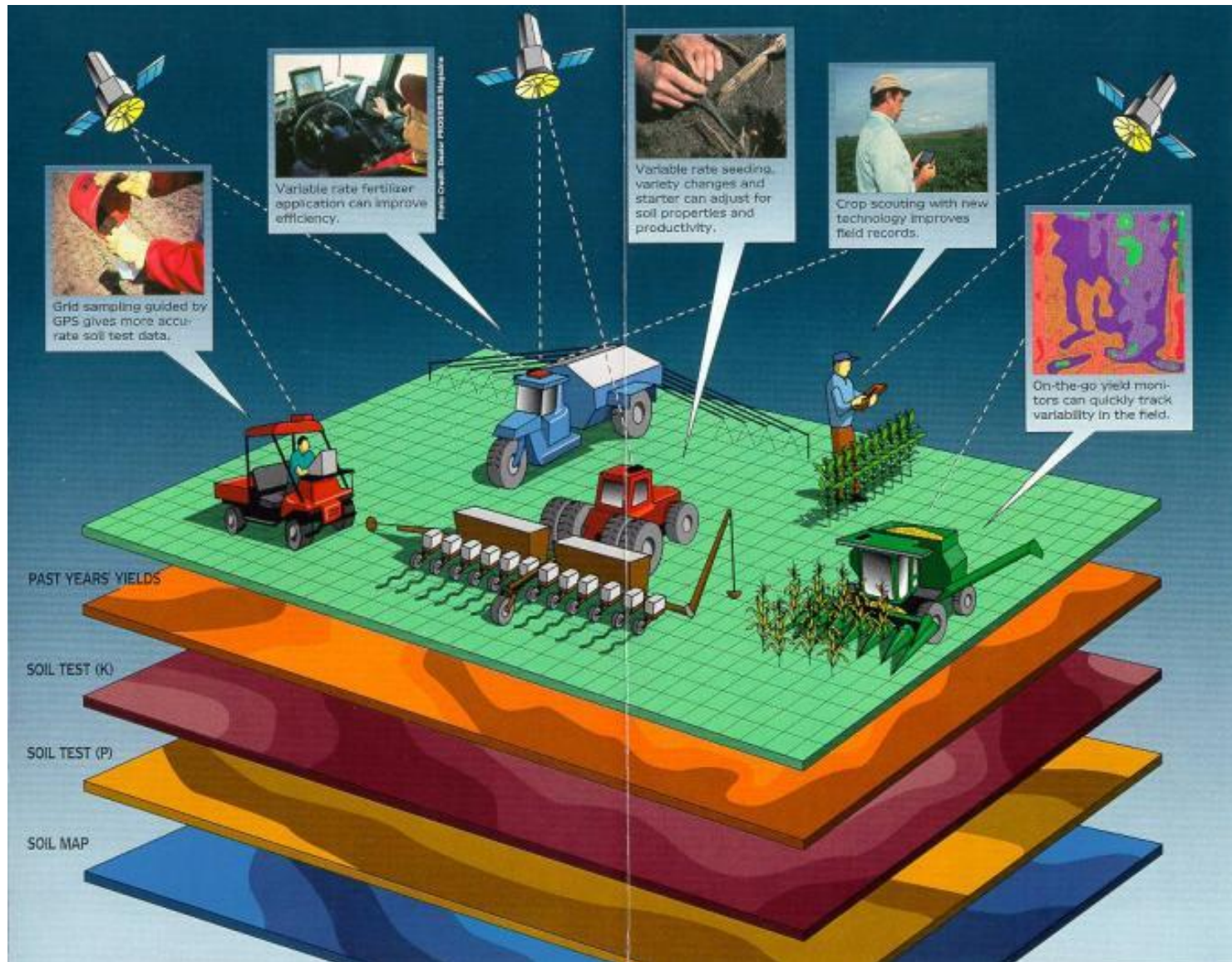
**2000s** – millions of general and public users (RS, GIS, GPS, MMM)

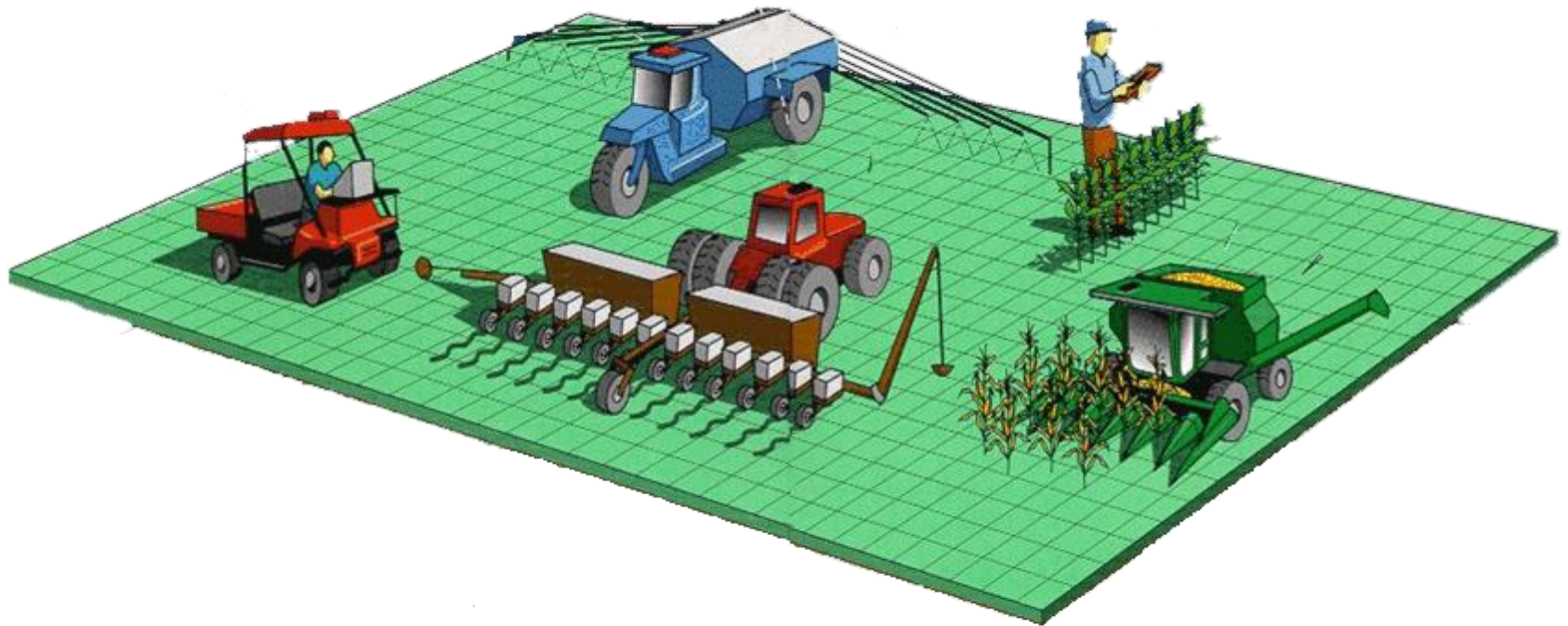
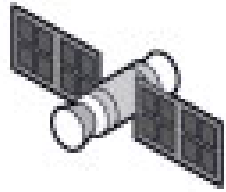
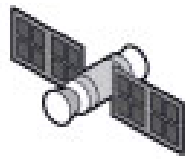
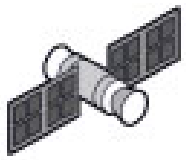
Figure 41.1. The evolution of the Geotechnology Community has broadened its membership in numbers, interests, backgrounds and depth of understanding.

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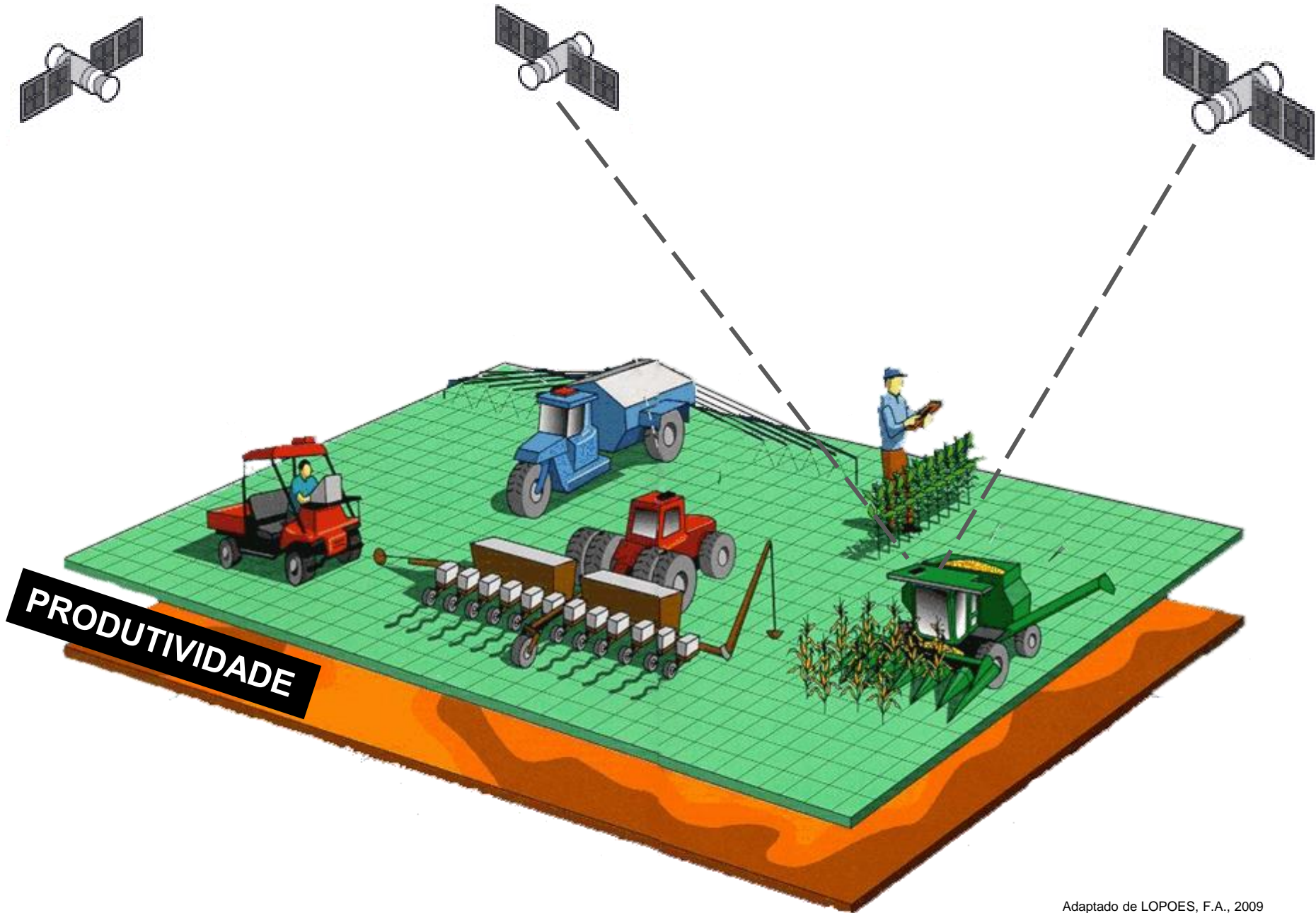
# SIG para AP





Adaptado de LOPOES, F.A., 2009



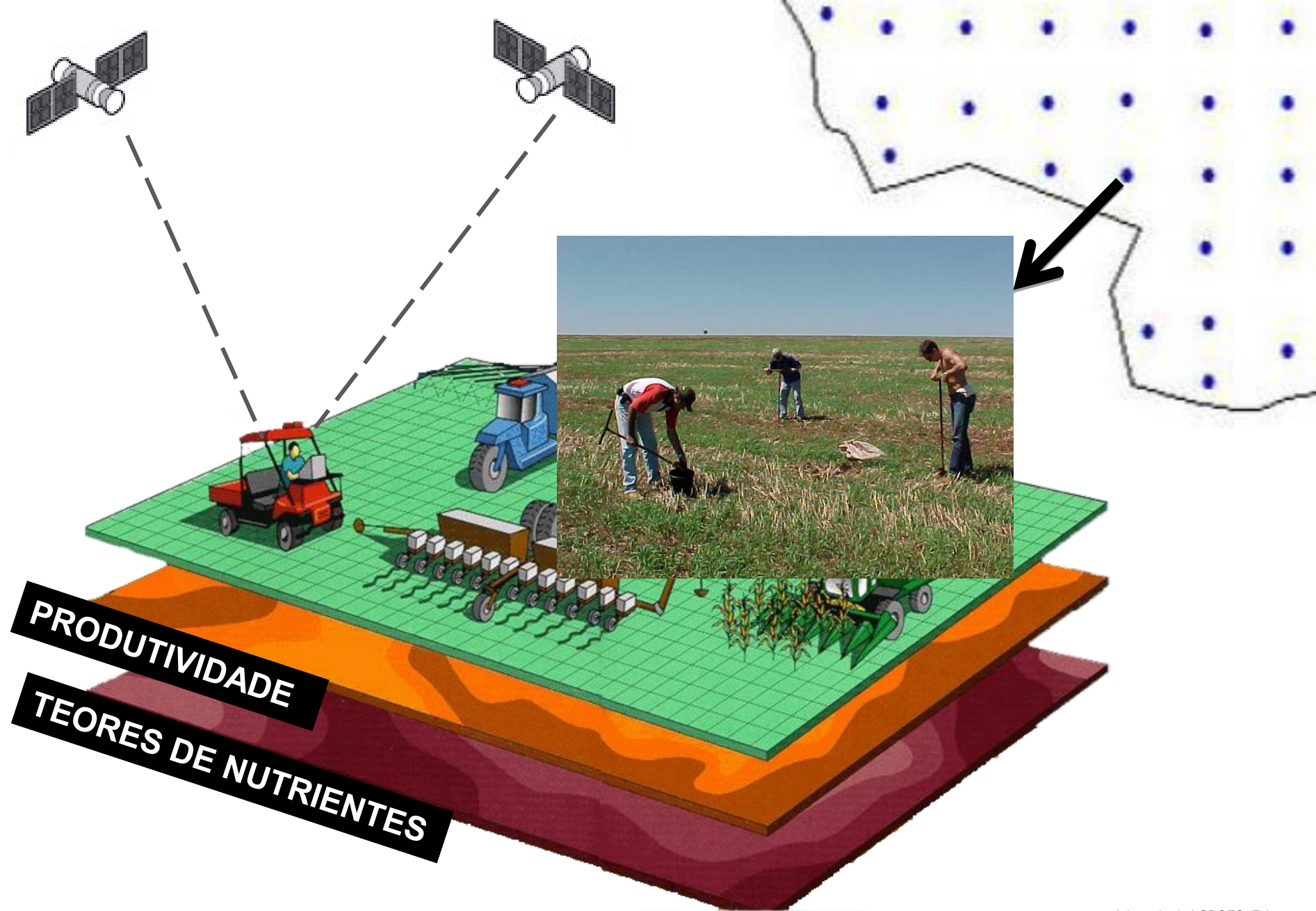


**PRODUTIVIDADE**

Adaptado de LOPOES, F.A., 2009

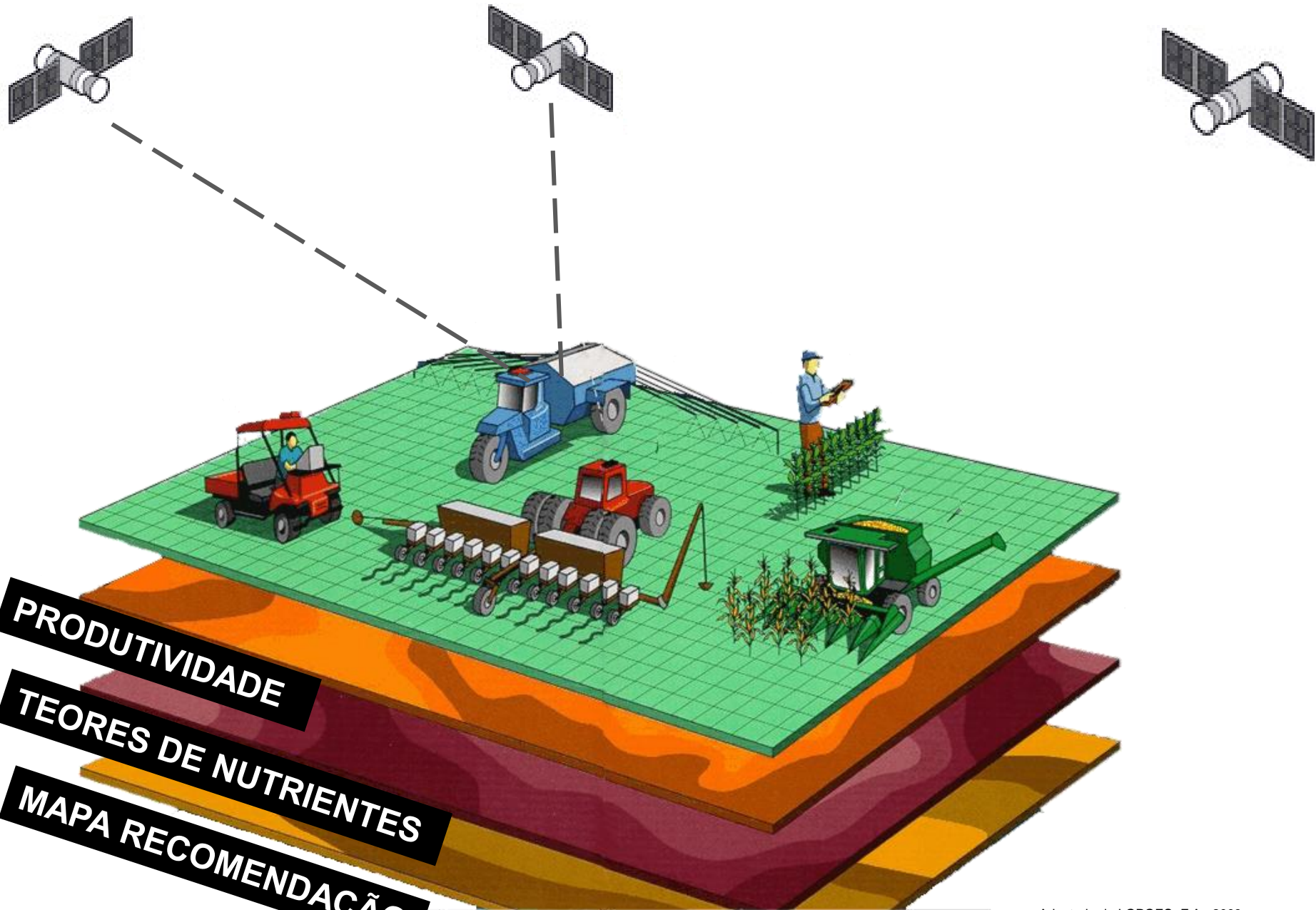


Prof. J. P. Molin



Adaptado de LOPOES, F.A., 2009





**PRODUTIVIDADE**

**TEORES DE NUTRIENTES**

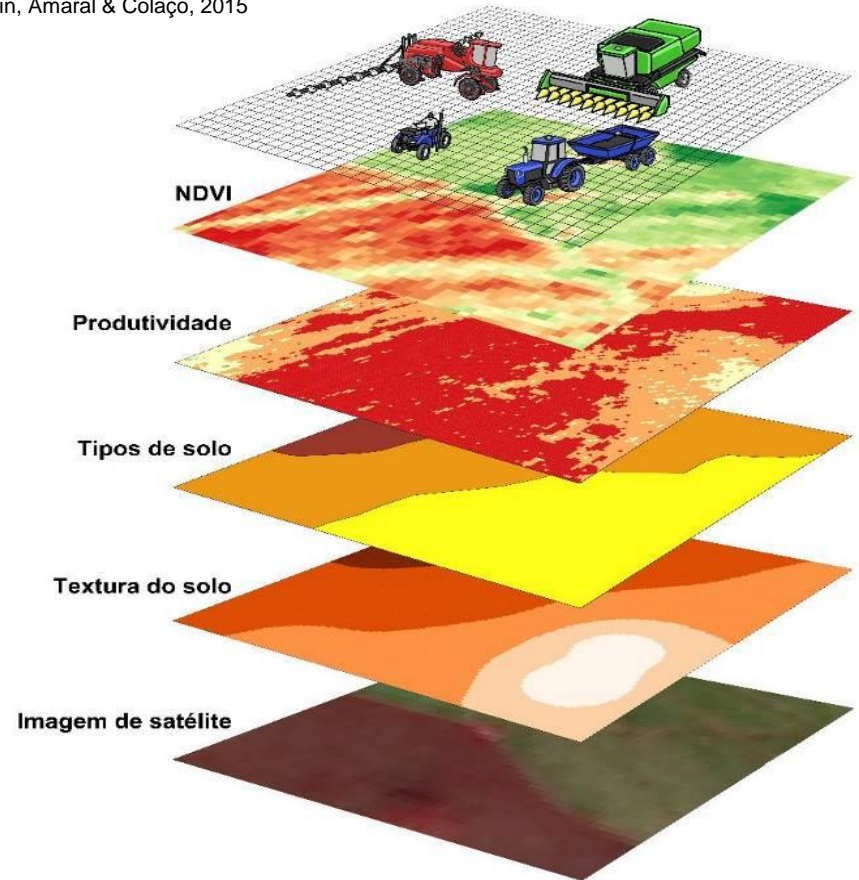
**MAPA RECOMENDAÇÃO**

Adaptado de LOPOES, F.A., 2009

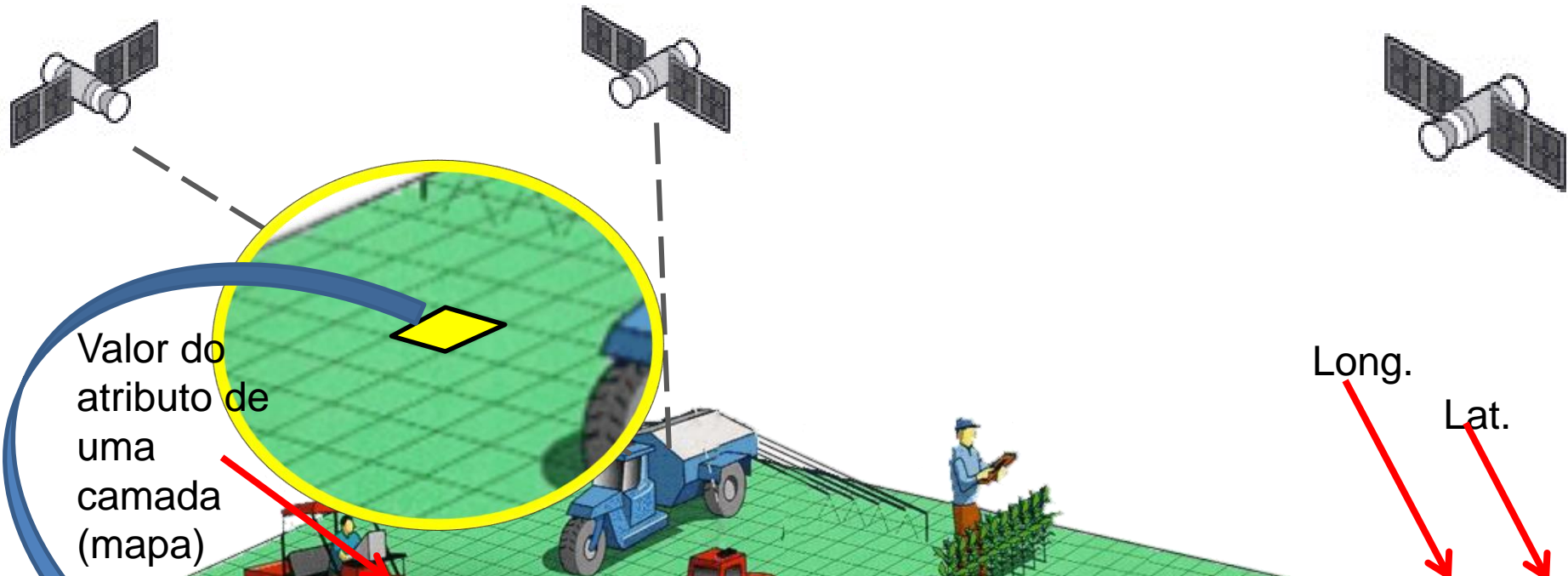


Prof. J. P. Molin

As informações virtualmente são organizadas em camadas para análises e operações matemáticas



Pixel ID	Longitude	Latitude	NDVI	Produtividade	Tipo de solo	Textura	Estágio da vegetação
1	-48,76788	-21,53682	0,256	3525	PVe	388	Inicial
7	-48,76957	-21,53790	0,236	3985	PVe	382	Inicial
18	-48,80212	-21,54530	0,369	4502	PVe	406	Intermediário
26	-48,82565	-21,54981	0,345	4105	PVe	395	Intermediário
32	-48,78892	-21,55361	0,368	3950	PVe	369	Intermediário
66	-48,77752	-21,55789	0,372	4921	LVAAd	264	Inrmediário
105	-48,79289	-21,57411	0,252	3211	LVAAd	316	Inicial
115	-48,81532	-21,58369	0,569	5690	LVAAd	307	Final
129	-48,80145	-21,58991	0,695	6100	LVAAd	310	Final
167	-48,81798	-21,59311	0,495	5230	LVAAd	257	Intermediário
198	-48,77711	-21,59723	0,574	5812	LVAAd	254	Final
214	-48,79369	-21,60002	0,542	5345	LVe	538	Final
253	-48,76969	-21,61525	0,563	5625	LVe	594	Final
307	-48,78521	-21,61913	0,612	6023	LVe	580	Final



Valor do atributo de uma camada (mapa)

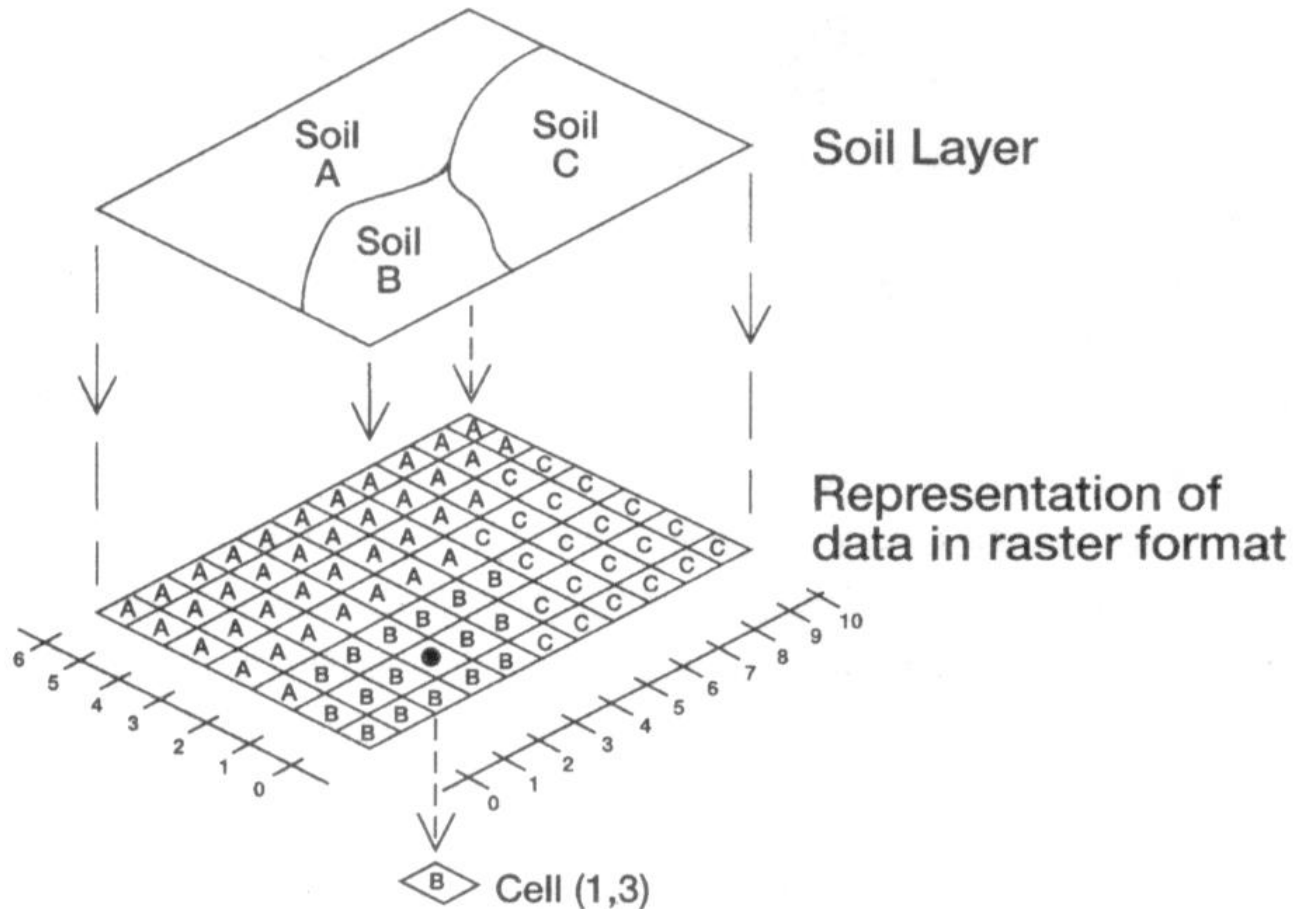
Long.  
Lat.

**PRODUTIVIDADE**  
**TEORES DE**  
**MAPA REC**

Shape	Id	Calcarra	Saja2013	Umsa2013	Elso2013	Umm2009	Elmi2009	Milha2008	Delet	Z 90	Z 30	Camg	S	M	V	T	Sb	Al	Mg	Ca	Cac	Mo	Fosmel	Longitude	Latitude
Polygon	972	3753.3800	3.3823	17.6778	510.5134	13.4231	511.67	3.3795	15.395	46.4	8.2	3.23	33.30	12.2	46.23	29.01	60.28	7.56	12.88	11.21	4.68	53.54	9.22	-55.59208109	-21.4044764
Polygon	973	3986.1802	4.2141	18.2015	510.7724	13.4178	511.74	3.6149	15.814	30.0	11.9	3.23	33.90	13.3	44.67	27.91	57.64	8.19	12.28	13.37	4.64	53.62	9.37	-55.59188811	-21.4044764
Polygon	974	4223.0838	3.8481	18.5899	510.9949	13.3932	511.41	2.7659	15.847	55.4	12.0	3.23	34.52	14.5	43.08	26.80	54.98	8.83	11.68	17.51	4.61	53.72	9.52	-55.59169513	-21.4044764
Polygon	975	4417.6996	2.9497	13.8286	511.3740	13.4089	511.43	3.0639	16.027	55.0	10.9	3.23	35.04	15.4	41.77	25.91	52.79	9.37	11.19	15.99	4.58	53.81	9.63	-55.59150215	-21.4044764
Polygon	976	4492.1066	3.9062	16.5490	512.0450	13.3778	511.78	3.2368	16.844	20.0	12.3	3.23	35.24	15.8	41.27	25.57	51.96	9.57	11.00	15.41	4.57	53.85	9.67	-55.59130917	-21.4044764
Polygon	977	4368.5342	3.4030	15.0352	512.1740	13.3734	511.98	3.3583	17.324	35.4	13.6	3.23	34.89	15.2	42.11	26.12	53.33	9.21	11.31	16.37	4.59	53.77	9.61	-55.59111620	-21.4044764
Polygon	979	3613.8499	3.6826	16.7646	512.9941	13.6283	513.86	3.3834	18.424	52.6	10.6	3.22	32.74	11.2	47.22	29.56	61.78	6.99	13.25	12.25	4.70	53.29	9.19	-55.59073024	-21.4044764
Polygon	980	3607.3270	4.1891	13.7309	512.3952	13.4399	514.37	2.8973	19.333	29.1	12.3	3.21	31.99	3.9	43.33	31.43	68.38	3.78	14.31	15.48	4.73	53.02	8.33	-55.58993728	-21.4044764
Polygon	981	2894.4059	2.8893	15.8515	513.3370	12.8582	515.09	2.1462	19.737	44.2	14.5	3.20	30.65	7.3	52.16	33.12	70.03	4.78	15.16	17.99	4.80	52.82	8.67	-55.59033428	-21.4044764
Polygon	982	2681.2886	2.9811	15.8388	513.8842	12.8133	515.37	2.8472	20.512	48.0	14.4	3.20	30.11	6.0	53.66	34.46	72.67	4.08	15.78	19.79	4.83	52.69	8.43	-55.59015015	-21.4044764
Polygon	983	2548.1822	2.9986	13.9376	513.8241	13.0956	515.12	3.0450	20.796	58.5	13.9	3.18	29.96	5.2	54.64	35.66	74.58	3.62	16.25	11.03	4.85	52.61	8.18	-55.58995833	-21.4044764
Polygon	984	2471.9446	3.5263	16.1365	514.4690	13.2578	515.07	2.6831	21.125	68.8	17.4	3.17	30.21	4.7	55.27	36.91	76.06	3.34	16.66	11.91	4.87	52.56	7.91	-55.58976535	-21.4044764
Polygon	985	2438.3207	3.2193	15.7378	514.7268	13.0186	515.37	2.3712	20.760	70.8	14.6	3.13	30.90	4.4	55.66	38.39	77.37	3.20	17.07	12.57	4.87	52.50	7.57	-55.58957237	-21.4044764
Polygon	986	2444.3395	2.3148	13.0350	514.5199	13.2961	515.40	2.8687	20.543	47.0	14.4	3.09	32.03	4.2	55.85	40.21	78.60	3.12	17.52	13.05	4.88	52.40	7.16	-55.58937939	-21.4044764
Polygon	987	2493.2901	2.7428	13.2823	514.0141	12.9548	515.52	2.6586	20.843	51.5	17.6	3.02	33.59	4.0	55.84	42.32	79.68	3.09	18.02	13.31	4.87	52.24	6.68	-55.58918641	-21.4044764
Polygon	988	2581.2589	3.3910	15.2509	514.6107	13.3051	515.74	2.8923	21.134	61.1	17.2	2.93	35.38	3.9	55.62	44.48	80.49	3.11	18.52	13.31	4.87	51.99	6.18	-55.58899343	-21.4044764
Polygon	989	2676.1285	4.0798	16.0503	515.1405	13.4214	515.89	2.5625	21.432	44.9	15.1	2.85	36.96	3.9	55.32	46.25	80.97	3.13	18.93	13.14	4.86	51.73	5.78	-55.58880046	-21.4044764
Polygon	990	2706.6404	3.4638	12.9377	515.0527	13.2803	516.27	2.6889	21.554	58.6	12.4	2.82	37.68	3.8	55.26	47.13	81.34	3.13	19.13	13.17	4.85	51.64	5.57	-55.58860748	-21.4044764
Polygon	991	2596.7316	2.6692	12.8107	515.2019	13.1387	516.51	2.4347	21.798	78.0	13.9	2.87	37.12	3.8	55.83	46.93	82.08	3.07	19.08	13.92	4.87	51.93	5.59	-55.58841450	-21.4044764
Polygon	992	2328.8023	2.3192	12.8373	515.4899	13.4566	516.79	3.1699	21.831	58.0	15.6	3.01	35.45	3.6	57.18	46.02	83.58	2.94	18.85	15.62	4.91	52.63	5.75	-55.58822152	-21.4044764
Polygon	993	1952.4979	3.3994	14.1465	515.5721	14.1845	517.04	3.6935	21.701	43.3	19.4	3.20	33.31	3.4	59.12	44.93	85.83	2.75	18.57	18.06	4.96	53.60	5.94	-55.58802854	-21.4044764
Polygon	994	1536.5435	3.9960	15.3146	516.0191	14.2184	517.29	4.2761	22.045	75.9	23.8	3.41	31.21	3.1	61.29	44.02	88.52	2.53	18.31	10.85	5.02	54.67	6.07	-55.58783557	-21.4044764
Polygon	995	1135.0070	4.5912	16.2478	516.3921	15.0139	517.61	4.5487	22.277	68.0	26.6	3.61	29.41	2.8	63.43	43.43	91.32	2.30	18.10	13.65	5.08	55.69	6.15	-55.58764259	-21.4044764
Polygon	996	782.7250	4.9589	16.7678	516.5949	14.8014	517.98	4.3553	22.776	55.8	21.4	3.77	27.94	2.5	65.32	43.25	94.01	2.11	17.97	16.24	5.14	56.59	6.19	-55.58744961	-21.4044764
Polygon	997	494.0408	4.4118	17.8040	516.6580	14.6801	518.24	5.1943	23.239	89.0	30.1	3.90	26.70	2.3	66.86	43.65	96.60	1.94	17.96	18.60	5.18	57.31	6.19	-55.58725663	-21.4044764
Polygon	998	254.0215	4.9319	17.4238	517.0253	14.4396	518.70	5.7260	23.574	105.3	34.9	3.98	25.48	2.1	68.10	44.93	99.42	1.81	18.16	17.99	5.21	57.89	6.16	-55.58706365	-21.4044764
Polygon	999	15.9035	4.8360	16.5648	517.2772	14.2464	518.85	5.3323	23.699	155.3	33.0	4.03	24.02	2.0	69.26	47.40	103.05	1.70	18.60	17.88	5.24	58.44	6.08	-55.58687067	-21.4044764
Polygon	1000	0.0000	3.6629	16.3575	517.5095	14.9444	519.01	5.7383	24.919	39.0	25.9	4.06	22.13	1.8	70.65	51.19	108.03	1.56	19.31	17.76	5.27	59.08	5.96	-55.58667770	-21.4044764
Polygon	1001	0.0000	5.1867	16.2488	517.6443	16.3904	519.33	6.9892	25.128	46.4	34.8	4.11	19.87	1.5	72.38	55.90	114.22	1.38	20.17	12.56	5.30	59.85	5.81	-55.58648472	-21.4044764
Polygon	1002	0.0000	5.2553	16.1880	517.6867	16.5037	519.34	4.1961	25.499	60.1	33.3	4.16	17.71	1.3	74.13	60.44	120.31	1.19	20.99	17.31	5.34	60.63	5.65	-55.58629174	-21.4044764
Polygon	1003	0.0000	5.2450	16.2433	517.6875	16.8079	519.31	5.2967	25.351	83.0	32.0	4.19	16.31	1.1	75.30	63.39	124.28	1.06	21.52	10.42	5.37	61.14	5.56	-55.58609876	-21.4044764
Polygon	1004	0.0000	4.8238	16.7727	517.7020	17.1350	519.41	5.6376	25.391	122.5	32.5	4.20	15.99	1.1	75.44	63.98	124.96	1.06	21.62	10.94	5.37	61.23	5.54	-55.58590578	-21.4044764

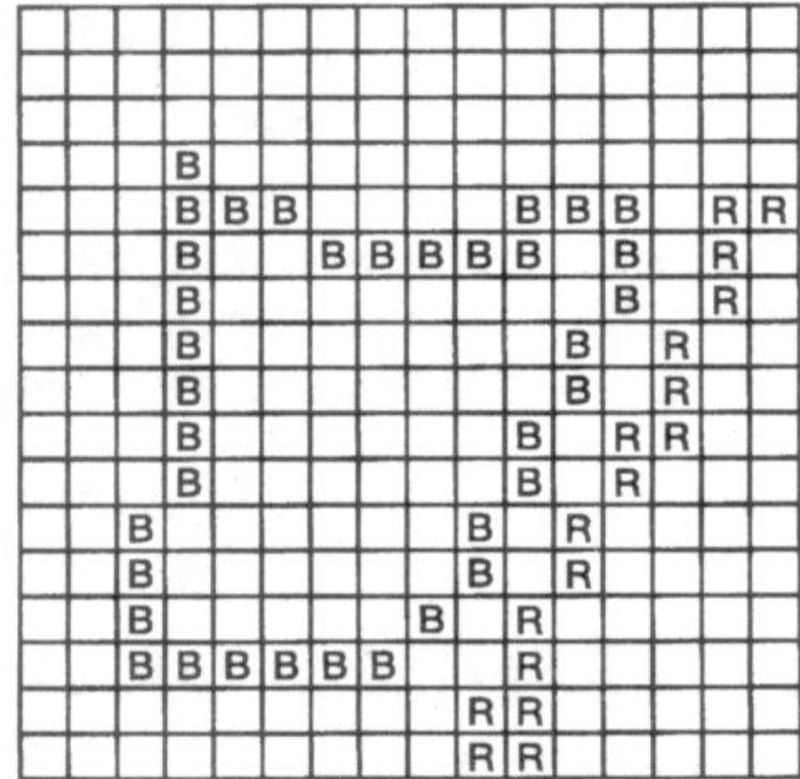
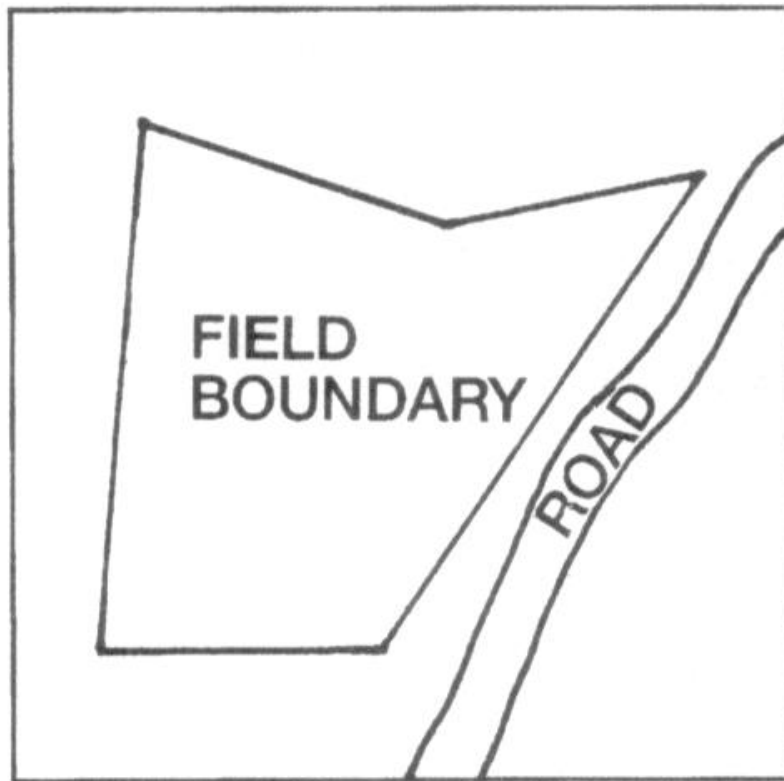


# SIG – Sistema de Informação Geográfica



No formato RASTER o espaço é dividido em células, cada célula tem um valor e este valor define a forma da apresentação visual.

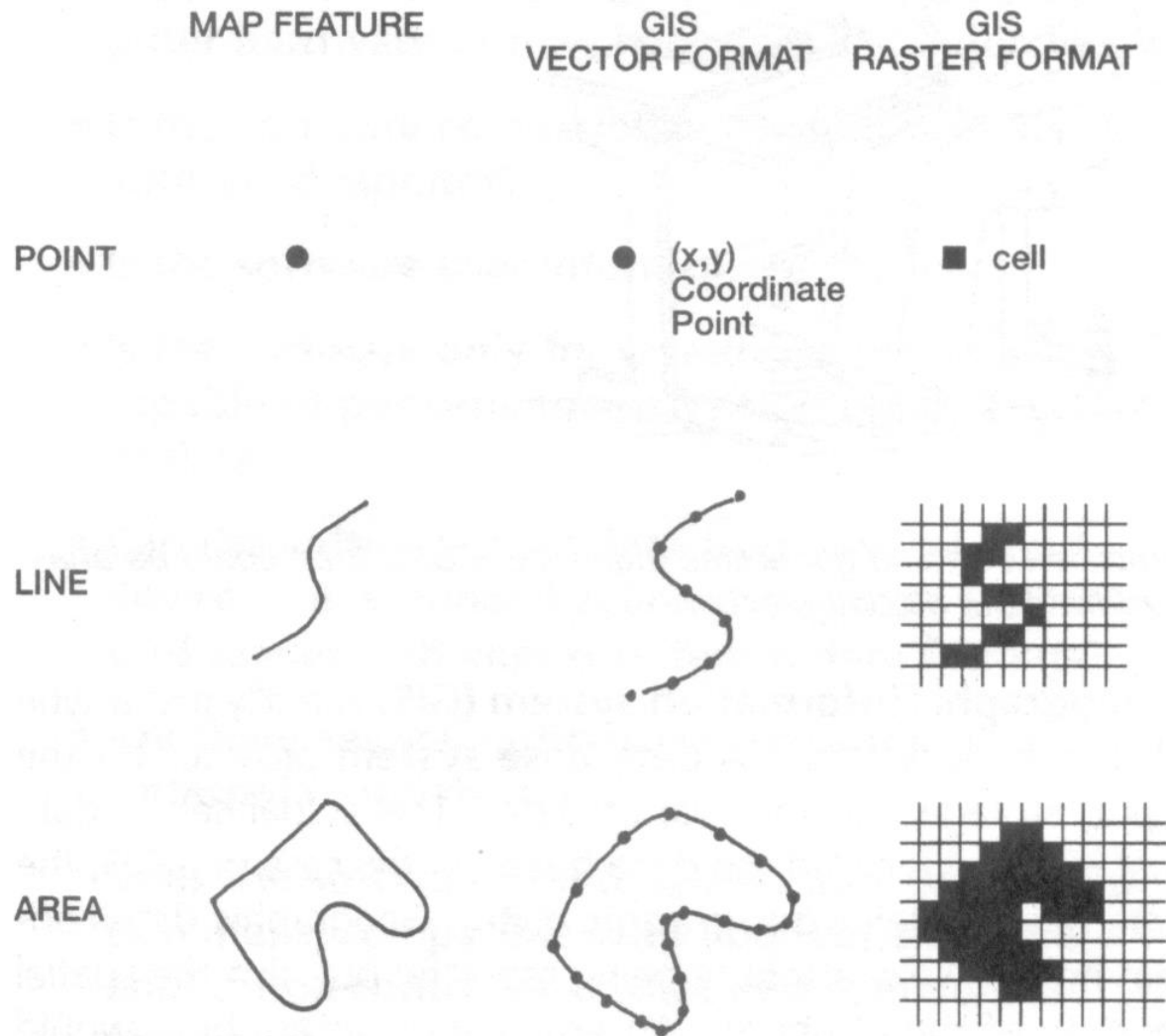
# SIG – Sistema de Informação Geográfica



RASTER REPRESENTATION OF  
FIELD BOUNDARY & ROAD

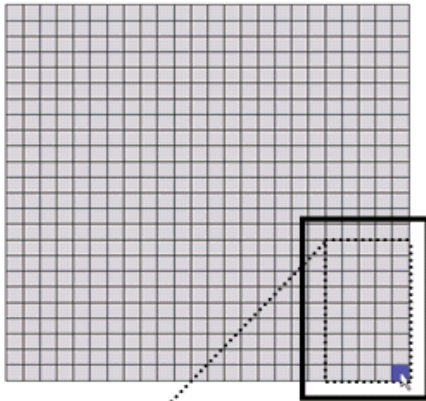
No formato VECTOR (ou Lattice), a unidade básica são pontos ou linhas com coordenadas x e y (latitude e longitude).

# SIG – Sistema de Informação Geográfica

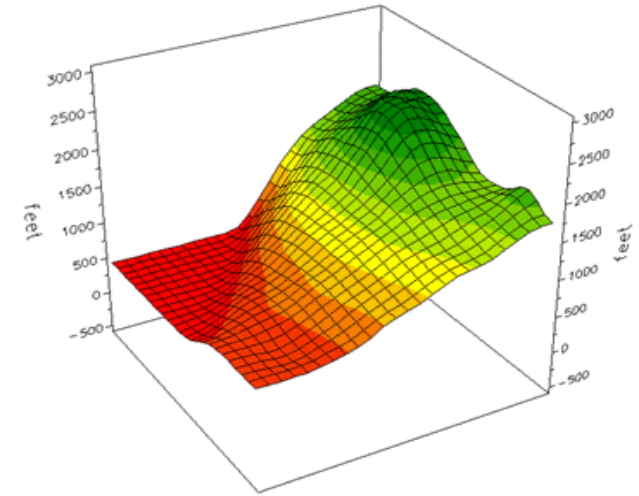
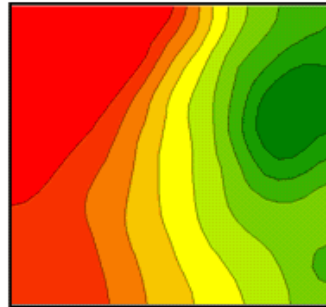


Representações gráficas de Vector (Lattice) e Raster.

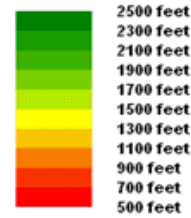
### Reference Frame



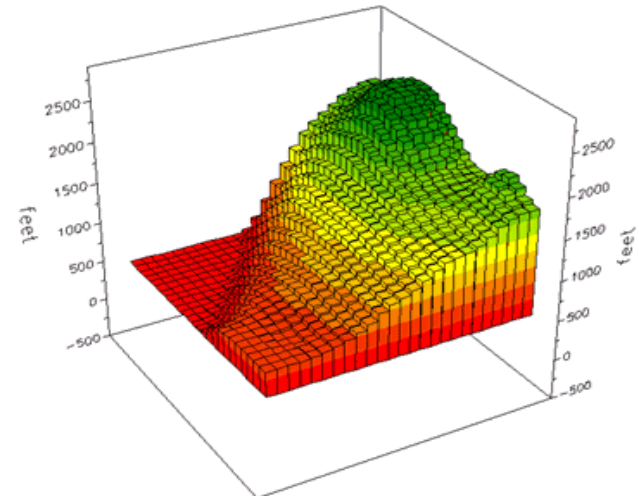
### 2D Lattice



### 3D Lattice

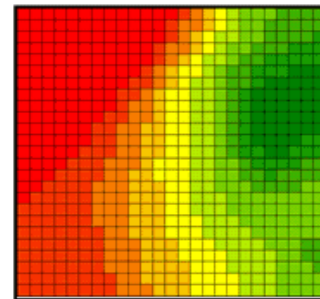


### 3D Grid



Data					
	21	22	23	24	25
9	1,879	1,877	1,846	1,817	1,802
8	1,814	1,818	1,812	1,804	1,805
7	1,781	1,794	1,801	1,816	1,823
6	1,756	1,784	1,814	1,863	1,894
5	1,725	1,770	1,841	1,927	1,990
4	1,693	1,754	1,847	1,944	2,016
3	1,664	1,737	1,826	1,896	1,943
2	1,636	1,718	1,784	1,826	1,843
1	1,623	1,709	1,768	1,795	1,800

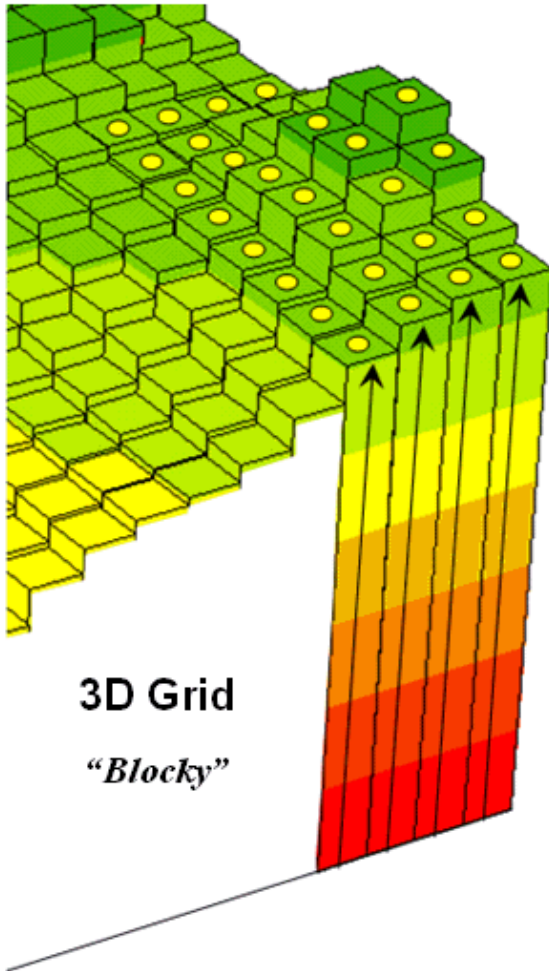
### Data Values



### 2D Grid

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*... 3D Grid display pushes each cell up to the level of the stored value*



*... 3D Lattice display pushes the nodes of the wireframe up to the value*

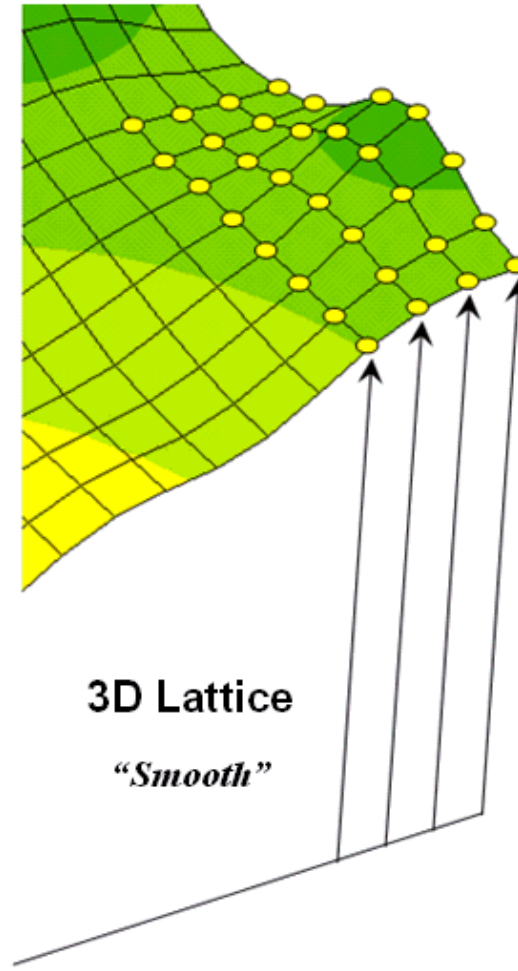


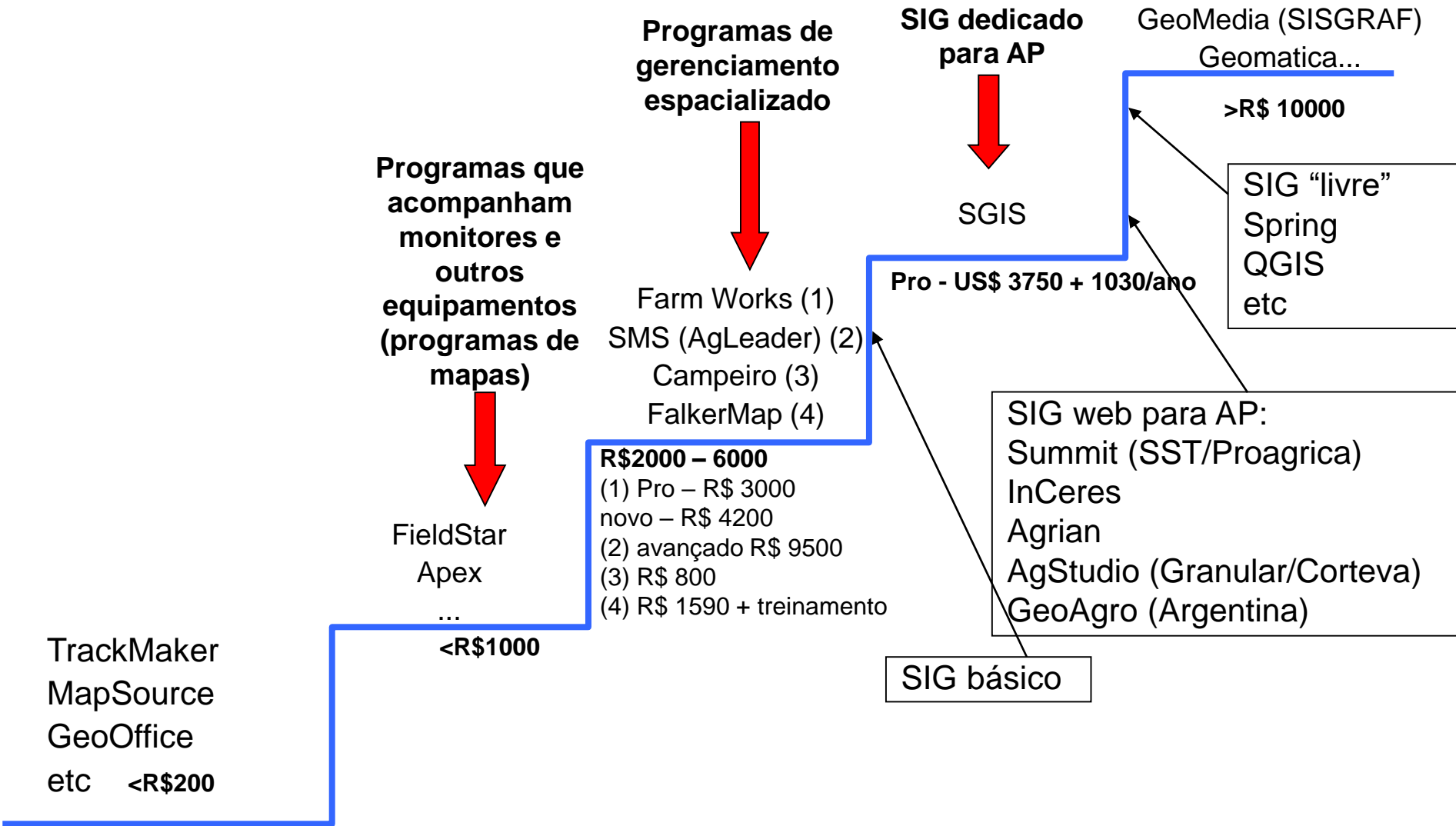
Figure 1.3. 3-D display "pushes-up" the grid or lattice reference frame to the relative height of the stored map values.

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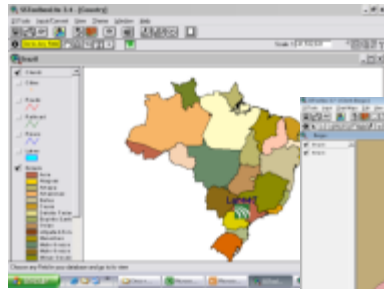


# AP e Sistemas de Informação Geográfica

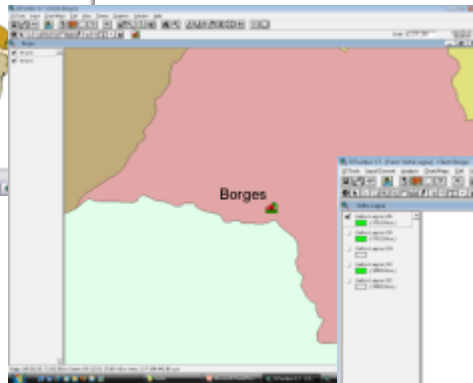
## Mercado de SIG



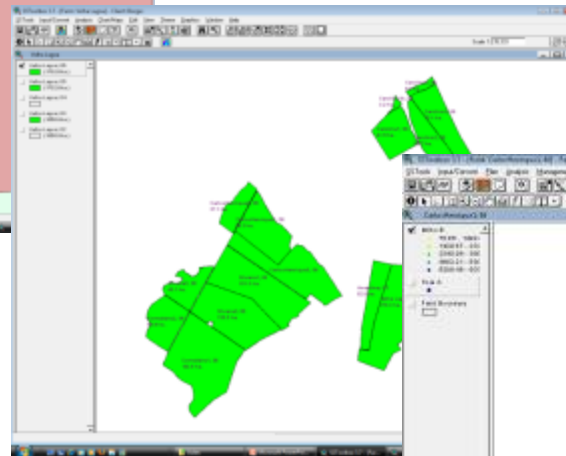
# Organização hierárquica dos dados facilita a geração de informação para o gerenciamento



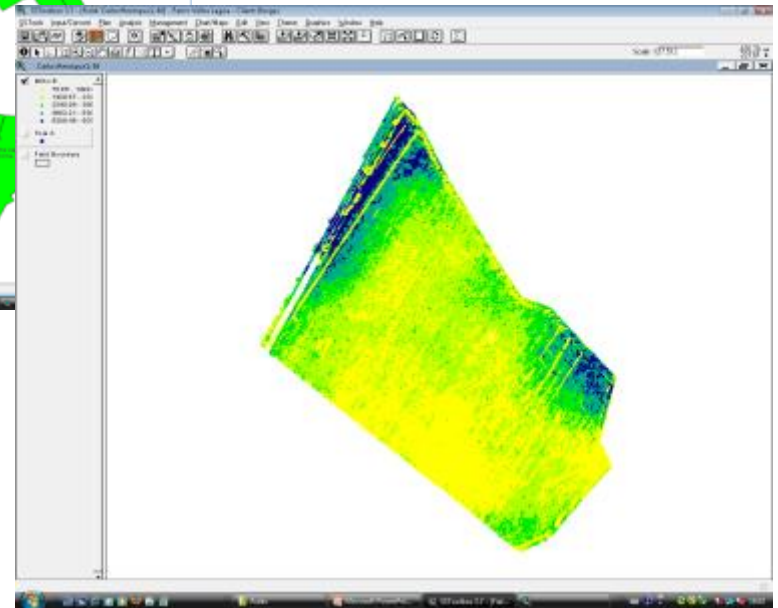
*País*



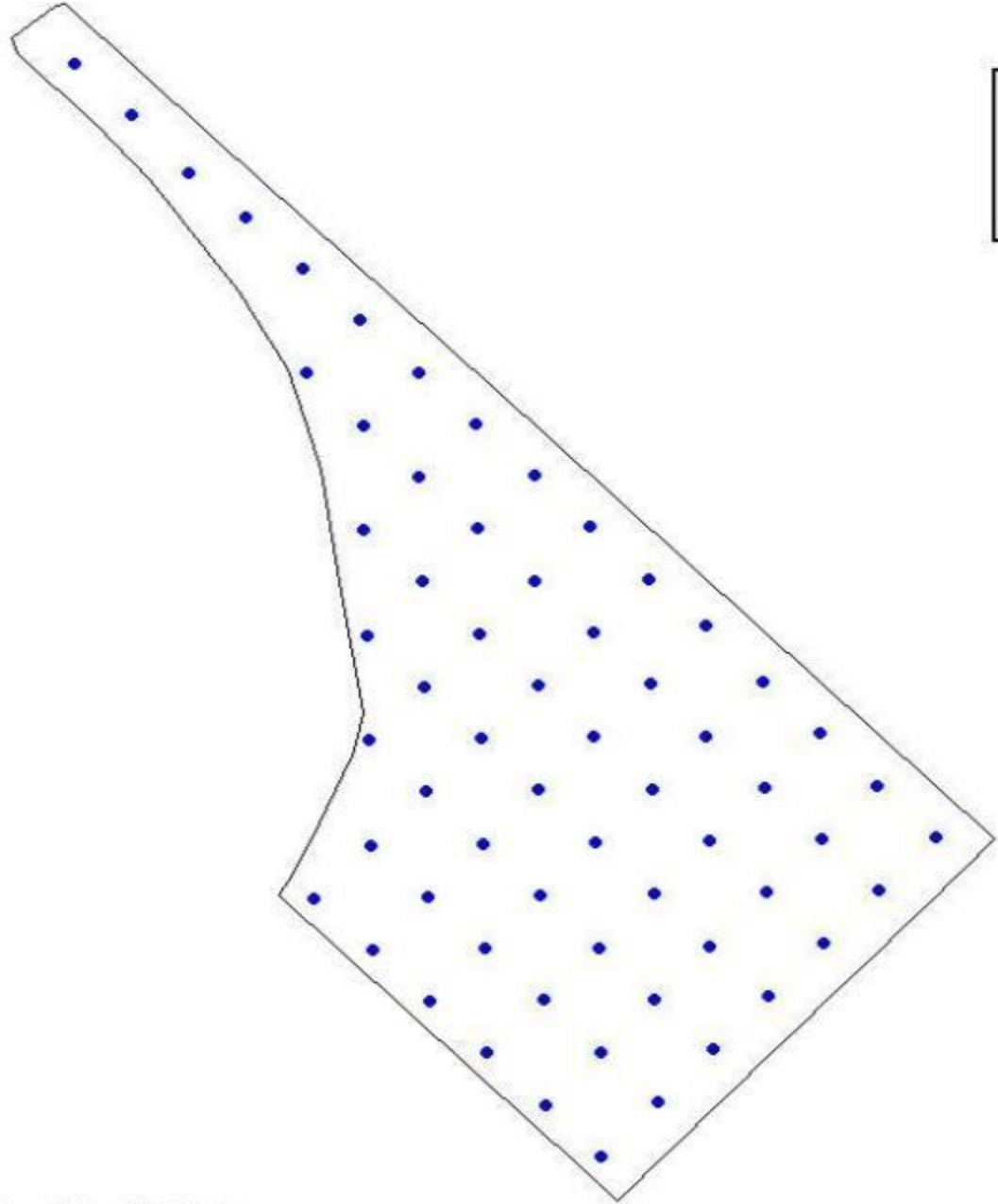
*Cliente*



*Fazenda*



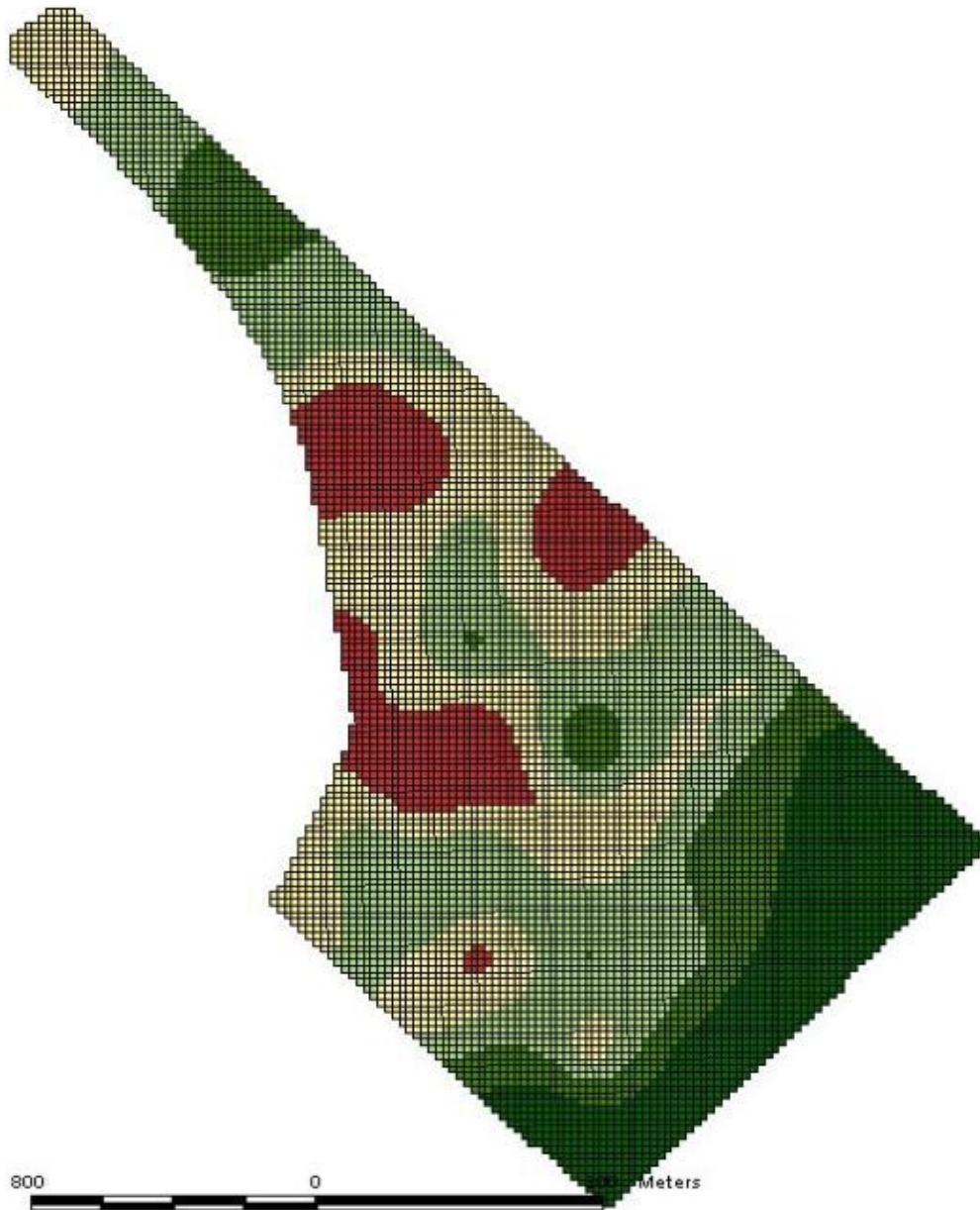
*Talhão*



□ (302.2ha.) Field Boundary  
• Pontos

200 0 200 400 Meters





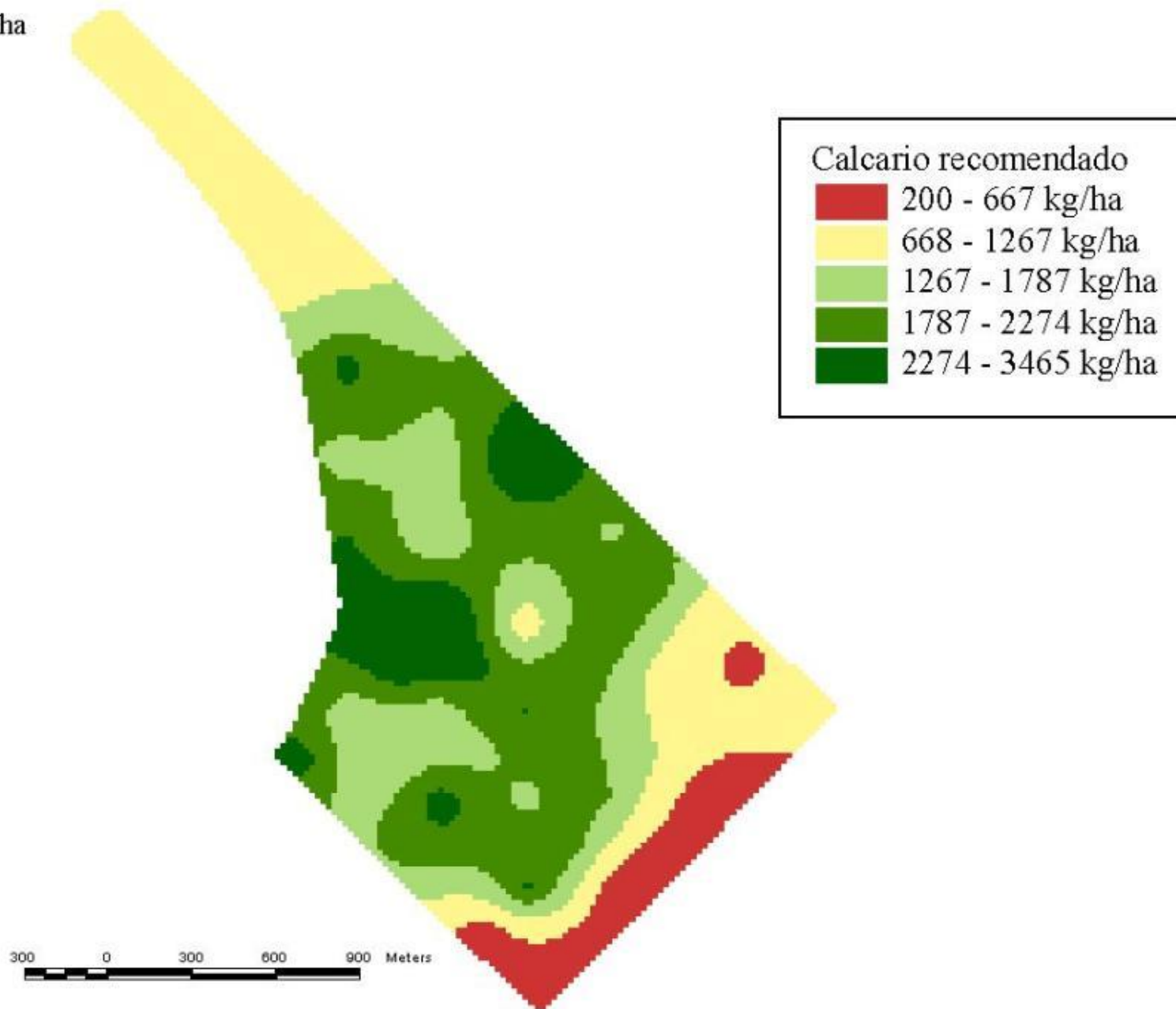
V

Red	21.0 - 33.0
Yellow	33.0 - 37.9
Light Green	37.9 - 42.8
Medium Green	42.8 - 49.7
Dark Green	49.7 - 58.1

800 0 Meters

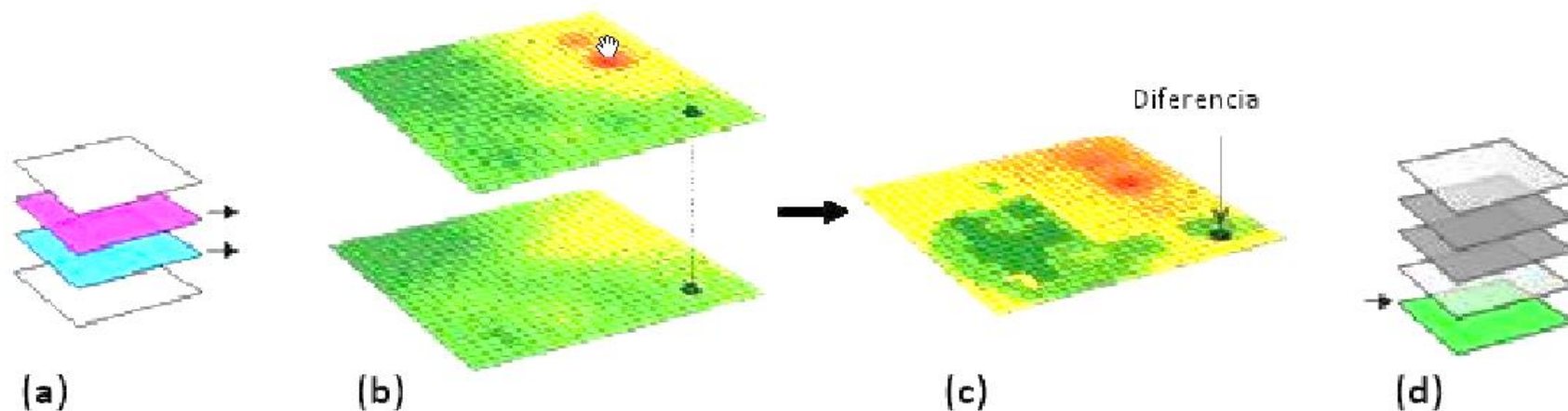


Alhao 302.2 ha





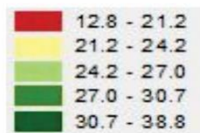
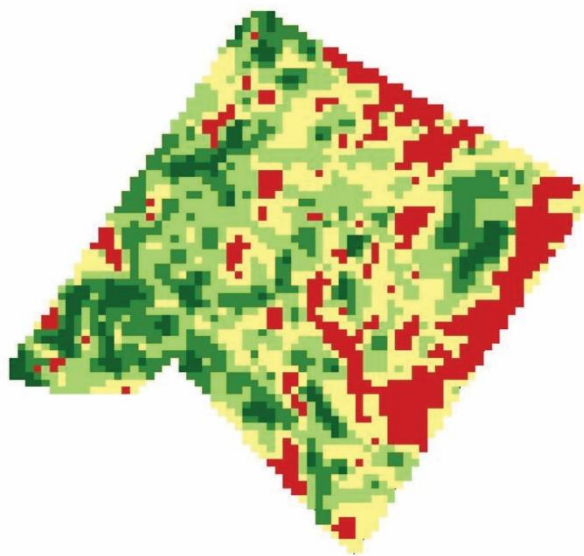
# Álgebra de mapas



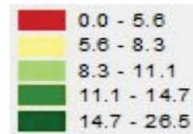
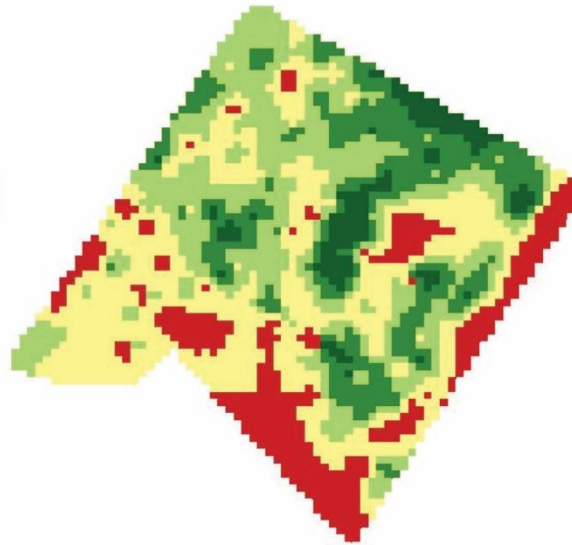
Os dados (mapas) são adquiridos da base de dados (a); dois temas no formato raster são usados (b) para gerar um terceiro tema (mapa) por álgebra (c) e o novo tema (mapa) é armazenado na base de dados (d)

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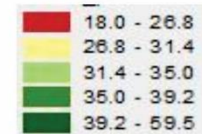
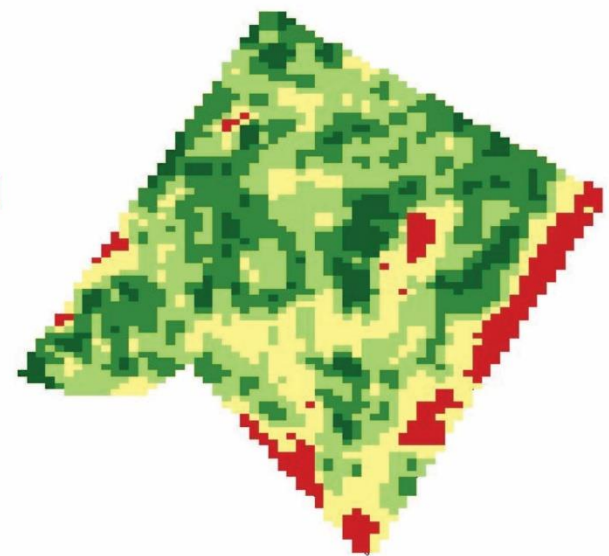
## Mapas de colheita de laranja com suas respectivas legendas: primeira colheita (a), segunda colheita (b) e da soma das colheitas (c)



(a)



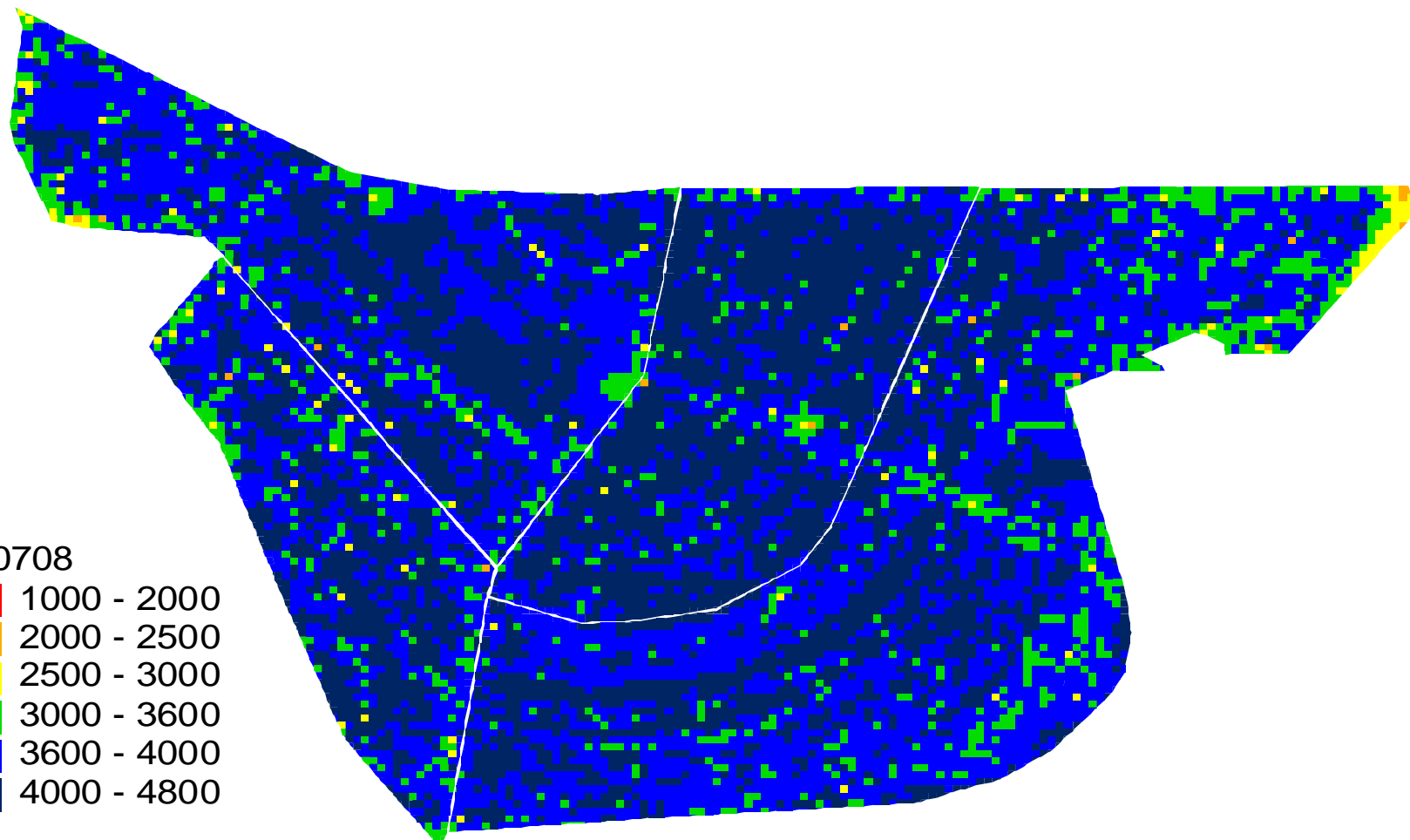
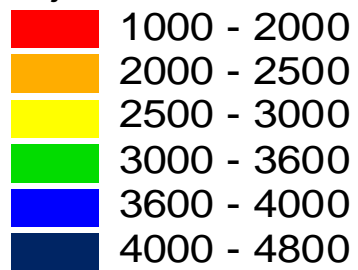
(b)



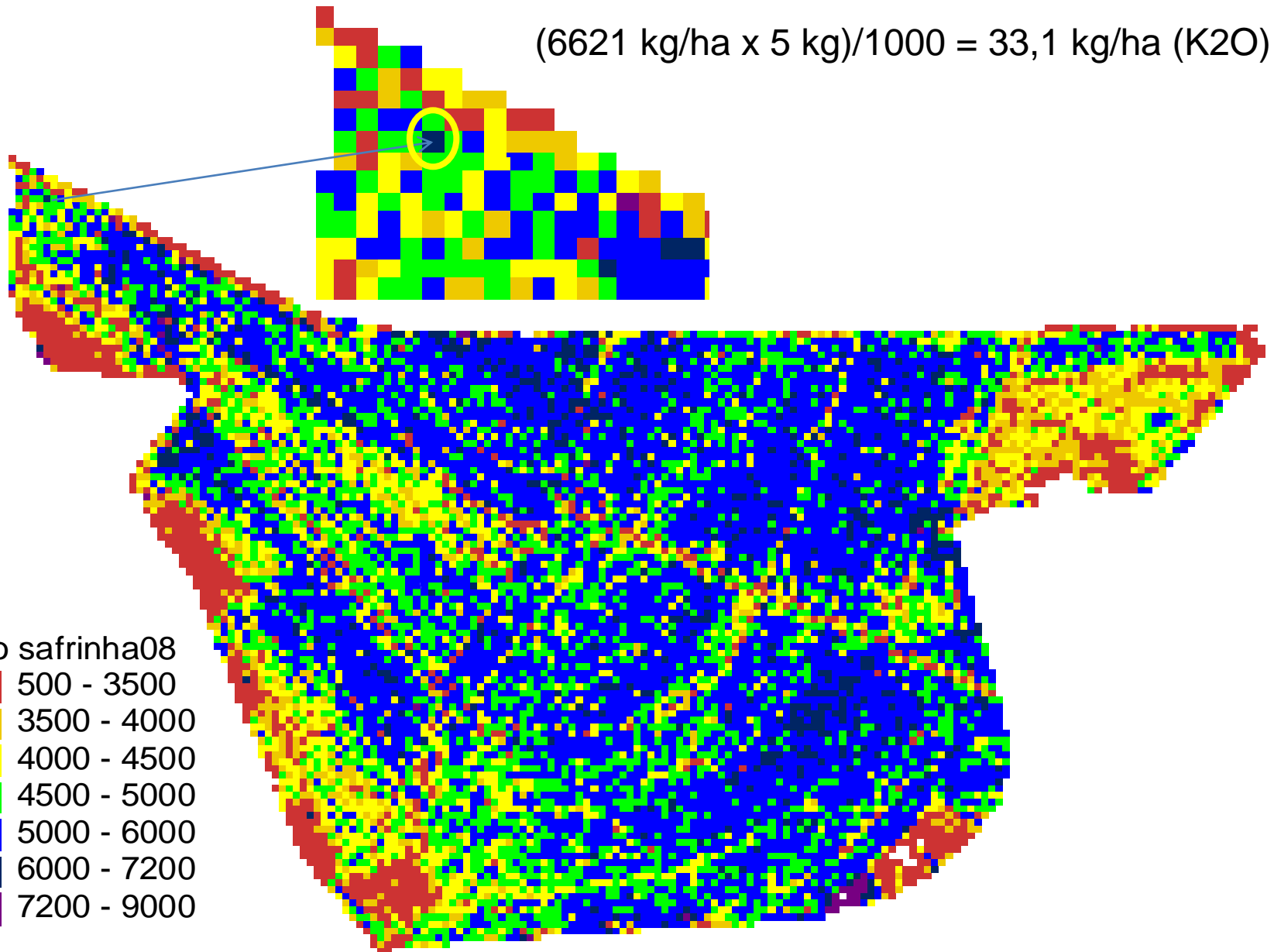
(c)

As planilhas permitem que o usuário efetue operações aritméticas no próprio SIG. Mantendo a coluna “Id”, que é a coluna de identificação dos pixels, pode-se adicionar novas colunas nessa tabela, como por exemplo as produtividades de outros mapas. Após adicionar a produtividade de outro mapa, pode-se fazer as somas das produtividades.

soja0708



$$(6621 \text{ kg/ha} \times 5 \text{ kg})/1000 = 33,1 \text{ kg/ha (K2O)}$$



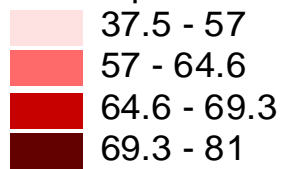


K2O Exportação Milho

- 1 - 6.5
- 6.5 - 16.9
- 16.9 - 23
- 23 - 27.2
- 27.2 - 49.9



K2O Expotacao Soja



# Recomendação para aplicação de KCl com base na exportação do milho e da soja

Total : 39408.88 Kg.

