The sustainable solutions coming from the tropics

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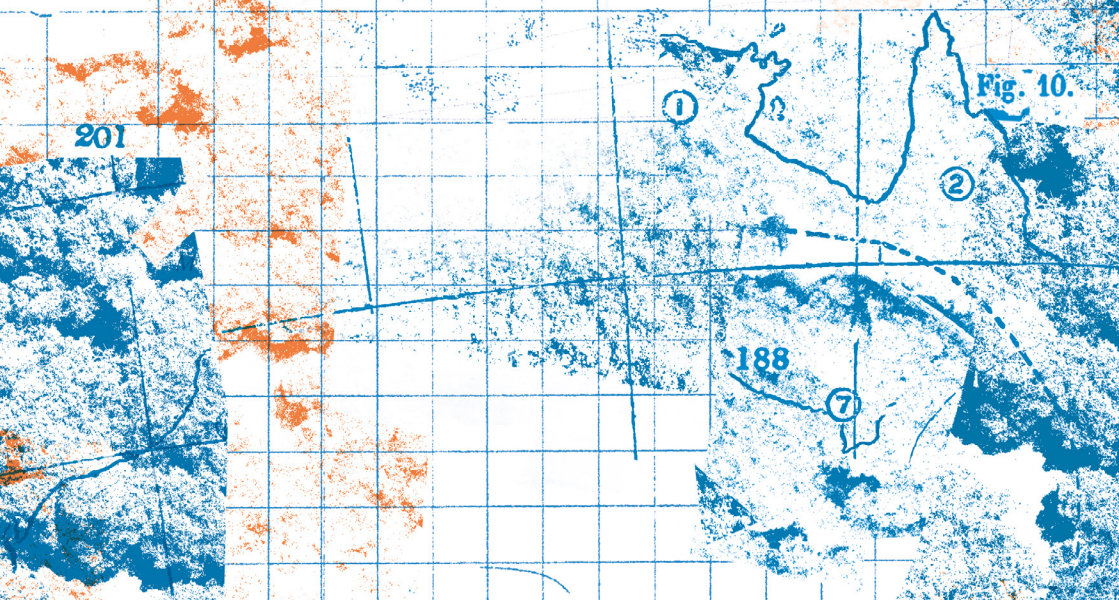

Will there be climate, food, and peace if tropical peoples lack access to science, quality of life, and social and technological inclusion?

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SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

Will there be Climate, Food and Peace without Tropical Peoples' access to Science, Quality of Life and Social and Technological Inclusion?

EDITOR'S NOTE

Bringing the rural and urban worlds in Brazil closer together in a single project for society and paving the way for interaction between the economic and technical-scientific skills Brazil has achieved and the universal desire for more food (and improved distribution), more renewable energies, adapting production to the demands of the climate transition and reducing social inequality through the democratization of Knowledge, social and technological inclusion of the tens of millions of producers and companies that today operate in the tropics that are excluded from knowledge.

In this sense, this book has been purposely designed to support the debate at the Forum for the Future-Norway Seminar, showing the wide range of potentialities, weaknesses and opportunities that the mega-crisis presents us with. The complexity of the factors that combine to form a chasm between available knowledge and the reality currently experienced by Humanity is exponential. In practice, this translates into a dissonant picture: wars, misery, hunger and growing social and political disagreement take place just when we have the means to materialize, universalize and meet the demands of the People and the Planet.

Brazil has developed the best tropical science. And through it, it has signed one of the most beautiful pages in the History of Food: the creation of Tropical Agriculture, which has led to levels of productivity and sustainability that are still unparalleled today. The raison d'être of this book, however, is not just to repeat these mantras. The task: to introduce the Brazilian and tropical contribution to the global debate and to find solutions that can systematize what we know in order to manage what we do in a consistent and sustainable way.

Thus, in Brazil, connecting the rural and the urban in a single Nation project in the midst of critical global challenges is no mere utopia; it is an unavoidable imposition of civilizational trajectory.

For these reasons, this work has been guided and founded on the principle of humility. At this challenging time, no one knows everything. In an increasingly polarized and fractured world, we need to join hands. The key word is "collaboration". We need to relearn how to cooperate in society. Creating a practical roadmap of replicable sustainable development models to ensure that knowledge lands in real life involves redesigning the way we think and act.

All the parts in the equation need to be engaged in the same objective: frank and constructive dialogue between Science, Business and Citizenship. We will only build a common vision of the future if Knowledge and development institutions, corporate entities, producers, final urban consumers and young people - the true owners of the future - are on the same page.

Consistent dialogue begins with a careful choice of language, the means by which human beings convey meaning and purpose. We haven't managed to fully democratize the message in direct language, it's not accessible to the lay public yet. But we have come a long way. Institutions and authors of the greatest relevance are open to dialogue and cooperation at National and International levels. And being available for Dialogue is the first step towards the "Third Leap".

Fernando Barros
Executive Director of the Forum
for the Future Institute

PREMISES FOR A NEW "COMMON FUTURE"

In 1987, the UN World Commission on Environment and Development, led by the Prime Minister of Norway, Gro Harlem Brundtland, presented the concept of Sustainable Development to the world, publishing the document "Our Common Future".

The Report indicated that the high level of consumption of natural resources by developed countries and the poverty of "third world" nations, in the language of the time, prevented equal development and caused serious environmental crises.

Roughly speaking, this causal relationship remains unchanged.

In the 1970s, Alysson Paolinelli, who headed the institution that became what is now the Federal University of Lavras, led the process of creating "Tropical Agriculture". Science was still unaware of the use of tropical soils for food production. Minister of Agriculture, Paolinelli led the process of training Brazilian researchers in the main global centers, set up Embrapa and designed a model for colonizing the Cerrados that was a milestone in the modernization of the Brazilian economy. This dynamic broke with 4,000 years of domination of the food supply by temperate climate agriculture; it transformed a deserted space into an economic, social and cultural powerhouse and allowed Brazil, then a food-importing country, to now be responsible for feeding 800 million people around the world.

Nonetheless, a lot remains to be done.

In Brazil alone, 4.5 million agricultural addresses still lack access to Science, Management and Technology. Add Africa and Latin America and there are tens of millions of rural producers and other players (small and large businesses) in the same situation.

With this perspective in mind, in 2012 Alysson Paolinelli founded the Forum for the Future Institute. Its mission: to insert the planet's tropical zone into the global debate as a source of strategic governance solutions.

After 12 years of collaborative, cross-cutting analysis, integrated into a network, bringing together the contributions of the Technical Sciences and the Humanities in the same space, the Forum for the Future Institute is offering national and international reflection on the elements it considers critical in this serious and complex moment in the 21st century.

The summaries presented here are intended to universalize the debate. And, in a practical and tangible way, to simplify the purpose of the possible utopia defended by the visionary viewpoint that transforms the social and technological inclusion of tropical actors into a page of Human Rights.

It's the "Third Leap", as Paolinelli described the challenge of more than doubling food production by 2050 and at the same time tackling Energy Insecurity, Climate Change, Social Inequality, the prospect of the collapse of Global Governance and the need to combine Artificial Intelligence and Strategic Communication as instruments to enable dialogue for the construction of a new "Our Common Future":

- **The economic viability of projects is a sine qua non condition for achieving social and environmental objectives;**

- **Linking “Science Policies” (public or private) and transfer tools makes it possible to bridge the gap between the knowledge available in institutions and the reality experienced by the final actors who directly operationalize the use of natural resources.**

By making the access to Knowledge democratic, we ensure a quality of life that meets civilizational standards and allow for:

- The legitimate participation of tropical peoples in a slice of the global food market. It's an existential question: food production is the only sector in which the region's players are competitive and dedicated;

- The mitigation of the migratory flow is in the strategic interest of the developed nations of the temperate zone and is in line with the fact that tropical populations only leave their territories when forced to abandon their culture and family environment, when under pressure to survive and increasingly because of the degradation of local climatic conditions;

- The creation of decent jobs for tens of millions of rural producers and other stakeholders is the essential basis for an effectively sustainable development process.

And we also agree on the following:

- The relationship between deforestation and the predatory use of nature promoted by populations with no alternatives for survival and no access to process management resources is indisputable;

- The Amazon is home to 28 million people in Brazil alone. It is a record holder for hunger and poverty when compared to other regions of the country;

- Engaging social and productive actors in sustainable development processes is more efficient than investing ever-increasing amounts of resources in inspection and control systems of dubious applicability;

- Considering that Development Agencies can successfully replicate the sustainable development models designed for each of Brazil's six biomes throughout Africa and Latin America;

- Understanding the systematization and organization of production chains is imperative to ensure the best possible use of natural resources (productivity), the minimum impact of interventions on nature and the best social outcome for the populations involved, especially when it comes to family farming or indigenous communities;

- Establishing as an essential objective the valorization of the scientific method and, in the particular case of this approach, the role of Tropical Sciences as an indispensable reference for sustainable development processes;

- Including the scientific vision as the guiding principle of educational processes from elementary school onwards;

- Connecting Brazil's scientific leadership in the areas of biological pest control and regenerative agriculture with programs and projects committed to the production of healthy food;

• Promoting the analysis of the degree of sustainability considering the systemic vision that encompasses the whole of a given territorial and ecosystem reality. It is essential to consider and validate the degree of sustainability of the territory as a whole, and this necessarily includes all the actors, regardless of size or productive configuration;

• Considering the challenge of transgenerational dialogue as a vital part of this strategic agenda;

• Valuing the potential for industrial and service scaling in the Tropical Bioeconomy (ESG space of productivity, located beyond the gate of production units) as a possible axis for a new cycle of sustained growth in the global economy;

• Perceiving Strategic Communication as a central element in the harmonization of the vision of a "New Common Future", guided by the proposal of "Advocacy", in which the cause is to found relationships of trust that can move this "ecology of linked differences" towards the presentation of a new window of hope for Humanity.

CONTENTS

VISION

FOR A NEW GLOBAL FOOD PACT

Alysson Paolinelli*

It is vital to make peace with hope.

It is indeed possible to build a better world right away. We can weave the logic of a new economic, social, and environmental order that gives meaning to the trajectories of nations, from the most developed to the poorest, of people — especially the youth, the protagonists of the future, and of the Planet.

The immense challenges of this new Era require rethinking political, management, and planning paradigms. They also demand strong doses of empathy and courage to bridge scientific and technological achievements with reality in societies.

Omission is not an option here.

In this sense, the powerful body of knowledge gathered by the sciences practiced in the tropical zone can be surprising. This is the primary goal of the book "Sustainable Solutions Coming from the Tropics," coordinated by the Forum of the Future Institute, with the aim of provoking global reflection on the transformative potential of this knowledge.

It is not simple or easy. But it is logical, desirable, and feasible.

By 2050, some central connections will guide aspirations and searches for structural solutions: the increase in population (approaching 10 billion) and the rise in demands: for food (200,000 new mouths to feed each day until then), for energy (an increase of 50%), for water (an increase of 40%).

However, we have never had so many scientific and technological means to act on reducing inequality, combating hunger (food prices), and inflation through increased supply; addressing the climate transition; and managing forced migration flows.

The climate agenda is non-negotiable, nor is deforestation an option. However, food security and social and technological inclusion are on the same level.

Brazil is a reference in food democratization, grounded in the pillars of science and entrepreneurship, a result of the second largest leap in food supply in human history, achieved in the 1970s.

Humanity now calls for a "Third Leap": more food and of better quality; reduction of losses and waste; regeneration, recovery, and preservation of biodiversity; reliable metrics for broad monitoring; and control in the governance of sustainable processes (ESG).

These intentions are what the Forum of the Future seeks to embody in Demonstration Hubs for Sustainable, Inclusive, and Healthy Tropical Bioeconomy, through replicable models showcasing the civilizational potential of this proposal.

*Alysson Paolinelli, in his term as a Minister:
Led the creation of Tropical Agriculture in the 1970s;
Coordinated the training of scientific leaders at leading global centers;
Established and structured Embrapa[1];
Developed a model for the modernization and interiorization of the Brazilian economy.

[1]Embrapa - Empresa Brasileira de Pesquisa Agropecuária: Brazilian Agricultural Research Corporation

MORE SUSTAINABILITY, MORE FOOD, INSTRUMENTS OF PEACE

Roberto Rodrigues*

Recent studies speculating on global macro-trends for the next 20 years have repeatedly pointed out their four major determinants:

- growth, urbanization, and aging of the population
- increase in per capita income and GDP
- technological development
- sustainability

Obviously, issues such as education, health, peace, legal security, food security, housing, mobility, democracy, and many others should fit within this labeling. However, one aspect of sustainability — specifically one concerning the environment — has been a priority topic in any event worldwide.

Critical points surrounding sustainability are the subject of endless discussions: climate change, global warming, extreme events, basic sanitation, deforestation, water and land use, decarbonization, greenhouse gas emissions, production systems, traceability, certification, and more recently — starting with COP 26 — the regulation of the carbon market globally and payment for environmental services here in Brazil compose a formidable agenda.

Since young people from all continents are highly interested in environmental protection, this topic will remain on the agenda for several more decades, as they will take on leading roles in public and private institutions and will eventually discover what actually needs to be done, based on science and accumulated technical knowledge. This connection between technology and sustainability is not always communicated. Occasionally, less public-spirited interests overshadow scientific knowledge, leading to the essential defense of natural resource preservation to be used as an argument for or against food trade, for

instance. It is necessary to eliminate the misuse of information in communication about sustainability, always prioritizing science and the truth that emerges from scientific knowledge, regardless of whom it may upset. This is justice!

For this reason, technological development and sustainability represent half of the foundations for scrutinizing the future. Both are irrevocably linked. There will be no legitimate sustainability without technological development, and technology will establish sustainable practices, emphasizing environmental preservation.

This relevant situation is complemented by another aspect that has been greatly emphasized by the tragic COVID-19 pandemic, which swept the planet at the end of the second decade and the beginning of the third century: food security.

Many countries lacking self-sufficiency in food production sought to secure supplies to guarantee their populations' food security. This concept holds great significance since supply shortages cause social and even political disturbances, lead to insurrections, and may even result in the overthrow of governments. In other words, food security is synonymous with socio-political stability. The rise in demand coincided with global stocks being below average in 2019 and 2020, which caused the prices of major commodities to increase spectacularly in dollars, generating food inflation worldwide. Producers from all regions increased their cultivated areas to take advantage of the good prices and demanded far more inputs, such as fertilizers, pesticides, machinery, and agricultural equipment. Consequently, manufacturers had to increase investments to ensure supply, further driving up prices and exacerbating inflation already amplified by logistical complications caused by the pandemic.

All these issues have established sustainable food security as humanity's greatest short-term demand: guaranteed food and a preserved environment!

Now, which sector will take care of both? Undoubtedly, it is agriculture. But which one? Tropical agriculture because the tropical belt of the planet offers available land for cultivation, as well as space to increase productivity per hectare through the introduction of tropical technologies.

Brazil will play a key role in the growth of food supply for consumers around the world. Currently, according to EMBRAPA[1] , the country

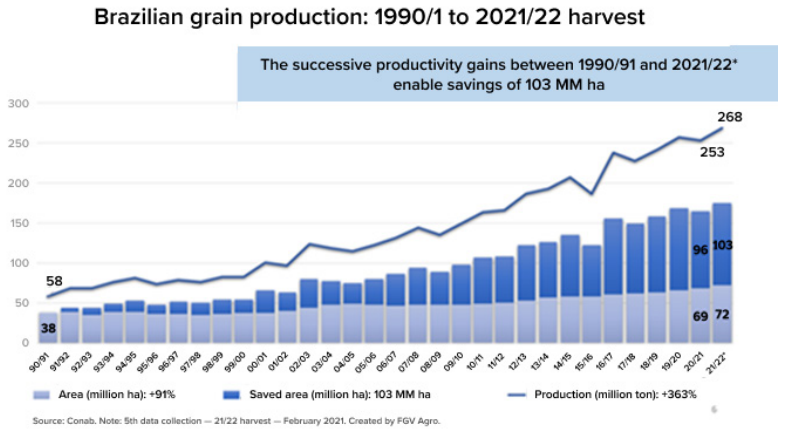
[1]Embrapa (Empresa Brasileira de Pesquisa Agropecuária): Brazilian Agricultural Research Corporation

already feeds over 800 million people in 190 countries.

Recurring studies from the OECD[2] , FAO[3] , and USDA[4] indicate that the global food supply must grow by 20% to ensure no one goes hungry in ten years. However, for this to happen, Brazil will need to increase its supply by 40% — twice the global requirement. The institutions justify this forecast based on three key factors: the sustainable tropical technology developed here, the availability of land, and the skilled human resources present across various agricultural production chains.

Regarding technology, the chart below shows impressive numbers.

CHART 1: AREA PLANTED WITH GRAINS AND ITS PRODUCTION



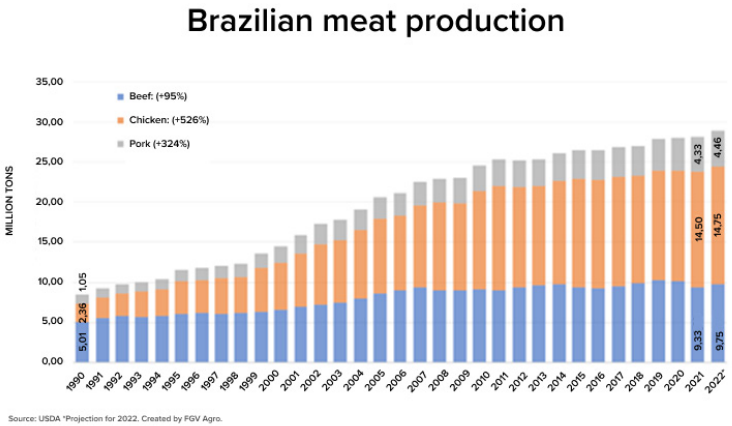
From 1990 (a landmark year due to the Collor Plan[5]) to today, the area planted with grains has grown by 91%, while production has increased by 363%, nearly quadrupling. If these figures are spectacular, even more remarkable is the information that today 72 million hectares are cultivated with grains in Brazil. However, if productivity per hectare to-

[2]OECD: Organisation for Economic Co-operation and Development
[3]FAO: Food and Agriculture Org anization
[4]USDA: United States Department of Agriculture
[5]The Collor Plan was a set of economic measures implemented in Brazil in 1990 to combat hyperinflation. It included freezing prices and salaries, and confiscating a portion of bank savings. The goal was to stabilize the economy, but it led to social unrest and economic challenges.

day were equal to that of 1990, an additional 103 million hectares would be needed to achieve the 2022 harvest. In other words, these millions of hectares were preserved, eloquently demonstrating the sustainability of the technology developed here.

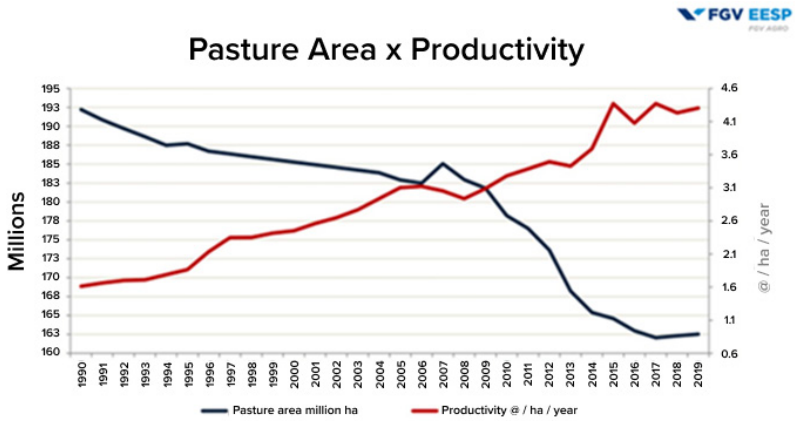
The same growth trend is observed in Chart 2 regarding animal protein.

CHART 2: MEATS



In fact, Chart 3 shows that pasture areas are decreasing while beef production has increased.

CHART 3: PASTURE VS. BEEF



This trend is observed with permanent or semi-permanent crops, fruit cultivation, coffee, horticulture, etc. All this is based on technological innovation that continues to advance with the Low Carbon Agriculture programs, which focus on the integrated crop-livestock-forestry systems[6] , as well as direct planting, recovery of degraded areas, biological nitrogen fixation in the soil, and many others.

The sustainability of the Brazilian energy matrix is impressive, with 48% being renewable, compared to only 15% of the world's energy matrix. This high percentage is largely due to agroenergy, which accounts for 19% of Brazil's energy supply, primarily from sugarcane. Sugarcane produces ethanol that emits only 11% of the CO2 produced by gasoline, along with bioelectricity generated from bagasse and leaves. Additionally, corn ethanol has been growing significantly. On average, ethanol production replaces 31 billion liters of gasoline per year, reducing the demand for imported oil.

Biodiesel from oilseed crops like soy and palm, or from waste such

[6]Integrated crop-livestock-forestry systems (ICLFS) are an emerging production strategy in Brazil that combines agriculture, animal farming, and forestry in the same area. This approach can involve intercropping, crop succession, or crop rotation, allowing for mutually beneficial activities. Its goal is to optimize land use by enhancing productivity, improving input use, diversifying production, and creating more jobs and income, all while minimizing greenhouse gas emissions and promoting environmental sustainability.

as animal fat, emits 20% of the greenhouse gases released by fossil diesel.

Moreover, planted forests for industrial purposes now total 10 million hectares.

Notably, according to EMBRAPA, Brazil still has over 65% of its territory covered with native vegetation, and due to the world's most stringent Forest Code. The code requires forest reserves on all private rural properties, and these reserves account for 25% of the total territory, at the owners' expense and risk. Furthermore, all cultivated plants in Brazil, except pastures, occupy only 9% of the 8.5 million square kilometers of the country. Pastures occupy another 21% but are gradually being replaced by agriculture.

All these numbers lead to new relevant information.

Chart 4 shows the advancement of Brazilian agribusiness exports by product from the year 2000 to the present.

CHART 4: EXPORTS BY PRODUCTS

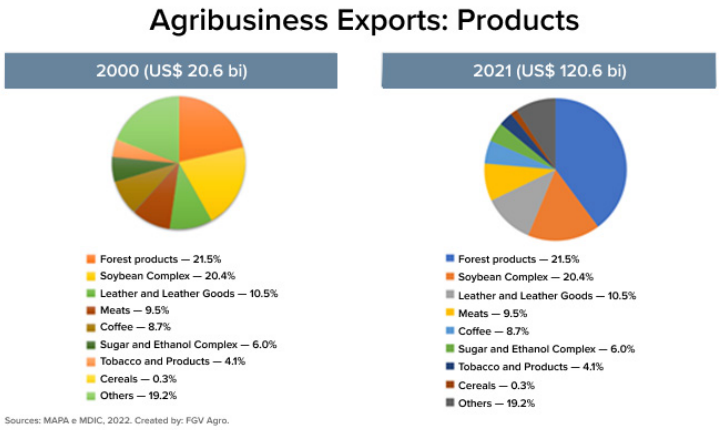
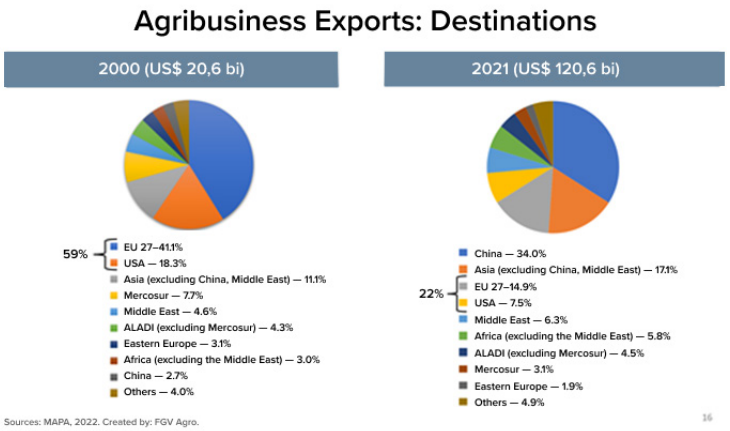


Chart 5 shows the destinations of the exports, highlighting the growth of exports to developing countries.

CHART 5: EXPORT DESTINATIONS



With this data, it is evident in Table 6 that Brazil's trade balance has been systematically increasing due to agribusiness, consistently showing a surplus.

CHART 6: TRADE BALANCE

It is absolutely essential to point out that the success of Brazilian agribusiness can be replicated in the tropical belt of the planet, which encompasses practically all of Latin America, all of Sub-Saharan Africa, and a large portion of Asia.

This demonstrates the potential for job and income generation in all these regions, along with guaranteed social and political stability, and the contribution the tropical world can offer to global food security.

Of course, all this cannot be achieved solely through science and technology. Issues such as logistics and infrastructure, market-opening policies, income policies in rural areas (including functional rural credit and insurance), and legal security are essential for progress in the desired direction. Many of these depend on government actions, as well as the enforcement of laws. It is incredible that, in Brazil, this focus still lies, even in the 21st century, on eliminating illegal deforestation, especially in the Amazon, as well as on criminal fires, land invasions and land grabbing, clandestine mining, and land regularization. All of this depends on oversight and control by the established authorities at three levels: federal, state, and municipal.

On the other hand, the private sector is required to better organize the production chains, especially with regard to adding value to commodities through the processing industry. In this context, the Brazilian cooperative movement is exemplary, accounting for 54% of the country's agricultural origination, and it should be encouraged to fulfill its historical role in the social inclusion of thousands of small producers who are still outside the market.

An absolutely central role is reserved for the tropical production system in feeding populations across all continents. Certainly, if they fulfill this role, they will be ensuring universal peace: there will be no peace while there is hunger.

***Roberto Rodrigues**
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[7]FGV: Fundação Getúlio Vargas

THE IMPACT OF INCLUSION TECHNOLOGY IN THE TROPICAL WORLD

Diego Árias*

Technological advances are accelerating at an exponential rate. Digital and genetic technologies have revolutionized research and accelerated innovation processes in various sectors of the economy in recent decades. Agriculture is no exception, but technological advances are not reaching all farmers or all regions of the world. Tropical agriculture, if it can adopt technologies that allow it to have a greater environmental and nutritional impact, can become part of the solution to the major global problems facing the world. Climate change, accelerated loss of biodiversity, and increasing malnutrition are global problems where tropical agriculture plays a key role in protecting natural resources, mitigating greenhouse gases, and securing food and nutrition for local and global populations.

This book aims to focus on the challenges and the opportunities that innovation and new technologies can bring about so that tropical agriculture has a central role in solutions for a sustainable development of the planet. More specifically, how to take advances in science to all farmers and producers? How to link research and adoption of technologies in the field? The fact that many of the new technologies do not come from research institutions is a key problem to solve, and then provide for economic, environmental and health improvements to get to the most vulnerable farmers and families. Allowing research institutions to share their technologies more freely, but also cogenerate technologies with the private sector, universities and civil society should be the highest priority. If an agricultural research institute takes 6 months to sign a memorandum of understanding with a private company to test a new technology, it kills innovation, because at the pace of scientific advances today, after 6 months this technology has become obsolete. Today, innovations for agriculture and food can come from

other sectors, not only from researchers in agronomy, and this opening has to exist so that tropical agriculture can benefit from the latest genetic, digital, and other disruptive technologies.

Tropical agriculture has already gone through a period of great technological advancement, changing a country like Brazil from an importer to an exporter of food, reducing rural poverty levels and contributing to the structural transformation of the country's economy. However, today tropical agriculture is being called upon not only to achieve economic objectives, but also environmental and human health ones. Science has shown that there are solutions to meet the triple objective of a healthy economy, a healthy people, and a healthy planet. The challenge now is to connect technological innovation with tropical agriculture actors in our region.

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DIGITAL INCLUSION OF TROPICAL PRODUCERS, THE CAPITAL CHALLENGE

Silvia Massruhá*

Digital inclusion in tropical agriculture goes far beyond simply adopting new technologies; it is a crucial factor in promoting equity, sustainability and competitiveness in the agricultural sector. Digital tools make access to information more democratic, bringing farmers, technicians and managers closer to practices and innovations that optimize productivity, reduce costs and promote a more rational use of natural resources. Technologies such as drones, sensors, artificial intelligence and *blockchain* not only increase production efficiency, but also have the potential to transform the entire value chain, from production to marketing.

There are countless possibilities and prospects where digital can transform reality in the countryside, but there are challenges that need to be overcome if all the potential is to become reality. Studies show the gaps and positive impacts, for example, of effectively expanding access to connectivity in the countryside. *Brasil* (2019) and *Brasil* (2021) present data from an ESALQ/USP study commissioned by the then Ministry of Agriculture and Livestock. Preliminary data from the study in *Brasil* (2019) indicated that in 2019 only 5% of Brazil's arable land had connectivity, leaving 58% of rural establishments without access to a cell phone signal. To achieve 90% coverage, at least 5,600 new antennas would be needed at the time, with an estimated investment of R$6 billion.

The current scenario has several studies that seek to clarify the percentage of connectivity in question, depending mainly on the connection technology. One example is the study by Conectar Agro (2024), in partnership with the University of Viçosa, which found that in 2024 around 23.8% of the agricultural area has mobile internet coverage, with 4G and even 5G in some cases. What is central to this perspective

is that producers have been looking for any technology that will allow them to become part of digital agriculture, including satellite connections, 5Ghz and 6Ghz Wi-Fi and TV *White Spaces*, among others.

In addition, *Brasil* (2021) presents data showing that the expansion of the internet has been a crucial factor in increasing productivity in various sectors. The estimate of a positive economic impact - from R$14.02 billion to R$79.60 billion between 2022 and 2026 - related to the Gross Value of Agricultural Production (VPB) as a result of expanding the availability of internet signals in rural areas, reinforces this idea. The data also shows that the variation depends on the availability of inputs and the ability of companies and producers to adapt to new technologies.

On the other hand, the newspaper Valor Econômico (2024) sums up the current challenge well, arguing that the lack of connectivity limits the adoption of precision technologies in agriculture, such as sensors, management *software* and monitoring platforms, harming the productivity and competitiveness of rural producers, especially the larger ones, who need these tools to optimize their processes and increase efficiency.

The article illustrates the problem with examples of producers facing difficulties in using drones, automated irrigation systems and other technologies due to the lack of robust and stable internet. On top of this, the difficulty of accessing real-time information on the weather and markets limits the ability to make strategic decisions.

When it comes to small and medium-sized producers, the majority in Brazil, the challenges are even greater. Buainain, Cavalcante and Consoline (2021) also address regional inequality and point out that connectivity is much lower in the North and Northeast regions of Brazil, which disproportionately affects small producers in these areas. The authors point out that small farmers are most affected by the lack of connectivity, facing significant barriers to adopting new technologies.

On the one hand, there is a lot of basic technology ready to be used, and on the other, there are basic infrastructure challenges. However, it is undeniable how inclusive digital agriculture, if expanded in the country, could transform production and promote sustainability and inclusion from the north to the south of the country. Therefore, three pillars of action guide the future of digitalization in the rural tropical world:

- *Digital Training*: investing in training and developing digital skills for producers;

- *Innovation*: encouraging inclusion and innovation through the use of digital technologies in production processes;
- *Infrastructure*: improving the technological and communications infrastructure to support the expansion of the internet.

This way, the digitalization of the countryside has the potential to profoundly transform tropical agriculture, promoting innovations ranging from the use of sensors and drones to monitor crops to e-commerce platforms that connect producers directly to consumer markets. By facilitating access to government services, communication platforms and financial facilities, such as the use of payment and financing apps, family farmers can manage their businesses more efficiently and competitively. This digital transformation must be accompanied by public policies that guarantee access to connectivity and digital education, expanding opportunities for all farmers. The integration of digital agriculture with the UN's Sustainable Development Goals (SDGs), like the reduction of hunger and inequality, reinforces its strategic role for the future of tropical agriculture, contributing to sustainable, inclusive and resilient growth in the face of the environmental and socio-economic challenges of the 21st century.

The implementation of this technological revolution faces specific challenges in tropical regions, where factors such as great distances, dispersion of farms, economic difficulties for many farmers and lack of digital infrastructure, such as quality internet access, represent significant obstacles.

In addition to these regional challenges, the digital inclusion of family farmers, especially the most marginalized, involves issues related to low educational levels, difficulty in accessing technical assistance and rural extension services (ATER), whether public or private, and barriers to accessing markets and improving income.

In this context, digital inclusion is emerging as a strategic pillar for the sustainable and equitable development of tropical agriculture. It is essential that governments, research institutions, the private sector and their representative organizations collaborate in the formulation and implementation of public policies that promote access to digital technologies. Connectivity and knowledge must be accessible to all farmers, regardless of their geographical location, scale of production or participation in production chains.

Traceability, driven by digital technologies, has therefore become essential for the modernization of agricultural production. Although

already applied in some production chains, such as beef, its use was often merely formal, aimed at complying with regulations. With digitalization, it is possible to monitor the entire production process, ensuring quality and food safety, requirements that are increasingly valued in the international market. Cooperatives in the coffee, cocoa and fruit sectors have led the way in adopting this technology, reducing costs and increasing competitiveness. Digital traceability, as well as contributing to the sustainability of production, plays an important role in the dissemination of new technologies in the agricultural sector.

Despite the progress already made, scientific, technological, social and economic challenges remain. The work by Bolfe et al. (2020) highlights issues such as the security of agricultural data, the need to integrate the demands of producers with the digital solutions offered and the efficient management of both plant and animal production through emerging technologies such as sensors and drones. On the socio-economic side, limited connectivity and high technology costs are barriers that still need to be overcome to ensure the democratization of digital technologies in agriculture.

In addition to connectivity and access to a quality internet signal, access to knowledge depends on technology transfer strategies, through closer relations between scientific research institutions such as Embrapa and the State Agricultural Research Organizations (OEPAs), based on the development of digital tools that enable:

- The democratization of access to basic technical and technological information, the basis for the economic and social development of farmers;
- The complementarity of these tools with the work of ATER service professionals, based on the premise that information and knowledge technology tools do not replace but complement the work of these professionals;
- The need for a territorial approach to digital inclusion actions, respecting the different cultures, traditions, histories and social and economic logics of the various Brazilian territories.

The last point raised - the territorial focus of digital inclusion actions - is extremely important. Actions to support access to digital technologies must take into account the differences intrinsic to Brazil's various rural regions and territories, both economic and social, environmental and climatic. The differences between the support structure for farmers,

especially in relation to public and private ATER services, and the state of connectivity service infrastructure must also be taken into account.

Considering regional and territorial differences and peculiarities opens up space to consider another crucial issue: the development of human capital. The success of this transition requires the training of farmers, technicians and managers so that they can adopt and use the new digital tools efficiently. The adoption of digital technologies needs to be accompanied by a continuous training effort. From planning to marketing, all the links in the agricultural production chain, such as the input industry, transportation and the financial sector, benefit from these solutions. However, their full potential will only be achieved if people are prepared to use them.

Training farmers to use these new technologies efficiently requires more than one-off training sessions; it requires a continuous and integrated digital education effort in the countryside. Without this support, technological progress can deepen inequalities, widening the gap between small and large producers.

Digital education must be intrinsically linked to farmers' technical, technological and organizational needs, besides being based on capacity-building actions, training and the exchange of knowledge between farmers themselves. Successful experiences in certain territories can become a valuable tool for the development of other territories, especially when these capacity-building, training and knowledge-sharing actions are accompanied by support for the formation of leaders in the territories, seeking not only technical preparation, but also emancipation and autonomy.

Support for improving ATER systems - including digital tools; improving connectivity and internet access infrastructure; promoting digital education through capacity building, training and promoting the exchange of knowledge between farmers, and the need to consider regional and territorial differences and peculiarities - brings the clear need to develop integrated public policies. Incentive programs, plans and projects that have digital inclusion as a central axis for reducing costs and economic barriers to market access, adding value and economic and social development, especially for family farmers, indigenous people and traditional peoples and communities.

In this way, digital inclusion in agriculture plays an essential role in promoting sustainable development, especially if we add a fourth dimension to the economic, social and environmental tripod: the temporal dimension, the relationship between generations. The focus should

also be on maintaining optimal conditions for the development of future generations.

From this perspective, digital inclusion makes a direct contribution as a tool for increasing the capacity of social actors (farmers, technicians, entrepreneurs, public agents and others) to analyze the situations and environment in which they find themselves, to learn, to devise solutions that respond to their problems, to anticipate future problems and opportunities and to mobilize human, financial and technical resources to support their own development and that of the territories where they live.

Access the link to the bibliographical references

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SINOP, 2040: THE POSSIBLE UTOPIA

Cesar Borges de Sousa*

Mobilizing a municipality in Brazil's agribusiness around a great dream. This is essentially the mission left by the legacy of Alysson Paolinelli: to embody a revolutionary vision of the state, whose main purpose is to align the interests of developed nations with those of the tropical world. How can this be done in a global environment which is ungoverned, polarized, and unpredictable? Paolinelli's recipe is to build models that demonstrate, on a small scale, that we are talking about a possible, achievable utopia: elevating Tropical Agribusiness to the category of Bioeconomy, and making occupy a space of sustained and sustainable leadership as part of a new cycle of expansion of the world economy — the "Third Leap."

To achieve this, it is essential that the models prove that this pact will generate well-being and wealth through the democratization of knowledge (with a direct impact on reducing forced migration flows from South to North). Moreover, it must, that at the same time, be able to provide concrete answers to the unavoidable challenges of our time and the coming decades: food and energy insecurity; climate change; and social inequality.

With these basic ideas and the support of the World Bank – a primary partner in Paolinelli's dream – we completed the first stage of the Project for implementing the Global Hub for Sustainable, Inclusive, and Healthy Bioeconomy of the Amazon in Sinop. It was not simple. And it will not be. Just as in the international arena, the complex negotiations here involve various dimensions of interests and understanding. However, in Sinop, the determined engagement of productive leaders and local researchers has opened windows of previously unthinkable perspectives.

Yes, we can go very far.

Sinop can become the first tropical "biomunicipality." This is no small feat. Consider the wide range of possibilities...

NATURE-BASED URBAN SOLUTIONS

Nature-Based Solutions (NbS) are tools that allow public and private institutions to act efficiently and transformatively, where natural infrastructure is part of a strategy to create smarter, more resilient cities that offer dignified and sustainable income and job opportunities.

The Agricultural Base

Bioeconomy programs are driven by "biological input." In other words, they rely on agricultural products that go beyond being mere raw materials (commodities) to become critical factors in the universalization of sustainable development.

Therefore, a Global Bioeconomy Hub will only make sense if the structural conditions are established to enable and optimize the functioning of the agricultural sector. In the case of Sinop, the main bottleneck identified by local stakeholders lies in logistics, given the existing inadequate crop transport systems.

In this context, the Forum of the Future has connected the Global Hub Project, through UNESIN[1] (Union of Entities of Sinop), to Porto Central, the company managing the most ambitious logistics project currently underway in Brazil. Implementation is already in progress: a port in the Espírito Santo State with twice the capacity of the existing port in Santos, which is one of Brazil's busiest ports, and a railway (named "Alysson Paolinelli") linking the State of Minas Gerais to the port facilities.

Porto Central aims to be a logistical alternative for Sinop.

Another key aspect is the proposal for digital inclusion. Only 10% of the productive units in Sinop have access to the Internet, placing the proposed digital hub, originally suggested by Embrapa President Silvia Massruhá, at the core of the issue of universalizing opportunities in a rapidly changing world.

Green Infrastructure

Green infrastructure, one of the applications of Nature-Based Solutions (NbS), is being utilized in various regions around the world. By implementing, maintaining, or restoring green areas in strategic locations within cities, a natural system is created that can absorb rainwater, filter soil sediments, and reduce costs associated with sanitation and public health.

[1]UNESIN: União das Entidades de Sinop

Alysson Paolinelli advocated for the absolute priority of preserving "recharge areas of aquifers" as the basis for a strategy of "water production."

A study coordinated by WRI Brazil, published in 2018, showed that increasing forest cover by 8% in the Cantareira System, in São Paulo, could reduce sedimentation by 36%. Green areas prevent more sediments from reaching rivers and treatment stations. Natural infrastructure improves the financial performance of sanitation companies by lowering water treatment costs. In Sinop, alongside existing programs for expanding forest cover and managing urban waste, this effect could be significantly enhanced through Circular Economy Planning and Integrated Management of Waste, Reuse Identification of economic opportunities arising from preservation efforts.

For example, the important Teles Pires River, instead of being a destination for sewage with limited treatment, can offer robust potential for multiple socioeconomic uses: aquaculture, sport fishing, gastronomic tourism, etc. We need to quantify and assess the socioeconomic opportunities resulting from the qualified use of natural resources.

Urban Planning and Construction

Partners in the Sinop Project, EDB[2] (which produces vegetable polyurethane from soybean oil) and Weber Ambiental[3] are opening up vast possibilities for innovation and material reuse in the construction sector. Soybean houses, rural storage structures made from vegetable polyurethane, the use of new technologies, waste reduction, and the identification of new materials are among them.

The technology brought by Weber is so bold that it enables the transformation of waste into aviation fuel. With the aim of integrating various existing sectoral actions, the company has applied to join the group of supporters of UNESIN.

[2]EDB (Eco-Desenvolvimento Brasil): A Brazilian company that specializes in producing vegetable polyurethane from soybean oil, focusing on sustainable practices and innovative materials, and contributing to eco-friendly solutions in various industries.
[3]Weber Ambiental: A Brazilian company that specializes in environmental solutions and sustainable practices, focusing on waste management, recycling, and the development of technologies that convert waste into valuable resources, such as fuel.

Strategic Planning for the Use of Biofuels

The pricing structure in Brazil traditionally favors fossil fuels, as consumers' purchasing decisions are heavily influenced by price and convenience, often at the expense of sustainability. This is the case worldwide. However, in Sinop, it can be different.

The coordination of an integrated strategy to promote the use of biofuels in public and private operations (in buses and public vehicles, farm tractors, school transport, and personal vehicles...) could enable Sinop to showcase a globally impactful experience: while 90% of the global economy continues to rely on oil, our municipal performance can be significantly better.

The production of corn ethanol and soybean biodiesel for public transport and agricultural tractors could be eligible for tax incentives from the state. This measure supports and justifies the innovative and visionary role that Caramuru Alimentos[4] and Inpasa[5] already play in the region.

One can imagine the international impact of an initiative that is a direct and comprehensive response to the issues raised in global debates.

Legitimizing the activity of Tropical Agribusiness has not been possible through advertising and marketing alone. However, unquestionable examples like this present a historic opportunity to showcase what Brazilian Technological Agriculture, grounded in science, can offer to the world.

Planning for the Industrialization and Services of Bioeconomy

We know that a solid and structured agricultural base is essential. After all, the raw materials for the bioeconomy are "biological inputs," in other words, agricultural products. However, the strategic focus shifts: instead of solely aiming for the export of commodities, the bioeconomy emphasizes investment alternatives that promote value addition locally and reduce the threats and risks that Brazilian agriculture faces due to the dependence on commodity market prices.

From a forward-looking perspective, allowing the economic and financial health of the sector to be governed by the performance of the Chicago Board of Trade means relinquishing control over the quality of our future.

[4]Caramuru Alimentos: A Brazilian company that specializes in producing various food products. It is known for its commitment to sustainable practices.
[5]Inpasa (Indústria Nacional de Processamento de Algodão e Soja): A Brazilian company focused on processing agricultural products and is involved in the production of biofuels and other related products.

The Sinop Project presents a historic opportunity: the alignment of the interests of the national agricultural sector's economic power with the vision and expectations of urban consumers. This is the platform that can ensure Brazil's leadership in the global bioeconomy market, which generated $13.5 trillion in 2023, compared to $5 trillion for the fossil fuel industry.

It is when soy transforms into over a thousand industrial products, true diplomats that can represent the interests of Agribusiness in urban dialogue. Sinop opens a new window of hope for Brazil and the world.

Integrated collaborative mobilization in a network requires humility, empathy, appreciation for each participant, and great faith in the future of Brazil.

Hope, however, is not a strategy. Paving this new path will require hard work, collaboration, and understanding among all those involved.

Let's dream together.

***Cesar Borges de Sousa:**
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President of the Sustainable Soy Network
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Member of EDB – (Soybean Houses)
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PRESENT-DAY BIOLOGICAL CONTROL IN BRAZIL

Evaldo F Vilela, Ph.D*

The use of Biological Control in Plant Protection in Brazil is on the increase. According to Prof. José Roberto Postali Parra, from the SPARC-Bio-ESALQ USP, this is mainly due to an advancement of knowledge on the subject. Entomological studies in the Brazilian graduate programs have grown since 1970. Successful cases of Biological Control against insect pests have been reported on in Brazil and there are, in fact, excellent programs in place that use macro and micro microrganisms for insect pest control. Most of the studies has been published but not readily available internationally, unfortunately. Sugarcane crops, million hectares, are treated with natural enemies (macroorganism) and pathogens. In contrast to other countries, the challenge in Brazil is to implement programs in large farms, where we can assume a world leadership position in the use of Biological Control in tropical regions as Brazil is already a leader in tropical agriculture.

Brazil has been developing new agricultural production systems that are closer to nature, with experiments in large commercial areas, especially in soybean plantations. They use techniques and principles of regenerative agriculture, or biodynamics, such as the "Regenera Cerrado" project, in the region of Rio Verde, State of Goiás, conducted by the partnership between Embrapa, the Federal Institute of Goiás, the Federal University of Lavras, GAAS and other institutions, with funding from Cargil. "Regenera Cerrado" has improved the use of bioinputs in no-till areas, with appreciation of crop-livestock integration. The results have been very satisfactory from the point of view of availability of bioinputs (bioinsecticides, biofertilizers and others, see Figure) and accessibility for producers, who manage to increase profitability and productivity as it improves soil quality and the sustainability of the agrosystem.

In addition, Brazil has been pioneering the intensive use of biological pest control, using macro and microorganisms, in commercial plantations, such as soybean. The use of biological pest control in the open field has contributed to the conservation of the environment and, consequently, is an important factor for the growing sustainability of tropical agriculture.

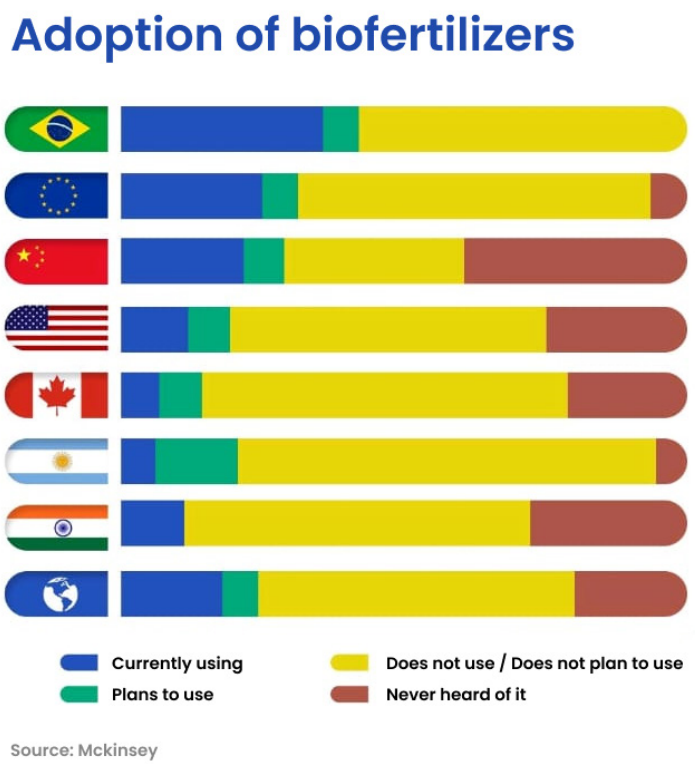
But the main goal is to use Biological Control as part of the Integrated Pest Management-IPM, as a path toward sustainable agriculture that is in harmony with other pest control methods. In fact, as Prof. Parra, always emphasizes, Brazil has developed biological control technologies adapted to tropical regions, rather than copying models for temperate regions, which are usually inappropriate for tropical conditions.

As researchers began to specialize in Entomology, in the 1970s in Brazil, a change in mindset occurred, so the idea was no longer simply "to kill" insects, but to mass-rearing them in order produce beneficial insects for inundative releases, in time with the implementation of IPM, which required the development of host rearing techniques (natural or alternative) for use in BC programs. Techniques of insect mass-rearing started at ESALQ-USP in the decades of 1970 and 1980.

As a result, the literature on BC has expanded enormously with publications on insect rearing techniques. New facilities were initially financed by federal programs, but, currently, they are being developed by private companies to supply the expanding market for BC agents.

SUCCESSFUL CASES IN BRAZIL

The most efficient BC program in Brazil, which is among the best in the world, is conducted to control the main pests that target sugarcane, *D. saccharalis* and *M. fimbriolata.* To control *D. saccharalis,* 3.3 million ha are currently being treated with *C. flavipes*. In 2010, T. galloi was also used on 500,000 ha of sugarcane to control the eggs of the sugarcane borer (Parra et al., 2010a). *Mahanarva fimbriolata* is controlled with the fungus *M. anisopliae*, covering an area of 2 million ha.



The main insect species used to control insects in Brazil are listed in Table 2 (Parra et al., 2011) and some of them are shown in Figure 3. Other less extensive programs are also important, such as that used to control forest pests initiated in the 1960s by Prof. Evôneo Berti Filho, ESALQ/USP, currently coordinated by Prof. José Cola Zanuncio, Federal University of Viçosa, and Prof. Carlos Frederico Wilcken, of the São Paulo State University, Botucatu. Another research program on phytoseiid mites is conducted by Prof. Gilberto José de Moraes, ESALQ/USP.

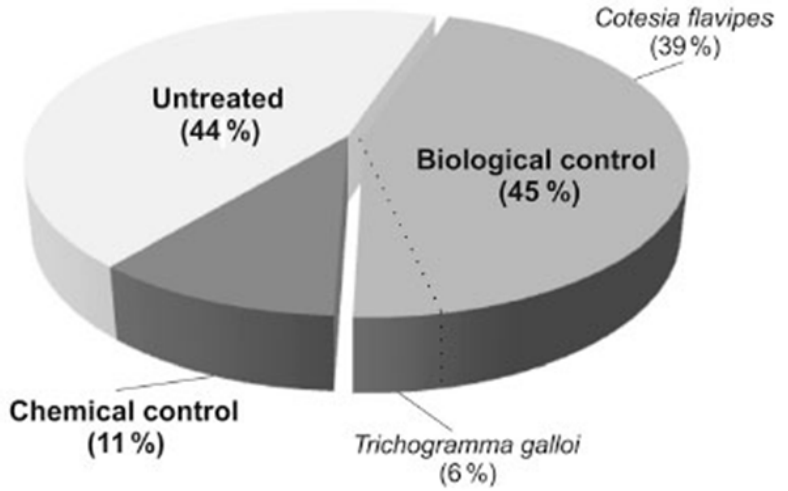


Figure 2 – Percentage of the sugarcane area in Brazil, treated with releases of natural enemies.

It is worth mentioning that microbial pest control is progressing well in Brazil. There are examples of BC programs conducted on several crops and commercially available products with formulations of *Bacillus thuringiensis* for controlling caterpillars and *Beauveria bassiana*, *Metarhizium anisopliae, Baculovirus anticarsia; Trichoderma harzianum* for controlling several agricultural pests, diseases and even nematodes, such as *Deladenus siricidicola*, for controlling Sirex in Pinus (Alves, 1986; 1998; Alves and Lopes, 2008). Approximately 20 companies are presently marketing BC agents (insects and mites) in Brazil to control pests in sugarcane, soybeans, tomato, cotton etc., and another 30 companies are producing pathogens. Approximately 20 laboratories at sugarcane mills are producing *C. flavipes* to control *D. saccharalis*, and *M. anisopliae* to control *M. fimbriolata*. These are either national or international companies, including multinational pesticide companies that grow pathogens or insects for applications in the biological control of pests.

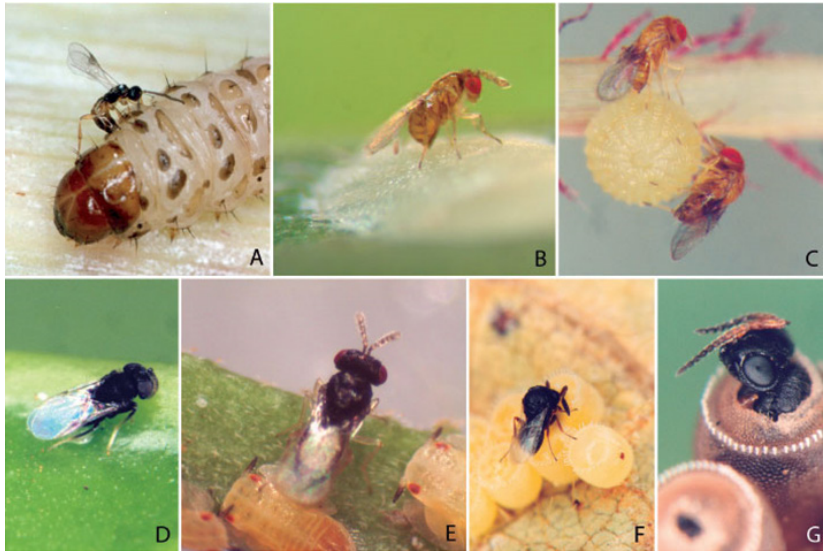


Figura 3 - The most frequently used natural enemies of crop pests in Brazil (A, B, C, D) and other potential natural enemies (E, F, G). A - Cotesia flavipes vs Diatraea saccharalis; B - Trichogramma galloi vs D. saccharalis; C - T. pretiosum vs Helicoverpa zea; D - Ageniaspis citricola vs Phyllocnistis citrella; E - Tamarixia radiata vs Diaphorina citri; F - Trissolcus basalis vs pentatomid eggs; G - Telenomus podisi vs pentatomid eggs.

CHALLENGES IN IMPLEMENTING BC PROGRAMS IN LARGE AREAS IN BRAZIL

Although the use of BC has grown in Brazil, there is a need to develop our own technology to apply BC to huge crop areas in the country. The main challenges are:

- **Grower's Culture**

The typical Brazilian grower is used to the culture of applying agrochemicals and is uninformed about BC and how to use it;

- **Technology Transfer**

To extend the use of BC, it is necessary to have effective extension services, which are, unfortunately, still undeveloped in Brazil. Extension field days are needed, to demonstrate what BC is and how a given BC agent parasitizes or preys on pests;

- **Pest Monitoring**

Well-defined pest monitoring methods exist for small areas, but for huge areas of Central Brazil, as are found in the states of Goiás, Mato Grosso, Mato Grosso do Sul, Bahia, Maranhão and others, methods employed for monitoring pest populations must be compatible with the size of the area. Techniques using pheromones and remote sensing will need to be developed;

- **Availability and quality of biological input**

Considering the extensive land area dedicated to agriculture in Brazil (around 76 million ha of cultivated area in 2014), no company is large enough to meet the entire market demand. As in any activity, there are good and bad companies involved in producing natural enemies and/or pathogens. Companies that produce poor-quality BC agents might eventually discredit the value of BC for growers. Therefore, quality control of laboratory-produced insects is essential, as is the establishment of standards for monitoring insect quality (Lenteren, 2003);

- **Logistics of storage and transport**

Considering the size of the country, if companies do not take care in storing and transporting Biological Control agents, especially insects, the product may arrive at the final destination under inadequate conditions for use, parasitization, or predation of a given pest. In many cases, by the time the product is received by the user, the natural enemies are already dead or unable to emerge. If natural enemies are not properly protected at the time of the release, high temperatures often encountered in the field (on plant or soil surface) can affect their emergence;

- **Adequate legislation for natural enemies**

Legislation on this topic is still incipient in Brazil and was adapted from regulations for chemical pesticides. Despite the presence of the ABCBio (Brazilian Association of Biological Control Companies) and its involvement in regulation of this sector, much still needs to be done. Recent international discussions on "Access and Benefit Sharing" must be taken into consideration (Cock et al., 2010; Lenteren et al., 2011; Coutinot et al., 2013);

- **Chemical pesticide selectivity**

BC must not be considered in isolation, but rather within the context of IPM. Accordingly, if pesticides are needed, they must be selective, i.e. they must kill the pests but not the natural enemies;

- **Release Technology**

In contrast to many European countries where BC is used, Brazil has an enormously diverse fauna, including many ant species. These ants can prey on natural enemies when they are exposed and susceptible. In the case of Trichogramma, its release is done by exposing pieces of stiff cardboard with parasitized eggs in the crop, and predation by ants can reach 100% within 2 h after the release. Therefore, releases must be conducted in such a manner as to protect the natural enemies from predation, such as enclosed in starch capsules for Trichogramma. In large crop areas in Brazil, releases cannot be done by farmhands on foot, which is impractical and time-consuming. The methods of releasing natural enemies must be rapid and effective. To control H. armigera, BC companies are employing men riding motorcycles to spread natural enemies in the field. Other means have been studied to enhance the release of natural enemies in large crops, such as the use of drones or airplanes;

- **Dynamic Agriculture**

Brazilian agriculture is highly dynamic, with continual changes in farmland, climatic and edaphic conditions, planting systems (for example, no-tillage and off-season crop in recent years), irrigation, crop succession and rotation, new varieties, and introductions of new pests such as H. armigera, recently reported in the country. All these factors lead to changes in the beneficial and pest entomofauna. The diversity of crop pests as well as their habits change constantly, an effect that is reinforced by the massive use of chemical products.

FINAL COMMENTS:

Brazil, a leader in the development of tropical agriculture, will have to create a BC model adapted to the local conditions, extensive farmlands, and dynamic features of its agricultural system. This dynamism leads to continual changes in beneficial and pest populations because of the different farming systems used, such as no-tillage, continuity of crops, crop succession and rotation, irrigation, new varieties, large-scale use of transgenic plants, emergence of new pests, etc. Additionally, Brazil is progressively becoming an exporting country and, therefore, must adapt to international market requirements for chemical residues, which create difficulties in achieving a sustainable agriculture, an urgent issue in modern times.

Access link to the full article, including bibliographical references.

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BIOECONOMY: BUILDING A NEW CYCLE OF EXPANSION FOR THE GLOBAL AND BRAZILIAN ECONOMY

Paulo Haddad*

The urgent need to adjust the agribusiness sector to climate change also presents an excellent opportunity to drive sustained and sustainable growth in the global economy through the scaling of the bio-based industry and services — that is, those rooted in agricultural products. A clear indication of this potential emerges when we closely analyze the economic performance of some of Brazil's most vibrant agricultural hubs, evaluated through holistic indicators such as the FIRJAN INDEX[1], developed by the Federation of Industries of Rio de Janeiro. There is a strong concentration of income and wealth within the farms, where, due to investments in research and management made over five decades, productivity expansion levels are quite limited. Meanwhile, "beyond the farm gates," industrial scaling—where soybeans, for example, serve as raw material for over a thousand different processed products—offers opportunities for productivity increases ranging from 30% to 40%.

This is the origin of the ESG concept, initially formulated by the financial sector in its ongoing quest to enhance capital returns. It is precisely in this space of converging interests among capital, society (fair wages and dignified jobs), and science (the urgent need to mitigate greenhouse gas emissions) that a logic of optimism and hope emerges, even in such complex times as those currently faced by humanity. This cross-cutting, collaborative, and inclusive vision of perspectives, understandings, and knowledge has always been the hallmark of the work led by Alysson Paolinelli, particularly in the establishment of the Cerrado colonization laboratory that we developed in São Gotardo (MG).

[1]The Firjan Index of Municipal Development analyzes social and economic development of over 5,000 Brazilian municipalities, focusing on three areas:Job and Income, Education, and Health.

The visionary Paolinelli's ultimate dream was to bring to life the "21st CENTURY PADAP[2]" as a reflection of the Third Scientific and Technological Leap in Tropical Agriculture, addressing food scarcity (the hunger that still affects 700 million people worldwide) while ensuring a sustainable production system focused on delivering healthier food. In other words, a model that prioritizes the circular economy and is committed to eliminating deforestation.

THE BRAZILIAN ECONOMIC MOMENT

Since 2014, the Brazilian economy has been stagnating. The growth of per capita GDP has been virtually nonexistent. There have been years of negative growth rates and others with positive growth rates during the decade in which the COVID-19 pandemic caused declines in employment and income levels for Brazilians, followed by a leveling off of economic activities in 2021 and 2022. When presented in a graph, the rates resemble an electrocardiogram, with ups and downs, and should not give the illusion that a sustained expansion cycle has begun.

However, throughout the current century, Brazil's economic growth has been negligible. According to data from the World Bank, while China grew by approximately 345% in the first two decades, Brazil only saw a growth of 26%, placing it among countries with low to moderate growth. If the country had maintained an annual GDP growth rate of 5%, as observed from 1960 to 1980, Brazilians would now enjoy a standard of living comparable to that of Italians or Spaniards.

The slow pace of the economic expansion since 1980 has led to several serious socioeconomic and socio-environmental issues:

• There has been an increase in the number of families living in extreme poverty and the rise in the number of Brazilians experiencing chronic malnutrition and hunger. The dynamics of poverty levels can be observed: the impoverishment of lower-middle-class families and the deterioration of low-income families into extreme poverty.

[2]The Guided Settlement Program of Alto Paranaíba (PADAP), established in 1973 in Minas Gerais, was the first project for colonizing the Brazilian Cerrado. It served as a model for future projects and gained renewed interest due to significant land use changes and the introduction of new crops since the late 1980s.

• The discontinuity in public policies for regional development, whose main objective was to reverse spatial polarization, caused the poorer state economies in the country to continue to have living conditions that are significantly lower than those of the wealthier state economies. For example, residents of Maranhão and Alagoas have economic and social indicators nearly three times lower than those of the more developed regions in the South and Southeast. Dissatisfaction with these asymmetries and inequalities is expressed among local populations through political movements and projects in the National Congress aimed at creating new Federative Units (18 new states and three new territories).
• The availability of intangible capital (human, intellectual, social, institutional, etc.), a necessary (along with physical capital) and sufficient component to drive a process of sustainable development, is asymmetrically distributed among the 27 Federative Units and the 5,568 municipalities in Brazil, impacting their local development potential. Currently, there are about 1,700 municipalities that survive in economically depressed areas thanks to the compensatory social and fiscal policies of the Federal Government.
• The frantic pursuit of profit and wealth has led an increasing number of individuals and productive organizations to engage in the predatory use of ecosystems, particularly in recent decades in the Pantanal and Amazon biomes.
• The fragility of public accounts at all three levels of government has left the quality and quantity of essential public services (health, security, infrastructure, education, etc.) in precarious conditions, particularly in large metropolitan areas.

All of these and other structural problems are more likely to be addressed if the country can accelerate its sustainable development in the medium and long term, as this would lead to the creation of a larger economic surplus, a significant portion of which could be used to finance various public policies at the three levels of government. This development acceleration could be structured through a model of globally competitive economic growth, with a fair distribution of national income and wealth among different social groups and regions, and, finally, the responsible use and non-use of environmental resources through conservation, preservation, and rehabilitation policies for ecosystems.

A NEW CYCLE OF EXPANSION: CREATIVE DESTRUCTION

A cycle of expansion is generally characterized by a relatively long and continuous period (around a decade) of sustained growth, with high and widespread global and sectoral expansion rates exceeding 7% per year. It is implemented through a set of economic and political-institutional reforms that enable the elimination of bottlenecks and other obstacles to mobilizing economic and social development potential. Depending on the prevailing characteristics of the political system, ongoing technological innovations, the degree of international economic integration, and the consistency of macroeconomic balance, each cycle can have a different impact on the profile of personal and spatial distribution of national wealth and income, as well as on environmental sustainability indicators. This was evident in the two cycles of expansion in the Brazilian economy after World War II: President Juscelino Kubitschek's "Goals Plan" in the 1950s and the "economic miracle" of the 1970s, when levels of income and employment grew geometrically, and opportunities for young people to pursue their life projects expanded significantly.

Capitalism is an economic system that progresses through cycles of innovation. In 1910, Austrian thinker Joseph Schumpeter identified five types of innovations: the introduction of a new product or a new quality of a product, the introduction of a new method of production, the opening of a new market, the acquisition of a new source of raw materials or semi-finished goods, and the establishment of a new organization in any industry. The type of change Schumpeter refers to emerges endogenously from within the system, displacing its equilibrium in such a way that the new cannot be achieved from the old through infinitesimal steps: "Add as many carriages as you like, but you will never have a railway." This is what he termed the **process of creative destruction;** new innovations render previous innovations obsolete, and growth through creative destruction establishes a stage of constant conflict between the new and the old.

In Brazil, while the Federal Government does not structure and implement a policy to provide effective incentives for the technological upgrading of Brazilian industries, technological progress continues to advance in rural areas. The evolution of industrial innovations has a successful economic history in Brazil. It began with the import substitution process, deepened with President Juscelino Kubitschek's "Goals Plan", and was revitalized in the 1990s with the globalization of the Bra-

zilian economy. Currently, Brazilian industry is financially weakened, undergoing a disrupted process of *aggiornamento*[3], yet it has not lost its entrepreneurial dynamism.

On the other hand, starting in the 1970s, under the leadership of Professor and Minister of Agriculture Alysson Paolinelli, Brazil experienced a **revolution in agriculture**. This revolution, based on scientific and technological knowledge developed in universities and public and private research centers, triggered a progressive and continuous process of Schumpeterian innovations in the field. The Minister's leadership was recognized internationally, to the extent that his name was suggested as a candidate for the Nobel Peace Prize.

The most notable event of this "green revolution" was the significant transformation of the Brazilian Cerrados, from a physical resource with no economic value into a highly productive and globally competitive economic factor. This transformation has been able to mobilize powerful value chains that currently feed 1 billion people worldwide and sustain income and employment levels, as well as the country's trade balance, even during years of deep recession. The Embrapa[4] system of agricultural research, which includes numerous public and private scientific research institutions, keeps the flame of technological innovations alive.

With this progress in agriculture, traditional farming practices that deforest and burn the environment, engage in pre-capitalist social production relations, and do not meet the phytosanitary standards of agricultural defense systems are likely to become relics of history. However, they still maintain a politically disproportionate representation in the National Congress and professional organizations.

It stands in contrast to modern agribusiness and family agriculture, which produce with greater emphasis on scientific and technological knowledge and a more efficient use of land. These methods consume less water per ton of irrigated production, recycle waste and byproducts from productive activities, and conserve, preserve, and rehabilitate environmental assets as natural capital. Most importantly, they have the capacity to produce sustainable, healthy, and climate-resilient foods without deforestation, employing business strategies focused on cost reduction, product differentiation, and activity diversification.

[3]Aggiornamento is an Italian term that translates to "updating" or "renewal." In economic contexts, it refers to the process of adapting and modernizing practices, technologies, or strategies to meet current standards and challenges. In the context of Brazilian industry, it implies efforts to update and improve industrial processes and technologies to remain competitive, especially in a globalized economy.
[4]Embrapa (Empresa Brasileira de Pesquisa Agropecuária) — Brazilian Agricultural Research Corporation

There is still much to be done to qualify and consolidate the green revolution in Brazil's tropical areas, eliminating many of its socioeconomic and socio-environmental issues. However, the most significant scientific and technological advancements in various production systems are currently at the forefront of national agriculture. Hence, it can be asserted that, in the current context of our economic history, capitalism resides in the countryside. Researchers state that "if we adopted just 50% of the available and tested scientific and technological innovations, it would be possible to double agricultural production without deforestation." As Alysson Paolinelli highlighted when he presided over **the Forum of the Future Institute:**

"Since the Second Revolution of Brazilian Agriculture, the country has gained respect as a global player in the world food supply and is in tune with the current phase of the new industrial revolution, which has sometimes been referred to as natural capitalism.

"We have made the Second Leap into the future with Brazil's entry into the global production system. Now, it is essential to confront the challenges and historical opportunities that a state vision demands to propel us into the Third Leap. This comes at a time when the world is significantly increasing its demand for renewable and clean energy, more food, and production agents and systems that offer security."

Global food demand continues to grow, particularly in Southeast Asia (e.g., China, Vietnam, South Korea, Japan, etc.), where there is an expansion of the internal market and food security program. At the same time, the implementation of the Third Scientific and Technological Leap in Brazilian Agriculture promotes geometric growth in food production. What remains to be analyzed is the logistics of transportation and communication for accessibility to consumer markets in the regional development axis of Western/Northwestern Amazon (Mato Grosso / Rondônia / Acre) / MATOPIBA[5]. Transportation logistics may benefit from the inauguration this year of the mega Port of Chankay, built by Chinese private groups 80 km from Lima, Peru, aimed at facilitating the export of Latin American production.

[5]The term "MATOPIBA," an acronym with the initials of the states of Maranhão, Tocantins, Piauí, and Bahia, designates a portion of the territory of these states that belongs to the Cerrado biome, where high-productivity agriculture is developed using intensive modern inputs.

Ultimately, the new cycle of expansion in the Brazilian economy could be based on the Third Leap of Brazilian Agriculture, which was also structured under the leadership of Alysson Paolinelli. It is grounded in the five Schumpeterian innovations: the introduction of a new product (healthy, sustainable, and climate-resilient foods) or a new quality of a product (business strategies for product differentiation); the introduction of a new method of production (precision agriculture, low-carbon farming, etc.); the opening of a new market (Southeast Asia, with reduced accessibility costs); the establishment of a new source of raw materials or semi-finished goods (enhancing the value chains of highly replicable products); and the establishment of a new organization in any industry (the organizational model of productive clusters, featuring anchor companies that integrate the interests of large enterprises with small family production).

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THE REDISCOVERY OF BRAZIL: JAPAN AND THE THIRD LEAP

Paulo Afonso Romano*

It is difficult to contextualize the profound civilizational changes without placing the pursuit of peace, energy insecurity, and especially food insecurity — affecting eight hundred million people suffering from hunger due to social and income inequality — at the center of tense geopolitical discussions. This discrepancy generates the relentless waves of migrants that we are all too familiar with.

These are the challenges where Brazil and Japan can play a leading role in a new and virtuous phase of cooperation based on successful experiences in food production. The results of PRODECER — Nipo-Brazilian Cooperation Program for the Development of the Cerrados — are well known, having been carefully planned and negotiated between 1974 and 1978 under the leadership of the visionary and determined Minister Alysson Paolinelli. The implementation of the program began in 1979.

PRODECER and POLOCENTRO — the Cerrados Development Program (1975) — provided essential support for the implementation of infrastructure, research, technical assistance, production financing, and the organization of producers through cooperatives. In other words, these were the civilizational tools through which dozens of cities were created and equipped, and over two hundred experienced a magical journey from the isolation deep in Brazil to the reality of a modern country.

It is almost unbelievable to imagine that the city of Primavera do Leste — now nicknamed "Mato Grosso's Dubai" — was founded in 1986, a mere blip in historical terms. Today, it is home to three universities, one of which offers a mechatronics program due to the high demand for engineers in the local economy and bringing in a professional from São Paulo to maintain a tractor used for cotton harvesting would cost $800 per day, not including travel and accommodation.

This impressive dynamic is not limited to the economic process. Primavera do Leste — ranked 15th among the most prosperous Agricultural Hubs in the country — features a canoeing track used for training the Brazilian national team.

Agriculture was undeniably the engine of Brazil's modernization, but telling this story requires a much broader perspective. Japan, always concerned with its own and global food security, financed half of the $550 million invested in PRODECER. Additionally, through JICA — the Japan International Cooperation Agency — it supported the establishment of Embrapa Cerrados[1], for example.

The project's impact was evidently much greater: it contributed to the modernization of a country that is now among the world's leading economies. Therefore, dreaming of once again having Japan's collaboration to boost the Third Leap of Sustainable Tropical Agriculture seems both natural and convergent.

In Paolinelli's definition, the "Second Leap," represented by the creation of Tropical Agriculture in the 1970s, must now be followed by a new revolution: the challenge remains to more than double Brazil's food production by 2050, but it is now imperative to do so while addressing the conditions of sustainability, energy security, and the reduction of social inequality. In other words, Japan and Brazil would offer their historical ties as a platform to promote the scaling of the global bioeconomy from the tropical zone.

On the global stage, this historical perspective is largely unknown. Rarely has something like this been seen: the virtuous transformation of a reality in a territory that has ceased to be an economic and social void to become a leader in the global supply of various staple products for food and energy.

Concepts and strategies were outlined and successfully implemented in the Japan-Brazil partnership. None was as effective as the trust generated by the peaceful relationship between the two countries.

In practical terms, the institutions linked to the Japanese community in Brazil (the largest population of Japanese descent outside Japan) have always been mobilized. The vision of the state has always been present. At the end of the project agreement and thirty years of funding, one singular fact is enough to reveal the scope of the initiative: the Cerrado region, which previously produced nothing, began to produce 10% of the world's soybeans by 2009.

[1]Embrapa Cerrados, created in 1975, is one of 42 units of the Brazilian Agricultural Research Corporation and focuses on developing sustainable agriculture in the Cerrado biome.

Today, with diversified and integrated agriculture, and efficient production systems, the Cerrados decisively contribute to Brazil's leadership in the production of food, fiber, and bioenergy. Unequivocally, this is a civilizational achievement attained in just a few decades. Until recently, only the temperate regions of the globe had the scientific and technical knowledge for the competitive large-scale production of food.

President Juscelino Kubitschek's dream inspired the great statesman who loved and practiced democracy to build Brasília, integrating Brazilian territory and establishing the foundation for what he called "a new civilization in the Central Plateau of Brazil."

All of this combined does not meet the demands of a new consumer who was born and raised with the prevailing and real vision of wealthy countries in the Northern Hemisphere and even of poorer countries in the Southern Hemisphere. A colonial mindset persists regarding numerous rules, concepts, and parameters in South/North relations. Different perspectives insist on prioritizing South/South relations when, in truth, humanity is one, despite having different histories and cultures, and therefore distinct realities. Yet, in some way, they always have complementary vocations.

In the tumultuous moment of international relations, characterized by unstable geopolitical formulations that are forced and dangerous, if not belligerent, the secure path of the solid, fruitful, and historical relationship between Brazil and Japan should be considered highly relevant. It is a striking example of integration between such disparate cultures, opposing geographic and hemispheric poles, and differing economic conditions. These two countries have amalgamated their commitment strategies in COMPLEMENTARITY.

For Japan, there is a need for food supply: soybeans and derivatives; animal protein; cellulose; etc. It is a rare case of food insecurity in a wealthy country during peacetime, as occurred at the end of the 1960s, which stimulated the search for cooperation with Brazil.

On the Brazilian side, there was a glaring insufficiency in food production for domestic consumption, with imports accounting for 30% of needs in 1970. This was a critical aspect, as Brazil did not have sufficient foreign exchange and was increasing its external and internal debt. Despite being wealthy, Japan depended 100% on imported oil. Poor Brazil, with a trade deficit, imported 80% of its demand. Note the historical fact: the well-known oil crisis of 1973 caused the price of a barrel to rise from $3.00 to $11.00 overnight, when the powerful OPEC

cartel was established.

Amid the complexity of the current historical moment for humanity, the agenda of climate change stands out, established within both public and private sectors in various countries. Hence, COP-30 will be held in Brazil. However, its complexity, costs, and the respective distribution between rich and poor have hindered its satisfactory implementation for decades.

Among the new agendas for countries, opportunities for innovative forms of cooperation stand out, initially along a "soft" line of information exchange and conceptual discussions aimed at seeking or validating concepts and parameters to level knowledge, generating and strengthening understandings between Brazil and selected countries. Notable mentions include the Nordic countries and Japan.

The statesman vision of Minister Alysson Paolinelli, supported by President Geisel (1974–1979), found a receptive audience in the strategic and pragmatic nature of the Japanese government and people in pursuing common objectives. Since then, the strong relationship has been consolidated. However, no significant movement toward new cooperation has occurred. For all these reasons, the moment is extremely opportune for Brazil and Japan to intertwine for new levels of cooperation, deepening their commitment to global peace and social justice based on science, technology, and innovation. This would pave the way for the Third Leap of Sustainable Tropical Agriculture through the social and technological inclusion of over four million small and medium-sized farmers in Brazil alone. This represents an urgent and complex demand that is well-suited for a joint action between two countries and societies that have already demonstrated, in different ways, their capacity for integrated action.

Tropical technology, which is continuously improving, will be ensured by EMBRAPA, state research companies, and universities. A joint program should be organized. Compliance with legal requirements aimed at adhering to agreed-upon sustainability standards would be properly ensured.

The awareness that technological intensification is a priority would be a fundamental principle. To achieve this, a new level of support for education, science, technology, and innovation would be essential.

For economic strengthening and support for the producer's business and family, the implementation of cooperativism would be fundamental and mandatory. It was the foundation of the success of PRODUCER. Alignment with the principles of regenerative agriculture will

be observed from the perspective of valuing a biological pathway for production systems.

Finally, as a foundational measure of maximum scope (political, strategic, diplomatic, commercial, and environmental), the following would be agreed upon within the framework of this new cooperation:

- Zero deforestation
- Priority for bioproducts and bioinputs (bioeconomy)
- In the Amazon, a vigorous and exhaustive search for alternatives to add value (value-added) to cultivated or extractive products.

CONCLUSION:

Industrialized and wealthy countries in confrontation with poor countries? Or a meeting of complementarity in the pursuit of sustainability, where it is essential to PRESERVE but also to PROPERLY ENJOY, with the support of Science, Technology, and Innovation, while respecting the millions of people who currently live in sensitive regions like the Amazon? This would support my thesis and that of the Forum of the Future that "the forest that makes up the Amazon Biome is worth more standing than cut down."

"There is no simple solution to a complex problem" is a common saying.

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BIOECONOMY AS A DRIVING FORCE OF TRANSFORMATION IN BRAZILIAN AGRIBUSINESS

Rodrigo Rodrigues*

Agribusiness has always been one of the pillars of the Brazilian economy, representing a significant share of the Gross Domestic Product (GDP) and accounting for a large portion of the country's exports. However, as the world faces global challenges such as climate change, resource scarcity, and the increasing demand for sustainable practices, there arises a constant need for reinvention in the sector: innovation is the new fertilizer.

In this context, bioeconomy — integrating the use of renewable biological resources and biotechnological processes for the production of food, energy, chemicals, materials, and services — emerges as a viable and strategic solution at a global level. In this regard, Brazil already has a significant competitive advantage.

In terms of emissions, Brazilian agriculture is already low-carbon. Our energy matrix is one of the greenest in the world, with nearly half of it based on renewable sources. We make extensive use of biofuels and differentiated soil management practices. We are leaders in the use of biological products in agriculture; for instance, it was in Brazil that biological nitrogen fixation in soybeans was first achieved.

Yes, we have successfully done a crucial part of our homework. We have already implemented a structured plan for mitigating and adapting to climate change, the ABC Plan[1], which is part of the country's strategy to fight global warming. While we still have much to do, today the most critical task is to work on our image so that we can access new markets and engage different stakeholders in ongoing dialogue.

We have already achieved a lot — but we have forgotten to share

[1]ABC Plan — In Portuguese, *Agricultura de Baixo Carbono,* is a Brazilian initiative launched in 2010 to promote sustainable agricultural practices to mitigate climate change. It focuses on reducing greenhouse gas emissions in the sector while enhancing productivity, emphasizing sustainable land use, carbon sequestration, crop management, and technology and innovation.

and speak about Brazil's leadership in this area. What we lack is marketing, and it can make a difference in the long run. The transition to a robust bioeconomy is not only essential for environmental sustainability but also offers the country a strategic opportunity to reposition Brazilian agribusiness on the global stage. To achieve this, cooperation among all players is essential, from rural producers and companies to government representatives, research institutions, and opinion leaders.

In addition to everything that has already been done, we have one of the highest levels of biodiversity in the world and vast natural resources. These facts place us in a privileged position to lead the transition to a bioeconomy globally. It is also worth noting that it could add over R$ 1 trillion to Brazil's GDP by 2030, according to projections from the Ministry of Agriculture, Livestock, and Food Supply (MAPA[2]). This estimate includes not only agricultural and forestry production but also innovation in biotechnology, bioenergy, and new materials derived from renewable sources.

We are on the right track. However, for the country to fully harness the potential of the bioeconomy, it must overcome several challenges. To spur the development of new products and technologies, it is essential to have a regulatory framework that encourages both innovation and sustainability. Additionally, it is crucial to expand access to financing options to unlock value that can also be added by startups and small businesses.

The fact is that bioeconomy requires substantial investments in research. On the other hand, it also needs a truly robust innovation ecosystem, stemming from alignment among different players, whether they are universities and research centers, entrepreneurs, government representatives, or startups, all working towards a common agenda focused on development. For Brazil to reach its full bioeconomic potential, effective cooperation among these entities is essential, supported by technological innovation, public policies, and societal engagement.

OPPORTUNITIES AND CHALLENGES FOR ACCELERATING THE BRAZILIAN BIOECONOMY

Despite its potential, the transition to a full bioeconomy in Brazil faces significant challenges. The lack of infrastructure in some regions and

[2]MAPA — Ministério da Agricultura, Pecuária e Abastecimento

resistance to change are among these obstacles. It is also necessary to train professionals to work in specific bioeconomy areas, as well as to have an educational system that prepares agribusiness workers for the use of new technologies.

One of the fronts is the integration of research institutions with biotechnology companies, allowing these innovations to reach the market efficiently. Although we have the Brazilian Agricultural Research Corporation (Embrapa[3]) excellently fulfilling this role, there is room to expand partnerships with universities and companies to accelerate innovation.

Another avenue could be the creation, by the Brazilian government, of programs that promote the development of bioeconomic products, certifying and encouraging the use of biologically based materials across various industries. An exemplary case of such a program is the BioPreferred Program from the United States Department of Agriculture (USDA).

Here, initiatives such as the National Biofuels Policy (RenovaBio[4]) are steps in the right direction, but it is necessary to expand the scope to other areas of the bioeconomy. The production of biofuels, for example, is already a success, with Brazil being the second-largest producer of ethanol in the world. However, we have significant potential for the exploration of other bioproducts, such as biodegradable plastics and biofertilizers.

According to the Brazilian Agribusiness Association (ABAG[5]), the adoption of precision agriculture technologies could increase agricultural productivity by up to 20% in the coming years. To fulfill this promise, subsidies and tax incentives for research and development in biotechnology have been essential for the growth of the sector.

In Brazil, awareness of the benefits of bioeconomy is growing, but there is still a long way to go. A survey by the Confederation of Agriculture and Livestock of Brazil (CNA[6]) revealed that more than 70% of Brazilian consumers prefer to buy sustainable products, provided that the cost-benefit ratio is a positive one.

Awareness campaigns combined with policies of transparency and traceability can help boost this emerging market. It is necessary to nurture and provoke reflection among all of Brazilian society on structural issues from the perspective of sustainable development. Hence, it is important not only to outline pathways but also to show that we are already following them in a practical way, grounded in science, research, technology, and innovation.

Using the American market as an example once again, there is a strong culture of engagement between consumers and producers in the United States, encouraged by awareness campaigns about the benefits of sustainable products. A network of opinion leaders, including digital influencers, NGOs, and community leaders, can help foster this awareness by promoting the importance of sustainable practices and biological products.

Greater awareness of the benefits of bioeconomy will certainly lead to a reduction in production costs. It will also drive the opening and consolidation of new markets for differentiated products with higher added value.

Bioeconomy offers a unique opportunity to transform Brazilian agribusiness, making it more sustainable, innovative, and competitive. To reach this new level, it is essential that all players — research institutions, producers, companies, opinion leaders, and the government — work together in a coordinated effort to ensure that this reality is recognized in Brazil and worldwide.

We are in a good place to lead this transformation. If Brazil has a unique and strategically coordinated agenda, which includes marketing, it can positively influence the global development of the sector. We are fully equipped to spearhead a movement that promotes an agribusiness model that balances economic growth with environmental preservation and social inclusion.

[3]Embrapa — Empresa Brasileira de Pesquisa Agropecuária
[4]RenovaBio is an initiative from the Ministry of Mines and Energy (MME), launched in December 2016. Its goal is to expand the production of biofuels, based on environmental, economic, and social predictability and sustainability.
[5]ABAG — Associação Brasileira do Agronegócio
[6]CNA — Confederação da Agricultura e Pecuária do Brasil

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ADVANCES AND CHALLENGES IN TROPICAL REGENERATIVE AGRICULTURE

Pablo Hardoim, Eduardo de Souza Martins*

The world is challenging agriculture to provide food security for a demographic that is still growing, to contribute with negative emissions to climate change and to contribute with nutritionally dense and quality production. Brazilian agriculture can make a significant contribution to this agenda. Currently, Brazil is among the top 5 food producers and ranks first in the export of various agricultural products. It is considered the most important grain producer in the tropics. It is estimated that Brazil's agricultural production already feeds more than 1 billion people in the world and that OECD-FAO projections indicate a considerable increase in Brazil's importance in the global agri-food trade by 2032. There are many reasons for these important achievements. We may point out the contribution of industrial agriculture through the "green revolution", for example. However, the production of plant and animal food, fiber and energy is often also anchored in hidden costs to the environment: the biodiversity of the system, the quality of agricultural soil, the health of people in cities, the health of end consumers, animal welfare and the welfare of people working directly in the fields. In addition, it is well known that this conventional production system needs stable environmental conditions to guarantee good yields. In other words, the conventional system is extremely susceptible to climatic adversities, which are becoming increasingly frequent in different regions of Brazil. The negative externalities of the conventional production system, coupled with its adaptive limitations to climatic extremes, require a regenerative transition and new production fundamentals.

Within this context of raising society's awareness about food without chemical residues, with superior organoleptic characteristics and greater nutritional density, of the need to mitigate the effects of climate change, to guarantee the maintenance of resources for future

generations, to meet present demands and to preserve the biodiversity of the production system, some producers have implemented agricultural practices that are well known to science. What's new is that these solutions are being adopted on a large scale. These regenerative management practices and techniques (Fig. 1) are capable of significantly reducing dependence on imported inputs and environmental pollution, while increasing the efficiency and resilience of production systems, allowing good yields to be maintained even during prolonged periods (more than 60 days in the case of grains) without rainfall. The evolution of regenerative practices allows for an improvement in the production environment with better soil quality as the farmer's main capital. They also begin to provide environmental services for society as a whole, especially for cities, by supplying quality water and food, as well as mitigating climate effects through carbon abatement using low-emission inputs, with management that favors increasing organic carbon in the soil, and also allows carbon to be sequestered permanently through the improved weathering of silicate minerals, which are used as soil conditioners, bioactivation of the system, improvement of soil quality and sources of nutrients. By promoting and enhancing biodiversity through the integration of productive areas with remaining natural areas, these producers ensure the refuge of natural enemies of pests and obtain important ecosystem services. On top of that, by using inputs and services from their local and regional contexts, they share prosperity with society, creating wealth and opportunities for the surrounding community, thus meeting ESG (*Environmental*, Social *and* Governance) requirements in full.

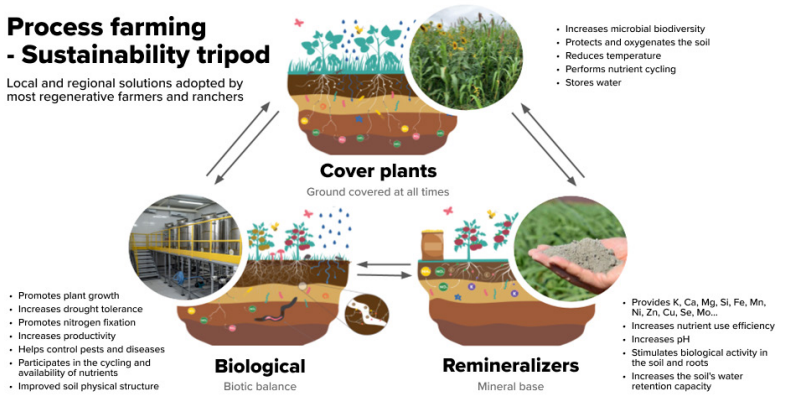

Fig. 1: Tropical Regenerative Agriculture is a new model of agricultural and livestock production that seeks to continuously improve the health of the productive ecosystem and the efficient use of finite resources. It is based on process agriculture, where different types of management, techniques and practices are integrated to achieve holistic ecosystem management.

In this way, Tropical Regenerative Agriculture (ART) is understood to be a set of actions and good practices that act to recover the productive ecosystem in such a way as to leave a balance of positive impacts on the physical and chemical characteristics of the soil, on soil micro- and macro-diversity, on the resilience of production, on the reduction of waste in products, on carbon sequestration and on the improvement of local and regional society. These food, fiber and energy producers act consciously in adopting management and practices that aim to positively promote the production environment using accessible resources and technologies in the most efficient way possible within process agriculture, in which biotic and abiotic challenges are addressed through preventive management. Because of all these characteristics, ART has a strong connection with the end consumer, who prioritizes the regeneration and healing of agro-ecosystems, aiming for positive impacts on the environment, on the chain and on society. With this mission, producers aim to create new forms of relationship with the supply chains of inputs, services and equipment, as well as loyalty to the value chains and to consumers, making their production stand out, both in the way they produce and in the intrinsic quality of the end product.

The practices used at ATR include:

• Integrated soil fertility management through the use of remineralizers, natural mineral fertilizers, correctives and organic matter circularity with the proper processing of organic inputs, aimed at eliminating pathogens and weed germination;

• Crop rotation and no-till planting on straw, with the aim of increasing the diversification of plants in the system while keeping the soil covered and turned over as little as possible;

• Use of functional microbial communities and specific microorganisms that meet the needs of the crop;

• Reducing and, where possible, eliminating inputs that harm soil, plant and human life;

• Recovering degraded pastures;

• Crop-livestock-forest integration;

• Integrated landscape management.

Implementing these practices depends on the farmer getting out of their comfort zone and experimenting with new processes aimed at reducing costs, using local and regional solutions. It is up to the farmer, rancher and/or consultant to identify the list of priorities to be addressed and determine the best way to act on the processes to implement the transition. For example, many diseases and the presence of pests can be addressed with adequate and balanced nutrition. As there is no table for determining the crop's nutritional requirements and balance for each type of soil, the most appropriate approach is to build the soil fertility in a structural way and let the plant determine which nutrient is needed at a given physiological stage. This soil fertility can be built up over the years with integrated soil fertility management, which aims to increase the efficiency of soluble fertilizer use through the use of remineralizers, natural mineral fertilizers and organic compounds. At the beginning of its implementation, occasional corrections through foliar fertilization may be necessary throughout the crop cycle. Weekly monitoring of the crop is necessary in order to meet nutritional demands and corrections to suppress pests and diseases.

With common sense and public policies, the adoption of regenerative practices should continue to grow towards the sustainability of our agriculture. From the country's perspective, the expansion of agricultural regeneration has many reasons to become a strategic initiative, implemented permanently and legitimized in the National Agricultural Policy. Because we can significantly reduce our international dependence on key inputs; we can increase farmers' incomes and activate local economies with the circulation of resources from the purchase of inputs and services; we can promote a significant reduction in contamination and offer better quality products; we can perform carbon-negative agriculture and, finally, we can meet the demands and commitments of value chains for regenerative products.

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SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

SUSTAINABLE AGRICULTURE IN THE AMAZON: OPPORTUNITIES FOR A BIOECONOMY BASED ON NATIVE SPECIES

Guilherme Oliveira*

The Amazon, with its vast biodiversity, represents a unique opportunity for the development of a sustainable agriculture model that respects and promotes the integrity of ecosystems. The transition to a bioeconomy based on native species is a promising path, for forest conservation, for biodiversity enrichment, and also for improving the lives of local communities. This model should value the potential of ecosystem services provided by the standing forest, promote the recovery of degraded areas, capture carbon and increase biodiversity, and also generate income in a fairer and more equitable way.

Soil health, in particular, should be central to any sustainable agricultural model. Degraded soils lose their ability to support crops and have less capacity to accumulate carbon. Native species are adapted to the climatic and biological characteristics of Amazonian ecosystems and can contribute to the restoration of ecological balance in already impacted areas. The recovery of degraded areas with native species can also increase the resilience of productive systems to climate change, an issue of growing concern in the region.

Another key point: the greater value added and distributed by agroforestry systems that combine crops of economic interest with native forest. Species such as Brazil nuts, açaí and cupuaçu can not only generate income for local communities, but also have the potential to provide inputs for industries that use the product itself or its tailings to generate more robust production chains. Other species, such as jaborandi (*Pilocarpus microphyllus*), have high value for the pharmaceutical industry. Jaborandi, for example, is a plant native to the Amazon used in the production of medicines and its sustainable exploitation

can be integrated into a bioeconomy model that can be leveraged from the genetic knowledge of the species. Others that can be an input for the production of medicines are traditionally known and used by indigenous peoples. The partnership with these communities for the research, management and exploitation of these species in a sustainable way is fundamental to ensure the responsible use of natural resources and the fair distribution of benefits.

Pollination also plays a crucial role in agricultural productivity and in maintaining biodiversity. In this sense, the breeding of native bees, such as *meliponas*, is an opportunity that deserves to be explored. The production of honey from native species not only generates income, but also contributes to the pollination of agricultural crops and native plants, promoting a virtuous cycle of conservation and productivity. This approach adds value to the standing forest while strengthening local production chains.

However, despite the great potential, there are still significant knowledge gaps that need to be addressed for a bioeconomy model based on native species in the Amazon to grow. The lack of genetic dominance over these species limits the advancement in domestication and genetic improvement, restricting their productive potential and adaptation to climate change. More robust research on the genetics of native species is essential to develop varieties that are productive, resistant to pests and adapted to sustainable agroforestry systems. An example is the *Genomics* of *Brazilian Biodiversity* project, which will sequence the genomes of species of economic interest. But greater advances in investment in research and development are needed to include traditional knowledge and transfer technology and capacity building from local communities for the sustainable management of native species.

Therefore, a sustainable agriculture model in the Amazon needs to be multifaceted and supported by knowledge generation. It should integrate environmental conservation, restoration of degraded areas, replacement of monocultures with agroforestry systems, enhancement of ecosystem services and income generation for local communities.

Only with this integrated approach will it be possible to transform the Amazon into a sustainable bioeconomy model, in which the standing forest and biodiversity are seen as fundamental assets for economic development. The key to the success of this transformation is to value not only the natural, cultural and human resources of the region, but also its traditional and scientific knowledge, seeking to promote a form of development that respects the rich diversity of the Amazon.

SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

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THE IMPACT OF AGRO-INDUSTRY: A COMPREHENSIVE AND SUSTAINABLE VIEW

André Menezes*

INTRODUCTION: THE PROBLEM AND THE NEED TO MEASURE IMPACTS

Agribusiness is critical to the global economy, feeding billions of people and sustaining economies, especially in developing countries. However, the expansion and intensification of the agricultural sector brings significant challenges related to environmental, social and economic impacts. Accurately measuring these impacts is essential to mitigate negative effects and maximize benefits.

Every action has an impact, whether positive or negative. Understanding the consequences of these actions on the planet has helped people and organizations develop strategic plans and implement key activities that minimize or even eliminate negative impacts, while strengthening the positive ones. Although it seems simple, not all markets are prepared to recognize, without bias, the negative effects of their activities, assume this responsibility and publicly commit to mitigate them.

While it is crucial to use data and facts for more complete decisions, it is also important to avoid the idealism of trying to solve all problems at once. As the saying goes, "you can't perform an about-turn on an ocean liner," referring to the need for time and planning for changes in large organizations.

This challenge affects the whole of society, including governments, companies and social organizations, and the agribusiness sector is no exception. The search for more sustainable practices has been gaining momentum, but there is still a long way to go. Problems such as inadequate agricultural practices, deforestation, overuse of pesticides and soil degradation require urgent attention. In addition, social issues

such as income inequality and lack of labor rights also need to be addressed. Recognizing the positive aspects of agribusiness, such as increased productivity and food security, is equally important to create policies and practices that extend these benefits.

Broadening the view on the impacts of agribusiness depends not only on knowledge, but also on processes and people. It is necessary to build solid and transparent foundations to understand both the negative impacts and the essentiality of agriculture for the planet. This balanced approach will allow the debate to expand more fairly. We need to be open to new ideas, dialogue with those who think differently and reduce our biases as much as possible. To do so, it is essential to learn from other markets, where sustainability has already been incorporated into the triple bottom line strategy, and to look at examples of non-agricultural sectors that can inspire us or help test hypotheses.

Perhaps it is time for agribusiness to learn from other sectors and make the long-awaited evolutionary leap, discovering and demonstrating, based on data and science, how essential it is for the planet and for people, and how it can generate a positive impact.

THE MARKET SCENARIO: POSITIVE AND NEGATIVE IMPACTS OF AGRIBUSINESS

Some examples of Positive Impacts:

- **Productivity and Food Security**

The use of agricultural technology, including pesticides, has allowed significant increases in productivity. Brazil, for example, is one of the largest producers and exporters of soybeans, corn and beef, contributing to the food of approximately 800 million people worldwide. This has made it possible in the past to drastically reduce hunger and provide access to healthier food for the population base. It is clear today that without it feeding everyone is not possible.

- **Job Creation**

The agricultural sector is one of the main sources of employment, especially in rural areas. In Brazil, the sector employs more than 28 million people directly, according to Cepea (Center for Advanced Studies in Applied Economics), contributing to the reduction of rural exodus and the promotion of regional development.

• **Innovation and Technological Development**
Biotechnology research and the use of bioinputs are promoting more sustainable practices, improving soil health and reducing the need for synthetic chemicals. The average growth rate of the bioinput sector in Brazil between 2018 and 2022 was 63%, compared to 12.5% of international growth rate in the same period, showing its local potential and production in tropical agriculture. According to CropLife's expectation, Brazil is estimated to reach R$17 billion in this market by 2030.

Negative Impacts that we can perceive and deserve further study:

• **Deforestation and Biodiversity Loss**
Agricultural expansion is a major cause of deforestation, especially in biomes such as the Amazon and the Cerrado. The loss of natural habitats threatens biodiversity and contributes to global climate change. According to a survey of the System of Environmental Economic Accounting: Physical Accounting, by IBGE (Brazilian Institute of Geography and Statistics), Brazil lost 513,000 km² of green area in two decades, equivalent to 6% of the national territory, with the most noticeable villains being livestock industry, the increase in agricultural frontiers, in addition to the expansion of mining practice, construction in forest areas, among others.

• **Greenhouse Gas (GHG) Emissions**
Agriculture is responsible for a significant portion of GHG emissions due to enteric fermentation of livestock and the use of nitrogen fertilizers. In Brazil, livestock is responsible for 69.3% of all agricultural emissions and for 18.5% of total emissions in Brazil, the data are from 2020 by SEEG.

• **Pesticide Use and Human Health:**
Brazil is one of the largest consumers of pesticides, which raises concerns about soil and water contamination and the health risks to rural workers and consumers. Although pesticides increase productivity, their improper and exaggerated use can lead to health problems. Six organizations are responsible for about 80% of the commercialization of pesticides on the planet: Syngenta, Bayer, BASF, Corteva, Upl and FMC, together they sold more than US$43 billion of these products in 2020.

These impacts, both positive and negative, reinforce the need to measure and manage agriculture holistically. Understanding these consequences is essential to implement practices that ensure the environmental, social and economic sustainability of the sector. At the same time, it is crucial to analyze the data in an unbiased way, expanding knowledge about the results and impacts of agribusiness. This will allow us to make viable, future-oriented decisions. To achieve this broader view, the sector needs to create an environment conducive to the debate on data and its challenges, promoting the union between different market players in favor of larger and global goals. Thus, we will be able to guarantee the essence of sustainability: preserving the natural resources we have today for future generations, ensuring that our grandchildren and great-grandchildren can have access to them under the same conditions that we have now.

SUSTAINABLE SOLUTIONS: GLOBAL INITIATIVES AND INSPIRING EXAMPLES

Faced with the challenges of agribusiness, several solutions have been implemented to promote a more sustainable agriculture:

UN Initiatives and Public Policies:

• **Sustainable Development Goals (SDGs)**
The UN promotes global goals, such as SDG 2 (Zero Hunger and Sustainable Agriculture) and SDG 13 (Action Against Global Climate Change), which encourage sustainable agricultural practices, conservation of natural resources and reduction of GHG emissions. Alysson Paolinelli was a great promoter who brought attention to this integrated view of a society where human rights and sustainable agriculture bring more progress to everyone, whether it be for countries and territories, or for companies and businesses.

• **Government Policies:**
Several countries have adopted public policies to encourage sustainable agricultural practices, such as subsidies for bioinputs, tax incentives for low-carbon technologies and reforestation programs. In Brazil, legislation to boost and subsidize bioinputs has already been regulated, which is now being re-discussed due to its growth. Because it is a

new agenda, it is natural to be unaware about it, but it is also normal that when changing the market, those who previously controlled it will get bothered and bring forth more discussions. However, it is certainly impossible to stop this growth and development, which will go through its regulation and will bring more sustainability to the sector. Historically, the large organizations that anticipate their sustainability strategy and report their impacts are those that are more lasting and that lead future markets.

Good practice examples:

- **Syntropic Agriculture**

This agroforestry method, developed in Brazil, integrates trees, crops and animals in a way that mimics natural ecosystems, increasing biodiversity, sequestering carbon and improving soil health. This model has been successfully implemented in regions such as the Amazon and the Cerrado, promoting regenerative and sustainable agriculture. Still on a low scale, but with increasing attention in recent years, we already have relevant cases of large organizations investing in practice and studying more thoroughly their positive results in sustainability, but mainly in the financial economy in the long term.

- **Use of Bioinputs**

The increasing adoption of biofertilizers and biopesticides instead of synthetic chemicals reduces environmental impacts and improves soil and plant health. Brazil has been leading research in this area, with significant advances in biological control and biotechnology, as seen above with corresponding data.

- **Sustainable Certifications**

Organizations such as the Rainforest Alliance and Fair Trade promote sustainable practices along the agro-industry value chain, encouraging social and environmental responsibility among producers and consumers. The certifications expand the potential of organizations to move faster to a more sustainable model by seeking support in consulting and for the development of indicators and impact measurement, as well as the implementation of sustainability management and governance in their operational, tactical and strategic structures.

BRAZIL'S DIFFERENTIALS AND THE ROLE OF DEVELOPING COUNTRIES

Brazil has unique characteristics that place it as a potential leader in sustainable agriculture:

- **Biodiversity and Natural Resources**

With vast biomes such as the Amazon and the Cerrado, Brazil is home to one of the largest biodiversity on the planet. This natural wealth can be used to promote bioeconomy and regenerative agricultural practices.

- **Pioneering in Tropical Agriculture**

Brazil's introduction of tropical agriculture has transformed the country into a major food exporter. Continuing this pioneering spirit through more sustainable practices can consolidate Brazil as a global model of sustainable tropical agriculture.

- **Technology and Innovation**

Brazil has advanced in the use of cutting-edge technologies, including precision agriculture systems, drones for crop monitoring and artificial intelligence for crop management and resource optimization.

Developing countries such as India and Indonesia are also adopting innovative practices to enhance agricultural sustainability by taking advantage of their tropical conditions and available technological resources. Despite these global advances, Brazil stands out as a leader in creating biological solutions to agricultural challenges. The country is widely recognized as the birthplace and global center of bioinputs, as often mentioned by Evaldo Vilela, former president of CNPq and professor at renowned Brazilian universities. Vilela has dedicated his career to clarifying, in an accessible and understandable way for all involved, the impacts of the agribusiness market and the importance of these solutions for the sustainable future of the sector.

THE ROLE OF TECHNOLOGY AND ARTIFICIAL INTELLIGENCE IN THE FUTURE OF AGRIBUSINESS

Technology plays a key role in the transformation of the sector:

• **Precision Agriculture**
Tools such as soil sensors, drones, and satellites help monitor crop health, optimize water and input use, and increase production efficiency.

• **Artificial Intelligence**
AI can predict weather patterns, identify diseases at early stages, and recommend farming practices specific to each soil type and climate, reducing losses and improving sustainability.

• **Blockchain and Traceability**
Blockchain technologies help ensure traceability of agricultural products, promoting transparency and security in the supply chain.

The adoption of emerging technologies is crucial to make agribusiness more efficient, sustainable and competitive. Companies that do not keep up with these transformations risk being left behind in an increasingly demanding market in terms of sustainability and innovation and may even cease to exist in the next 20 years. This prediction is not only a warning, but a conclusion based on practical and scientific data. Farms that have dedicated themselves to studying and implementing these innovations have already recorded significant financial results, such as the reduction of 30 to 40% of costs per hectare. Although there is still much to be done for these practices to spread and be viable for all producer profiles in a country of continental dimensions such as Brazil, progress is already underway.

CONCLUSION

Agro-industry plays an essential role in both food supply and global economic development, but faces major challenges related to its environmental and social impacts. The adoption of sustainable practices, combined with the use of technology and innovation, can not only turn these challenges into opportunities, but also promote a more balanced and prosperous future for the sector and for society. The strategic implementation of ESG (Environmental, Social and Governance), combined with the use of bioinputs, syntropic agriculture and emerging technologies, will be the basis for ensuring that agribusiness thrives in a responsible and sustainable manner.

As an ESG specialist and an impact entrepreneur, I believe that the path to sustainable agriculture lies in the integration of these innovative practices and in the conscious management of natural resources. In addition, we can learn from industries that already apply these practices, drawing lessons from parallel and similar markets. The preservation of your business strategy is directly linked to these choices. The time is now: choosing to be part of this transformation movement is not only a strategic decision, but a responsibility for the future of the planet and of the next generations. You get to choose whether you're in or left behind.

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MANAGE-MENT

SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT: CONSIDERATIONS ON TROPICAL AGRICULTURE AND THE AMAZON

José Oswaldo Siqueira*

KNOWLEDGE AND DEVELOPMENT

Although Science deals with the unknown and with uncertainties, and has become complex and multifaceted, it allows us to analyze the world and see beyond what our eyes can see. Through it we can make conjectures about reality, facilitate decision-making about development and bring about changes in society. The Science-society relationship represents a virtuous cycle that has been going on since ancient times, with the discovery and use of fire and agriculture, to the present day.

Considering the broad dimension of Science and a very simplified view of its role, it can be considered that it has two basic aspects: one, very deep and complex, which concerns our own existence, which asks how the Universe formed and became what it is today, and how it will be tomorrow; another, more utilitarian, concerns the application of Knowledge so that we can have a healthy life and a better future. As a consequence, research and Science must directly benefit society and contribute to economic and social development, being able to continuously transform our lives and the world in which we live. The role of Science is not simple and involves at least four coexisting and generally interdependent dimensions: ***Social,*** improving the quality of life and human well-being; ***Economic,*** increasing the production and competitiveness of business; ***Environmental,*** conserving nature and contributing to the sustainability of the Planet; ***Intellectual,*** contributing with new ideas, making Humanity increasingly more aware.

Over time, **scientific knowledge** has increased and become the most important factor in promoting development and the greatest

wealth of Man. It is an intangible asset, but one that can be manipulated and transferred. It is a factor of relational value and essential for the survival and development of Humanity. It is inexhaustible, but suffers an intense process of obsolescence, so it needs to be renewed continuously. Its insufficiency or lack widens the contradictions between wealth and development and generates an insurmountable chasm for development. This results in technological exclusion, which leads to a spiral of poverty with high economic dependence, resource evasion and no effective development. Therefore, Knowledge must be a strategic choice for the development of a country, a region, a community, an economic sector and any planned enterprise.

The world has been undergoing profound waves of transformation that accelerate development, but with each wave comes new challenges that are increasingly complex in nature and high in terms of risk. Facing these challenges requires new knowledge of the same order of complexity and depth and the risks involved are increasing. In this scenario of complexity and risks of different natures, **scientific ignorance and disinformation** occupy a prominent position. While we build a society dependent on Knowledge, few people are able to understand complex data, much less Science, its foundations and application. According to astronomer Carl Sagan, this is a recipe for the failure of sustainable development and the harbinger of social disaster. Researchers and scientists publish about 2.5 million new articles a year, a volume that has been increasing at very high rates, but this valuable information is confined to the **academic bubble**, having its impact on the development process greatly reduced and making the generation of Knowledge and its application further apart.

We live uninterrupted cycles of dynamic processes of development of Humanity, materialized as a sequence of revolutions of different nature and content. Among the innumerable inventions of Man, I highlight agriculture, with its positive and negative impacts; the discovery of antibiotics and the emergence of resistant bacteria; the industrial fixation of atmospheric nitrogen and the pollution of rivers. Agriculture is considered the greatest of the great inventions, and to fulfill its primary role of feeding the world, it will have to produce in the next 50 years what it produced in the last 10,000 years of its existence; and, also, reduce the negative impacts it causes to the environment, face the scarcity of natural resources and climate change. Thus, Knowledge for development is an endless race towards an uncertain and increasingly complex future. Certainly, what got us here will not get us where we want to go.

SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

AGRICULTURAL REVOLUTION, THE GREATEST INVENTION IN HUMAN HISTORY

The agricultural revolution, considered the most important of all, was based on the use of the empirical knowledge of the inhabitants of the Neolithic Period, and, throughout history, has provided the grounds for several revolutions in human life. As it was the first occupation of Man and it reaches the entire Earth, it is the basis of all industries and technological development worldwide. As discussed by Yuval Harari, in his book *Homo sapiens*, the agricultural revolution arose because of the first of the great revolutions, the cognitive one. Agriculture is considered man's greatest invention, which saved him from extinction by the threat of famine and set him on the path to prosperity and progress. It is *such a unique and grand invention, that the process of its creation is not yet finished; it is constantly evolving and cannot stop.* The agricultural revolution presupposed an easier life, but the transition from hunter-gatherers to peasants actually made life more difficult and led to greater risk, Harari argues. The essentiality of agriculture for the existence of Humanity is unquestionable when considering its ability to feed, clothe and shelter the inhabitants of the Planet. From hunter-gatherer times to the present day, the Planet's ability to feed its inhabitants has increased by 40,000 times, thanks to the development and use of technologies that have been continuously revolutionizing agrifood systems. Brazil is the latest example of this revolution. In the last 40 years, thanks to public policies, specific knowledge and investments, the country has become the global agribusiness giant. About 60% of the sector's GDP growth was due to the adoption of new technologies, a process that continues to challenge us, demanding new knowledge and disruptive technologies. Without adequate technologies, sustainability and development of agricultural territories cannot be achieved. Theodore Schultz, Nobel laureate in economics in 1979 for his studies on agriculture and development, suggests that *traditional agriculture should be abandoned, because it is not efficient, but poor and incapable of creating value to be shared.* Therefore, we must always be looking for productive and sustainable modernization. Brazil did not stick to its traditional predatory and extractive agriculture; on the contrary, it made large investments in human capital and technologies and radically transformed its agriculture, which grew 3.6 times more than the industry, in recent decades. Even so, Brazilian agriculture has been the subject of questions and controversies around

the world. Although today's agriculture is considered advanced and sustainable, it faces great challenges, feeds fierce discussions and political positions, which deserve our deepest respect and consideration from all sides. To meet these challenges, we need intelligence, ethics, and lots of quality Science. It is important to emphasize that the conflicts and distortions involving the current agribusiness often arise from the lack of science-based knowledge of the conflicting parties, making it clear we need dialogue and communication to continue our increasingly sustainable and resilient growth and development trajectory.

As in all areas, the scientific and technological advancement of agriculture is extremely dynamic and increasingly rapid. These advances cannot be restricted to the academic sphere and the input chain; in fact, they need to reach the biggest protagonists of the activity, rural producers, especially small producers, generally little contemplated with the knowledge and benefits of modern Science. The result of this scenario is a huge contingent of small producers excluded from development, who need to be guided and assisted. The science applied to the field, which moves agribusiness, results from the integration of several areas of Knowledge, going far beyond Agronomy, Animal Science and Agricultural Engineering, in a process that expands and deepens on a daily basis, incorporating new knowledge from areas never before thought to contribute to the advancement of the field. This has resulted in profound transformations in the way of producing and in the quality and safety of products, especially food, as well as the negative impacts of agricultural production. The agricultural production chain and innovation act in an integrated manner at the junction of numerous activities, such as the production of inputs, machinery and equipment, production systems, agribusiness, market and agro-service sector. Therefore, the abundance of natural resources alone is not enough to maintain our global competitiveness. We have a lot of technological and managerial intelligence and conventional and disruptive innovations in the agrifood chain. Our development was based on the creation of technical-scientific competence and a lot of local public research, and we currently have a strong role for the private sector in R&D and innovation activities.

In the past, riches were discovered, as historically occurred with mining and agriculture itself, only on fertile land, of course; but nowadays riches are created by knowledge. An example is the cultivation of the Cerrado, which in its natural state was managed with fire and its soils were considered not suitable for cultivation, but with knowledge

they became fertile and very productive, created wealth and opportunities and started an actual revolution in the countryside and in the city. *We can say that with the cultivation of the Cerrado we reinvented tropical agriculture*. To become the world's food barn, we have built soil fertility, adapted crops to acidic soils, developed efficient management systems, and now we enter a new phase of rebuilding the Cerrado **soil microbiome**. For this new stage, we adopted multidisciplinary concepts and cutting-edge technologies for a new era of its agriculture, which goes beyond sustainability and enters the era of **Regenerative Agriculture.** Thus, it is evident that challenges continue to arise and increasingly require the production of quality science and effective communication to ensure the necessary transformations of agrifood systems. We need to be attentive and connected to the vision of innovation, as Robert Taylor did, *who only invented liquid soap after seeing that the bathroom soap bars became doughy and gooey after a few uses.* We must keep alive the idea of innovation, which is necessary in the competitive world in which we live. Here is a historical fact that *the stone age did not end for lack of stone, but for the need for innovation.* We have to understand the relationship between Science and innovation: "*technology arises from Science, but survives from the market", that is, from its adopters.* Keeping farmers well informed and aligned with innovation needs is a *sine qua non* condition for the existence of innovation demands in the field. Without effective demands, there is no innovation, and the knowledge generated in S&T institutions is restricted to the academic environment and, therefore, without social and economic value.

To maintain a competitive, sustainable and resilient agriculture, we need production systems that are increasingly less impactful on the environment, that use fewer natural resources (water, energy, chemical inputs and fossil fuels) and that can maintain and even increase productivity. In general, production gaps are connected to proper crop nutrition (fertilizers and nutrient management), efficient water use, pest control, maintaining soil integrity and health, and reducing emissions. The transformation of systems will require at least 75% of production *gaps* to be overcome, and this is done with the adoption of cutting-edge and sustainable technologies. To face these changes, we need a multidisciplinary and integrative analytical approach to risk and opportunity scenarios with an emphasis on the diversification of production systems and development of new products and foods and new production patterns; a new *mindset* for farmers and consumers about sustainable

production systems and with new standards of acceptability; actions for technological inclusion of large producers that are extensive to new technologies and social and environmental patterns of production; expansion and consolidation of the new sustainable bioeconomy and circular economy; social and technological inclusion in a competitive approach, in new market niches for small producers, currently short of information, knowledge and credit.

As a strategy to face the problems arising from the need for changes, we have to consider several aspects, such as: carrying out an assessment of scenarios and trends on a technical basis and having an accurate diagnosis, focusing on opportunities and weaknesses; evaluating the technological gap and focusing on the immediate needs of technologies, organization and management; following the market trends of the products and the offers of demanded technology; aligning with a purpose and defining strategic planning focused on the future, on sustainability and on the activity competitiveness. To achieve success with Science-driven processes, actions must be kept centralized on two basic principles: ***effective knowledge*****,** which is directed to solving problems and meeting challenges already well outlined, and ***scientific rationality***, which deals with knowledge that can positively impact the production system and society.

The great and widespread concern with **sustainability** arises from the need to contain the negative impacts of the anthropization of the Planet and the fact that its natural resources are finite, even renewable ones, whose pressure for use does not allow their regeneration in a reasonable time, in addition to economic and social inequalities. Conceptually, at first glance, sustainability expresses a paradoxical view between production and conservation, and when it comes to agriculture, sustainability represents more opportunity than risk, provided that we act in time and with competence to reduce and reverse the negative impacts of the activity, to ensure the existence of agricultural activity and businesses in the agricultural chain. Generally, when we mention the impacts of agriculture, we mean the negative environmental and social impacts. In fact, the negative impacts are quite evident and disclosed, especially those caused by the vast territorial extension of the activity and the intensive use of chemicals, which point to the general perception of low sustainability of Brazilian agriculture. However, more recently, the positive aspects and opportunities for Brazilian agribusiness in the scenario of climate change mitigation, biodiversity conservation and the positive impacts of agrarian activity on the

country's community and economy have been discussed. The widespread view of the adverse impacts of agriculture is responsible for the negative public perception of the sector and its low reputation, which involves several aspects, such as a*) lack of interest of much* of the rural business community, which does not care about this issue and does not strive to change; b) the *prominence of disinformation, in the sense that* the greatest challenge is not to understand the urgency of changes, but to rethink habits and forms of production, for which knowledge is essential; *c) social inequality* – the lack of access to knowledge, technologies and public policies leaves most farmers out of the development process and creates serious anomalies, which compromise the sustainability of the agricultural sector.

The low reputation of Brazilian agribusiness brings a series of questions about its sustainability and social and market risks, and points to the need to improve environmental performance and expand social benefits. To change this scenario, we need to improve the efficiency of the use of natural resources, producing more with less, minimizing, mitigating and offsetting negative impacts and promoting regional socioeconomic development to reduce immense inequalities. In the political dimension, sustainability advocates the generation of wealth and development, construction of infrastructure, creation of strong and active organizations, and must contribute with a legacy to society. It should be aligned with the 2030 Agenda for the Development of United Nations and seek to achieve the goals of the SDGs (Sustainable Development Goals) linked to this agenda. Among the various SDGs, the ones that stand out are related to small producers and the elimination of poverty, the fight against hunger and for food and nutritional security, and a productive and regenerative, competitive and inclusive, fair and resilient agriculture, as well as the conservation of terrestrial ecosystems and water.

Despite sustainability being a much-desired and sought-after guideline, its difficult metric makes it a gray and cloudy horizon, which makes its widespread adoption difficult. It presupposes integration, with a high degree of interdependence and balance between environmental, economic and social aspects. Therefore, sustainability is easy to define, but difficult to achieve and maintain. When achieved, it is not a stable balance, and can be easily altered by external factors. Currently, there is a new approach to sustainable systems, which incorporates regenerative principles that are based on the natural foundations of organic agriculture, but the defining criteria are more flexible in terms

of management and use of production inputs. From these changes, **regenerative agriculture** emerges, a new conception, a new stage of sustainable agriculture, which encompasses production systems based on regenerative techniques, which also incorporate social aspects. This way of producing is very promising and already widely accepted by producers and consumers.

With a vision of the future, we seek to place more emphasis on the essentiality of production activities for human survival and adopt a broader view of the sustainability *framework*, focusing on the availability or scarcity of resources and their limits. As a strategic vision for the next decade, it seeks to explore the synergy of two independent but very convergent visions, which is innovation and sustainability, giving rise to a new concept, **innovability,** that is, innovation for sustainability. Discussions about sustainability are often fraught with polarized views, polemics, and lack of consensus, which often hamper constructive dialogues. To face these situations, we have to build a new discourse and a new conception, taking the focus off the negative aspects of the activity. A new idea based on *tradeoffs* between positive and negative impacts of the enterprise or practices adopted emerges, called **Net Positive**. Agriculture, like any other enterprise, fits this concept very well**,** which is very useful in scenario studies and in the vision of the future. As an ambitious and cutting-edge new concept, it establishes good practices for sustainable business and is based on the following guidelines: a) adding more to society than it takes away in resources; b) minimizing, mitigating and offsetting negative impacts; c) establishing objectives and goals based on environmental and social limits; d) promoting noticeable changes in business, and e) ensuring its contribution to sustainable development. To achieve its materiality, **Net Positive** is based on the following main criteria: a) impacts must be demonstrable and measurable; b) results must be delivered in a robust manner; c) never compensate for unacceptable or irreversible impacts; d) act within the limits of ethics and transparency, and e) create positive impact through broad partnerships.

THE CHALLENGES OF DEVELOPMENT IN THE AMAZON

The planetary crisis of climate change and food production, biodiversity loss and environmental degradation puts the Amazon in great evidence on the world stage. As a synthesis of the critical considerations

of these issues, we can highlight: a) the most dynamic area of land use change and the last global frontier for sustainable development; b) it is under strong pressure for human occupation, which puts this biome under risks and threats due to high carbon emission, savannization process, loss of biodiversity, water regulation and economic inequality ; c) the Amazon is in severe social vulnerability; high rate of severe food insecurity, which is 3 times higher than that of the South/Southeast; d) it is mandatory to break the cycle of destruction of wealth and reproduction of poverty; e) an economy, innovative investments , self-development with recurring prosperity is urgent, and f) understanding the economic and contradictory dualism that exists in the Amazon: Subsistence extractivism x Advanced capitalism based on natural resources.

The Amazon is one of the richest and most valuable natural heritage on the planet that cannot be destroyed irrationally, as it has happened. But it is not enough just to protect its natural resources; it is necessary to transform them into economic goods and generate shared wealth capable of promoting the sustainable development of the region. This development must be compatible with environmental preservation, and be able to keep the forest standing and also lift most of the almost 30 million inhabitants of the region out of absolute poverty. From this point of view, the Amazon is a great paradox: on the one hand, an immense wealth estimated at tens of trillions of dollars, and on the other, states and municipalities surviving precariously on federal transfers, while unassisted communities survive on a backward extractivism that only contributes to perpetuate poverty and misery in the region. Several Amazon development plans have already been implemented in different cycles and periods of Brazil's history, but the **development cycles implemented so far have not brought about the expected results**, and the consequence is a region with an index of social progress at the level of the poorest countries in Africa. Reversing this situation is one of the biggest challenges that Brazil will have to face in the 21st century.

Legitimately, the country is under strong pressure from various sectors to reduce deforestation in the Amazon. Internal pressures are mainly motivated by intense poverty and high vulnerability, while external pressures arise from the impacts of environmental degradation and other interests of developed countries. As an option to promote sustainable development, we have to convert the extractive economy installed in the Amazon into a new economy based on Knowledge. Despite being an economic activity compatible with nature, in

general, what is practiced there is not sustainable, as it is based on a fixed supply of resources determined by nature, being viable only while small and generating a product of low market value. When production scales, products are valued and the market grows, exploitation goes beyond the natural limits of these resources, which can be exhausted or require expansion to new areas, causing degradation. This is already happening with the açaí chain, whose available resources do not support market pressures.

We need a new economy that is able to attract investments that are innovative, sustainable and compatible with the local reality and that is based on the sustainable use of natural resources established on a scientific basis and employing a holistic and specific approach to each situation. These initiatives must be based on the concepts of sustainability, considering the characteristics of the territories involved and the *status* of the different regions in relation to human, cultural and environmental conditions and the rational use of land and other natural resources that form the basis of the Amazonian economy.

In this model, the abundance of biological natural resources, such as flora and fauna, represents the leverage platform of a *Sustainable Tropical Bioeconomy,* structured in the verticalization of the use of biodiversity, in the production of bioinputs and various forest and river products, in the payment of environmental services and in a wide range of opportunities for technological innovations in promising chains: the production of energy, pharmaceuticals, new materials and raw materials, natural foods and superfoods.

Considering the vast wealth, diversity and vocation of the Amazonian territories, this biome **can become the largest global storehouse of natural products extracted from the forest and its components,** according to a plan and with sustainable management in natural agroforestry systems or technically implanted in already devastated areas. These systems must be designed in agroecological practices and in the restorative principles of regenerative agriculture. **Sustainable business opportunities** are diverse and extend to areas already deforested and with an aptitude for intensive low-carbon grain production systems, fruit growing, intensive beef and milk farming, including crop integration systems with livestock and forests, agroforestry systems, black pepper, horticulture and fruit growing and planted timber, including reforestation with native species of high economic or ecological and restorative value, crops for bioenergy, aquaculture and fishing and numerous other activities that fit the various ecosystems that make up the biome.

SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

Social vulnerability and hunger are among the biggest problems to be faced in the Amazon, and we can only face poverty by generating wealth, and these can come from all the resources of the biome, and not only from bioeconomy. The numerous sources of wealth generation must act in a synergistic and complementary way to ensure the equity and economic stability of the development process. In this context, it is necessary to consider the extraction of mineral goods, since the subsoil of the Amazon is very rich and diverse in terms of mineral resources. Currently, mining contributes with 40% of Brazil's mineral production and generates about US$10 billion/year. Mineral extraction done legally and responsibly generates great wealth, using little land extension (0.02% of Amazon land use) and generating impacts that are reversible with appropriate technology. No other possible economic activity in the Amazon generates as much wealth as mining; and this wealth generates a lot of shared value for the region, as it happens in Carajás Mineral Province, in the state of Pará.

The great challenge to get rid of predatory extractivism in the Amazon is to find sustainable capitalist solutions for the region's businesses. Although still uncommon, there are already several successful businesses that conserve the forest, but in general these have little impact on social and economic development and face difficulties in maintaining or expanding their production and market scales. There are several products compatible with the forest that are marketed in the region, and about 60 of these products are already exported to several countries. However, the participation of the Brazilian Amazon in this multibillion market for non-timber forest products is still very small, as it represents only 0.17% of a global market estimated at more than US$2.0 billion annually. This shows the great market potential of products compatible with forest preservation, but this market is not reached by extractive practices with little or no access to knowledge and that do not adopt innovative production processes. Production, handling and market access techniques must be sharply improved.

There are opportunities for the implementation of new economic activities designed and well-planned to be sustainable and resilient and that respect the environmental and cultural limits of the biome. These economic activities should contribute to mitigating poverty and reducing the wide social inequality in the region; operate on the front lines of combating global warming and biodiversity loss; respond to the growing demand for forest products and safer and healthier food, as well as serve as a mirror for sustainable actions in other tropical regions of the planet.

Sustainable business opportunities in the Amazon, such as those based on the concept of regenerative capitalism and on agrosilvopastoral practices that are conservative of the environment, are, at least in theory, infinite and can be categorized into several axes such as: a) **nature-based businesses compatible with the standing forest**, which are based on extractivism and already have several chains in operation, most of which are subsistence chains and have little sustainability. In this group, typical forest plant products stand out, such as açaí, heart of palm, chestnut, babassu, rubber, waxes, aromatics, medicines, dyes, fibers, gums and copaiba oil. There are numerous opportunities for new technology-based businesses and innovative management, with emphasis on new products, process improvement and even businesses based on new discoveries in Science; b) **businesses in deforested and degraded areas** aiming at their recovery and environmental restoration and sustainable intensification of agricultural systems, taking advantage of the benefits of the devastation that has already occurred. There are extensive areas dedicated to economic activities that can be used in various ways depending on the location, quality of the land and its degradation *status*. In this case, in properties with environmental compliance, as provided for in the regulatory framework for this biome and economic ecological zoning, it is possible to implement activities aimed at the carbon market and protection of biodiversity and production systems with varying degrees of technology and complexity: spontaneous or assisted regeneration of the forest; reforestation for economic or environmental restoration purposes; implementation of integrated agricultural and livestock production systems, such as traditional or more elaborate agroforestry systems and high technology with CLFi systems; high-performance pastures for livestock intensification; agricultural production systems, such as low-carbon grain crops (soybean and corn); horticultural systems, with native and naturalized species, dedicated to the wide diversification of the biome and perennial crops with various products and purposes such as cocoa, açaí, oil palm, rubber, fibers, chestnut, guarana, colorants, cosmetics, pharmaceuticals and others. Considering the edaphoclimatic and cultural conditions of the Amazon, there is great potential for the scaled structuring of an **organic production system for a variety of vegetables and fruits** such as açaí, palm heart, peach palm, camu-camu, cocoa, mango, pineapple, citrus, acerola, cashew, watermelon, cassava, jambu and peppers. It is important to mention that there is already a powerful and well-diversified agriculture in several regions of the Amazon, made up of systems ranging from subsistence extractivism to systems with advanced technologies and respect for the environmental regulatory framework, with high sustainability and resilience. Agriculture is well located in certain regions of the Amazon, where, according to MapBiomas, it already occupies 17% of the area, with 15 million ha of crops and 70 million ha of pastures in different degrees of productivity, with 90 million head of cattle, whose production contributes with 5% of the biome's agricultural GDP. *In the Amazon, there is more cattle than people.* Agriculture contributes to a GDP of R$84 billion, which corresponds to 13.7% of regional GDP, with 41.7% of this GDP coming from soybeans. There is great potential for agricultural expansion **without new deforestation** and in full compliance with environmental legislation. In the state of Pará alone, the government indicates that there are 26 million ha of land available, where 15 different crops can be grown and livestock production increased by 3 times, with commercial fish production having the same growth potential. There are also 7 million ha of forests suitable for **sustainable forest management** for the extraction of timber of high commercial value; c) **other animal products** such as those from aquaculture and managed fisheries, with tremendous and diversified productive potential and with high market competitiveness, in addition to the production of honey from Africanized and native bees and naturalized buffalo exploitation in the region.

One of the several activities to promote the sustainable development of the Amazon are the **Demonstration Centers**, led by the Forum of the Future. These are basic development projects in S&T and communication that are structured based on innovative anchor technologies and on the principles of sustainability. The Centers' strategy is to organize, make available and apply appropriate knowledge for innovation in territories of tropical biomes to promote food security, prosperity and peace. Their main mission is to integrate in an innovative way aspects of Nature, Science and Technology in the generation of shared wealth that is capable of promoting development, respecting the limits of natural resources and achieving full sustainability of the territories. Their value is to guide initiatives by the universal ethical and moral standards of the civilizing process, stimulating the democratic participation of young people, women and men in the design and construction of their own future, seeking to be a global reference in inclusive, ethical, restorative and sustainable innovation processes in the territories of tropical biomes.

SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

Around the Centers there are aggregated actions of S&T, entrepreneurship and market, education, environment and culture, involving researchers, *stakeholders*, local organizations and communities. Initially, we start from qualified demands from local actors and *stakeholders* that are internalized in an academic view to define development actions. The projects are selected based on minimum criteria such as: geographical, economic, environmental and cultural representativeness in the biome; existence of science and technology institutes (ICTs) in the territory, organizations and political and civil society representation with actions related to the purpose of the project; existence of local actors with interest in its implementation; existence of themes or products aligned with the guidelines and scope of the biomes project; multiplicative potential and for scaling and replicability of economic activity; potential for change from extractive activity to bioeconomy based on science and technology; feasibility analysis of implementation and conduction; potential for economic, social and environmental impact within the scope of the basic principles of sustainability, with emphasis on income generation and forest preservation. Following this methodology, after several studies and meetings, some projects were prospected and they are at an initial phase, with exchange of general information and technical complementation for later evaluation of this intermediate stage of the project flow and then submition to the Board of the Forum. The Forum articulated and coordinated the implementation of a project on regenerative agriculture in the region of Rio Verde, in the state of Goiás, and in the SINOP Center, which is under implementation.

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REAL AMAZON: A NEW TERRITORIAL, ECONOMIC, SOCIAL AND ENVIRONMENTAL PERSPECTIVE

Judson Ferreira Valentim*

For decades, the Brazilian Amazon has remained the focus of debates between local, national and international views. Some perceive the region as a demographic void to be occupied and integrated into the national development process. Others perceive it as the largest stock of natural capital, with a vital role in the hydrological cycles and climate regulation. Meanwhile, over the last five centuries, the region has remained mostly a storehouse of biodiversity of interest to the global economy.

Historically excluded from the forums of debate, the Brazilian Legal Amazon, with an area of five million square kilometers, faces an unsustainable paradox. It has a growing population, currently with almost 30 million inhabitants, with a large part, especially those who live in rural areas and have been the "Forest Guardians" for centuries, surviving with the lowest Human Development Indexes (HDI), living in conditions of poverty and extreme poverty and dependent on government income supplementation programs.

As a result of policies implemented over the last 70 years, 20% of the Amazon biome has been converted to agricultural use, mainly cultivated pastures and areas with secondary vegetation, and the other 80% were designated as Conservation Units for Sustainable Use and Full Protection, Indigenous Lands and a considerable part consisting of Union lands still without designation. Almost 50 million hectares of public lands remain undesignated and subject to illegal land grabbing and deforestation due to the ineffectiveness, inefficiency and low effectiveness of the governance of environmental policies.

Over the last fifty years, public and private investments in research and development have resulted in impressive gains in agriculture productivity, making Brazil a major global producer and supplier of food,

fibers and biofuels. This has been achieved with increasing use of low-carbon tropical agriculture technologies developed by the Brazilian Agricultural Research Corporation (Embrapa) and a wide range of public universities and state research institutions. As of August 2024, the areas converted to agricultural use in the nine states of the Legal Amazon generated a gross production value of 30 billion dollars, accounting for 14% of the national total. However, current productivity is only one third of its potential with the appropriate use of technologies already available, but currently inaccessible to most farmers.

At the same time, the extraction of forest products generates a farm gate value of 780 million dollars per year, although the global value of production chains related to the Amazon bioeconomy is worth 450 million dollars per year. This demonstrates that the region continues to be a storehouse of biodiversity assets, with much of the wealth being generated outside its area, with few benefits for reaching the "Forest Guardians".

The rural reality in the Legal Brazilian Amazon is the existence of more than 920 thousand agricultural establishments, 83% of which are characterized as family farms. In this social segment, which includes settlers, indigenous, extractive, and riverside communities, only 8% have access to technical assistance, 4% have tractors and 51% do not have access to good agricultural or forestry production practices.

The complexity of the Amazonian challenges towards inclusive sustainable development is a result of the environmental and socioeconomic diversity. Solutions require State policies and not government policies. These must be the result of dialogue processes, ensuring the leading role of the different social segments in the region in their formulation, execution, monitoring and evaluation of efficacy and effectiveness.

For the "Forest Guardians", the challenge is the implementation of effective development policies and promotion of technological and social innovations that enable and strengthen widespread adoption of bioeconomy of socio-biodiversity. In this context, the focus should be in adding value to forest products, in addition to promoting environmental and cultural tourism activities, as well as payment for environmental services as sustainable strategies for productive insertion and improving the well-being of traditional populations.

For the over 700 thousand family famers in settlements, policies must focus on developing and promoting widespread adoption of technologies for the transition from slash-and-burn to agricultural production systems without the use of fire and the recovery of degraded areas, in order to ensure food security and increase family income and well-being. In this context, technologies for agroforestry and silvopastoral systems, cultivation of perennial species such as coffee and fruit species, associated with the implementation of cooperative agro-industries to supply local, regional, national and international markets, are excellent options. These should be combined with the recovery of degraded areas as a strategy to increase family land and labor productivity, with a reduction in deforestation and fires.

Additionally, adequate credit policies and acceleration of the land regularization process, validation of the Rural Environmental Registry and resolution of environmental liabilities can contribute to accelerating technological innovation with the recovery of degraded pasture areas and increased livestock productivity in areas already open. This will allow the release of areas with potential for conversion to agriculture to meet the growing global demand for production of food, biofuels and fibers, in addition to allowing land for the resolution of environmental liabilities in the Legal Amazon.

Certainly, this scenario will only be possible if the Amazon and its population are perceived as a solution and not as a problem and are protagonists in the design and implementation of policies that, instead of punishments (the stick), prioritize mechanisms that encourage (the carrot) producers to adopt good agricultural and forestry production practices. Furthermore, it is vital that there is effectiveness in the governance of environmental policies to curb illegal acts committed predominantly by public land grabbers.

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SCIENCE AS A PILLAR FOR BUILDING A NEW BRAZIL WITH FOOD AND NUTRITIONAL SECURITY

Mariangela Hungria*

Evidence that food security has always been a central issue for humanity is lost in time, as prehistoric cave paintings confirm the concern about obtaining food. However, it is surprising that discussions at a global level about the importance of safeguarding food for the population only gained momentum after World War I, when it became clear that the availability of food should be a concern of the state and directly related to national sovereignty. The Universal Declaration of Human Rights, adopted and proclaimed by the United Nations General Assembly in 1948, acknowledged the right of every human being to food. This was followed by the International Covenant on Economic, Social and Cultural Rights in 1966, which confirmed the right of every person to food and the responsibility of the state to promote concrete programs to ensure this. In Brazil, the Covenant entered into force in 1992, and the right to adequate food was included in the Constitutional Amendment of 2010, which modified the 1988 Constitution to introduce food as a social right.

At the initial stage of discussions on food security, particularly between the 1950s and the 1970s, the main focus was on food production. This was largely influenced by the Malthusian theory that the population would grow exponentially, in contrast to the arithmetic supply of food, leading to famine and wars. In addition, there was a shortage of production, including in Brazil, which was an importer of food, with frequent newspaper reports of "food shortages" and "low food stocks". But it was in the 1970s that a visionary look at the country's potential productive capacity resulted in a call for Science with government financial support. There was then heavy investment in agricultural research, with the creation of the Brazilian Agricultural Research Corporation (EMBRAPA) in 1973 being a highlight. This was followed by 50 years of progress and deliveries, which raised the country to the level of one of the world's largest food producers, as well as being the largest exporter of soybeans, coffee, orange juice, sugar, beef and chicken and a leader in tropical agriculture. At the same time, forums were created to propose public policies to mitigate hunger, such as the National Council for Food and Nutritional Security (CONSEA), its state and municipal analogues and the National System for Food and Nutritional Security (SISAN). Extensive discussions and advances in knowledge led to the next step, a change in concept, going beyond the simple search for productive self-sufficiency, now with the goal of food and nutritional security supported by the right of peoples to define their own policies and sustainable strategies for the production, distribution and consumption of healthy food.

Unfortunately, despite global efforts, it is estimated that 8% of the world's population is still in a situation of hunger. In Brazil, according to a survey by the Brazilian Food and Nutrition Sovereignty and Security Research Network (Rede Penssan), released in 2022, there were 33 million people with severe food insufficiency. This classification applies to people who are not guaranteed a single meal a day and even though the end of the pandemic and the return of more effective social programs have reduced this contingent by several million, there is still a lot of hunger in the country. It is unacceptable for a single Brazilian to go hungry in the world's fifth largest food producer. Furthermore, the Global Alliance against Hunger and Poverty, which called for achieving Sustainable Development Goal (SDG) 2, Zero Hunger, by 2030, will have to reconsider this target, as malnutrition levels remain high, particularly in the poorest countries.

There is no doubt that Brazil has revolutionized its production system in half a century, certainly lifting millions of Brazilians out of hunger, with estimates that today it produces enough food to feed 800 million people globally. Now, the "giant" needs to rise again from its "splendid cradle". Agriculture and food policies need to be reinvented, and Brazilian Science is ready for these new challenges. Without Science, the country could lose in five years what it has acquired in half a century. But we now know that food and nutrition security goes far beyond food production. Science indicates that the solution now requires multidisciplinary and transdisciplinary actions, strongly based on innovation in all its aspects, i.e. agricultural, food and health, social, public policy, economic, communications and education sciences. Science also indicates that producing the food of the future and fighting

SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

hunger require the joint participation of multiple actors, the public sector, the private sector and the third sector. We need to innovate even in Science itself, because today's world and the future demand a different type of scientific knowledge, based on the principles of citizen Science, with the participation and commitment of the various sectors.

Starting with food production itself, there is an urgent need to invest in new lines of research, facing the new challenges of the decade, especially climate change and maintaining competitiveness in relation to countries that are investing heavily in innovative technologies, such as *big data* analysis, the use of artificial intelligence, automation and robotics, *blockchain*, autonomous vehicles, sensors, RNA interference, gene editing, among others. But investment in research in Brazil falls dramatically every year. As an example of the stark contrast in each nation's priorities, in 2021 the United States of America and China allocated 3.47% and 2.41%, respectively, of their gross domestic product to research and development, while in Brazil it was only 1.15%. Without investment, there are continuous losses; for instance, in the market for seeds such as soybeans and corn, which is now dominated by multinational technologies, or fertilizers, where 85% of what is needed for agriculture is imported. This great dependence exposes the fragility in which national agriculture finds itself. With regard to climate change, research is needed to obtain tolerant germplasm and more resilient crop systems. However, tackling this issue will only be possible with joint action by all sectors, and the private sector is starting to wake up to its need to participate. There are investments made by agribusiness in preservation areas, forest recovery, education to train the workforce, technologies for regenerative agriculture, investment in localization of food production and economically interesting partnerships for agribusiness, such as the case of support for bee breeding by small farmers close to large properties.

Still considering food production, the time has come to recognize the importance and value of family farming by investing in research for the sector. Family farming is responsible for more than half of the food that goes onto Brazilians' tables. For example: 41% of beans, 80% of cassava, 31% of beef, 45% of poultry and 51% of pork, 48% of bananas, 69% of pineapples, among others. Investing in this sector is also strategic, because it accounts for one third of the gross value of national agricultural production and two thirds of jobs in the sector. Science can help shape a new model of agricultural development, and agricultural extension needs to be restructured and innovated. Another important and undervalued factor, even in family farming itself, are women. Women and their essential role in the domestication, preservation and acclimatization of species, in the conservation of Creole seeds, in the cultivation and use of medicinal plants, home and community gardens. Women preserving "ways of knowing how to make" culturally significant food, preserving memories, stories and feelings. Women and their essential role in promoting healthy eating habits. We need to support them in the agricultural sciences, aiming for sustainability in agricultural resources, in the economy, making sure they are included in the agri-food market, in the social sciences, with new labor models and the creation of support networks.

Science can also contribute to the inclusion of emerging food production chains. As an example, there is a lot of talk about the bioeconomy and the riches of the Amazon, but current knowledge is poor. In the most diverse biome on the planet, it is necessary to develop appropriate technologies based on participatory methodologies, combining tradition with innovation. We need to conduct studies that lead to the valorization of regional food chains and invest heavily in education, allowing human resources to settle in these regions.

Brazilian Science also needs to find solutions to reduce the 30% of food production that is lost, placing the country among the top ten in this sad category. There are losses, referring to the reduction in the availability of food along the chain, from production to processing, and there is waste, which occurs at the end of the food chain. Estimates of losses and waste in Latin America are alarming. For example: 72% in fruit and vegetables, 47% in roots and tubers, 31% in cereals. Yet there is plenty of knowledge in the agricultural sciences to be able to advance in various areas to reduce losses, such as more efficient harvesting equipment, pest control in storage, and they can also contribute to reducing waste, for example with innovations in food processing. All the other sciences can make major contributions to mitigating losses and waste.

If food is produced, it needs to reach every Brazilian. Those who don't have a single meal a day, who wake up thinking about how they're going to feed themselves, can't work. For the hungry, public policies need to be defined, allowing them to be brought back into society and, only then, into work. Nevertheless, public policies need precise information and data science is fundamental to knowing who and where these people are. This requires science to develop and validate appropriate methodologies, with solid research design and teams

prepared to collect, process and analyze data. Without this data, analyzed in macroeconomic, microeconomic and social studies, it is not possible to determine what the minimum income is to ensure a healthy diet and where the people who need assistance are. For instance, in 2020, economic studies defined that the minimum income for a typical family should be R$424. This information is valuable for defining public policies, but it needs to evolve, as it is necessary to define values at regional or even community levels.

We also need to invest in Science in order to advance nutritional security. Define the nutritional values of foods and meals. Strategies need to be defined to get the population to consume more fruit and vegetables, preferably fresh ones, supplied by local producers. It is important to value regional foods, achieving a healthy and sustainable dietary model. It is essential to reduce the differences in dietary models between the poor and the rich by defining public policies that support food justice. It's not enough for food to reach the table; we need to know how to eat, making it easier for people to access nutritionally healthy food and to know what a healthy diet should look like.

There is no doubt that the country's great food and nutrition revolution will only come about through the education of the new generations in the context of healthy eating. Today, the link between education and food is rather limited to school meals, which are essential for more than 35 million students. But it is necessary to educate for health, self-care and nutrition. By educating today's children, a new healthy generation with a better quality of life will emerge.

Finally, it is essential to make this generation and those to come aware of the fundamental role of Science in everyone's daily lives. Unfortunately, society is bombarded by an excess of unreliable information, including about hunger, which contaminates the formation of public opinion. Conflicting information leads to conflicts between people and to public policies going backwards. Food production itself in Brazil is a source of conflicting information. After all, is agribusiness "*pop*" or is it environmentally devastating? Today, this answer does not depend on the concrete results of science, but on the means of information. Consequently, it is also essential to innovate in scientific communication, giving credibility to information and enabling the construction of a more balanced, fairer society, in which food production is abundant but sustainable, available in quantity and quality for every Brazilian.

In conclusion, Brazil needs to find the path to a fairer society in terms of food and nutrition security. Without Science, it won't be possible to meet the challenges so that we can have the country that Brazilians deserve. Investments for the various areas of science to help build a new country will give a great economic and social return to all.

The information commented on in this text is detailed in a book published by the Brazilian Academy of Sciences, which has 18 chapters written by 41 authors from 23 institutions (Hungary, 2024). The final message of this text and the book is that Brazilian Science is capable in all its fields of ensuring food and nutritional security for Brazilians. But for this to happen, it needs long-term investment, ongoing human resources training and, above all, it needs to be listened to by leaders and society.

Access the link to the bibliographical references

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TO BE HEARD, BE TANGIBLE... THE PACIFICATION OF THE "BIOECONOMY" CONCEPT AND THE QUALITY OF THE FUTURE

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Freedom of expression is one of the most relevant of human rights. It cannot, obviously, be a transferable right for robots. In the first place, it advises about the democratic right to of all those involved in social understanding, regardless of the size of the group and its representativeness, to express their opinion. In the second place, as a rule, algorithms work in the service of an economic power, today with an exponential capacity to influence behaviors and agendas on a universal scale. In this new Information Age, developing mechanisms that separate the truth from lies has become vital. Accounting for the social, economic and environmental impact of public and private management decisions defines responsibilities and shines a light on what we are gaining, or losing, with the decisions made. In the present, now, immediately...

The apocalyptic alarm about what will happen in 2100 has not moved societies, does not generate social production of meaning, nor does it turbocharge decision-making and political processes. If it is not tangible, it does not click. In Brazil, the tragedy of the floods recorded in early May (2024) in the state of Rio Grande do Sul did not lead to trigger measures to prevent the scheduled crisis of the wildfires in September. Inertia prevailed in the face of widespread fire of natural heritage, public authorities and organized private representation of an agribusiness-dependent country, whose future is umbilically linked to the quality of nature management. This schizophrenic picture led to a tragicomic joke among mainstream media journalists: "Brazil is in Mad Max; Brasília is in Narnia".

It would be a serious mistake here to repeat the simple diagnosis

that blames governments and private agents in the context of the dispute for spaces of power. The issue is not Brazilian. It's planetary. It is a direct product of the lack of a direct channel between Science and Citizenship, which makes it possible to translate understandable complexities for a few into social production of meaning. Or, what all this has to do with everyday life, with people's lives.

The fact is that, in a polarized world, the most relevant alert scenarios end up converted into ammunition for the "black or white" debate of social media.

In Palo Alto, tech entrepreneur Patick Collinson and economist Tyler Cohen started a movement in favor of creating a discipline aimed at translating scientific complexities into civilizing values understandable by lay citizenship.

In Brazil, only 8% of the population produces or understands complex data. Even the darkest end of the world will not mobilize the remaining 92% if the warning comes in technical and scientific language.

The production of the best truth has become a very expensive, complicated and often painful exercise for those who practice it. At a time when the degradation of the influence of science on societies is evident, contributing to valuing and preserving the scientific method is critical for those who prefer social debate guided by facts rather than beliefs.

That is why it is so important to value the method, almost never censored, displayed or debated from the perspective of its unique beauty: the researcher brings a hypothesis that can be confirmed in theory. This, however, at the immediately following moment will be subject to collective and permanent peer review. It is a continuous cycle of validation and improvement of knowledge.

In the philosopher Zigmunt Baumann's reading, the milestone from which the method began to guide the evolution of the human civilizational trajectory was the tragedy of Lisbon in 1755 - earthquake, fire and tsunami, all at the same time. There the Divine was replaced by Science.

And why has the climate tragedy not yet become a "turning point", the central element of a renegotiation of planetary adjustments? Doesn't it seem obvious that existence is at stake? Why do we allow belief and the divine to return to the spaces of power three centuries later?

Cognitive reality explains this, at least in part...

The climate phenomenon is global and systemic. When one of its

extreme manifestations reaches a specific point in the territory, it does not necessarily invoke in lay perception the need for global and supranational responses. Often, not even what happens in the neighboring municipality: on the cell phone, the images become an ephemeral consumer product.

That is why it is essential to produce reliable indicators before the public opinion and defend the integrity of a concept as valuable as that of bioeconomy.

It is necessary to account for, to resort to accounting, to consider the internal and external socio-environmental impacts (externalities) to economic activities.

Today, economic agents often move against Nature-Based Solutions without realizing that they undermine their own survival and competitiveness.

Due to an economic structure in a constant evolutionary process, new competing enterprises arise every day, causing existing ones to improve their production and technological processes and, also, there is a gradual increase in the exploitation of natural resources.

This view of development, with a focus only on internal patrimonial structures and the optimization of their results, fails to contemplate external factors, such as the social development of the community as a whole, and the level of use of environmental resources made by the development of economic activities.

In order to improve business production processes, with a view to economic development, it is necessary to also improve the social conditions of employability, generating employment and income for the people involved, as well as minimizing environmental impacts caused by the development of business activities.

BIOECONOMY, THE GETAWAY IT IS URGENT TO PRESERVE AN EXTRAORDINARY CONCEPT

Bioeconomy (the agro-industrial sector) moved US$13.5 trillion in 2023. The aggregation of value (industry and services) from the biological base (agricultural products) injects a rare optimism into the anticipation of the scenario for the coming decades in the most diverse crisis we experience.

In 2017, the Food and Agriculture Organization of the United Nations (FAO) hosted a global "Summit" to discuss a concept. And defined "Bioeconomy": https://openknowledge.fao.org/server/api/core/bitstreams/d8f82717-d3f1-495c-a788-863f7512fa89/content

In this sense, it is the economic, social and environmental space where activities carried out from biobased inputs interact. It is the space where the sustainable development proposals conceptualized by ESG governance evolve.

But at mega speed, words can lose meaning before they fully exist in people's everyday speech.

In the network debate, the bioeconomy concept has been swallowed up by ideological customization. Now, it is interpreted as a new version for extractivism, which excludes productive systems based on chain organization. Now, as a new packaging for us to continue producing food and energy without the mandatory adjustments.

It is necessary to advance in conceptualization. For this reason, the Forum of the Future opens its national and global debates with the updating and rescue of two contributions that have helped to define the path of world development in recent decades: those of Gro Harlem Brundtland and Alysson Paolinelli.

The Prime Minister of Norway was head of the UN environment commission when, in 1987, it launched the concept of sustainable development through the document "Our Common Future". In it, it was argued that the "Social" and "Environmental" pillars of the trilogy would only be achievable if the propositions were supported by economic viability.

It is clearer to understand the purpose when we look at the Amazon, which many prefer untouched (when there are Science and sustainable technologies for its sustainable use) in front of the 28 million spectators who inhabit the region, today a record holder of misery and hunger in Brazil.

Paolinelli adds to the dialogue the view that promoting the social, technological and digital inclusion of tens of millions of tropical rural producers is an opportunity that history offers to face the climate challenge and at the same time contain migratory movements.

In short, it is urgent to add "People" to the concept. This is what the World Bank, whose focus is the generation of decent jobs, intends to do. Without the organization of production chains in search of efficiency and sustainability, the revenue of the luminaries of History falls.

BIOECONOMY IN AGRO-INDUSTRIAL SYSTEMS

The information of processes in Bioeconomy needs to be integrated into the Economic, Environmental, Social and Governance (EASG) context of entities, whether they are from the private sector, public entities or the third sector of the economy – all in fact governed by economic viability. Therefore, the environmental sustainability of the activities and the social dignity of those involved do not make up the tripartite vision of the institutionalization of views and protocols.

In this sense, society should be concerned with fostering the production of new economic models that enable the exploitation of natural resources in a sustainable manner, assertively contributing to decarbonization. Where possible: generate added value to products, create jobs and contribute to environmental goals through low-impact activities, by minimizing the extraction of non-renewable natural resources.

According to the definition adopted by the 2020 Global Bioeconomy Summit, the term bioeconomy refers to "the production, use, conservation and regeneration of biological resources, including related knowledge, science, technology and innovation, to provide sustainable solutions (information, products, processes and services) in all economic sectors and facilitate a transformation to a sustainable economy".

However, what has been observed in recent years is that the concept of bioeconomy is evolving into sustainable practices in Agro-industrial Systems, focusing on carbon sequestration and the use of renewable biomass. In this sense, bioeconomy can be a catalyst in addressing the climate crisis. This model aims to provide sustainable solutions for various economic sectors, facilitating the transition to a greener and more efficient economy.

One of the greatest concerns, worldwide, in favor of the sustainability of the planet, is characterized by the initiative to seek reductions in emissions of harmful gases in the atmosphere.

Thus, for the implementation of the concept of bioeconomy, it should be borne in mind that science, technology and innovation (such as remote sensors and automated platforms) play crucial roles in supporting the increase of accurate information, in near real time, of estimates of Greenhouse Gas (GHG) Emissions and Sequestrations in the atmosphere. It involves the production, use, conservation and regeneration of biological resources (Circular Economy) to be adopted in agro-industrial production processes.

Continuous monitoring and adaptation of strategies are also necessary to ensure a more sustainable future, both specifically for the Amazon and for the world.

In this context, bioeconomy should be seen as an opportunity for global renegotiation, where economic, social and environmental sustainability go together. What is at stake is the survival of the planet and future generations.

In short, bioeconomy not only drives sustainable development, but also promotes the preservation of the environment and the social dignity of all involved. Its successful implementation depends on the union of science, technology and governance, always with the aim of creating a more sustainable and fair future.

The concept of bioeconomy is a gateway to contemporary global challenges. Sustainable development depends on the ability to combine science and practice in a tangible way that resonates with people's daily lives. In Brazil and in the world, this transformation can be the decisive factor to ensure the prosperity of future generations and the preservation of the planet.

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AGRO TROPICAL: READY FOR TRANSPARENCY AND TOTAL CONTROL IN TERRITORIAL DATA MANAGEMENT?

Carlos Antônio da Silva Junior*

According to the vision advocated by Alysson Paolinelli, who led the creation of Agro Tropical in the 1970s, the social and technological inclusion of the dozens of millions of rural producers in the tropical world who are excluded from science and technology is essential for curbing the advance of global warming. The total contribution of the agricultural production system is estimated at 30% of the overall total, but the social and environmental degradation faced by these communities, cut off from science and technology, goes far beyond that. In this context, systems for managing territorial data, which guide public and private policies, have become central to this process. Also in this context, Brazil can contribute advanced monitoring and control tools in the management of territories through the use of satellites.

In Brazil, agriculture represents 30% of GDP and accounts for more than 50% of the country's exports. It produces 40% of the soybeans and half of the sugar that the world purchases. We are responsible for 30% of the coffee produced and 80% of orange juice. When we assess the exponential economic weight of agriculture when combined with industry from a bioeconomy perspective, it becomes clear that the quality of Brazil's economic future will increasingly depend on our ability to incorporate trustworthy sustainable practices in the eyes of our commercial partners and the ever more demanding urban consumers. Whether they are located in São Paulo, Oslo, or Tokyo, consumers are monitoring the actions and behaviors of economic agents in real time, and in an increasingly inflexible manner.

Soybean production, the flagship of our agriculture, lacks information based on science, and the data available to the public often comes

from estimates that are not always accurate. Soybean production requires precise data, especially in a context of significant trade restrictions imposed on this commodity by the international market.

The idea of monitoring soybeans through remote sensing and providing science-based data was a personal project aimed at continuing the use of the algorithms developed during my Master's and Doctoral research. In 2015, I began, using my own resources, to build a platform that presents annual data on Brazilian soybeans, focusing on Mato Grosso State, down to the municipal and producer levels. Within a few years, the platform, named "SojaMaps," gained recognition and was visited by people and institutions in over 60 countries. The reach and impact of the platform demonstrated that it could become a scalable commercial product, incorporating data related to the sustainability of soybeans, territorial intelligence, soil, climate, carbon balance, mapping of other strategic agricultural crops, productivity data, and other information that could be used by everyone, from producers to governments, in formulating public policies — all based on applied science and validated by articles published in scientific journals.

The next step was to transform the idea into reality. Recognizing the challenges involved in this scenario, I gathered a group of researchers and investors in Alta Floresta and Sinop (a municipality located at the transition between the Cerrado and Amazon biomes), determined to create a deep-tech startup to develop a territorial management technology that met the highest standards of reliability. The process was challenging, but it progressed quickly, and in just over a year, SpectraX was launched with the goal of revolutionizing soybean mapping/monitoring and the territorial intelligence of Brazilian municipalities. What distinguishes SpectraX is its strong academic foundation in generating data supported by cutting-edge scientific research. While other platforms in the market merely compile data, SpectraX generates it, setting itself apart from the competition.

The use of satellites to obtain strategic data goes beyond merely identifying deforested areas; it serves as a versatile tool for decision-making in both the public and private sectors. Satellite-based technology now allows us to assess soybean areas, including their locations, the varieties being planted, productivity estimates, and the identification of diseases and mineral deficiencies. This information is relevant to a wide range of stakeholders, from rural producers to banks, governments, exporters, importers, agricultural input industries, and even railways that need to estimate harvests to determine how many

cars will be required to transport the production.

One sector that is still emerging in the country is the carbon market. Estimating carbon stocks and flows in a forest has traditionally been a labor-intensive task, requiring manual measurements of trees. With remote sensing technology, through automated platforms developed by us and scientifically validated, a rural producer can obtain the amount of carbon stored and its flow on their property in just a few minutes.

Another sector that will greatly benefit from this technology is the meat industry. Not only soy producers but also meatpackers are looking for sustainability in the Amazon. The sustainability pursued by meatpackers in the Amazon necessarily involves identifying degraded pastures and formulating policies for their restoration. There are over 70 million hectares occupied by cattle, and remote sensing is available to quickly indicate the priority areas for action by meatpackers or governments, showing where degraded and non-degraded pastures are located.

The use of satellites is not limited to rural areas; it is also present in cities, contributing to the territorial intelligence of municipalities. Managers have access to automated platforms capable of quickly providing strategic information for their cities. Mapping heat points or tracking the number and location of new constructions each year are good examples of how these technologies can promote sustainability in urban areas. The use of remote sensors and automated platforms is a new tool that is gradually being incorporated into society. There is no doubt that environmental sustainability in agroecosystems and solutions for territorial data management will increasingly rely on information from space, supported by deep tech platforms.

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THE AGE OF *MINDFACTURING* - MINDFACTURE

Divisions that segmented the economy are disappearing; identifying globalization with the obsolescence of manufacturing regions and sectors is wrong. We are witnessing the emergence of talent as an essential factor of production – so called mindfacture.

Marcos Troyjo*

One of the main characteristics of the contemporary economy is the assumption that robotics and automation, as well as other cutting-edge technologies, threaten the existence of professions and jobs as we have known them until now.

The hypothesis is true. "3D remote designer", "cloud data administrator", "artificial intelligence (AI) curator applied to logistics" are some of the new professions. They make some occupations - social media image management or web designer - which had just been introduced, seem less innovative.

The power of technology to transform the world of work is immense. It is therefore a mistake to blame globalization for the obsolescence of manufacturing regions and sectors in the main economies of the West.

When certain industrial activities are transferred to other countries, whether due to greater productivity, specialization or lower costs, efficiency gains can be used to reinvest in areas with greater added value (such as marketing, design or research & development).

When we look at these phenomena, we are facing the fundamental transition from manufacturing to mindfacturing.

Along the same line, it is wrong to blame the influence of immigration for the shift in the employability of some sectors in advanced economies, such as most of those that make up the OECD (Organization for Economic Cooperation and Development).

In the case of the US, recent surveys have already shown that Americans fear the impact of AI on their jobs more than that caused by

immigration or by moving links in the production chain to other countries. In fact, the majority of Americans believe that AI is more likely to destroy than create job opportunities.

By the way, the immigrant-technology-job relationship more often than not seems to go the other way. As immigration restrictions are put in place, investment flows from technology-intensive foreign companies change.

Canada, for instance, with fewer restrictions on the immigration of qualified personnel in high-tech sectors, is beating the US in the global race for talent - and attracting a large volume of tech start-ups.

As we know, concern about the effect of the introduction of new technologies on work is not new. At the beginning of the 19th century, with the Industrial Revolution in full swing, we saw the emergence of Luddism - a movement in England in which artisans invaded weaving factories and destroyed the machines that were apparently robbing them of their livelihoods.

Although some historians argue that the movement itself had nothing against machines, but everything in favor of better working conditions, Luddism was marked as a sterile effort in the face of the imperative dynamic of innovation.

The extent to which this debate on technology and work is shrouded in analytical subtleties can be clarified by examining contemporary economies such as the USA, China, Japan and Germany. These are, respectively, the countries with the four largest GDPs (gross domestic product) in the world.

They are also the four nations that file the most patents, a good measure of the pace and volume of innovation, with WIPO (World Intellectual Property Organization).

Now, if the advance of technology puts jobs at risk, and this process is obviously something that hasn't just started, it stands to reason that technology-related unemployment would grow progressively and structurally in these economies, right?

Well then, what about the latest statistics on the level of unemployment in these four countries? Over the last 10 years, it's impressive to note that it's at a very low level: The USA, China, Japan and Germany have all experienced unemployment rates below 4%. Just to remind you, unemployment in Brazil - which is not exactly a technological power - is over 6.5%.

In addition to their high rate of technological innovation, these countries have in common the large comparative scale of their economies; their profile, in aggregate, as the four largest trading nations (measured by the combined nominal flow of exports and imports); good macroeconomic governance and institutions that encourage and ensure innovation.

In short, more competitive economies - contrary to what their current leaders sometimes preach - enable the transformation of the world of work and enterprise. Instead of avoiding them, they prepare for the challenge of new times. It's much better to be aware of this than to fight imaginary battles against enemies camouflaged in globalization, immigration or technology.

Many of these observations make us realize that the topic "industrialization" has to undergo an inevitable conceptual update.

We are used to thinking of metrics such as the G7, the group of industrialized economies, or referring to some developing countries as merely producers of primary goods.

Perhaps this way of thinking refers to the three great industrial revolutions we've been through - the first associated with the introduction of steam engines in the 18th century, the second characterized by productive organizations based on methods such as Fordism or Taylorism, and the third marked by the introduction of semiconductors and computerization in final goods.

In each of these three revolutions, the scope of manufacturing was not vigorously challenged as a reference for the division of economic sectors. This is why it is said that the primary sector is made up of agriculture, mining or extraction, the secondary sector of manufacturing and the third sector of services and commerce. According to this traditional division, the primary sector provides raw materials for the secondary sector.

It is precisely here that a particular feature of the current phase of economic evolution lies. Rather than simply a Fourth Industrial Revolution, the current dynamic of business models and technological innovation is taking us beyond industry. It is more accurate to call the ongoing movement a "new economic transformation". This is due to the realization that the new parameters of competitiveness encompass all sectors, not just manufacturing.

In this context, terms like "industrialization" or "post-industrial" countries take on new meaning. Much of the literature on growth strategies has been centered on the assumption that the transition from societies that have agriculture as the mainstay of their economy to the manufacturing sector tends to imply an increase in income.

Today, this increase in income is less related to mere industrialization and more to the content of added value in one activity or another. In an industrial environment in which automation and robotics are increasingly ubiquitous, the workforce in the industrial sector - if unprepared to interact with new technological tools - will experience unemployment or falling incomes.

The divisions that used to separate the different sectors of the economy are thus disintegrating. In agriculture, mining, industry or services, what matters is the degree of added value and technological components.

In countries like Brazil and the USA, the phenomenon of deindustrialization is being complained about. And this concept is associated with the decrease in the relative share that manufacturing production occupies in the overall gross domestic product (GDP).

In order to face this challenge, it is important to bear in mind two unavoidable facts. The first is that the great industrialization currently taking place in Southeast Asia has high-tech aspects, as in China, where in many sectors the country is leading the way in the introduction of robotics and artificial intelligence. Secondly, the region still has significant manufacturing that is intensive in cheap labor.

In other words, the competition for countries like Brazil and the US, if they focus only on industrialization intensive at low labor costs, is doomed to "eat dust" from Asians like Vietnam, India, Indonesia, etc.
The big bet is on the technological training of human resources - in a word, on talent. If well trained, more important than the traditional concept of their use in industry is that these professionals will be able to work in any sector of the new economy.

So the main challenge is to prepare workers for mindfacturing, whatever the sector. The driving force behind the new economic transformation is mindfacturing.

SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

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THE ROLE OF AGRI-SOCIOENVIRONMENTAL INDICATORS FOR AN EFFECTIVE GLOBAL AGENDA

Pedro Luiz de Freitas*

Brazil, one of the largest producers of food, fibers, biofuels and raw materials in the world, faces the challenge of being defined, by global forums, as a country of poor agri-environmental performance for presenting indicators that signal a high environmental impact of its agriculture.

In this scenario, it is essential to evaluate, adjust and improve metrics and procedures for the calculation of agri-socioenvironmental indicators (ASI) that, based on scientific innovation and adapted to the reality of tropical agriculture, demonstrate the sustainability and resilience of Brazilian agriculture to climate change. The objective is to enhance its image, showing the internal public – especially consumers in urban centers – and other nations and forums the capacity to regenerate Brazilian agri-food systems as an effective contribution to building a fairer world and a sustainable planet.

The Brazilian agri-environmental scenario, monitored by global forums (FAO, OECD, UNFCCC, CBD) and in line with the global agenda, plays a decisive role in international trade of agricultural and agro-industrial products and is directly related to the SDGs/Agenda 2030. Objectively, farms in different countries are compared and ranked regarding the sustainability of agricultural production, without considering different economic, social, cultural and environmental realities, especially edaphic and environmental ones. For these forums, Brazil is defined as a country of poor agri-environmental performance because it has indicators that signal a high environmental impact of its agriculture. Thus, when compared to OECD member countries, Brazil is positioned as the third largest emitter of Greenhouse Gases (GHG) and the largest emitter of ammonia gas (NH3) from agriculture, with values close to those of the USA and much higher than the largest

emitters. Our country also has the fourth largest surplus of phosphorus in the soil, representing a high risk of surface water pollution with phosphates. In addition, it had the largest volume of commercialization of chemical pesticides in 2020, estimated at 685 thousand tons of active ingredient or 10.5 kg/ha, considering the area with annual crops (66 million ha).

In this context, researchers and analysts from Embrapa and collaborating institutions, at the invitation of the Ministry of Agriculture and Livestock (MAPA), show that the agri-socioenvironmental indicators used internationally to evaluate Brazilian agriculture use methodological aspects that cause misinterpretations of agri-environmental performance, in generally unfavorable narratives. Based on these studies, gathered in the IS_Agro Project, the following narratives are possible:

• Regarding the emission of ammonia gas, studies show that high productivity gains achieved in the last three decades, accompanied by the increase in the use of inputs, herds and production areas, have been achieved efficiently, that is, the emission of ammonia per plant or animal unit produced has been decreasing over time. Thus, the annual variation in five-year periods is lower than other emitters such as the USA and close to those of countries such as Russia and Turkey;

• Likewise, GHG emissions in agricultural activity show a tendency to increase with the growth of the production area and the use of technologies. Even so, they occur at a lower rate than the growth of Total Factor Productivity (TFP), indicating a gain in efficiency in the use of resources, with a higher degree of technology and better management, in other words, Brazilian agriculture produces more with less resource investment.

• A greater efficiency in the use of nitrogen (N) and especially phosphorus (P) is observed in the study of the balance between use and extraction of these nutrients when considering the tropical and sustainable characteristics of Brazilian agriculture. In the case of N, around 50% of the N-fertilizer applied is recovered by the crops, and the surplus remains retained in the soil organic matter, preventing the contamination of groundwater by nitrates. An up to threefold increase in P efficiency is observed even considering the high fixation potential observed in tropical soils. Instead of representing a risk of water contamination, the excess in P in the soil indicates a fertility

construction process, releasing this nutrient gradually to the plants, allowing to reduce doses of phosphate fertilizers in periods of high input prices;

• Regarding the commercialization and use of chemical and biological pesticides, studies indicate the need for adjustments in data collection (collected by IBAMA/MMA and, soon, by MAPA), excluding pesticides for non-agricultural use, sales between industries and use of adjuvants/spreaders, in addition to corrections in the concentration of active ingredients and the need for separation by categories. Thus, less than 90% of the marketed volume is actually used in areas with annual and perennial crops, planted forests and cultivated pastures. In this case, only 3.8 kg of i.a/ha is applied in these areas (well below the 10.5 kg/ha released by FAO). Also, there is a significant increase in the use of biopesticides (semiochemical and microbiological), which demonstrates the commitment of the Brazilian farmer to the adoption of more sustainable and regenerative techniques;

• Finally, studies indicate an increase in areas with a tolerable risk of water erosion (below 6 t/ha year), especially due to the adoption of the no-tillage system. In areas with pastures, more than 100 Mha (almost 50%) presents a tolerable risk of water erosion due especially to pasture recovery programs and the adoption of integrated crop, livestock and forestry systems (iLPF) and Agroforestry Systems (SAFs);

• These studies also supported the proposition of a producer responsibility index (IRP) that evaluates farmers' commitment to the environment and the health of humans and animals. The index is based on three foundations: i) toxicity, handling, efficiency in the application and risk of pesticide contamination; ii) crop conduct and the farmer's effort to mitigate the impacts of applied inputs and environmental protection in relation to soil water erosion associated with measurements related to the efficiency of fertilizer use; and, iii) quality of crop rotation, preservation of native vegetation (natural reserves, forests and water bodies on the property) and the adoption of new and sustainable technologies that make evident the responsibility of the Brazilian rural producer to the environment and all that inhabit it.

These narratives demonstrate the need for a robust information system, which automatically processes and updates several indicators,

using metrics adapted to the reality of Brazilian agriculture. The objective is to make transparent the advances achieved by Brazilian farmers in the search for sustainability with the adoption of conservationist and regenerative practices and techniques. The IS_Agro Project represents an important step in this direction, developing the basis for the creation of sustainability indexes as an instrument for the implementation and monitoring of public policies, with emphasis on the ABC+ Plan, which encourages the adoption of technologies such as biological nitrogen fixation, pasture recovery, the no-tillage system and the iLPF, considered the most modern and sustainable agricultural production system in the world.

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03 CRITICAL AGENDAS

3.1 FOOD INSECURITY

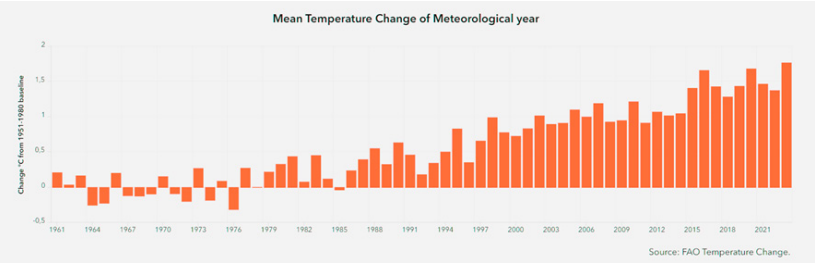
Increasing Production with Minimal Impact on Nature

THE SUSTAINABLE BRAZIL THAT EVEN BRAZILIANS DO NOT SEE AND THE NEW CLIMATE REGULATIONS: CHALLENGE AND OPPORTUNITY

Fernando Naufall*

In recent years, the world has watched with great concern the intensification of climate events in all corners of the planet. Floods, droughts, wildfires have consumed lives, crops, and homes, melted glaciers, evaporated waterways, decimated livestock, devastated communities, in an unequivocal demonstration of the perverse effects of global warming.

World forums began to prioritize climate discussions, and actions to combat global warming were accelerated, from the bleak perspective that perhaps all mitigating efforts are irrelevant, in the face of a relentless escalation of the occurrence of extreme weather events resulting from the rise in the global temperature.



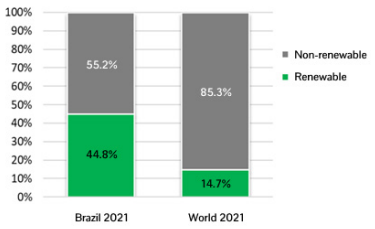
Note: These data were provided by the Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) and are based on publicly available data from GISTEMP, data collected by the National Aeronautics and Space Administration Goddard Institute for Space Studies (NASA GISS).

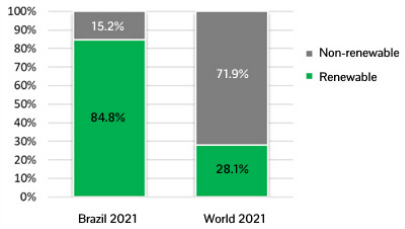
In this scenario, changes in Brazil's environmental public policies, starting in 2016, pushed Brazil towards misalignment with the millennium goals, with serious consequences for the country's perception on the international stage. The abandonment of the Amazon Deforestation Protection and Control Plan (PPCDAm) and Provisional Measures/MP 756 and 758 in 2017, reducing protected areas and freeing up resource exploitation and mining on indigenous lands, the extinction of the Secretariat for Climate Change and Forests in 2019, and of the body responsible in the Ministry of Foreign Affairs (MRE) for climate policy, are some of the changes observable in public policy at that juncture. The number of infraction notices for crimes against flora applied by Ibama in 2019 in the Amazon (2,534) was the lowest in two decades, down 40% compared to 2017-2018.

All this did not go unnoticed. Brazil had its image brutally exposed in the national and international media, being implicated in the set of negative climatic factors in outbreak around the world. This cloud of smoke that began to hang over the territory and Brazilian society prevented, and still prevents, undeniable facts of the Brazilian contribution to the climate fight from being noticed even by our own population.

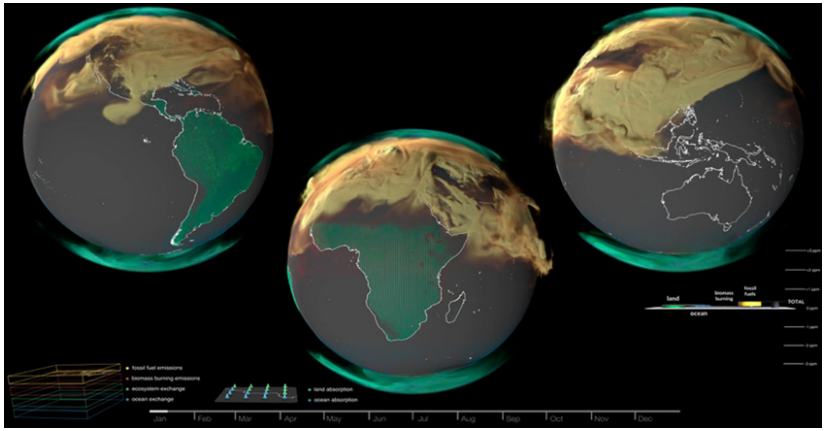
BRAZIL, IN SPLENDID CRADLE.

In this sense, the fact that more than 60% of the national territory is still made up of forests, mostly untouched biomes, is neglected. It is also forgotten that the energy produced in Brazil comes 44.8% from renewable sources, while the world average is 14.7%. In the electricity sector, sustainable production is even more impressive, with 84.8% from clean sources (hydro, wind, solar, etc.).



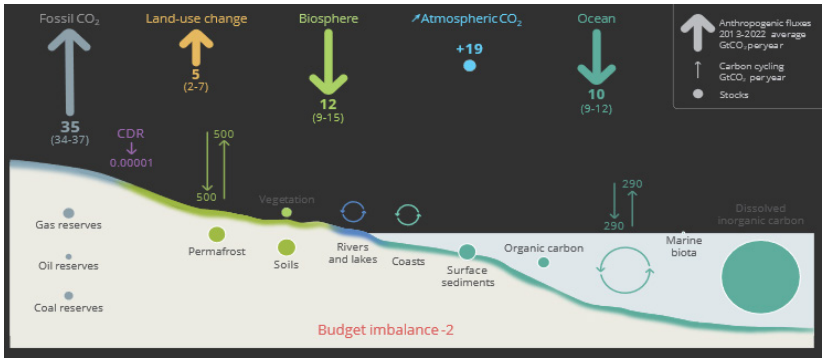


The data collected by NASA, converted into graphic animation, show us this reality, which gave rise to climate offset actions, carbon markets:



Source: https://svs.gsfc.nasa.gov/vis/a000000/a005100/a005110/CO2composite.00100_print.jpg

According to data from the American Space Agency, the biomes of the southern hemisphere, as well as agricultural production, represented above in green, maintain photosynthetic processes extracting tons of carbon from the atmosphere, while plants in the North work in the opposite direction, emitting unsustainable amounts of greenhouse gases (in yellow). During the summer of the North, the photosynthetic pumps of the South exceed the planet's emissions by twice their volume. If this scenario were maintained, we would not have global warming. However, as it approaches the peak of winter, the North triggers so many emissions that, on annual average, they total twice the removals provided by the South. Thus, it is a fact that Brazil is not part of the warming problem, and it can be an active element in the solution. This statement is consolidated in the table of global emissions versus removals in the various sectors, published by the World Climate Research Programme:



Source: https://globalcarbonbudget.org/carbonbudget

Fossil emissions from burning carbon stocks exceed the sum of biosphere and ocean removals. However, emissions related to land use change, a sector that includes Brazilian agricultural production, are significantly lower than removals.

DISTORTED PERCEPTIONS

The new generations faced with the unprecedented question of whether there will be an accessible future in the coming years, have become extremely critical of the mediatized Brazilian reality. In contrast to this look of disapproval of the national, we had the emergence of excessive pride, which sees in this criticism global conspiracies against Brazilian sovereignty, seeing in legitimate actions by the climate struggle barriers to Brazilian development, especially in agribusiness. In this context, new climate regulations, in particular European laws, have been interpreted. According to this view, the EUDR, the first in a series of laws aimed at greater climate efficiency to impact our exports, was created to prevent the entry of Brazilian production into the European market. This argument does not resist any careful analysis. First, the fines resulting from deforestation-linked production fall on European importers, not Brazilian producers. Second, the measures affect all sources of imports to the European continent, not just Brazil. Third, and most importantly, the first six products listed in the EUDR are basically products that Europe needs to import, such as coffee, cocoa, soy, palm oil, and cattle. Timber, the only item for which Europe has significant production, was already regulated by the European Union Timber Reg-

ulation, the EUTR.

Soy, a Brazilian product that has been causing the most heated and intense discussions, is an essential input for the European production of animal proteins, such as eggs, dairy products, poultry and pigs. There is no nutritional substitute for soy protein in animal feed. The table below shows how many tons of soybeans are needed for animal protein production in the EU-27:

Table 8 - Estimated Soy Content in Different Feed in the EU27+UK (2020)

Type	FEFAC compound feed production (1,000 tonnes)	Average soybean meal content (%)	Soy product in feed (estimates, 1,000 tonnes)				Total soy products (1,000 tonnes)
			Soybean meal		Soybeans[b]	Soybean oil[b]	
			Low estimate	Corrected[a]			
Pigs	52,412	10.1%	5,317	6,928	509	17	7,454
Dairy cows	28,682	14.2%	4,064	5,296	278	10	5,584
Cattle[c]	19,980	3.0%	599	781	194	7	982
Broilers	37,615	25.6%	9,639	12,560	365	13	12,938
Laying hens	17,931	15.1%	2,711	3,532	174	6	3,712
Other meat[d]	6,885	6.2%	426	556	66	2	624
Farmed fish[e]	1,401	45.3%	634	634	-	0	635
Total	**164,865**		**23,390**	**30,287**	**1,587**	**55**	**31,929**

Of the total, just over 30 million tons per year, Brazil delivers practically half:

Table 5 - Soy Imports to the EU27+UK (2020)

Country / region of origin	Soybeans		Soybean meal		Soybean oil		Total soy products share (%)
	1,000 tonnes	Share (%)	1,000 tonnes	Share (%)	1,000 tonnes	Share (%)	
Brazil	8,316	52.4%	7,843	44.7%	1	0.2%	48%
Argentina	121	0.8%	7,376	42.0%	2	0.5%	22%
United States	5,036	31.8%	407	2.3%	0	0.0%	16%
Canada	1,497	9.4%	164	0.9%	-	0.0%	5%
Ukraine	496	3.1%	177	1.0%	184	39.9%	3%
Paraguay*	96	0.6%	478	2.7%	54	11.8%	2%
Russia	0	0.0%	336	1.9%	51	11.2%	1%
China	19	0.1%	162	0.9%	0	0.0%	1%
India	14	0.1%	102	0.6%	0	0.0%	0%
Uruguay	12	0.1%	28	0.2%	-	0.0%	0%
Bolivia	-	0.0%	21	0.1%	-	0.0%	0%
Other countries	253	1.7%	456	2.8%	168	36.5%	3%
EU27+UK imports	**15,860**		**17,551**		**461**		
of which UK imports	**783**		**1,549**		**18**		**7%**

Source: Mapping the European Soy Supply Chain Embedded Soy in Animal Products Consumed in the EU27+UK. ("Mapping the European Soy Supply Chain | WWF") https://wwfeu.awsassets.panda.org/downloads/mapping_the_european_soy_supply_chain_e4c.pdf

This has caused Brazilian bran exports to the European Union to grow in recent years, a clear indication that there are no plans to replace Brazilian exports in the EU supply chain.

Bran Exports - Brazil

Destination	2020	2021	2022	2023
Asia	7,513,978	7,946,735	9,862,048	10,233,904
European Union	8,345,610	7,952,515	8,948,713	10,283,068
Middle East	348,225	941,429	1,290,085	1,468,946
Other Destinations	730,103	369,508	252,134	487,584
Overall Total	**16,937,917**	**17,210,187**	**20,352,980**	**22,473,503**

Source: ABIOVE, 2021

The Norwegian aquaculture market, the world's largest salmon producer, although not part of the European Union, will follow the same EU-27 guidelines for EUDR (zero deforestation) and maintains a special relationship with Brazilian soybeans. To produce fish feed, a derivative of high protein soybeans, SPC (Soybean Protein Concentrate), has only five factories in the world. Four of them are in Brazil. The Russian unit, due to the embargoes of the war, suffers serious obstacles in delivery to the European market. Brazil remains the only viable alternative.

In the segment of products certified as free of genetic engineering, the main market for European poultry, eggs and dairy products, Brazilian exporters such as Amaggi and Caramuru, and trading companies such as Bunge, have been working since the soy moratorium in 2008, with deforestation-free origins, already following the regulations to be required from 2025 on.

Destination	2020	2021	2022	2023
China	60,595,851	60,476,502	53,682,583	74,471,944
European Union	8,376,783	8,738,040	7,755,053	6,100,659
Asia (Except China)	7,308,194	8,959,840	8,274,071	7,163,559
Middle East	1,235,263	1,943,660	3,086,125	3,138,033
Other Destinations	5,457,333	5,989,551	6,050,597	10,995,695
Overall Total	**82,973,424**	**86,107,593**	**78,848,431**	**101,869,890**

For the Chinese market, Brazil delivers more than 70 million tons of soybeans annually. Added to beef exports, we can infer that more than a third of the protein nutritional needs of each of the 1.4 billion Chinese are met by Brazil*. China cannot absorb more soybeans from Brazil, there is an increase in Asian soybean stocks, despite the increase in demand.

Exports to Europe have been growing, mainly due to the processed product, bran, already reaching 10 million tons last year, despite the increase in local European grain production.

Thus, we need to improve our communication with our customers, abandoning a defensive attitude, which seeks to repel demands for greater sustainability, and show the world - and our own people - the true profile of Brazilian agricultural production. We have undeniable environmental issues, but most of the Brazilian production strictly follows all global sustainability standards.

TROPICAL SUSTAINABILITY

Brazilian production systems use the world's highest average of bioinputs. While our forests are in balance between emissions and sequestration, production in Brazil, one of the three largest food producers and exporters in the world, annually converts millions of tons of carbon in the atmosphere into organic matter in the form of soybeans, corn, coffee, pasture, fruits, nuts, sugar and citrus. Our climatic conditions allow biological interactions in our soils that can make the consumption of synthetic fertilizers unnecessary. N2, whose greenhouse effect is much more impactful than CO2, can be completely replaced by nitrogen fixation promoted by bacteria in the soil. Remineralization, whose sources are abundant in the country, in addition to providing nutrition for agricultural production, has the long-term effect of fixing carbon in the soil for thousands of years.

The multiple annual production cycles, viable under tropical agriculture, combined with vegetation cover techniques, produce much more efficient carbon balances than their counterparts in the northern hemisphere, including for livestock production. If Europeans are famous for the design and performance of their cars, in the soils of Brazil there is a food manufacture that beats in volume, quality and relevance any European or Asian export product. And with an unparalleled added bonus: our production removes the carbon that the world releases

in our planet's atmosphere. The areas that produce a soybean cycle in the north here produce, on the same hectare, soybeans, corn and a cover crop in the same period. Eucalyptus here takes five years to reach cutting height, versus 20 years above the equator. We can raise cattle with two heads per hectare, slaughter in 24 months, against their 1 ox/ha, slaughter in 36 months. This reduces our livestock's emission from 153kg/CO2 eq to 3kg/CO2 eq. If we have pasture cultivated within the regenerative principles, we will have carbon neutral livestock.

We need to change our narrative, embracing environmental requirements, proving that we can produce far above the demands for sustainability, and start pricing this differentiated production. It's not an easy task, but it's absolutely possible.

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* The daily protein consumption per capita of each Chinese is about 124 grams. Brazilian soybeans have a protein content of about 33 to 36%, that is, we deliver about 25 billion kilograms of plant-based protein annually to the Chinese in the soybean complex, or 40 grams daily per capita. In addition to soybeans, Brazil also exports 2 million tons of meat (poultry, beef and pork) to the Chinese, or 2 billion kilos, equivalent to about 600 million kilos of animal proteins.

3.2 ENERGY INSECURITY

ENERGY TRANSITION AND TROPICAL AGRIBUSINESS

Joaquim Paulo da Silva*

The leading role in the global energy transition is strongly associated with tropical agribusiness, since many energy inputs come from agricultural crops, their by-products and agricultural waste. A continental country like Brazil, with a National Integrated Energy System (SIN), favors the transmission of large power blocks from one region to another. This makes it possible to generate energy from several regions and diversified inputs. A perennial and sustainable energy transition requires this diversity of energy inputs, associating their availability with periodicity and seasonality.

This diversity also allows us to deal with climatic issues, such as periods of drought in some regions and rainfall in others, making it possible for the demand to be met by the availability of generation in different areas of the country. The Brazilian soil allows the production of renewable inputs distributed throughout the territory, shortening the distances between production and consumption. This generation, transmission and distribution structure, based on a diversified, renewable and integrated matrix, increases the resilience, reliability, continuity and quality of low-carbon energy.

However, this needs to be analyzed within a strategic plan. Many of these studies can be found in the Ecological-Economic Zoning of the State of Minas Gerais ("Ecological-Economic Zoning of the State of Minas Gerais: socioeconomic, geophysical and biotic components, zoning and exploratory scenarios", edited by Scolforo J. R., Oliveira A. D. and Carvalho L.M.T., Lavras: Editora UFLA, 2008).

In addition to its SIN, Brazil has an enviable capacity in low-carbon food production technology, tradition in no-till farming, high productivity and a tropical soil conducive to cultivation, which generates millions of tons of agro-industrial waste. These wastes have the potential to reduce dependence on fossil fuels, in addition to offering storage ca-

pacity for their energy derivatives and greener transport logistics, due to the proximity between production and consumption. This results in a low-carbon energy generation matrix, contributing to the mitigation of the effects of climate change.

The National Integrated Energy System (SIN) is managed by the National System Operator (ONS) and is mainly composed of hydroelectric, solar, wind, biomass, biogas and natural gas generation sources, among others. This brings great challenges, especially with the strong expansion of distributed generation of renewable energy, which, due to its intermittent nature, requires energy storage or the increase of consolidated and reliable sources to guarantee supply. If the choice falls on fossil thermal sources, such as natural gas or coal, there may be an increase in the emission of greenhouse gases (National Energy Plan – PNE2050, EPE).

Therefore, it will be necessary to adapt and mitigate climate effects, which is not a simple task. It will require a lot of work, commitment and technology. The volume of data to be handled is immense, the scenarios change rapidly, and the sources are variable and intermittent. It will be necessary to have redundancy in supply, storage, maintenance of quality and continuity of supply, in addition to efficient transport logistics.

Most agroenergy resources have the potential to generate millions of jobs, increase income and tax collection. Some renewable sources have great capacity to recover degraded areas, generate carbon credits and reduce greenhouse gas emissions. Electric energy is essential for the productivity and development of crops, being present at all stages of the production chain. Therefore, it is crucial to develop innovative technologies that harness agricultural by-products to produce biodiesel, activated carbon, green hydrogen (H2V), sustainable aviation fuel (SAF), building materials, fertilizers, feed and cosmetics.

In recent decades, national policies have been marked by decisions independent of local and regional characteristics, often focused on large projects and comprehensive solutions. Today, it is necessary to focus on local resolutions that reverberate regionally, nationally and globally. We need to solve, at the municipal level, issues such as energy quality, sustainability and infrastructure.

It is necessary to measure and create databases, generate information and have valid indicators to assess environmental, social and economic impacts, in addition to ensuring replicability in different national and continental biomes, respecting the diversities of natural resources,

availability of solar, water, biomass and urban solid waste energy. The transport of energy assets requires adequate infrastructure, efficient logistics, rational use, fair prices and validation of the by-product chain. Strategic planning is essential in the face of the challenge of decarbonization, considering political changes, the discontinuity of investments, adverse environmental scenarios, pandemics, new disruptive technologies and population variations over the years.

Local decarbonization, by adopting the best forms of energy generation, storage, reduction of greenhouse gases and optimization of transport logistics, will positively impact at a regional, national and global level.

Faced with an adverse climate scenario, tropical agribusiness plays an essential role in energy transition, with responsibility, sustainability, social inclusion and environmental preservation. The use of local and regional solutions for the generation of energy from agroenergy generates jobs, income, preserves water, reduces distances in production chains, reduces greenhouse gas emissions, recovers degraded areas and generates carbon credits.

Brazil has the potential to lead energy security with its ability to generate energy from renewable sources and store surpluses for use at critical times. Energy storage increases security of supply by allowing, for example, to conserve water in reservoirs and provide power at peak times or during outages.

Strategies that drive the development of technological innovations need to be innovative and, in some cases, disruptive. Advanced bionanomaterials have stood out as sustainable solutions, capable of protecting the environment and climate, ensuring global quality of life. Some strategic examples are:

- Innovations in renewable energies, such as the production of H2V from microorganisms, expanding the concept of 4th generation biofuels, in addition to storage methodologies that save water in periods of drought.

- Development of agrovoltaic systems that allow the cultivation of food and the production of electricity simultaneously.

- Use of agroindustrial waste for the generation of electricity, green diesel, ethanol, SAF, among others, with production chains capable of recovering degraded areas, generating employment and acting in decarbonization.

• Adoption of AI for the development of quality control systems, ensuring the safe implementation of bioinputs in rural properties.

• Development of nanostructured biological inputs to replace pesticides and chemical fertilizers, in addition to the promotion of nanostructured probiotics to reduce methane emission by ruminants.

These strategies will only be possible with the use of systematized data in big data and artificial intelligence to manage natural resources efficiently, considering decentralized generation, system stability, energy transport logistics and accountability for efficient use.

In short, long-term strategic planning, with social involvement, is needed to protect, improve and ensure the continuity of life on Earth.

Understanding the finitude of land resources is essential. Today, distances once considered immense are just a click away, connecting us globally. Although there is good engagement from various sectors of society, there is still much to be done. We need to recover the simplicity of nature, the origins of food and the generation and consumption of energy.

Climate change has affected the way we live, move, work, raise our children, and plan for our future. How to plan for a future society with such unpredictable climate? In some regions, we face severe droughts, in others, devastating floods, high temperatures, and food shortages. Will we maintain our modern lifestyle?

We will need a lot of energy, but much of that energy still comes from sources that emit greenhouse gases. How to reconcile human development, increased energy consumption and the need for low carbon emissions? The answer lies in energy transition, in the use of renewable and low-emission sources to generate energy.

Climate change represents significant transformations in the Earth's natural cycles, caused by the progressive increase in global average temperature, triggered by the emission of greenhouse gases. These climate changes also impact the performance of agricultural activities.

To support these strategies, ecological-economic zoning and PNE2050 solutions can be useful for they consider environmental aspects, soil, infrastructure, market, income generation, employment and disruptive technologies.

Therefore, the initiative of the Forum of the Future Institute and the Executive Committee to create the Global Pole of the Tropical, Sustainable, Inclusive and Healthy Bioeconomy of the Amazon, in Sinop, represents the beginning of the full-scale development of strategic planning to address climate change, ensure energy security and reduce carbon emissions.

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SUSTAINABLE SOLUTIONS COMING FROM THE TROPICS

3.3 CLIMATE CHANGE

Adapting the Agroindustrial System to the New Climate Reality

THE AMAZON HAS A SOLUTION HOW MUCH DOES A PACT FOR FORESTS, THE PLANET, AND PEOPLE COST?

Oberdan Pandolfi Ermita*

Yes, it is possible to reconcile the interests that make up the Amazonian equation, which is currently stalled in a polarized and unproductive political debate. A realistic and courageous diagnosis is urgently needed to pave the way between aspirations and reality. Stuck in a dangerous comfort zone, the debate favors conflicting extremes. Some want to completely destroy the Amazon, while others wish to keep it untouched. In the middle, 29 million Amazonians face the daily choice between preservation and survival.

In simpler terms, two extremes of perception regarding the Amazonian issue prevail.

On one side, the incongruous defenders of freedom invoke principles such as private property, sovereignty, and free enterprise, but refuse to adhere to environmental codes. When it suits them, they cry out for the law. They argue that the environmental issue is merely protectionism, and that climate change is a backdrop for neocolonialism.

On the other extreme, neo-Malthusian environmentalists believe in a global environmental cataclysm and advocate for an untouched Amazon, proposing increasingly restrictive measures. They do not accept the environmental code as a sovereign and legitimate instrument. They foster polarization between "agribusiness and family farming." By questioning the legitimacy of private property, they inhibit solutions like payment for environmental services.

The creation of the environmental code was preceded by a long debate in our society, addressing a tangled web of previous laws and seeking to legalize those who wanted to comply with the law.

However, its effective implementation is not so simple. From one

perspective, environmental and land regularization represent an existential threat to the planet, as they legitimize deforestation of up to 20% of properties in the Amazon. Some argue that these properties are appropriated from public lands or traditional communities. They insist that Brazil has at least 120 million hectares that have already been deforested, either underutilized or used solely for real estate speculation, and claim that there is room for production without further deforestation. Others counter-argue that delaying action allows for coexistence with illegality and avoids the burden of reforesting irregularly occupied productive areas. While these opposing sides confront and sabotage each other, deforestation continues to advance.

Brazilian producers must reduce the productive portion of their properties for environmental reserves (in the case of the Amazon biome, 80%). It's like building a hotel but not being able to commercially use all of its rooms. This presents a problem of efficient resource allocation and also a paradox because the environmental services resulting from preservation are public goods (enjoyed by all of humanity) but are borne by the burdens and risks of private individuals. It is necessary to consider payment for environmental services.

Brazil owns 851,000,000 hectares, and it can be estimated that 25% (212 million hectares) of those are private environmental reserves maintained by landowners. Considering the opportunity cost of livestock farming (an average gain of R$ 400.00 per hectare per year according to data from Inttegra[1]), compensating for 212 million hectares would cost approximately US$ 16 billion annually. And how much is it worth for humanity to preserve 212 million hectares, converted into mitigation of greenhouse gases and various risks arising from climate change?

The global military budget amounts to 2.2% of US$ 96.5 trillion, which is US$ 2.2 trillion per year. Thus, investing US$ 16 billion dollars in effective preservation would represent only 0.2% of the planet's GDP.

On the other hand, the producer should consider that it makes no sense to proceed with deforestation, even if legal. The path of technological incorporation can break the vicious cycle of low productivity, low income, and pressure on new areas.

A pact between rural producers, other economic actors, environmentalists, and the perspectives of science and the state begins with dismantling prejudices and ideologies. Technological solutions that ensure sustainable employment and income, committed to social, environmental, and economic responsibility, already exist. The bargaining chips for building this pact are payment for environmental services, technological inclusion, and a moratorium on deforestation.

[1]Inttegra (Instituto de Métricas Agropecuárias): A Brazilian company that offers technological solutions to maximize agricultural production based on data collection, knowledge, and management.

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ILPF, AN UNEXPLORED POWER

Abílio Rodrigues Pacheco*
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Crop-Livestock-Forest Integration (ILPF) is a technological innovation that consists of the diversification of activities and income on rural property, enabling the recovery of degraded pasture areas through the cultivation of annual crops, in consortium, rotation and/or succession with forest species and with the breeding of animals, providing increased production per unit area, minimizing climate and market risks, mitigating deforestation, reducing the emission of greenhouse gases (GHG) and carbon sequestration by the biomass of forest and forage species, greater infiltration of rainwater and consequently reducing erosion and recharging aquifers, the windbreak effect of trees, reducing the spread of pests and diseases and maintaining soil moisture, enabling pastures to remain green for longer in the drought period, due to the reduction of dehydration of forage plants between tree branches.

ILPF is certainly one of the most comprehensive and impactful technologies among all those developed by Tropical Science. In order to understand the exact dimension of its potential, we turn here to Professor Paulo Haddad, Former Minister of Planning, who contextualizes its economic meaning:

A clear sign of this potential comes when we closely analyze the economic performance of some of the most exuberant Brazilian Agricultural Centers, submitted to the light of holistic indicators, such as the FIRJAN INDEX, developed by the Federation of Industries of Rio de Janeiro. There is a strong concentration of Income and Wealth from the farm gate inwards, where, also due to investments in research and management carried out over five decades, the levels of productivity expansion are very restricted. Whereas "from the farm gate outwards", industrial scaling – soybeans, for example, are raw materials for more than a thousand different industrialized products – beckons with room for increased productivity that runs between 30% and 40%. This is the origin of the

ESG concept, initially formulated by the financial sector in its permanent search for improving the remuneration of capital. And it is precisely this room where the interests of capital, society (decent income and jobs) and science (urgent mitigation of greenhouse gas emissions) converge to that maintains a logic of optimism and hope, even at a time as complex as the one currently experienced by humanity.

ILPF is an intelligent and versatile production model that makes it possible to blend the agricultural, tree and animal components, in a harmonic, simultaneous or sequential way in time and space, on a temporary or permanent basis, with economic, environmental and social benefits. These systems are recognized for allowing thermal comfort to animals, increasing their performance, which translates into up to 20% increase in milk/cow/day production and up to 15% increase in weight gain/animal/day, in addition to enabling, in the short term, the production of grains such as soybeans, corn, sorghum, sunflower, etc., and in the medium/long term, the production of timber for multiple uses such as energy, cellulose, treatment of stakes and fences, sawmill, civil construction and even railway sleepers.

ILPF can be implemented in any size of property, in any region of the country and in any type of soil, and its adoption has been growing significantly in Brazil, especially in recent years, due to the social appeal for food security, animal welfare, sustainable production and several actions for promotion, dissemination, training and credit line to finance its implementation (Plano ABC+, Renovagro).

But some structural and conjunctural bottlenecks have hindered its wide adoption, with emphasis on: cultural aspects, that is, specialization or monoactivity of the rural producer, only a farmer or only a rancher or only a forest farmer; difficulty in accessing innovations and technical assistance by small and medium-sized rural producers, especially ranchers; lack of skilled labor to work in multiactivities; lack of knowledge of the market for new activities, especially in the purchase of products and in the sale of production; difficulty with connectivity in the field; decoding of technical and scientific information generated by the research; adaptation of the language and approach to the reality of producers in different regions and biomes; insertion of the ILPF approach in the curriculum of high schools and higher education institutions of Agricultural Sciences; and obtaining results of medium and long-term economic analyzes in the ILPF.

The dissemination of ILPF has been mainly based on lectures,

courses, technical visits and field trips, in addition to the study of successful cases. A successful case in the implementation of the ILPF is the Fazenda Boa Vereda, by Abílio Rodrigues Pacheco, who is a researcher at Embrapa Florestas and a rural producer, located in the municipality of Cachoeira Dourada, in the state of Goiás. The introduction of the forest component resulted in diversification of income on the rural property, with the production of 20@/ha/year of beef and 45m^3/ha/year of timber, and also led to environmental or ecosystem services, such as the reduction of GHG emissions, carbon sequestration and "water production".

Due to the promising results of increased profitability and sustainability at Fazenda Boa Vereda, the work was expanded to Fazenda Varjão/Macaúba, both in the southwestern region of the state of Goiás. Such properties were typical cases of traditional beef cattle ranching, with very low economic profitability, in addition to being made up of pastures with a considerable degree of degradation, like most properties in the region.

We sought to work so that Boa Vereda and Macaúba became Embrapa's technological reference units (URTs) and examples of a business model feasible for small, medium and large properties. The forest component received a lot of attention in the adopted system and, having tested several configurations of system arrangements regarding the spatial arrangement of the trees, in order to improve the system and mitigate the low productivity of the pasture within the eucalyptus fields.

Thus, over the years, these URTs have worked as a platform for generating research, development and innovation (RD&I) and technology transfer (TT) actions. Currently, the technology has expanded to about 120 rural properties in the southwest of Goiás, with the partnership of rural extension and other institutions.

In parallel, several research works were carried out in the areas, especially master's dissertations and doctoral theses that generated reliable data and information on the results of the adoption of the technology. In addition, a broad technology transfer program has been carried out with rural producers and opinion makers in partnership with Emater/GO. These URTs annually receive events such as field trips and tours with rural producers, national and international agencies interested in knowing ILPF and the benefits of managing the forest component.

ILPF is recognized nationally and internationally as one of the best

technological alternatives for the sustainable intensification of food, fiber and agroenergy production, and, as a smart strategy to mitigate deforestation, reduce GHG emissions, sequester carbon dioxide and adapt to climate change, and it represents an untapped power of the bioeconomy in Sustainable Tropical Agriculture.

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3.4 SOCIAL INEQUALITY

VOCATIONAL EDUCATION, YOUTH AND SUSTAINABLE DEVELOPMENT

Fernanda Aparecida Yamamoto*
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Education is seen as the key to a nation's sustainable socioeconomic and environmental development. In the Brazilian context, the preparation of young people for the world of labor, the expansion of enrollment in technical courses, and the effective connection between school and the productive sector are essential components to achieve the Sustainable Development Goals (SDGs), especially SDG 4: Quality Education. But what are the challenges, related to education, that have been impacting socioeconomic and environmental development in the country?

When it comes to education and youth in Brazil, one of the most significant challenges is the insertion of young people in the world of labor. Many students finish high school without consistent training and with few opportunities to meet the increasingly complex demands of the productive sectors.

According to the IBGE, the average unemployment rate of the young population, aged 18 to 24, in Brazil reached 19.3% in 2022, ten percentage points higher than that of the general population, which was 9.3% in the same period. In the National Household Sample Survey (PNAD), carried out in 2023, 19.8% of young people aged 15 to 29 years old were neither working nor studying, among these, 14.2% were men and 25.6%, women. (IBGE, 2024)

It is true that school dropout and evasion are caused by various reasons ranging from teenage pregnancy to immediate income generation needs, but the lack of association between what is learned and the immediate interests and needs of young people is an important factor and about which much is discussed but still lacks effectiveness. (OEIU, 2020)

Another study, entitled The future of the world of labor for Brazilian

youth, when analyzing the challenges faced by young people in social insertion, recommends that access to and quality in vocational training, with vocational and technical education (VTE) and work-based learning (WBL) initiatives be intensified, as well as the incorporation of the world of labor with actions in school through articulations with the State, companies and civil society, in order to facilitate young people's access to initial positions in the labor market and improve the connection between supply and demand. (IET, 2023)

The integration of technical courses into high school is a privileged strategy to contribute to this more qualified training. This is because technical and professional training provides students with the development of skills in several areas, preparing them for the complexities of the productive sectors, which are already quite technological.

In this sense, the expansion of enrollment in technical courses integrated into high school is important to prepare these young people, since it is one of the last public policies accessed by them. Data from the National Institute of Educational Studies and Research Anísio Teixeira (INEP) show that the number of enrollments in professional education is still low if compared to regular high school. Investing in the expansion of these courses can increase youth employability and contribute to the country's economic development.

The connection between schools and the productive sector is a key element in ensuring that technical education is relevant and effective. Currently, many technical schools operate without a direct link with the needs of the labor market, resulting in a mismatch between the training offered and the demands of the productive sector that increasingly lead to the need for qualified professionals in technological and innovative areas, such as information technology, engineering, and environmental management.

The research "Skills for Jobs" (OECD, s.d.) identified that in Brazil creative and technological skills are growing below the expected average in the context of emerging global economies, according to the analysis, due to insufficient economic investments in innovation, technology and cultural diversity "elements that directly influence the qualification of professionals and the demand for vacancies involving technological and creative skills." (EIT, p. 89)

But what about sustainability? Sustainability is an essential component in the promotion of citizen technology, requiring that the development and application of technologies consider environmental, social and economic impacts, ensuring that technological innovations

not only meet the immediate needs of a sector or even society, but also preserve natural resources for future generations.

In this regard, we have not even taken the first step, which is ensuring accessibility for all. By 2022, 33.9 million Brazilians were disconnected and 41.8 million underconnected (PWC, 2022). On top of that is the second social, intellectual, scientific and economic challenge; the use of available technologies, from a citizen's point of view, integrating from the initial training and, in the specific case of education, the perspective of use and development of technologies in a way that they benefit society as a whole, meeting public needs in a transparent, accessible, inclusive and sustainable way in all school curricula.

To do so, it is necessary to have a combination of political will and pedagogical objectivity in order to enable students to access and understand the complex interactions required by the technological society in which we live.

The second challenge is even greater because it lies not only in the sphere of knowledge generation, but also in understanding within the scope of perceptions, specifically related to culture and, therefore, ethnocultural issues. In this sense, the proposal is that the approach to technology be incorporated into the initial training of young people, not in an instrumental way, but integrated into the culture that operates, through literacy that enables competence in management and the capacity for critical analysis, knowing that no technological resource is impartial, devoid of origins and or objectives. That is why it should be understood within an ecosystem of interactions.

However urban a population may be, it will not be out of nature. Thus, the perception of ecosystems must be a method for acting in an integrated and integral way between humans and humans, humans and non-humans, humans and machines, science and culture, through a worldview that breaks the fragmentary dimension that no longer responds to the complexities of the social and economic world.

Having a common strategy for integrated management fundamentally related to the formation of the person, providing the understanding of the phenomena, combined with technological access and the ability to solve problems in the contemporary world, within the scope of formal education, initially requires the contextualization of curricula with the demands of a technological and sustainable development from the perspective of the 2030 agenda, dealing with socio-cultural environmental issues, economic and scientific policies in an integrated way to enable the construction of critical awareness and priority lists

for society, in this case, the Brazilian one.

However, we know that the school education offered today often does not adequately meet these needs. There is a lack of dialogue between companies and educational institutions, which prevents the adaptation of school curricula to contemporary realities.

To improve this situation, it is necessary to implement strategic partnerships between companies and educational institutions. Internship programs, courses developed in collaboration with the productive sector, and technical visits are some of the ways to create a synergy between education and the labor market. In addition, the adoption of modern educational technologies and the promotion of active teaching methodologies can make learning more dynamic and aligned with current professional requirements.

SDG 4 aims to ensure inclusive, equitable and quality education, and promote lifelong learning opportunities for all. The expansion of technical courses integrated into high school and the effective connection between schools and the productive sector are directly aligned with this objective. These initiatives not only increase young people's employability, but also contribute to the reduction of social and economic inequalities.

Quality technical training can have significant socioeconomic and environmental impacts. By training skilled professionals, the country can advance in areas such as renewable energy, waste management and sustainable development, contributing to the protection of the environment. In addition, the reduction of unemployment and qualified professional insertion have positive effects on the economy, generating growth and social stability.

The potential of Sinop - socioeconomic and sustainable development

Since the 1970s, with government encouragement for migratory occupation in the region, schools in Sinop have been a determining factor for the permanence of families arriving in the new city. (Tomé, 2017).

Through reports presented in Tomé's research from 2017, it is possible to notice the awareness of part of the residents about the importance that education would have as an instrument of socioeconomic development and "progress", since they present a discourse still very much in line with the foundations of the military government's project for occupation of the territory in the 1970s.

Today, although there are different types of educational offers in the city, the number of vocational technical education schools is not even

half of the institutions, and only three of them are free of charge (ETEC and IFMT-Sinop), showing the need for investments in this training to consolidate Sinop as an educational center, boosting the development of the region.

The expansion and improvement of partnerships between the sectors and schools such as ETEC and the Federal Institute of Mato Grosso of Sinop (IFMT), which already offers a wide range of professional qualification courses "covering communities and minority groups, such as women in situations of social vulnerability, indigenous populations, quilombolas and immigrants, in several cities of Mato Grosso" (IFMT, 2024) seems to be one of the ways to reduce inequalities and promote quality training.

There is no doubt about the region's potential to be a successful source for development and innovation in sustainable projects. To this end, partnerships between the various sectors are essential. The management of these projects must go beyond isolated initiatives, integrating demands and offers in an articulated way in the macro-social context. This seems to be the path to the possible utopia: an education that simultaneously promotes development, innovation, inclusion and equity.

We know that education is a powerful means to transform society and promote sustainable development. The integration of technical courses into high school and the creation of an effective connection between the productive sector and schools are fundamental steps to prepare Brazilian youth for the challenges of the future. By aligning these initiatives with SDG 4, Brazil can move towards a possible utopia, a society in which quality education opens doors to opportunities, equity and sustainability.

Access the link to the bibliographical references

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3.5 STRATEGIC COMMUNICATION

THE RESCUE OF SCIENTIFIC EVIDENCE AS AN INSTRUMENT OF CITIZENSHIP

Fernando Barros*

In an increasingly fractured and polarized world, scientific evidence is rapidly losing ground to misinformation and to the belief in the direction of society's destiny. Could this be the big warning sign that we really are entering a new era, revising the paradigms of civility that humanity has built up until now?

Scientific referencing, a value discovered by the Renaissance, truly began to dominate the decision-making process of nations after the Lisbon earthquake on November 1st, 1755. The catastrophe was so impactful (earthquake followed by fire and tsunami) that, according to philosopher Zigmunt Bauman, the "Divine" ceased to be the hegemonic source of power and interpretation of the reason for natural phenomena, giving way to the scientific method. Today, climate change, energy and food insecurity and growing social inequality form a new and gigantic tsunami, but its real dimension has not yet been properly incorporated and assimilated by the lay citizenry. In this challenging environment, which threatens the very existence of the human race, we see belief - whether it be political or religious - embarking on a surprising return to the limelight, while the exponential complexity of the scientific debate makes it difficult for the immense lay majority of public opinion to make sense of its message.

Evidence shows that the world in which knowledge was transferred from research laboratories to society through a consolidated pact between governing and scientific elites is rapidly liquefying. The search for a new model of understanding is still in its infancy, and the task is enormous. "Strategic Communication", the newest academic branch in this area, is in its teens - it's just over 15 years old. It proposes moving communication from the "output" instance (diffusion role) to the planning table, alongside the organizations' board of directors. Con-

necting content, purpose and governance is a means of survival in an ultra-connected world, where the end consumer now has the power to deny facts and instruct society's response.

In Palo Alto, a young IT entrepreneur, Patrick Collinson, and economist Tyler Cohen, are proposing the creation of a discipline aimed at materializing the social and economic value of increasingly complex scientific advances. Efforts are being made, but there is a speed gap: in the absence of a direct channel between Science and Society, persuasion processes based on belief have proved more effective. Meanwhile, in the tropical zone of the globe in particular, Science and Business resist leaving their identity "bubbles". This resilience, so far unshakable, expresses the conviction that they will be able to stick to their objectives in the third decade of the 21st century, without negotiating the purpose of their work with the end user: the citizen. Nothing could be more appropriate than recalling the remarkable concept outlined by French sociologist Dominique Wolton: "to communicate is not to inform - it is to negotiate".

But that hasn't happened yet. Agribusiness is predominantly restricted to the use of Marketing and Advertising. Knowledge institutions operate in the field of "scientific dissemination", an undecoded account of the sector's achievements. These instruments have not ceased to be important; they are just no longer sufficient. In Brazil, a first instance judge has just sentenced and fined two scientists who dared to refute a nutritionist who disseminated a thesis on the Internet that diabetes is caused by worms.

It is in this context that the Forum of the Future Seminar in Norway is intended to be a real opportunity to lay the foundations for a new communication platform that brings together such different worlds - the tropical and the Scandinavian - with a common and agreed upon planetary future as its guiding principle.

The hypothetical dialogue between two icons is the key element that illuminates this aspiration: Gro Harlem Brundtland, the Prime Minister of Norway who conceptualized sustainable development in 1987, representing the UN; and Alysson Paolinelli, who led the creation of Agro Tropical and allowed the consolidation of its sciences, which resulted in the "Cerrado Revolution" in the 1970s.

Brundtland brought the precursor premises of ESG governance: the prerequisite of economic viability in order to achieve the indispensable social and environmental results. Alysson, in creating the *Forum for the Future* in 2012, brought the social and technological inclusion of tropical actors (rural producers, companies, etc.) as a political and strategic means capable of promoting an effective and consistent agenda for the "Common Sustainable Future".

The Forum of the Future Seminar in Norway will have achieved its objectives if we manage to go beyond the mere informational parade of sustainable tropical solutions. On this path undermined by mistrust, it is more important to debate the validation of the robust solutions presented in this book, in the fields of politics, culture and the challenges of communication and trans-generationalism.

We have a lot to learn. In education, Finland teaches the world "media literacy" as early as pre-school. In 2011, Norway and its Baltic partners created the "Cod Academy", a dynamics of academic knowledge integrating technical and social sciences that has resulted in balancing cod stocks and improving the production chain. Few regions in the world other than Scandinavia have managed to turn "Science Policies" into a reality in public and private management.

It is in this context that the "Third Leap" - Sustainable Development based on social and technological inclusion of tropical peoples and focused on food and bioenergy production - must be seen as an immense window of opportunity and hope in the midst of mega crises, but also as an inalienable page of Human Rights.

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INTERACTION, INNOVATION, AND NETWORKED SOCIETY

Augusto de Franco *

It would be better to watch the video *Murmuration* than to read this article. It explores the flight of starlings and can be easily found on YouTube. But if you'd like, feel free to keep reading (and you'll find out why watching the video is a better option).

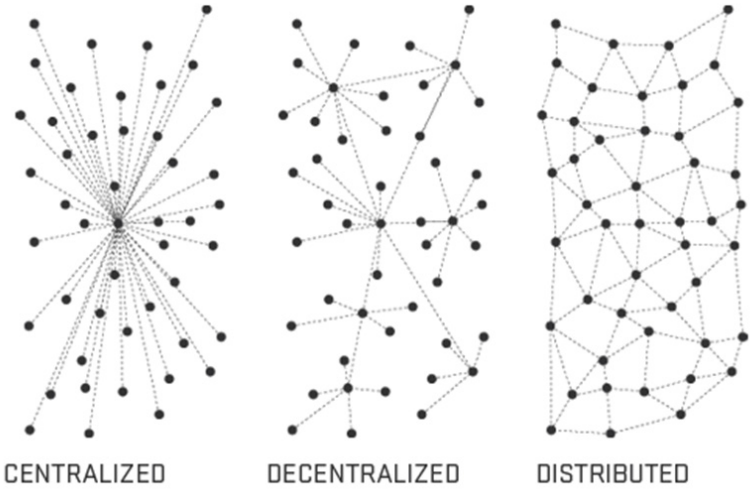
In general, when we talk about networked society and anything else, we end up talking about anything else and forget to talk about networked society.

Either that, or we assume that everyone already understands what a networked society is. However, one cannot grasp the concept of a networked society without first understanding what a network is. Three common confusions — made by most people today — hinder the understanding of networks:

- confusing decentralization with "distribution"
- confusing participation with interaction
- confusing the network's website with the network itself

THE FIRST CONFUSION

No one can understand what a network is without grasping the difference between "decentralization" and "distribution." The best way to understand this difference is to read the old paper On Distributed Communications, published by Paul Baran in 1964. In that text, I suggest taking a close look at the figure below. Baran's diagrams are self-explanatory, but the implications we can draw from them are not.



The first relevant implication is that connectivity comes along with distribution. Conversely, the more centralized a network is, the less connectivity it possesses. The second relevant implication is that interactivity accompanies connectivity and distribution. Once again, the more centralized a network is, the less interactivity it has. These laws govern the multiverse of interactions and thus apply to what we call a networked society. We refer to "social networks" those that are more distributed than centralized. On the other hand, networks that are more centralized than distributed are called "hierarchies." It's a convention, but a reasonable one.

THE SECOND CONFUSION

Few people realize that, in the sense of the convention described above, social networks are environments of interaction, not participation. Thus, one cannot understand the networked society without grasping the phenomenology of interaction. The problem is that, in general, we are so intoxicated by the participatory ideologies of the last century that we confuse participation with interaction.

Here is the so-called Web 2.0 to prove me right: everything boils down to liking, voting, preferring, adding, typing in a little box, and then clicking "send." The boxes are all set up. When you click on them, you

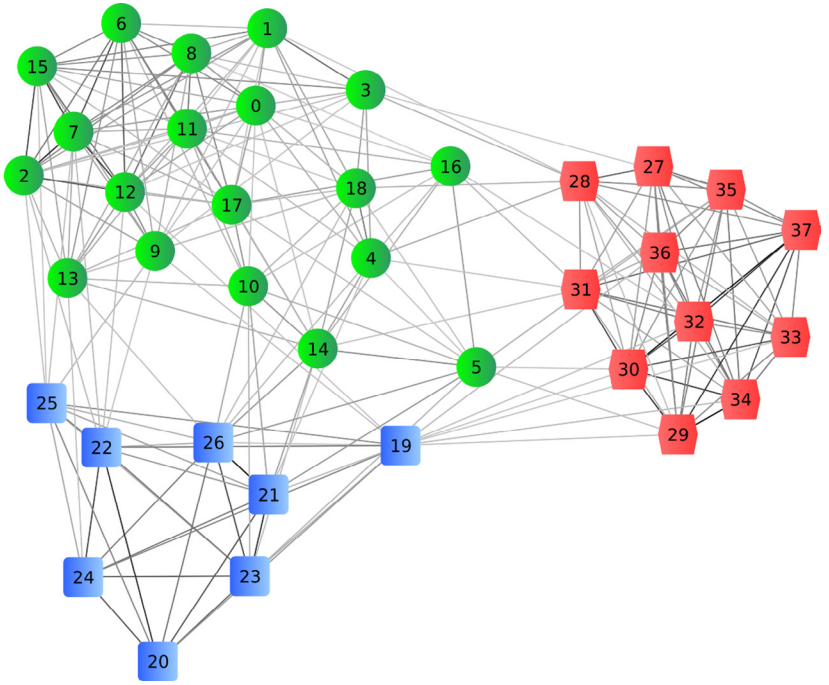
store a piece of the past somewhere. And then, poof! The interaction is lost, the flow has passed. Generally, only the platform owners have access to the data that you and all the other participants have thrown into the traps they built. This is a typical characteristic of participatory systems, where there is always an oligarchy with enhanced regulatory powers over the powers of the "users." They can program the platforms; you cannot. Argh!

In the process of interaction, things happen much differently. They happen regardless of our intentions to discipline the flow, to store it, or to freeze it. It's not possible to artificially create scarcity by introducing voting or preference processes. In the interaction process, you cannot herd people into a participatory space and then try to lead them here or there.

Participatory systems were an attempt to save command-and-control structures. It was an effort to avoid the abyss of interaction. Participation is to interaction somewhat like Creative Commons is to Public Domain. Yes, understanding the networked society means understanding networks, and understanding networks means grasping the phenomenology of interaction.

In my view, the four major discoveries of the new science of networks are the phenomena associated with interaction: clustering, swarming, cloning, and crunching.

CLUSTERING



Clustering: Everything that interacts clusters.

The first major discovery is: everything that interacts clusters. When we do not understand clustering, we fail to allow the forces of aggregation to act. Everything clusters, regardless of content, based on the degrees of distribution and connectivity (or interactivity) within the social network. When organizing a distributed network, it is not necessary to predetermine what the departments will be—the little boxes drawn in organizational charts. As long as the purpose of the initiative is clear to the participants, it is enough to let the forces of aggregation take effect.

SWARMING

The second major discovery is: everything that interacts can swarm. When we do not understand swarming, we fail to allow the swarming

behavior to take effect. Swarming (or swarming behavior) and its variants, such as herding and shoaling, do not occur only with birds (as seen in the video *Murmuration*) or with other animals like insects, ants, bees, mammals, and fish. In general terms, these collective movements (also known as flocking) happen when a large number of self-propelled entities interact. Some form of collective intelligence (swarm intelligence) is always involved in these movements.

But this also occurs with humans when crowds cluster and "evolve" synchronously, without any direction (neither from the blunt orders of command-and-control structures, nor from the gentle inducement inherent in participatory processes). Without the guidance of a leader, when many people swarm, they can provoke significant mobilizations. This happens without a call or centralized coordination, as seen in Madrid in March 2004, in Tahrir Square in Cairo on February 11, 2011, and in various cities in Brazil in June 2013.

CLONING

The third major discovery is: imitation is a form of cloning. When we do not understand cloning, we fail to allow imitation to play its role. As people — social gholas — we are all clones in the sense that we are culturally formed as variant replicas (though unique) of the configurations of the social networks in which we are entangled. The term "clone" derives from the Greek word klónos, used to denote "trunk" or "branch," referring to the process by which a new plant can be created from a twig. And that's precisely it: the new plant imitates the old one. Life imitates life. Coexistence imitates coexistence. A person imitates the social.

Without imitation, there could be no emergent order in human societies or in any collective capable of interaction. Without imitation, termites would not be able to build their magnificent mounds. Without imitation, birds would not fly in flocks, forming such surprising geometric shapes and performing those fantastic evolutions. Do you see now why I said it was preferable to watch the video *Murmuration* rather than read this article?

When we try to guide people on what—and how, when, and where—they should learn, we are actually attempting to replicate, to reproduce borgs: we want beings that simply repeat. When we allow people to imitate one another, we do not replicate; instead, we foster the formation of social gholas. As human beings, we are imitators.

Does the mention of "gholas" and "borgs" sound strange to you? I completely understand. But I'll try to explain the metaphor:

Gholas: naturally absorbed imitations, through interaction and coexistence in society. In fiction, they are artificial humans created from parts of humans who have "moved on to a better place."

Borgs: reproduced imitations, imposed through a social standard. In fiction, they are the cybernetic creation of the "perfect" race.

None of this pertains to content. In highly connected worlds, cloning tends to self-organize much of what we strive to organize by inventing complicated processes and management methods. This is especially true as all of this becomes irrelevant when worlds begin to contract under the effects of crunching.

CRUNCHING

The Fourth Major Discovery: Small is powerful. When we do not understand crunching, we fail to allow worlds to contract. This may be the most surprising fluzz discovery of all time. In other words, "small is powerful" means that the social reinvents power. Instead of the power to command others, the power to encourage them (and oneself) emerges – empowerment! You might be wondering: but what is fluzz? Well, fluzz is empowerfulness — the ability to empower people, through people!

When we detect an increase in interactivity, it is because the degrees of connectivity and distribution within the social network have increased; or, in other words, it is because the degrees of separation have decreased: the social world has contracted (crunch). The degrees of separation are not just decreasing; they are plummeting. We are now under the effect of this compression (small-world phenomenon).

Once again: this has nothing to do with content. Everything that interacts tends to become more entangled and closer together, reducing the social size of the world. The smaller the degrees of separation in the web where you live as a person, the more empowered you will be by that web. You will have more future alternatives at your disposal.

At this point, you, the reader of this article, might be wondering: this fellow — talking about these weird things... did he come from Mars? And I'll answer: if you don't know these things, you could live quite comfortably on Mars, but not in the bioanthroposphere of this planet

Earth. Because none of this exists on Mars (presumably). But here, it has been this way since the beginning of life and social coexistence.

THE THIRD CONFUSION

The third confusion that hinders the understanding of networks relates to the distinction between network sites (the media) and the network itself. Social networks have existed since the emergence of human society, meaning people interacting (according to our convention, interacting in a more distributed than centralized manner).

People can interact using different media: gestures and signals, face-to-face conversations, drums (as the pygmies did), or smoke signals (as the Apaches did); through written letters delivered by horseback (as was done in the so-called Philadelphia Network, which collectively wrote the United States Declaration of Independence); via landline or mobile phones (including SMS—which can lead to real swarming, as occurred in Madrid in 2004 or in Tahrir Square in Cairo in 2011); through social networking sites on the internet (like Orkut, Facebook, and Twitter); or through platforms designed for interaction (such as Ning, Grou.ps, Grouply, Elgg, and WP Buddy—though, in reality, these platforms were designed more for participation than for interaction).

By confusing the site of the network with the network itself, we are saying that there is no network (a social reality) without the site (a digital artifact). This is absurd. The screen of your phone is not the network. It is not the digital that is responsible for the manifestation of the phenomenology of interaction: "It's the social, stupid!"

But what does the creative economy have to do with all this?

Well, having talked about the networked society, let's now discuss the anything-else-on-screen. In this case, the so-called Creative Economy.

What would the Creative Economy look like in a networked society? Would it be an economy where economic agents are (individually) creative? Or would it be an economy organized in such a way that the constellations (of people formed within it) are creative?

No, it's not the same thing. The social is not the sum of individuals; rather, it is what exists between people. A collection of people is not the same as the settings of the flows they form.

Well, here comes the second question: is it possible to have a Creative Economy in a networked society with economic units that inherited hierarchical (and mass) societies, which were not designed for interaction?

Indeed... Our organizations have been designed to obstruct, direct, confine, and discipline interaction, not to let it flow. That's why efforts to make companies innovative—without changing their organizational patterns—are often so unsuccessful. Yes, generally, initiatives to implement creativity programs and even to establish innovation networks within companies tend to fail.

Observing the experiences already undertaken or ongoing, several reasons for such failure can be identified. Generally, these networks are artificially woven to follow a new trend and are adopted as a new corporate management practice that does not change the relationship patterns among the people who inhabit or orbit the company's ecosystem.

It is said that such network projects fail when the programmed networks cannot exist on their own, or, in other words, when they do not form a self-propelled entity. Some indicators of this type of failure can be observed when people: do not spontaneously express their desire to connect and interact; are not interested in sharing agendas on their own initiative; and do not regularly use the installed netweaving tools, which then become idle, leaving the task of maintaining them to a bureaucratic team. It's the end.

Weaving networks is about changing an organizational pattern (more distributed than centralized) toward greater distribution, but not about adopting a new type of organization or a new tool. An organizational pattern that is more distributed than centralized creates an environment that is more conducive to interaction. A more interactive environment increases the chances of innovation. Period. This should be the goal of those who want to stimulate creativity and foster the so-called creative economy.

To that end, it is useless to create programs (or even "networks") for innovation in companies if the company's environment is not innovative. And the environment is the hardware. There is no innovative software that can run on conservative hardware. The hardware is the topology. If the social network topology of a company is more centralized than distributed, the company will be more conservative than innovative. It does not depend on the will of its members.

In summary:

Do you want a more creative economy? Then it's useless to change the software (much less to give a completely updated speech); you

have to change the hardware. There are software solutions that can even change the hardware. For example, a language learned in childhood physically modifies the neural network of the child. But in the case of crystallized structures (like the centralized networks that exist in our companies), the hardware really needs to be changed.

It's not enough to change people's minds. The brain is merely the interface. Conservative programs that stifle creativity and hinder innovation are running in the social cloud we call the mind. Mental models are, in fact, social. Ideas do not change behaviors; only behaviors change behaviors. These models can only be changed by the individuals themselves, by interacting differently, in a more distributed than centralized manner, like those starlings captured in the beautiful video *Murmuration*. Watch it.

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INTERGENERATIONAL COMMUNICATION: A DIFFICULT BUT ESSENTIAL JOURNEY FOR BUILDING A SUSTAINABLE FUTURE

Mário Salimon*

Last May, we achieved something very rare in the world of multilateral projects: a major development bank agreed to finance an initiative in its early stages, betting on our ability to generate meta-knowledge from primary sources through a process of social concertation. In plain English, they decided to pay us to learn how to learn about the problems faced by a prosperous and emblematic community in the field of Brazilian agribusiness. Our goal was to break the ice between people and bring to the surface important issues for the future generation of a Global Bioeconomy Hub, capable of having a broad demonstrative effect. The project is progressing well, but it quickly encountered significant challenges.

Encouraged by this important vote of confidence, we set out to form the ideal task force for the project. We knew it was crucial to seek broad representation, both sectoral and identity-based, so we turned to our professional network to bring, through the Third Sector, the key actors needed to validate our collective. Environmentalists, women, young people, and members of indigenous communities could provide the scope we believed was necessary to ensure the robustness of our analyses. We also thought our offer would be appealing to the invited participants, as we would give them the opportunity to embed their DNA into an innovative project, giving them the chance to expand their relative contribution in projects that are only viable through joint actions.

The fact is, we fell flat on our faces. We thought our proposal would be obviously understood, but we underestimated the difficulties arising from communication in complex groups. Not only did we have low en-

gagement, but we also saw the quick departure of the few Third Sector representatives who had accepted to join the group. Functional enmity and communication difficulties quickly made our ideal construction unfeasible. Just because we are in the same here and now, speaking the same language, does not mean we understand each other.

Fortunately, we were able to overcome these difficulties thanks to the power of network phenomenology, as one of the universities participating in the process bridged the gap with the communities missing from the group, allowing their contribution to be satisfactorily included in the final work. However, this process generated some bitterness, leading us to reflections and speculations that we share in this article.

The concept of the "Third Leap," as proposed by Alysson Paolinelli, leads us to a significantly complex set of interaction and communication needs. If the idea is not to generate a ton of frustrated expectations, we must admit that it will not be trivial to organize, disseminate, and verify the perception of the hundreds—if not thousands—of concepts and definitions necessary to compose the vision of a new society capable of transcending the current agri-food model. In terms of processes, we know that before the leap, there will be many crossings, for which we will need to build bridges and more bridges.

We have immense challenges ahead, but in this article, I wish to focus on communication, understood here as the construction of one of the most important bridges: the intergenerational one, linking the present and the future. And for that to be viable, we must talk about communication difficulties between young and old. These terms are generic and harsh, but using any different categorization would immediately downplay and euphemize the really important discussions, as the perception we have in conversations is that there is rarely a middle ground. Regardless of our ages, we are always perceiving others and being perceived by them as part of one of the two categories.

It is an extremely subjective exercise that leads us to various types of asymmetrical comparisons and prejudices that ultimately hinder the understanding between those who supposedly— and here lies the greatest of prejudices—have already been and those who are yet to be. Factually, older people are curbing the opinions of the younger ones by seeing them as overly opinionated, while the latter cancel the former for being outdated. And everyone loses because this behavior prevents them from seeing life as the continuum it truly is.

This text aims to freely speculate about these communication difficulties between young and old. Far from being a scientific approach,

it superficially addresses issues that have frequently emerged in our attempts to generate generational representation in our strategic management consulting activities. To reduce the inevitable author bias, since I am 59 years old, I asked my son Luís and my daughters Ana Paula and Marina, who are now between 22 and 30 years old, to speak freely about the difficulties they have in their relationships with older people. I also listened to my stepdaughter Gabriela, who, during a recent family lunch, spontaneously completed the picture I had been painting. The ideas from what I call the “young wing” are, when not nominally cited, well represented in the analyses I will make later on.

THE ASSUMPTIONS

It cannot be overstated that communication is much more than the bilateral transmission of information, although this notion still prevails in various institutions, including families. The definition that interests us here has more to do with the construction of common meaning, which is why it is essential to consider feedback as the next step, the inflection point from which we have a real chance of transcending the confusion that may be generated by noise and the feeling of helplessness when facing what others say to us.

Thus, the opinion of the receiver about what the sender says is the key to verifying the perception of what is said. More than that, it instructs the sender, as long as there is the necessary openness, in the sense of changing their own view on the exchanged contents. It is not possible to build assertive and democratic relationships without the effective exercise of the process as conceptualized here. Without this effort, our bridges will collapse before we even reach the halfway point of their construction.

It would also be important to establish that communication can be seen as both process and product. In the former case, we speak of a dynamic construction of meaning, marked by actions, gestures, and verbalizations, but also by inaction and silence, which are often as much or more significant than their opposite. In the latter, we have the effect of the process, which reverberates in behaviors and the development of culture. As an effect, communication as a product is an important indicator of the quality of processes and, since intergenerational communication is very noisy, we can affirm that the process is inefficient and would not lead us to a good outcome, especially because

we must consider that ongoing technological changes will make the context—which serves as the backdrop for cognitive processes—even more complex and fragmented. Therefore, I move on to presenting and briefly discussing the topics that emerged in the conversations and investigations that resulted in this exploratory article.

THE TECHNOLOGICAL FACTOR

There is a general belief that each new technological development increases the distance between generations due to cognitive and motor factors. However, design techniques have increasingly focused on user-centered functionality, making it easier for older people to adapt to new operating systems and interfaces. A proof of this was the massive adoption of smartphones by older people, which have much more user-friendly interfaces than desktop computers or laptops. It is very likely that the popularization of voice-activated digital assistants will radically change the relationship between users and their machines, significantly reducing the cognitive and motor obstacles imposed by current methods of interacting with computing devices. Thus, this factor should not necessarily constitute a determining problem of digital separation between young and old.

However, devices and their interfaces are just one of several aspects of this new digital ecology that has emerged with smartphones and social media platforms. There are also issues such as territoriality and language. My daughter Marina is 22 years old and a linguist, recently graduated from the University of Porto. When asked to reflect on the theme of this article, she pondered that the radical changes in technologies have created a condition in which parents and children, although present in the same physical space, end up living in worlds that can be completely different. At each moment, myriad new territories, with their own characters, scenarios, and vocabularies, are configured in virtual spaces. "We grew up in another world, like another country, you know? And this difference greatly affects linguistic production," says my youngest daughter.

BACKDROP

As a result of these new territories and cultures, new value systems

and worldviews emerge. Ana Paula is my middle daughter. At 24 years old, she is a graphic designer and does remote work in three different countries. When I asked her to speak candidly about what bothers her in communication with older people, she said, "The older generation has beliefs that are already very entrenched, calcified. It's harder to get through that." It's not a matter of one generation being right and the other wrong, but of the younger ones being, though not necessarily more flexible, more open to change. Because of this difference, according to Ana, there are significant differences in the backdrop of conversations, a very important factor for the development of assertive and noiseless communication.

It should be noted that both Ana and Marina speak of a very serious problem. How will we be able to communicate efficiently if the fundamental elements of message generation and dissemination—code and culture—are in rapid displacement? More than that, there is still the issue of the frequency of conversations. Today, the visibility of online content is dictated by algorithmic models that may make two people connected by the same platform see completely different content. Ana Paula also notes that, as algorithms are altered according to system usage. As young people tend to communicate more virtually than personally, intergenerational conversations—which are less common—will always be out of sync with those conducted between people of the same age group communicating with the same frequency.

PRAGMATISM AND RESENTMENT

We have an almost instinctive understanding that we need to control the future to survive, so we channel our resources into shaping the world as much as possible to meet our needs, often at the expense of others. This leads us to make a tremendous effort to colonize the future with ideas from the past when educating new generations. Since the Sumerians created the first ziggurat, verticalizing society in almost every aspect, an anisotropy—a distortion of the social field—has emerged where those who are at the top or who came before are expected to know, command and have more than those who succeed them.

This distortion is not lost on the young, who resent the insistence of the older counterparts on shaping the new generations according to a world that is no longer viable. Marina says that new generations do not accept our understanding of what would be desirable for them in terms

of societal functionality because they "don't achieve the same things at the same age; we don't follow the same paths to succeed." In her view, this is causing a loss of authority among the older generation and even "a certain lack of respect" from the younger generation towards them. Gabriela brought up another relevant issue about hierarchy. For her, adults not only tend to direct the actions of the younger generation but also have a tendency to see the glass as half empty rather than half full, which can be very discouraging for those striving to learn and build their own worldview.

We, who are in power today, promised the youth a better world. The generations born in the 90s were raised with the perspective of a freer world, without wars or inflation. The fall of the Berlin Wall was seen as a symbolic marker of this new era. The youth also imagined that what they read in their textbooks about the environment would be taken into account by those who control the world. They resent seeing that we were good at talking, but not necessarily at managing. Why should they accept our determinations? As Humberto Maturana aptly said about determinism in our lives: "When we meet a professional fortune-teller, who promises us with their art of predicting the future, we generally experience contradictory feelings. On one hand, we are attracted to the idea that someone, looking at our hands and based on a determinism inscrutable to us, might anticipate our future. On the other hand, the idea of being determined, explainable, and predictable seems unacceptable to us. We like our free will and want to be beyond any determinism."

TOKENISM AND CANCEL CULTURE

Resentments are not few. The sociotechnical changes that have occurred in the last fifteen years have been disruptive and have complicated the already existing "generation gap" between those who experienced the effects of the counterculture and those who were born and grew up in an immediate and digital society. On one hand, ageism devalues the elderly, viewing them as ideologically outdated and inefficient in the digital game; on the other, the historical asymmetry of matriarchal and patriarchal relationships places the younger generation in an inferior position, as if they were merely unprepared and immature. The older generation insists on seeing the younger as drafts of people, projects still to be developed—and, worst of all, that is done as if glancing through a rearview mirror. Conversely, the younger generation sees us as a faded photograph, an iPhone from the year before last. Was that device not the most advanced version available when it was launched? Was there not still much to be gained from its capabilities? After all, we see and utilize only a tiny fraction of the potential of both people and iPhones!

The fact is, we are all somewhat closed off to dialogue. The older generation is accused of provoking but not considering the opinions of the younger, who are seen as "activists or virtue signalers," as Ana Paula pointed out. Meanwhile, the older generation is accused of tokenism—where representatives of minority groups are only figuratively included in political processes—resulting in being canceled and avoided in conversations. In the end, everyone loses. So, what can we do?

SOCIALIZATION AND AFFECTION

My son Luís Adriano is a journalist. He is 30 years old and has mentioned twice in his reflections that, as he gets older, he begins to understand the other side. According to him, different generations interact differently, with older people tending to be more rigid, formal, and engaging in more small talk. This more affective approach contrasts with that of the young, who "tend to go straight to the point of interest for them or the group" due to their anxiety. Affection seems to be the key that opens the doors to assertive communication. Luís notes that, although he recognizes the difficulties in intergenerational relationships, in his case, the problems seem to have been mitigated by his parents' efforts to keep him in contact with uncles and grandparents, creating a rich environment of affectionate memories. This interaction generated what Luís calls a "familiarized way" of relating to the older generation.

Such an assertion leads to the idea that as a society, we need to invest in ways of interacting that foster affection and solidarity between generations. We know that demographic developments resulting from increased life expectancy will intersect with economic and environmental factors, forcing interaction between different generations of adults. They will have to decide whether to compete or cooperate for resources, but we know that assertive communication will be a critical element in defining the quality of these relationships and the type of humanity that will result from them.

CONCLUSION

The power dynamics in communication processes now have new rules. Each recipient of information, who is also now a sender, views the world through their own lenses and tends to represent it according to the filters they have created. The ability to convince and mobilize society to transition towards something new and disruptive always has and always will require a very careful communication strategy. It must be tightly structured to ensure coherence of content, but simultaneously flexible enough to accommodate the peculiarities of different actors, messages, channels, and products. Without solid bridges, the crossing will be, if not impossible, very complicated.

Despite the vast availability of information, we have not been able to share with our youth a longitudinal view of the achievements and challenges experienced by Brazil in its process of growth and democratization. Neither have we properly addressed the socio-environmental and economic permacrisis that afflicts us. If we wish to build sustainable future projects, we need to enable, perfect, and amplify intergenerational dialogue so that the distinct phases of life are valued and utilized in their various potential contributions and cultural transformations.

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A RANT ABOUT BRAZILIAN AGRIBUSINESS: EVOLUTION, CHALLENGES AND THE IMPORTANCE OF COMMUNICATING CLEARLY

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My journey with agribusiness began in 1979, when my family arrived in Paracatu - MG, through the Cerrado Development Program (PRODECER). At that time, Brazil was facing the challenge of food insecurity, and we were dependent on imports of basic foodstuffs, while our economy was suffering from inflation and the country was going through a period of uncertainty. The Cerrado, seen as a land with difficult and unproductive soil, became a symbol of transformation, consolidating itself as one of the most fertile and productive agricultural regions in the world, thanks to the research, innovation and determination of many pioneers.

During this period, I had the privilege of meeting Dr. Alisson Paolinelli, one of the biggest names in tropical agriculture and a visionary leader who helped drive this revolution in the country. His work inspired a generation of professionals and laid the foundations for Brazil to become a global power in food production. PRODECER's impact was immense, leading the country to become a benchmark in food security and putting the Cerrado on the map as a strategic region for food production.

I learned a lot about agriculture and the environment from watching my father, an agronomist who always stressed the importance of respecting natural cycles and managing the land in a sustainable way. This relationship with nature has always been clear to me: rural producers depend deeply on the health of the soil, the balance of ecosystems and the water cycle to guarantee productivity and efficiency. This respect for the land is a reality that many outside the sector fail to see,

or worse, choose to ignore.

Today, Brazilian agribusiness is one of the country's economic engines, accounting for around 27% of its GDP and feeding 10% of the world's population, according to FAO. Innovative practices, such as Regenerative Tropical Agriculture, are being adopted to increase productivity while restoring the soil and protecting ecosystems. However, despite all these advances, we still face severe criticism from movements that often serve foreign interests. These movements consider the growth of Brazilian agribusiness to be a threat to the subsidized agricultural production of developed countries, which protect their markets at the expense of global competitiveness.

Of course, as in any sector, there are good and bad farmers. Generalizing and blaming the entire sector for isolated practices is unfair and dishonest. The real issue is that most producers work ethically and sustainably, understanding that preserving the environment is not just a responsibility, but a condition for their own survival.

This is where the crucial importance of **strategic communication** comes in. In a world where social networks amplify discourse and often distort facts, it is essential that we tell our own story, clearly, truthfully and directly, especially to the younger generations. **We need young people to understand that agribusiness goes far beyond producing food; it is present in their daily lives - in the clothes they wear, in the food they eat and in the jobs that support their families.**

More than just informing, we need to engage young people, bring this new generation closer together, showing that agribusiness is a modern, innovative and fundamental sector for the sustainable future of our planet. We need to speak their language, use the means of communication they master, and build a narrative that is inspiring and connects their concerns with the reality of Brazilian agribusiness. We need to show them that producers are not villains, but guardians of the land, who depend on environmental balance to continue thriving.

Building this bridge between agribusiness and young people is essential for the future. It takes courage to face the challenges and fight the distortions that surround the sector, but it is also vital to create a space where honest dialogue and exchange of ideas are possible. If we can bring young people into this conversation, we will be making sure that they are not only spectators, but active participants in building solutions that benefit both the people and the planet.

Brazilian agribusiness is more than an economic sector; it is a story of resilience and innovation, with an ongoing commitment to the land

and to the future. We NEED - and this is up to us - to communicate this truth in an authentic and inclusive way, especially to those who will shape the world of tomorrow.

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SCIENCE AND COMMUNICATION IN THE CONTEXT OF FUTURE AGRICULTURE

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In today's world, communicating science is essential to shape the Science of the Future, especially in crucial areas such as Agriculture and Climate Change. Broadening access to knowledge in a holistic and accessible way requires a significant change in mindset among knowledge generators. This is why categorizing research results is indispensable, as it facilitates more structured and comprehensive communication. Defining delivery areas that articulate technical and scientific articles, innovation, co-creation and support for public policies is fundamental to reducing the gap between technical language and broad understanding. Transforming knowledge into accessible language creates a two-way street, increasing both the dissemination and the impact of Science.

Agriculture of the Future offers solutions to challenges such as food, energy and water insecurity, amid problems such as climate change, loss of biodiversity and increased air, water and soil pollution. In this scenario, Brazilian Agriculture stands out for transforming the country from a food importer into one of the biggest global players in the sector. In a complex world, Science needs to offer society integrated solutions adapted to regional specificities, addressing issues such as agriculture, climate and biodiversity. Facing these challenges requires a systemic approach, capable of managing complexities in a sustainable, responsible and ethical way.

The roadmap of Brazilian agriculture begins with the expansion of arable areas and the transformation of acidic soils into fertile ones. The sector's competitiveness is growing with the adaptation of agriculture to the tropical climate, the development of new cultivars and the breeding of animals adapted to Brazil's five biomes. The intensification of production is advancing with technological and precision

agriculture. Today, we are experiencing yet another moment of transformation, with the tropicalization of sustainability in agriculture. As agriculture evolves, technologies and innovations are focusing on the decarbonization of production, the transition to a bio-based economy, the use of renewable energies and the adaptation to climate change. This future in motion reveals the resilience and adaptive capacity of Brazilian agriculture, preparing the sector for even greater challenges.

All of this transformation, based on science, brings concrete results for tackling climate change and biodiversity loss. Adaptation with mitigation co-benefits is an integrated approach, seeking solutions to climate challenges while helping to reduce greenhouse gas emissions. This process recognizes that adaptation actions - i.e. those aimed at reducing vulnerability to extreme weather events such as droughts, floods and heatwaves - can also generate additional benefits in terms of mitigation, which is the direct or indirect reduction of emissions.

Science, innovation and public policies are the deliverables that Embrapa generates for society. In the context of climate change, the implementation of practices and technologies that help communities and ecosystems adapt to the impacts of climate change also captures carbon or prevents the release of greenhouse gases. Research is the basis for all changes of course and technological advances. It contributes to the development of cultivars and the improvement of species resistant to extreme climatic conditions, such as drought-tolerant and pest-resistant varieties of corn and soybeans. The development of bio-inputs, which can serve as an adaptation to climate change, creates a microbiome around the roots, providing resistance to drought or excessive salinity and acting in mitigation through the transition to bio-based inputs. Climate models that predict the impact of climate change in specific areas help farmers make informed decisions about planting and crop management. Carbon sequestration technologies, such as biochar, help sequester carbon in the soil, and other technologies, such as no-till and the ABC Plan (low carbon agriculture) technologies, help mitigate emissions.

Innovation is manifested in the advancement of technologies for absorption by the production sector, such as intelligent irrigation, planting and harvesting systems, which, within precision agriculture, minimize the impact of the agricultural system. The implementation of integrated crop-livestock-forestry (ICLPF) systems promotes adaptation by creating more resilient and diverse agricultural environments, while sequestering carbon. Digital tools that offer personalized weath-

er forecasts and crop management recommendations help farmers prepare for extreme weather events.

In the context of Brazilian public policy, incentive programs such as subsidies for sustainable agricultural practices encourage farmers to adopt management practices that improve soil health and sequester carbon. The ABC+ Plan (Low Carbon Agriculture Plan) is a sustainable agricultural policy reference that combines climate change mitigation and adaptation objectives. It demonstrates that innovative agricultural practices can not only reduce emissions, but also strengthen the resilience of the agricultural sector. With six technological axes - (1) integrated systems; ICLPF (crop-livestock-forest integration) and SAF (agroforestry system); (2) no-till farming; (3) animal waste treatment; (4) planted forests; (5) BNF (biological nitrogen fixation) and bio-inputs, and (6) recovery of degraded pastures - and, transversally, the adaptation component. ZARC is a policy that advises farmers on the best planting times depending on the climate, helping to avoid losses and adapt agriculture to climate change. The Environmental Regularization Program (PRA) supports the recovery of degraded areas and encourages sustainable agricultural practices, promoting adaptation and helping to preserve biodiversity. PES policies pay rural producers who adopt environmental conservation practices, such as reforestation and the protection of water sources, helping to mitigate climate change.

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