Territorial intelligence approaches to support policy actions and sustainability

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- Embrapa’s Strategic Intelligence System (Agropensa) - Secretariat of Intelligence and Macro-strategy (SIM)
Factors of growth in Brazilian agriculture

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<tbody>
<tr>
<td>Corn</td>
<td>100</td>
<td>106</td>
<td>118</td>
<td>195</td>
<td>288</td>
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<tr>
<td>Soybean</td>
<td>100</td>
<td>206</td>
<td>236</td>
<td>311</td>
<td>347</td>
<td>392</td>
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<td>Wheat</td>
<td>100</td>
<td>96</td>
<td>215</td>
<td>241</td>
<td>246</td>
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<td>Rice</td>
<td>100</td>
<td>104</td>
<td>135</td>
<td>211</td>
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<td>430</td>
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<tr>
<td>Beans</td>
<td>100</td>
<td>78</td>
<td>72</td>
<td>97</td>
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<tr>
<td>Sugarcane</td>
<td>100</td>
<td>160</td>
<td>225</td>
<td>231</td>
<td>256</td>
<td>258</td>
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<tr>
<td>Beef cattle*</td>
<td>100</td>
<td>107</td>
<td>123</td>
<td>227</td>
<td>431</td>
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Data from IBGE, calculations and elaboration by Martha et al. (2012), Martha (2013).

“Productivity explained 79% of the growth in Brazilian beef production in the 1950 – 2006 period. The land-saving effect arising from these productivity gains was 525 million ha!”
Incentives to Brazilian agriculture (OECD/PSE)

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<tbody>
<tr>
<td>South Korea</td>
<td>64,9</td>
<td>59,0</td>
<td>50,0</td>
</tr>
<tr>
<td>Japan</td>
<td>58,7</td>
<td>55,4</td>
<td>51,0</td>
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<td>European Union</td>
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<td>Russia</td>
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<td>China</td>
<td>1,2</td>
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<td>Australia</td>
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<tr>
<td>Brazil</td>
<td>-6,7</td>
<td>5,3</td>
<td>4,8</td>
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Data from OECD (2013).
"Technical coefficients are not completely independent from prices at the farm level. Management choices, and thus, farm's productivity targets depend on relative prices in the moment decision takes place"
BE models + Territorial Intel. Appr. can provide a “bridge” between basic / applied research and “real-world” issues

• Biological and physical science research, which underpin analysis of agricultural and environmental issues, typically operate on tiny scales (cellular, plant, animal, or field scale) compared to the one used to determine which technologies affect the target-public. Such research scale is also different from the scale of measurement at which public policies are directed;

• Bio-economic (BE) models coupled with territorial intelligence approaches thus play a pivotal role to enhance the process to expand the interfaces and flows of scientific information in support to the decision-making process and public policies;

• Opportunity costs plays an important role in technology adoption and land-use decisions.

BE models + Territorial Intel. Appr. can improve communication with society and policy makers

• Given the unique regional and sector opportunities and challenges of agricultural value chains there is no such a thing as one size fits all. Solutions must be contextualized (territorial intelligence approaches);

• The role of science should be to provide information to decision makers and to ensure that uncertainties around that information are made clear, rather than simply advocating a course of action (opportunity cost approach);

• There is an urgent need for simple and consistent communication of the knowns and unknowns about key issues to fuel the policy-making process (territorial intelligence + opportunity cost approaches);

• It must be realized that based on the same evidence it is possible to pursue quite different options and that policy-making process includes other inputs – social, practical, economic, legal, electoral, ethical, cultural – in addition to scientific evidence.

Boyd, 2013; Lele et al., 2013; Gluckman, 2014
Opportunity cost layer

• The objective of this on-going research is to develop a pixelated opportunity cost layer for key commodities and regions in Brazilian agriculture to facilitate a host of prospective strategic assessments;

• Such analyses are particularly timely from a policy perspective given relatively recent developments in Brazil and the prospective expansion in regions with potential dynamic land-use changes.
For assessing agricultural technologies is necessary ...

a) to provide a detailed description of the technology or knowledge;

b) to determine which technology will be replaced, clarifying the advantages and disadvantages of the new technology compared to the one currently in use in farm;

c) to detail the systems where the new technology can be applied and the need for (and the extent of) changes/adaptations in the current system;

d) to inform the costs of production of the new technology compared to the one in use that this new technology is supposed to replace, including price and weather risks;

Alves, 2001
For assessing agricultural technologies is necessary ...

e) to inform the new technology’s potential response to modern inputs;

f) to inform if there are restrictions for adopting the new technology in terms of capital acquisition costs, education/training of the farmer, knowledge about technical service and credit limitations;

g) to identify the environmental impact of the new technology;

h) when applicable, to separate private and social costs and benefits.

Alves, 2001
Opportunity cost estimation

\[ TR_{ICLS} - (TC_{ICLS} + NR_{Esp.}) > 0 \]

\[ TR_{ICLS} = \text{total revenue in ICLS}; \]
\[ TC_{ICLS} = \text{total cost in ICLS}; \]
\[ NR_{Esp.} = \text{net revenue in specialized system (ex. cattle or soybean)}; \]

“In a second step, it is necessary to investigate the net revenue to the entrepreneur (return of the enterprise / R$ of total cost).”

“The farmer may have other reasons in the decision-making besides a rigorous economic analysis”

Martha Jr. et al. (2011).
Simple tools may be used to estimate the opportunity cost
“Pilot-region”: Triângulo Mineiro ("Minas Triangle")
Mesorregion

- Traditional cattle region;
- Potential high impact in land-use changes: expansion of sugarcane area (from SP), expansion of soybean area (from the Cerrado region);
- Opportunity costs will play an important role in land-use decisions.
Bovine herd in Triângulo Mineiro mesoregion (Ag. Census)

- Bovine population = 4.53 million;
- Pasture area = 3.61 million hectares;
- Avg. stocking rate = 1.25 hd/ha.

- In Triângulo Mineiro mesoregion ~ 75% of the municipalities present stocking rates ranging from 1.00 to 1.75 hd/ha.

G.B.Martha & M.P.Gomes, Agropensa/Embrapa (work-in-progress; in review).
Stocking rate is a good starting point but it does not provide a true measure of productivity. Capturing productivity – the product between stocking rates and animal performance – is key for insightful analysis representing the “real world”!
Animal performance x productivity

For a given stocking rate, moving from a low (left, 125 kg LWG/hd) to a high (right, 175 kg LWG/ha) animal performance level, compatible with the common range in tropical pastoral systems, can dramatically changes productivity output.

G.B. Martha & M.P. Gomes, Agropensa/Embrapa (work-in-progress; in review).
Increasing productivity through higher stocking rates and animal performance potentially reduces the intensity of GHG emissions. Overall emissions, however, are very sensitive to metrics (GWP, left x GTP, right).

GHG emissions and C sequestration estimates based on results from Barioni et al. (2009), Urquiaga et al. (1995), Corsi et al. (2001), G.B.Martha & M.P.Gomes, Agropensa/Embrapa (work-in-progress; in review).
Carbon sequestration by tropical pastures is potentially enormous. In many cases, GHG emissions (GWP) can be completely balanced in these systems. Improving productivity generally increases carbon sequestration (right graph).

Productivity strongly affects economic performance

Assessing relative prices are critical to avoid strategies that are not economically recommended. Gross margin (total income – variable costs) for low (left) and high (right) animal performance is showed below. Gross margin, however, poorly represents farm’s competitiveness potential in the long-run. For this end, net revenue (total income – total costs) should always be preferred!
Market failures reduce economic performance

Reducing market failures is decisive to agricultural production systems competitiveness and sustainability. The estimated effect of a net benefit of 7% in terms of trade (right), in net revenues, is illustrated below.

G.B.Martha & M.P.Gomes, Agropensa/Embrapa (work-in-progress; in review).
Market failures reduce economic performance

From a “capitalist” viewpoint, the internal rate of return is the relevant metric. Reducing market failures (a net benefit of 7% in terms of trade, right graph) is key to improve economic performance. Assessing relative prices are critical to avoid strategies that are not economically recommended.
Market failures reduce economic performance

Reducing market failures is also key to reduce the funds needed to implement incentive programs, for example, payments for environmental services. A net benefit of 7% in terms of trade (right) significantly reduces the need for incentives (USD/ha) to a 5% IRR target.

G.B.Martha & M.P.Gomes, Agropensa/Embrapa (work-in-progress; in review).
Agropensa's strategy for assessing technological shocks (and associated land-use changes) in the wider economy

2015/16

The op. cost of key-technologies, at the farm-level / regional, is analysed

2015/16

Pixelated opportunity cost (+time & distance to markets layer) is implemented for promising technologies

2016/17

Base and alternative cost of production from technologies are evaluated using TERM-BR model

2016/17

Selected technological / political shocks are tested using GTAP
Embrapa Strategic Intelligence System

"Targeting possible futures, their challenges, solutions and opportunities for the technological development of Brazilian Agriculture"

Thank You!

www.embrapa.br/agropensa