

Article

Green Growth and Agriculture in Brazil

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Abstract: This paper addresses Green Growth and Agriculture in Brazil, analysing the National Plan for Low Carbon Emission in Agriculture (ABC Plan). The main focus is to detail the structure and actions proposed and implemented by the ABC Plan, and also to identify its economic, environmental and social effects. Using a qualitative research approach, desk research was conducted through reports, newspaper articles, and official documents from the Brazilian government and the Brazilian Agricultural Research Corporation (EMBRAPA). The outcomes indicated that the ABC Plan did not address the main components of the literature on green growth policies, such as proper training of human resources in sustainable agricultural techniques, and access to financial support for promoting the implementation of sustainable agriculture systems. The lack of participation of local institutions in the creation and implementation of the ABC Plan is also pointed out.

Keywords: sustainable; social; rural extension; ABC Plan; low carbon emission in agriculture; social upgrading; environmental upgrading



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1. Introduction

Green Growth refers to a range of policy measures for promoting growth reconciling economic, social and environmental targets [1,2]. It also comprehends a transformation of consumer behaviour, industry system and technologies [3,4], and refers to resource-efficient, clean and more resilient cultivation processes [5]. Green Growth policies could seek different goals and should be designed by a combination of instruments, such as information creation and dissemination, norms and regulation, and innovation policies [5].

Regarding green growth related to agriculture, previous studies indicate huge challenges related mainly to climate change, increasing demand for food and agricultural raw materials, use of natural resources and renewable energy [6].

For implementing green growth in agriculture, it is essential to change the perspective of environmental protection from detracting to a driver of economic growth, and also include government agencies, corporations and society. The literature highlights the importance of the participation of different stakeholders for promoting green growth. The change in the social mentality focusing on long-run objectives was also pointed, along with the adoption of indicators for analysing links between economic indicators and results in terms of environmental goals and services [3].

According to the Organisation for Economic Co-operation and Development (OECD), it is essential to elaborate on a green growth strategy for food and agriculture to coordinate actions regarding economic, environmental, and social challenges. This strategy has to encompass a long-term vision, setting measurable targets, to consider in the implementation of the involvement of distinct stakeholders, public-private partnerships, and coordination among different institutional levels [7,8]. As far as we are concerned, previous studies addressing the implementation and effects of green growth policies in emerging countries are scarce. Moreover, there are few studies that analyse green growth implementation

under the perspective of social effects and local context [9]. We, therefore, elaborated a conceptual framework based on the literature of green growth and agriculture and the concept of upgrading for analysing the structure and the effects of the National Plan for Low Carbon Emission in Agriculture (ABC Plan) established in Brazil since 2010.

The ABC Plan is part of the Brazilian Government strategy to reduce greenhouse gas emissions. Specifically, the plan comprises of implementing technologies and using low carbon agricultural practices as restoration of degraded forest areas, as well as managing natural forests and developing integrated crop-livestock-forestry systems.

A qualitative exploratory study was conducted using desk research based on reports from Brazilian institutions, as Brazilian Agricultural Research Corporation—EMBRAPA, research institutes, official documents from the Brazilian government, and newspaper articles.

The paper is structured in three sections after the introduction. A theoretical background about green growth and agriculture is provided, as well as the concept of upgrading for analysing the effects of green growth policy. In the next section, the methodology is described, followed by details of the ABC Plan. Subsequently, we present the analysis of the results and the conclusions.

2. Theoretical Background

Green Growth and Agriculture

The Green Growth concept proposes combining growth and development, considering the protection of natural assets. It also includes the purpose of providing crucial resources and environmental services for the whole society [6,7], and resource-efficient and more resilient growth [10], conducting a win-win situation in economic and environmental terms [2]. Rosenbaum, E. [2] points out the importance of determining the right measures for green growth policies. The author highlights the elaboration of qualitative and quantitative measures, and also considers the spatial dimension of the phenomenon since environmental effects are not uniform. The local context also plays an essential role in the implementation and effects of the green growth policy.

Emerging economies comprise 80% of the world's population. In the case of Latin America, the region has one of the highest inequality rates in the world, and poverty affects 25% of the population. In these terms, the OECD Report published in 2019 [7] pointed out the need for emerging countries, such as Brazil, Colombia, South Africa and Chile, to accelerate the green growth transition considering the increased pressures on their natural resources. There are indications that air pollution is increasing because of urbanisation, as well as water scarcity. Countries, such as Colombia and Mexico, managed to reduce the level of deforestation, but there are signs of increasing deforestation in Brazil. The main economic activities of emerging economies are also major sources of environmental damage, such as agriculture, oil and gas extraction, mining and forestry.

According to the Food and Agriculture Organisation (FAO), the production of food and biofuels needs to increase by 70% for addressing the global demand from the population by 2050. However, agriculture is already the major user of water in the world, accounting for 30–40% of freshwater withdrawals in the OECD countries and 70% globally. It is also a major contributor to the global emissions of greenhouse gases [11].

The literature about green growth and agriculture indicates the importance of viewing environmental protection as a driver of economic growth and a long-term perspective for measuring the outcomes [3,12]. In this sense, traditional economic factors, such as productivity, farm incomes and employment, have to change to environmental and social factors, such as natural resource use, pollution, biodiversity, food security, poverty reduction and rural development. Agriculture has the potential to offset up to 20% of the global fossil fuel emissions, and its growth could increase employment and incomes. Activities, such as organic farming [13], production of biomass for energy [14] and ecotourism, are good examples [3].

The [7] pointed out some elements that need to be addressed for an effective green growth policy. They are high-level strategic direction, which implies the participation of multiple stakeholders, accountability, resources and knowledge dissemination [7,15]. Financial and human resources are crucial for implementing green growth policies. Moreover, sharing research through data and their analysis are essential. In these terms, the rural extension to producers is crucial for increasing agricultural production on a sustainable basis [16].

There are distinct instruments for promoting agriculture Green Growth policies, such as regulations and standards, support measures, trade and economic measures. The instruments based on prices and output levels are the most environmentally harmful, according to the OECD. However, it is essential to support the instruments that foster/favour adopting production practices with broader environmental objectives, such as planting trees and changing tillage practices for mitigating climate change and flood risk. The literature also highlights the incentives on farm-services as pest and disease control and seed and soil testing [17,18]. Additionally, innovation plays a key role in promoting green growth. Innovation in engineering, biotechnology and information technology lead to reducing the use of agrochemicals, to protecting soil and water, maintaining natural habitats, reducing the quantity of non-renewable energy used in the cropping cycle, among others [7,19].

Previous studies indicated that process innovations are fundamental for reducing carbon emissions by changing from carbon-emitting fossil fuels to renewable energy, promoting energy conservation and efficiency [20,21] and bioeconomy, such as organic food cultivation, plays a special role in green growth [13]. Biber-Freudenberger, L. et al. [22] is associated bioeconomic sectors with innovations. In the case of the food and feed sector, the main innovations are organic farming, integrated pest management and ecological intensification.

In a study conducted with data from BRICS countries, the results indicate that environmental technologies could reduce carbon emissions. In this sense, it is essential to invest in research and development for developing these technologies in low-income countries [22,23].

Regarding green growth related to human being and social effects, to our knowledge, few studies are dealing with the subject. In general, these studies refer to inclusive green growth [8,24,25], effects of green growth on human beings [26], effects on the poor [12]. Inclusive green growth is related to less poverty, more equitable resource access and food security, while only green growth refers to higher productivity, more sustainable resource use and less degradation [24]. According to Schoneveld, G. et al. [27], the main social impacts are food security, income security and health and education. The main environmental indicators are agro-biodiversity, land degradation, greenhouse gas emissions, pollution, land rehabilitation, whereas the economic effects are productivity and efficiency, employment generation and market articulation.

The literature also analyses the importance of local institutions in promoting green growth. They highlight some mechanisms for promoting green growth policies, such as enhanced institutions and participation, improved public services, improved access to finance and skills and information [24]. It was also pointed out the importance of strengthening informal institutions in the context of developing countries, such as village committees and microcredit groups, along with contributing to formal organisations, such as farmer cooperatives and agricultural extension departments from local government organisations [9]. According to Vazquez-Brust and Nava-Fischer [9] in research conducted in Brazil and in India, the green growth narratives of these countries underestimate farmers' voices and the "social relations embedded in specific places and cultures" (p. 2). Consequently, the green growth policy could be a disincentive for farmers' participation.

Considering this, the main components considered in the implementation of green growth policies are detailed in Table 1.

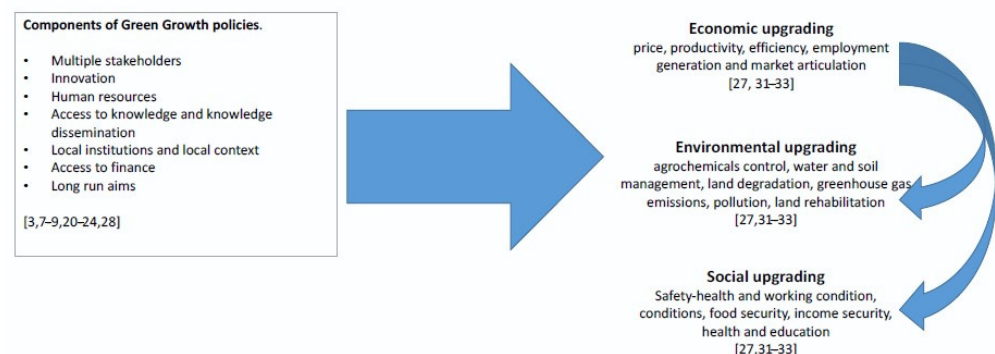
Table 1. Components of green growth policies and references.

Components	References
Multiple stakeholders and partnerships	[3,15,28]
Innovation/eco-innovation/technologies	[7,20–23]
Resources (human and financial)	[7]
Access to knowledge and knowledge dissemination	[7,24]
Local institutions and social relations embedded	[9,24]
Access to finance	[24]
Long-run aims	[3]
Different institutional levels	[7,8]

Source: elaborated by authors.

For understanding the effects of green growth policies in agriculture, we propose the concept of upgrading (economic, environmental and social) and its dimensions. Upgrading can be understood as improvements or incremental innovations. These improvements can be classified in product and process, called economic upgrading and environmental and social upgrading [29,30]. Previous studies adopted the concept of upgrading to analyse the effects of adopting voluntary sustainable certification on producers [31–33]. The main dimensions of economic upgrading are price, income, quality and productivity [32,34]. Social upgrading is usually analysed from the perspective of labour and safety issues for workers [34,35] and environmental upgrading from the perspective of agrochemicals control [36] and water and soil management [37]. The literature also highlights the relations between economic and social upgrading. Economic upgrading referring to a more efficient organisation of production could improve the work environment in terms of increasing regulated work contracts [34]. Moreover, better management of properties of coffee production involving voluntary sustainability standards could lead to environmental upgrading by a better control on the use of pesticides [31]. Therefore, the complementarities among different types of upgrading could be important to strength green growth policies.

We here propose analysing the effects of green growth policies on producers in terms of upgrading. We are most interested in the structure and implementation of green growth policy and its economic, environmental and social effects. The conceptual framework proposed is detailed in Figure 1.

**Figure 1.** Conceptual framework. Source: Elaborated by the authors.

2.1. Materials and Method

A qualitative exploratory study was conducted using desk research through reports, newspaper articles, and official documents from the Brazilian government and research institutes about the ABC Plan. The data source is detailed in Table 2.

Table 2. Data source.

Data Sources	
Reports and Documents from government institutions	Ministry of Agriculture, Livestock and Food Supply—MAPA; Brazilian government and the Brazilian Agricultural Research Corporation—EMBRAPA; The Brazilian Development Bank—BNDES Brazilian Ministry of the Environment The National Rural Learning Service—Senar Organisations for Economic Co-operation and Development (OECD); World Bank;
Reports and papers	Consultative Group on International Agricultural Research—CGIAR Natural Bureau of Economic Research Observatório ABC The Amazon Environmental Research Institute—IPAM The Nature Conservancy World Resources Institute—WRI Brasil United Nations Research Institute for Social Development
Papers from Scientific journals	Journal of Cleaner Production, Resources, AgroANALYSIS and Sustainable Development

Source: Elaborated by authors.

A conceptual framework was elaborated detailing the components of green growth policies and their effects considering the concept of upgrading. The ABC Plan is analysed from the perspective of the conceptual framework proposed. We followed the steps of some studies conducted previously, such as Marchetti L. et al. and Pólvara A. et al. [38,39].

Based on the conceptual framework, we conducted a coding process of components of green growth and different kinds of upgrading using NVivo software. These are detailed in Table 3.

Table 3. The codes of components of Green Growth policies and upgrading.

Components of Green Growth Policies (from the Literature)	Codes
Multiple stakeholders	Mult_Stak_
Innovation	In_
Human resources	Hu_Res_
Access to knowledge and knowledge dissemination	Ac_and Know_ diss_
Local institution and local context	Loc_inst Loc_cont
Access to finance	Acc_fin
Long run aims	Lon_run_out
	Price: pr_
	Productivity: prod_
	Efficiency: eff_
Economic upgrading	Employment generation: empl_gener_
	Market articulation: mar_art
	Agrochemicals control: agr_cont
	Water management: wat_man
	Soil management: so_man
Environmental upgrading	Land degradation: lan_deg
	Greenhouse gas emissions: gre_em
	Pollution: pol_
	Land rehabilitation: lan_reab
	Safety-health and working conditions: heal_work_cond
Social upgrading	food security: food_sec
	income security: inc_sec
	health and education: heal_ed

Source: elaborated by authors.

2.2. Empirical Study: The Brazilian Low Carbon Agriculture Plan (ABC Plan)

Brazil has the largest area of arable land in the world and is the first tropical country to be one of the world's leading exporters. The country is the leading producer of coffee, orange juice and sugar. It is also considered the country with the greatest biodiversity in the world with 12% of the world's species. Despite all this, Brazil has been registering high rates of deforestation and occupies the position of the fourth-largest emitter of greenhouse gases. There are indications that about 76% of the country's CO₂ emissions are caused by shifts in land and forest [40].

However, there are many alternatives for changing this scenario. For example, considering the restoration of pastures in the country, which comprises 40 million hectares of degraded pasture, would increase beef production from 30 kg/ha per year to 180 kg/ha, and decrease the pressure on expanding agriculture into the Amazon area [41,42].

At the COP15 in Copenhagen in 2009, Brazil agreed to reduce greenhouse gas emissions between 36.1% and 38.9% by 2020 (between 133.9 million and 162.9 million tons), which indicates a reduction volume around one billion tons of CO₂ [43]. The agreement was confirmed by the Brazilian Government in December 2009, with the introduction of the National Policy on Climate Change (PNMC). A year later, in December 2010, the Plan for the Consolidation of a Low Carbon Economy in Agriculture, the ABC Plan, started under the coordination of MAPA. The Plan was funded by the Brazilian Federal Government with a total budget of R\$ 3.15 billion Brazilian reais (around US\$ 1.5 billion US dollars) [44]. The scope of the Plan was national from 2010 to 2020, with revisions and updates foreseen in the period [43].

The ABC Plan aims to ensure the continuous improvement of agricultural practices that reduce greenhouse gas emissions [11] without compromising productivity and growth in the sector [45]. Besides, the Plan targets improving the efficiency of natural resources, increasing the resilience of production systems and rural communities along with promoting adaptation to climate change in the agribusiness sector. The ABC Plan also detailed the adoption of some technologies, such as degraded pasture recovery, crop-livestock-forestry integration and agroforestry systems, no-till systems, biological nitrogen fixation [46]. In addition to the technological objectives, the plan includes an operational component, which seeks solutions for its main obstacles, namely, training the main actors: The financial sector, rural extension workers and producers. In this sense, the plan also contemplates training the actors, financing research, and mainly, monitoring in carbon capturing activities, both from the financial point of view and from the efficiency point of view [11].

The quantitative targets of the ABC Plan are detailed in Table 4.

Table 4. Main targets of National Plan for Low Carbon Emission in Agriculture (ABC Plan).

Rehabilitating 15 million ha of degraded pastures
4 million ha of integrated crop-livestock-forest
8 million ha no-tillage system
Planting 3 million ha commercial trees
Treating 4.4 million cubic metres of animal waste
Training of 19,940 technicians and 935 thousand producers
Reducing greenhouse gas emissions between 133.9 million and 162.9 million tons)

Source: Elaborated by the authors based on Pólvara, A. et al., Cooper, P.J.M. et al., Ministry of the Environment, and Observatório ABC [39,44,46,47].

The financial resources destined to the Plan were planned to be delivered by special credit lines and to strengthen technical assistance, training and information, implementation of Technological Reference Units (TRU), public calls for hiring Technical Assistance and Rural Extension Services (RES). Funding for monitoring actions was also planned, such as actions regarding research and technological development, incentives for certification mechanisms and inoculants for family farmers and agrarian reform settlers [43].

The ABC Plan comprised an agricultural credit line from the Brazilian Development Bank—BNDES with 5.5% interest per year until the 2011/2012 crop year. The volume of credit made available by the ABC Plan grew year by year until 2013, rising from R\$ 2 billion in 2010, when it was implemented, to R\$ 3.4 billion in the 2012/2013 harvest, with an interest rate of 5% per year in that last period.

According to IPAM [48] five projects received contracts worth U\$ 1.7 million in the first year of the project implementation, from 2010 to 2011. From 2011 to 2012, it rose to US\$ 251 million. From 2015 to 2016, the amount loaned decreased to almost 50%. According to Newton, P. et al. [49], this reduction could be explained by the increase in the general credit interest rate (from an average of 5–5.5% to 8–8.5%). Additionally, there was the availability of other credit lines with lower rates and with the same focus.

For meeting the objectives established in the ABC Plan, it is essential to analyse the economic viability of projects under environmental principles. Both credit and financing must be linked to a production system or to a technology aiming to reduce greenhouse gas emissions and also promoting more efficiency in agricultural and livestock production systems [45]. Hence, the BNDES, the MAPA, the Brazilian Agricultural Research Corporation—Embrapa, the Brazilian Federation of Banks—Febraban, the Febraban Education Institute—INFI, the Brazilian Association of Financial Development Institutions—ABDE, and the Brazilian Agriculture and Livestock Confederation (CNA), through the National Rural Learning Service (SENAR), signed an agreement for technical cooperation to make low carbon agriculture projects feasible [50].

The main objective was to promote the creation of roadmaps for preparing technical projects with the technologies supported by the programme. It was also essential to train professionals from the financial agencies and rural technicians for supporting farmers in the adoption of such technologies.

The BNDES coordinated the actions made available to the accredited financial agents, the resources required for contracting the operations, respecting the budgetary schedule, subject to the determinations of the National Monetary Council (CMN). The resources from the BNDES were distributed through accredited banks, such as Bank of Brasil, which has contractual relationships with farmers and receives administrative fees [51].

MAPA was responsible for coordinating the technical support and promotion of events [50]. The Embrapa was responsible for training professionals indicated by the SENAR as “multipliers” (multiplicadores in Portuguese) of knowledge regarding technologies supported by the ABC Programme.

In December 2020, the ABC Plan completed the first decade since its regulation. There are indications of lacking investments in training technicians, extension workers, project developers and rural credit operators to work and to take the technology to the rural producers, essential for contracting financial support from the ABC Programme [16]. According to the Brazilian Ministry of Environment from 2010 to 2018, there was a reduction of greenhouse gas emissions between 100.21 million to 154.38 million tons of CO₂.

In the 2012/2013 agricultural year, about 2800 contracts for pasture recovery and crop-livestock integration were executed, actions recognised as having the greatest mitigation potential in the plan. However, for the total implementation of the plan, 78 hundred contracts for cattle producers were estimated by 2020. [11].

Regional imbalances in financing and the number of contracts signed by the ABC programme were also identified. Until January 2013, the North of Brazil accounted for 4% of the total programme expenses and 3.9% of the contracts. The Northeast, 5.1% of disbursement and 4.5% of contracts. In turn, the Southeast (45.7% of total expenses and 46% of contracts) and the South (22.9% of expenses and 29.6% of the contracts) had the largest share of the programme, although they have relatively fewer efficiency problems and more agricultural technology than other regions. The Centre-West region, the main pole of agricultural expansion in Brazil, presented a relatively low performance in ABC. The region only had 16% of the contracts signed [11]. In a survey conducted with farmers

in the Centre-West of Brazil, the results indicated that the use of credit lines from the ABC Plan by local farmers was limited [52].

Another factor of regional imbalance was the lack of dialogue of state climate change policies with ABC. According to Pereira O.J.R, et al. [11] from 25 states with their climate change plans, only six of them encouraged good practices in agriculture as a palliative strategy. Furthermore, there are indications of the lack of technicians capable of training farmers and cattle producers in low-carbon technologies, especially in the North and in the Northeast regions [11,45].

More than four million hectares of degraded pastures were recovered until 2018, and at least another seven million were managed with different sources of financing or the producers' resources, reaching close to the goal of 15 million. Concerning waste treatment, the programme reached 40 million m³ of treated animal waste, against the targeted 4.4 million. By 2017, nitrogen fixation reached 10 million hectares, compared to the targeted 5.5 million. Direct planting, which aimed to reach 8 million hectares, reached approximately 13 million, exceeding the target. The adoption of crop-livestock-forestry integration reached 6 million hectares, exceeding the goal by 2 million [16].

According to Lopes, D., & Lowery [51] in a study conducted about rural credit, the main obstacles to promote Sustainable Agriculture in Brazil are: The lack of familiarity of farmers with sustainable practices; the fact that banks and extension services are not well prepared for supporting producers in sustainable practices; lack of well-trained professionals in banks to support credit analysis to producers; the number of credit lines destined to technical assistance is insufficient; bureaucratic problems for accessing credit lines of sustainable agriculture; strict requirements of sustainability credit lines, and most of the credits are not for investment, but working capital. For promoting sustainable agriculture, it is essential to invest in durable goods, and it requires long-term changes in the production system.

Regarding financial resources, there are indications that BNDES established strict requirements for financing sustainable agriculture, while the Bank of Brazil was more successful in financing sustainable agriculture with its resources [53]. The BNDES accounts for most of the resources destined to the ABC Plan. However, until 2013, only 14% of the projects are executed by the BNDES against 86% performed by Bank of Brazil [45]. There is also an absence of monitoring programmes to access the results of the ABC Plan implementation [45]. In 2016, the ABC Platform was launched, located in the Embrapa unit called Environment, to develop tools and methodologies for monitoring and accounting for the mitigation of CO₂ emissions [54,55]. The assessment proposed by MAPA, EMBRAPA and ABC (Observatório ABC—Centre for Sustainability Studies of Sao Paulo Business Administration School at Getulio Vargas Foundation (FGVces/EAESP-FGV)) Observatory researchers is based on data collected through pictures from georeferencing, information collected from producers and data sample from production areas. However, it is not mentioned in the proposal collection of social data for analysing the effects of the ABC Plan is mentioned, or even trade-offs among economic, environmental and social effects.

2.3. Discussion

This section is based on the conceptual framework detailed previously and codes defined in Table 3. The objective is to demonstrate the main components of the ABC Plan according to the literature and to establish relations between components and upgrading.

The ABC Plan was created and implemented by different institutions, such as MAPA, BNDES, Banco do Brasil, Embrapa, Febraban, INFI, ABDE, CNA and SENAR. The BNDES actions are more at the macro level, which leads to less adherence to local contexts. Previous studies indicated that Banco do Brasil, which has many units spread throughout Brazil, financed more projects than BNDES [48]. Hence, despite all the institutions (Mult_Stak) involved in the creation and implementation of the ABC Plan, it lacks institutions more involved in the local context. The literature highlights the importance of multiple stakehold-

ers for promoting an effective green growth policy, as stated by Capozza, I. and Samson, R. and Pancino, B. et al. [7,15].

Evidence also pointed out that the North, Northeast and Centre-West regions received fewer resources, mainly financial, from the ABC Plan as compared to the Southeast of Brazil. Besides, there is no mention of the participation of cooperatives and associations of local producers in the creation and implementation of the ABC Plan, as mentioned by Berkhout et al. [24] and Vazquez-Brust and Nava-Fisher [9]. One of the weak points of the ABC Plan is, thus, access to the local context and regions, such as the North and the Northeast of Brazil, where infrastructure, human and financial resources are scarcer. The green growth literature emphasises the importance of financial and human resources in policy implementation, as stated by Capozza, I. and Samson, R. [7]. It also highlights the essential role played by informal institutions in developing countries for the success of policy implementation [9].

Considering the component of green growth police *Mult_Stak_*, there are indications that local institutions are not involved in the elaborations and implementation of the ABC Plan. The components *Mult_Stak*, *Loc_inst* and *Loc_cont* are closely related. The ABC Plan was created for the whole of Brazil, that comprehends distinct local contexts. In these matters, the component *Loc_inst* and *Loc_cont* play a special role considering the size of Brazil.

In terms of elaboration, the plan had the participation of multiple stakeholders. However, considering the size of Brazil, it lacks the consideration of local context features. The other components highlight in the outcomes is *Hu_Res_* and *Ac_and Know_diss*. The financing and number of contracts signed by the ABC Plan are very low in some regions of Brazil as North, Northeast and Centre-West. The Centre-West region is the main pole of agriculture expansion.

In terms of innovation, the ABC Plan focused on some technologies, related to environmental upgradings, such as degraded pasture recovery, crop-livestock-forestry integration and agroforestry systems, no-tillage systems, biological nitrogen fixation. However, it was not identified any initiative related to organic production, as stated by Reference [22]. Furthermore, it was not possible to identify any dimension of environmental upgrading identified in the literature (see Table 3).

Despite the lack of a monitoring tool, there is some evidence of environmental upgrading considering adopting these technologies. All practices affect distinct dimensions of environmental upgrading as *gre_em*, *pol_*, *lan_reab*, *agr_cont*, *wat_man* and *so_man*. However, there is a lack of monitoring tool for analysing the results reached by the ABC Plan. In this case, there are some results related to adopting technologies as detailed in Figure 2 that we considered as environmental upgrading. There are indications that the ABC Plan reduced greenhouse gas emissions between 100.21 million to 154.38 million tons of CO₂.

According to Ministry of the Environment [46], the targets of the ABC Plan were reached in the integrated crop-livestock-forest, no-till system and animal waste. The targets of the ABC Plan, sustainable technologies adopted, and results are detailed in Table 5. However, as far as we are concerned, there is no mention of social upgrading. The only effect proper measured is related to land rehabilitation (*lan_reab*) that refers to the rehabilitation of degraded pastures. The target is to rehabilitate 15 million ha of degraded pastures. To 2018, only 30% of degraded pastures were rehabilitated.

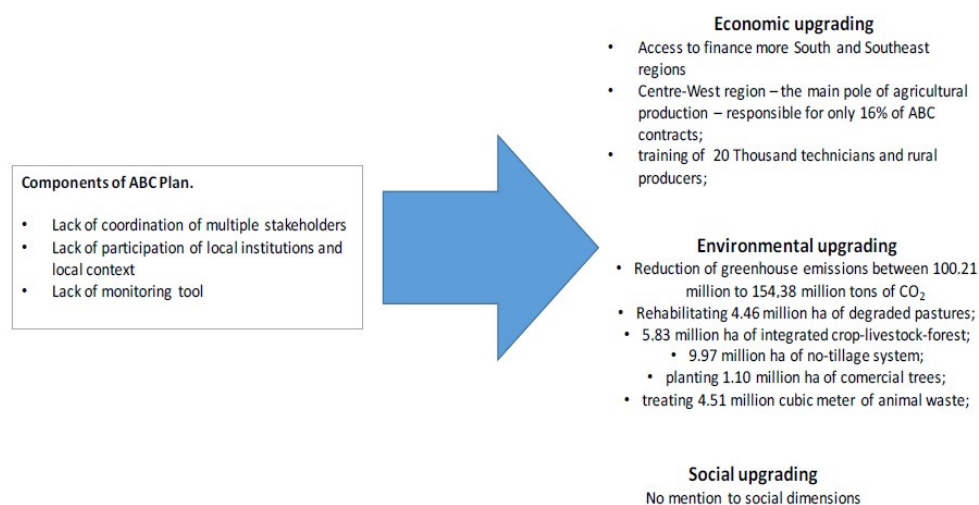


Figure 2. Components of the ABC Plan and upgrading. Source: Elaborated by authors.

Table 5. ABC Plan targets, sustainable technologies adopted and results.

ABC Plan Targets	Technologies Adopted
4 million ha of integrated crop-livestock-forest	5.83 million ha (to 2018)
8 million ha no-tillage system	9.97 million ha (to 2018)
Planting 3 million ha commercial trees	1.10 million ha (to 2018)
Treating 4.4 million cubic metres of animal waste	4.51 million of animal waste (to 2018)

Source: Elaborated by the authors based on CGIAR, Ministry of the Environment, and Observatório ABC [41,46,47].

The evidence also suggested the lack of rural extension expertise in sustainable techniques. As stated by Honigmann, S. [16], rural extension is essential to increase sustainable agricultural production.

Despite the importance of innovation in the implementation of green growth policies, the financial support promoted by ABC Plan does not incentivise novel initiatives for promoting sustainable agricultural systems, as organic farming and production of biomass for energy as argued by Grubor, A. et al. and Rodino, S. et al. [13,14].

Taking the different dimensions of each upgrading considered by the literature, it was not possible to identify these dimensions as effects of the ABC Plan. For now, the ABC Plan indicates some outcomes mainly related to the adoption of sustainable technologies, which could be related to environmental upgrading. There is also some evidence of economic upgrading if we considered the volume of financial support and training conceded by the ABC Plan in distinct regions of Brazil.

Considering this, the conceptual framework proposed previously, as detailed below with the components of the ABC Plan and its effects in terms of upgrading.

2.4. Conclusions

The objective of this paper was to detail the structure and actions proposed and implemented by the ABC Plan from the perspective of the literature of Green Growth and upgrading. We conducted desk research through research reports, newspaper articles, and official documents from the Brazilian government.

The results indicated that the ABC Plan reached good results mainly in terms of adoption of sustainable technologies as integrated crop-livestock-forest, tillage-system, and treatment of animal waste. In terms of environmental upgrading, there are two outcomes: The first one refers to greenhouse emissions and the second to land degradation. In both dimensions, there are indications of positive effects. However, in the case of land degradation, which was measured by the number of degraded pastures rehabilitated, only

30% of the target was reached. These two dimensions of environmental upgrading raised from the desk research about the ABC Plan. Institutions such as EMBRAPA, indicated the lack of a monitoring tool for measuring the results of the Plan. The Company is already developing an instrument, but it is not concluded yet.

In addition to this, the results suggested the participation of multiple stakeholders, despite the absence of local institutions in the creation and implementation of the Plan. Furthermore, the obstacles for transferring knowledge to producers, mainly in the North, Northeast and Centre-West of Brazil, were highlighted, and lack of financial support for implementing sustainable practices. There are, thus, missing links between policies aims and implementation, mainly related to the rural extension to producers.

The results indicated that the ABC Plan did not address the main components of the literature of green growth policies, such as proper training of human resources in sustainable agricultural techniques, and full access to financial support for promoting the implementation of sustainable agriculture systems. There is an evident lack of participation of local institutions in the creation and implementation of the Plan. The literature pointed out the importance of addressing the challenges of local contexts and the participation of local institutions, as cooperatives of producers and even informal institutions, for promoting green growth policies in developing countries.

The outcomes have theoretical and practical implications. Theoretically, the paper sheds some light on the analysis of green growth policies and their effects in terms of upgrading. It also indicates the importance of establishing clear targets considering the trade-offs among different levels of upgrading.

As managerial implications, the outcomes could indicate the importance of addressing local context demands, which is made evident in case of poor participation of the Centre-West, North and Northeast of Brazil in the contracts established by the ABC Plan.

The main limitations faced in this study were the difficulties in contacting representatives from the multiple stakeholders involved in the ABC Plan, mainly from the government, for conducting interviews. We also recognise that 2020 was the final year of the implementation of the ABC Plan, and because of all the disruption caused by the Covid-19 pandemic, it would be a challenge to have primary data about the ABC Plan results.

As future studies, we suggest conducting in-depth interviews with representatives of the multiple stakeholders involved in the creation and implementation of the ABC Plan. Moreover, it would be interesting to focus on stakeholders from the Centre-West, North and Northeast of Brazil to analyse the main obstacles for producers to engage in the ABC Plan and how to overcome these barriers.

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