Sustainable financing of Brazilian farming: the role that supply chains can play and carbon markets probably will not

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EXECUTIVE SUMMARY

Climate change raises unprecedented risks to all economic sectors, including farming, which is needed to produce food for a growing population. Financing farmers to be more sustainable and resilient is crucial to climate change mitigation and food security. This report analyzes the role of carbon markets (offsetting) and supply chains (insetting) as sustainable finance tools for agriculture.

The **goal** is to provide information and recommendations to the Brazilian farming sector regarding the increased risks, uncertainties, and complexity of accessing sustainable finances.

The **methodology** consisted of revising updated literature and news from national and international sources, attending seminars and conferences in Brazil and abroad, and meeting with players working and influencing the sector, such as government representatives. Brazil, New Zealand, Australia, the United Kingdom, France, Portugal, Indonesia, Japan and Italy (Word Food Forum at FAO in Rome) were the countries visited. The report is divided into three sections, in addition to the introduction.

The **first section discusses the relationship between climate change and the farming sector**: 1. Farming depends on the weather and is directly exposed to climate impacts, needing to adapt to reduce losses, as some real cases from the viticulture industry show. 2. Even if the agricultural industry is far from being the primary cause of GHG global emissions, in some countries, including in Brazil, it is after deforestation[i]. This raises the pressure and requirements to access markets and financing. 3. Farmers that implement sustainable/regenerative practices to mitigate their emissions and increase their resilience to climate change also increase their capability to sequester carbon. Therefore, agriculture is considered one of the solutions to climate mitigation. However, mitigation and adaptation must be shaped to the geography, soil, climate, and business model. In addition, it is a complex task for farmers, who deal with economic risks, market uncertainties, and barriers, including financing, technical assistance, access to technology, and human resources.

The **second section, the issue of this report, focuses on mechanisms to overcome financial barriers** to **transition to a more sustainable and resilient agriculture.** It analyzes to what extent carbon markets can be tools to finance farming and what are other alternatives, including supply chains. The section introduces carbon market concepts and brings information from other countries where carbon programs are already available for farmers. **Could carbon programs from other countries be benchmarks for Brazil and scaled up here? What is the ability of supply chains to drive behaviors?** The current context in countries where farmers already have options to engage in voluntary carbon programs is that the path between them and their financial compensation is rarely clear on their costs and benefits (it is even considered a "jungle" or "chaos")[ii]. They are very context-specific, and they have yet to scale up. There are still substantial barriers, such as technical, methodological, and market with slow development and low prices, to making these financial tools accessible to farmers and scalable in a way that delivers a real, sustainable financing option to them while robust climate mitigation. In addition, they are not costless or riskless to farmers who must carefully analyze carbon contracts before signing up.

Therefore, carbon markets will likely be limited in financing agriculture abroad and in Brazil. Insetting (companies investing in carbon reduction projects within their supply chain) is

considered "doing more good rather than doing less bad" in comparison to offsetting (World Economic Forum)[iii]. In the food sector, Scope 3 emissions account for more than 90% of total emissions on average, which shows the critical role supply chains can play in agriculture decarbonization. Still, policymakers and investors must understand farmers' and the sector's challenges (advocacy is necessary).

Agri-food companies must be engaged and be more transparent in measuring and publicizing the outcomes of adopting sustainable practices and toward farmers' payments. As one example showed, promising a premium price one year, then reducing it by half the following year, or even stopping buying from farmers who are not ready, will not support farming livelihoods, one of the outcome-based principles of regenerative agriculture, especially in the case of smallholder farmers. De-risking farmers through developing and scaling up mechanisms that include financial support (if not carbon markets, others) is essential for more sustainable, resilient agriculture and food security.

That said, the main **recommendations** for the Brazilian farming sector are:

- Farmers must continue adapting to climate change and transitional risks (with or without carbon payments).
- Focus on better practices that can contribute to soil health and carbon sequestration to foster productivity, cost reduction, and resilience in the first place, adapting to risks.
- If you have additional vegetation on your land, analyze it carefully before clearing it (the environmental role it may play in your business, market access – such as European Union restrictions and companies not buying soybean from deforested areas in the Amazon and the Cerrados, financial incentives, etc.).
- Ask for advice from other farmers, associations, and technical assistants. Each context is different and demands solutions and practices shaped for the climate, soil, market, and type of business. Practices to be adopted depend on that.
- Evaluate and monitor your business's climate and transitional risks, plan to mitigate and reduce your vulnerabilities, and increase your resilience. The challenge is also to lose less in difficult moments.
- Be attentive to rules and market demands. Get closer to your buyers/consumers to define the next steps. In many cases, the reward will be market access.
- Refrain from trusting solutions that seem easy and demand a lot of money. Access to carbon markets is complex and can be costly and risky. Read contracts carefully before signing.
- Choices also depend on the farm business's internal environment, whether you want to be an early adopter, take risks, etc.
- Early adopters should be rewarded and be included in the efforts of decarbonizing the sector. However, carbon markets may not be the best option because of the additionality needed to offset credits.
- If you have the means to do your carbon balance, it will help you to have indicators to manage your business better. Depending on your buyers and legislation, it can become an obligation, along with traceability.
- Be attentive to potential opportunities, including from supply chains and financial institutions. But take your time with doing a proper analysis.
- Scaling the carbon market and other opportunities will require resources and capacity. Cooperatives and farmers' associations have an essential role to play concerning the capacity building of farmers to navigate this scenario of increased risks and potential opportunities, including those related to supply chains.

- Farmers' voices have often been neglected in these transition discussions. Advocacy is critical to be at the table of negotiations to bring the perspective of agriculture as a solution and the most vulnerable sector with direct impacts on food security, including in international negotiations, legislation, and financing.
- Suppose the agriculture sector is included in the Brazilian Compliance Carbon Market. In that case, it can become an additional expense for the industry and a risk depending on its law and function. The sector needs more sustainable incentives, including reduced interest rates for adopting sustainable and resilient practices and no other costs.
- Nevertheless, everything is open at the moment and is evolving. Disruptions can occur and change the access to carbon markets in the future, making it more accessible. But the sector needs to be active and not reactive, having a place on the table of negotiations.

SUMÁRIO EXECUTIVO

As alterações climáticas levantam riscos sem precedentes para todos os sectores econômicos, incluindo a agricultura, necessária para produzir alimentos para uma população crescente. Financiar os agricultores para que sejam mais sustentáveis e resilientes é crucial para a mitigação das alterações climáticas e a segurança alimentar. Este relatório analisa o papel dos mercados de carbono e das cadeias de abastecimento como ferramentas de financiamento sustentável para a agricultura.

O **objetivo** é fornecer informações e recomendações ao setor agropecuário brasileiro sobre o aumento dos riscos, incertezas e complexidade do acesso a finanças sustentáveis.

A **metodologia** consistiu na revisão de literatura atualizada e notícias de fontes nacionais e internacionais, participação em seminários e conferências no Brasil e no exterior, e encontros com atores que atuam e influenciam o setor, como representantes governamentais. Brasil, Nova Zelândia, Austrália, Reino Unido, França, Portugal, Indonésia, Japão e Itália (Word Food Fórum na FAO em Roma) foram os países visitados. O relatório está dividido em três seções, além da introdução.

A **primeira parte discute a relação entre as alterações climáticas e o setor agrícola**: 1. A agricultura depende das condições meteorológicas e está diretamente exposta aos impactos climáticos, necessitando de adaptação para reduzir perdas, como mostram alguns casos reais da indústria vinícola visitados. 2. Mesmo que a indústria agrícola esteja longe de ser a principal causa das emissões globais de GEE, em alguns países, inclusive no Brasil, ela é depois do desmatamento. Isto aumenta a pressão e os requisitos de acesso aos mercados e ao financiamento. 3. Os agricultores que implementam práticas sustentáveis/regenerativas para mitigar as suas emissões e aumentar a sua resiliência às alterações climáticas também aumentam a sua capacidade de sequestrar carbono. Portanto, a agricultura é considerada uma das soluções para a mitigação climática. Contudo, a mitigação e a adaptação devem ser moldadas à geografia, ao solo, ao clima e ao modelo de negócio. Além disso, é uma tarefa complexa para os agricultores, que lidam com riscos econômicos, incertezas de mercado e barreiras, incluindo financiamento, assistência técnica, acesso à tecnologia e recursos humanos.

A **segunda secção, o tema deste relatório, centra-se nos mecanismos para superar as barreiras financeiras na transição para uma agricultura mais sustentável e resiliente**. Analisa até que ponto os mercados de carbono podem ser ferramentas para financiar a agricultura e quais são outras alternativas, incluindo as cadeias de abastecimento. A seção apresenta conceitos de mercado de carbono e traz informações de outros países onde programas de carbono já estão disponíveis para agricultores. **Os programas de carbono de outros países poderiam ser referência para o Brasil e ampliados aqui? Qual é a capacidade das cadeias de abastecimento para impulsionar a implantação de práticas sustentáveis?** O contexto atual em países onde os agricultores já têm opções de programas voluntários de carbono é que o caminho entre eles e a sua compensação financeira raramente é claro quanto aos seus custos e benefícios (é até considerado uma "selva" ou "caos"). Eles são muito específicos o contexto e ainda precisam ser ampliados. Ainda existem barreiras substanciais, tais como técnicas, metodológicas e de mercado com desenvolvimento lento e preços baixos, para tornar estas ferramentas financeiras acessíveis aos agricultores e escaláveis de uma forma que lhes proporcione uma opção de financiamento real e sustentável, enquanto fornecem uma mitigação

climática robusta. Além disso, não são isentos de custos nem de riscos para os agricultores, que devem analisar cuidadosamente os contratos de carbono antes de assiná-los.

Portanto, os mercados de carbono provavelmente serão limitados no financiamento da agricultura no exterior e no Brasil. Pagamentos diferenciados através das empresas que investem em projetos de redução de carbono na sua cadeia de abastecimento são considerados "fazer mais bem em vez de fazer menos mal" em comparação com os mercados de carbono para compensação (Fórum Económico Mundial) . No setor alimentar, as emissões de escopo 3 representam, em média, mais de 90% do total de emissões, o que mostra o papel crítico que as cadeias de abastecimento podem desempenhar na descarbonização da agricultura. Ainda assim, os decisores políticos e os investidores devem compreender os desafios dos agricultores e do setor (a defesa do setor se faz necessária).

As empresas agroalimentares devem estar envolvidas e ser mais transparentes na medição e divulgação dos resultados da adoção de práticas sustentáveis e dos pagamentos aos agricultores. Como mostrou um exemplo, prometer um preço premium num ano e depois reduzi-lo para metade no ano seguinte, ou mesmo parar de comprar de agricultores que não estão preparados, não apoiará os meios de existência agrícolas, um dos princípios da agricultura regenerativa baseados em resultados, especialmente no caso dos pequenos agricultores. Reduzir os riscos dos agricultores através do desenvolvimento e ampliação de mecanismos que incluam apoio financeiro (se não mercados de carbono, outros) é essencial para uma agricultura mais sustentável e resiliente, e segurança alimentar.

Dito isso, as **principais recomendações para o setor agropecuário brasileiro são**:
- Os agricultores devem continuar a se adaptar às alterações climáticas e aos riscos de transição (com ou sem pagamentos de carbono).
- É preciso concentrar-se em melhores práticas que possam contribuir para a saúde do solo e o sequestro de carbono para promover a produtividade, a redução de custos e a resiliência em primeiro lugar, adaptando-se aos riscos.
- Se a propriedade tiver vegetação adicional em sua terra, será preciso analisar cuidadosamente antes de desmatá-la (o papel ambiental que ela pode desempenhar no seu negócio, acesso ao mercado – como restrições da União Europeia e empresas que não compram soja de áreas desmatadas na Amazônia e nos Cerrados, incentivos financeiros, etc.).
- Como agricultor e pecuarista, peça conselhos a outros produtores, associações e assistentes técnicos. Cada contexto é diferente e exige soluções e práticas moldadas ao clima, ao solo, ao mercado e ao tipo de negócio. As práticas a serem adotadas devem considerar isto.
- Também avalie e monitore os riscos climáticos e transitórios do seu negócio, planeje como mitigar e reduzir as suas vulnerabilidades e aumente a sua resiliência. O desafio também é perder menos nos momentos difíceis.
- Esteja atento às regras e exigências do mercado, aproximando-se dos compradores/consumidores para determinar os próximos passos. Em muitos casos, a recompensa será o acesso ao mercado.
- Evite confiar em soluções que parecem fáceis e exigem muito dinheiro. O acesso aos mercados de carbono é complexo e pode ser dispendioso e arriscado. Leia atentamente os contratos antes de assiná-los.
- As escolhas também dependem do ambiente interno da empresa agrícola, se deseja ser um dos primeiros a adotar, assumir riscos, etc.
- Os primeiros a terem adotado ou a adotarem práticas e tecnologias sustentáveis deveriam ser recompensados e incluídos nos esforços de descarbonização do sector. Contudo, os mercados

de carbono podem não ser a melhor opção devido à adicionalidade necessária para compensar os créditos.
- Se o negócio rural possuir meios para fazer seu balanço de carbono, este ajudará a ter indicadores para gerenciar melhor o negócio. Dependendo dos compradores e da legislação, pode tornar-se uma obrigação, juntamente com a rastreabilidade.
- Esteja atento às oportunidades potenciais, inclusive das cadeias de abastecimento e das instituições financeiras. Mas não tenha pressa em fazer uma análise adequada.
- A expansão do mercado de carbono e de outras oportunidades exigirá recursos e capacidade. As cooperativas e as associações de agricultores têm um papel essencial a desempenhar no que diz respeito à capacitação dos agricultores para navegar neste cenário de riscos aumentados e oportunidades potenciais, incluindo aqueles relacionados com as cadeias de abastecimento.
- As vozes dos agricultores têm sido frequentemente negligenciadas nestas discussões de transição. A advocacia é fundamental para estar na mesa das negociações para trazer a perspectiva da agricultura como uma solução, além de o setor ser o mais vulnerável com impactos diretos na segurança alimentar, incluindo nas negociações internacionais, legislação e financiamento.
- Incluir a produção primária no Mercado Regulado de Carbono Brasileiro pode trazer custos adicionais e riscos, principalmente dependendo da sua legislação e funcionamento. O sector precisa de mais incentivos sustentáveis, incluindo taxas de juro reduzidas para a adoção de práticas sustentáveis e resilientes, não de outros custos.
- No entanto, tudo está em aberto neste momento e em evolução. Disrupções podem tornar o mercado de carbono mais acessível para os produtores. Mas o setor precisa ser ativo e não reativo, tendo um lugar na mesa das negociações.

1. INTRODUCTION

Carbon markets (offsetting) and supply chains (insetting) are tools to be used alongside other policies to finance economies' decarbonization and encourage climate action to preserve the natural capital as risks of climate change become more intense, long, and frequent. According to the Intergovernmental Panel on Climate Change (IPCC), the body of the United Nations for assessing the science related to climate change, the planet is warming in an unprecedented way, and each additional augmentation of temperature increases the chances of drastic weather events. Indeed, farmers from France to Australia are saying that they have already suffered the consequences of climate change due to more frequent extreme weather in the last five years.

The Paris Agreement aims to limit global average temperature to less than 2°C above pre-industrial levels and pursue efforts to limit the increase to 1.5°C. The international community must continue removing carbon from the atmosphere and reduce net greenhouse gas (GHG) emissions in the short term. Suppose effective policies continue not to be implemented globally. In that case, the average temperature at the top of the troposphere, which has already increased by 1.1°C, should reach the limit of 1.5°C ten years earlier than expected, already in 2030. According to the United Nations, the current path will lead to a 2.6°C increase in 2100.

In this scenario demanding mitigation and adaptation efforts in all sectors, agriculture has the potential to be part of the solution to climate change through carbon farming, which refers to reducing GHG emissions and/or sequestering and storing carbon in plants and soil at the farm level. Governments, the private sector, and farmers are more interested in carbon farming and/or carbon farming payment initiatives.

The initial goal of this study was to understand the existing models of initiatives paying carbon credits to farmers abroad to analyze if they could be adapted and scaled up in Brazil as a new option for financing sustainable and resilient agriculture in the country. They are very context-specific, and they have yet to scale up. There are still essential barriers (technical, methodological, market, prices) to making these financial tools accessible to farmers and scalable in a way that delivers a real, sustainable financing option to them while robust climate mitigation. In addition, they are not costless or riskless to farmers who must carefully analyze carbon contracts before signing up.

That said, this report goes one step back, intending to provide essential information and recommendations to the Brazilian farming sector to navigate in a context of increased risks linked to climate change (transition risks included), and where the access to sustainable financing for mitigation and adaptation is complex. The methodology consists of revising updated literature and news from national and international sources, attending seminars and conferences in Brazil and abroad, and meeting with actors working in the sector and/or influencing the industry, such as government representatives. Brazil, New Zealand, Australia, the United Kingdom, France, Portugal, Indonesia, Japan, and Italy were the countries visited. The report is divided into three sections, in addition to this introduction, as follows:

- The first section discusses the relationship between climate change and farming, pointing out the importance of adaptation to climate change and transition risks;
- The second section analyzes to what extent carbon markets can be tools to finance carbon farming and what are the alternatives, including supply chains.
- The last section delivers conclusions with recommendations for the agriculture sector in this context.

Vineyards in the Hunther Valley, Australia

2. CLIMATE CHANGE AND THE FARMING SECTOR: RISKS, MITIGATION, AND ADAPTATION

The farming sector, which has the challenge of producing food for a growing population[1], plays different roles regarding climate change: 1) It depends on the weather. It is directly exposed to climate impacts, needing adaptation to reduce losses. 2) The agricultural sector emits GHG, raising the pressure and requirements to reduce emissions to access markets and financing. 3) Finally, while farmers implement sustainable/regenerative practices to mitigate their emissions and increase their resilience to climate change, they also increase their capability to sequester carbon. Therefore, agriculture is considered one of the solutions to climate change.

2.1. Climate change impacts on farming

The climate change impacts on farming will depend on the rise of the temperature and the water sources available (consequently), and it will not be the same throughout the globe (Annex 1). Climate modeling draws a rise in favorable areas for farming towards the north and in altitude[iv]. This is already happening. According to Sylvain Hypolite (R&D Director at Agro D'OC - France), for example, in the Occitane region in France, warmer temperatures have advanced in 10 days of the plantation period, resulting in the possibility of double crops with irrigation[2].

In tropical Brazil, the trend is a rise in temperatures all over the country, a decline in rainfall and soil moisture in the North and Northern regions, and an increase in the South and Southeast regions. In the Cerrado biome essential for Brazilian grains production, the expected trend is that it will be drier (with precipitation projections decreasing from 20% to 70% depending on the location), with an average rise in temperature of around 4oC: up to 6oC in the transition region with the Amazon and around 2oC in the eastern part of the Cerrado[v].

1 According to FAO, food production globally will need to increase by over 50% by 2050 to meet the world's projected population of 9.8 billion.

2 However, environmental constraints to increase irrigation are a barrier to developing the irrigated area needed for double crops in the region.

Nevertheless, farmers in the caatinga biome are the country's most vulnerable to climate risks. Caatinga, where 36% of rural properties are located, has historically the lowest productivity in the country. The predominance is of smallholder farmers needing more tools to adapt to climate change.

Due to global warming, more frequent and longer extreme climate events have already impacted soil health, water resources, productivity, production quality, and rentability[3]. In the USA, for example, citrus growers in Florida lost 50–90% of crops due to high winds and rain in 2022[vi], and corn, the largest crop in the country, has been losing revenue of around 720 million dollars a year due to extreme heat, which should rise to 1.3 billion dollars in 2030[vii]. In Australia, the average farm profits of farmers declined by 22.6% under the recent climate scenario relative to historical climatic conditions[viii]. In Brazil, a severe drought in the south caused a US$ 4.3 billion loss last year. It is estimated that losses in agriculture have reached almost R$ 300 billion (~US$ 60 billion) in the country[ix].

Reinsurers also had record costs in agriculture in Brazil: 18 times in the first half of 2022 compared to the first half of 2021[x]. As a result, the insurance prices are already passed on to producers[xi]. Or, even worse, they are leaving the sector, like in California. In other cases, they are not even covered by insurance (such as the case of permanent fruit tree crops in Australia or Brazil, for example). Indeed, 80% of the rural properties in Brazil do not have insurance[xii].

2.2. The participation of agriculture in GHG emissions

Agriculture is far from the leading cause of global warming, with 12.72% of total emissions in 2020 - burning fossil fuels with ⅔ of total global GHG emissions is. Still, in some countries, agriculture can be a significant emitter. In New Zealand, for example, the agriculture sector represents over 50% of the country's GHG emissions because of etheric fermentation. Methane has an atmospheric warming potential 28 times greater than CO2, and enteric fermentation represents almost 50% of agriculture emissions worldwide (Annex 2). Applying synthetic fertilizers (nitrous oxide being 265 more harmful to global warming than CO2) responds to 9.4% of worldwide GHG emissions in agriculture.

Concerning emissions from agriculture in Brazil, almost 70% come from enteric fermentation (Annex 3), and 30% from agricultural soils such as manure left on pasture, nitrogen fertilizers, soil preparation operations, and crop residues. Agriculture responds to 27% of Brazil's emissions but is also a primary driver of deforestation. Land use change represents almost 50% of the country's GHG emissions (90% is illegal deforestation). According to an article published in Sciences magazine[xiii], agricultural expansion was estimated to be responsible for at least 90% of deforested land in the tropics from 2011 to 2015. Still, only about half was converted into productive agricultural land. According to the authors, links between agriculture and forest loss are complex as data availability and trends vary across regions.

Brazil has around 33% of the world's forests in its territory, with over 60% of it covered by native vegetation and 20% of it inside farms (Annex 4)[xiv] as farmers must preserve native vegetation by law (Forest Code)[4]. According to MAPA BIOMAS[xv],

[3] "The Food and Agriculture Organization estimates that yields of maize, wheat, and soybeans could decrease between 20 to 45%, 5 to 50%, and 30 to 60%, respectively, by 2100" (Vos & Cattaneo, 2016 in Sierra View Solutions and American Farmland Trust, 2023).

[4] The Brazilian Forest Code determines that Brazilian farmers must keep different rates of

of the total 37 billion tons (gigatonnes - Gt) of soil organic carbon existing in Brazil in 2021, almost two-thirds (63%) were stored in soils under stable native cover (23.4 Gt COS). Only 3.7 Gt COS are stored in soils in areas converted to anthropogenic use since 1985. More than half (almost 20 Gt COS) is in the Amazon.

Deforestation, which returned to 1.5 million hectares per year in 2021, makes Brazil the main responsible for deforestation worldwide, with 40% of the total. Consequently, it ranks as one of the main GHG emitters in the world, in the 5th position. Deforestation also increases the risks of a water crisis as cutting native vegetation compromises rainfall and water storage, directly impacting agriculture. In addition, according to Henrique Luz, manager of the Brazilian Business Council for Sustainable Development (Cebds) at Valor Econômico[xvi], "businesses in Brazil are highly linked to forest ecosystem services: out of 141 crops, 85 require animal pollination and rainfall irrigation". This is why tackling deforestation is a *sine qua non-condition* to effectively reduce the country's emissions and contribute to lowering agriculture risks.

"Businesses in Brazil are highly linked to forest ecosystem services: out of 141 crops, 85 require animal pollination and rainfall irrigation". (Henrique Luz, manager of the Brazilian Business Council for Sustainable Development at Valor Econômico)

2.3 Agriculture as a Mitigation Solution

Farming can be an opportunity for carbon sequestration and climate mitigation since plants can fixate carbon through photosynthesis, stocking it into the biomass (vegetation, roots) and soils, which have 2 to 3 times more carbon than the atmosphere (Annex 5). According to the *"4 per 100 initiative"*[5] (Annex 6), every year, about 30% of this CO2 is recovered by plants through photosynthesis, and when the plants decompose, living organisms in the soil transform them into organic matter rich in carbon and capable of retaining water, nitrogen, and phosphorus, essential for plant growth.

The challenge is to reduce emissions while increasing carbon sequestration, productivity, and resilience, resulting in a carbon balance equal to zero or negative. Some well-known conservative practices include no-till, cover crops, and crop rotation. How countries deal with these challenges varies significantly because they must adapt to local conditions and are subject to political and economic contexts.

The rates of carbon balance (emissions-sequestration) also vary from soil to soil depending on its characteristics, climate conditions, water, and practices used. Therefore, the level of mitigation potential differs across geographies and farm models, and they presuppose permanence to avoid the carbon stored in the soil being released into the atmosphere. In addition, "each soil has a maximum capacity to store carbon, and, over time, this storage can be reduced or even nullified, when the soil is at the point of balance".[xvii] In Brazilian tropical soils, for example, no-till is a sustainable practice that has been used for

vegetation in their land depending on their ecosystem. In the Amazon, it is 80%; in the transition between Amazon and Cerrados, 35%; in the rest of Cerrados and other ecosystems such as Caatinga, 20%.

[5] The "4 per 1000" Initiative – Soils for Food Security and Climate – proposes, in addition to forest protection and restoration, a growth rate of 4‰ per year in soil carbon stocks by implementing several practices that encourage plant coverage in all forms, from no-tillage to agroforestry. According to the initiative, this would nearly compensate for the annual CO2 increase in the atmosphere. It is not a normative target for each country but a direction proposition.

over 30 years with over 33 million hectares as it increases the fertility of soils and reduces erosion. According to Carvalho et al. (2009), this practice is estimated to increase on average in Brazil by approximately 0.5 tons of carbon per hectare per year.

The no-till practice still needs to be broadly adopted in the USA and Europe, where farmers can usually qualify for carbon programs when assuming only this practice plus cover crops (which would not be the case in Brazil since additionally is needed for carbon credits). One of the reasons for this low adoption is that, in the case of temperate countries, practices like no-till and cover crops reduce the time for planting because of the cold weather. Productivity can take 3-5 years to recover in those environments. In the short run, the costs can impact the margins.

However, in the long run, it increases carbon sequestration and soil health, reducing the loss of topsoil and expenses, according to Ruth McCabe[xviii], conservation Agronomist Engineer at Heartlandcoop, from Iowa, USA. Therefore, sustainable practices results vary from region to region, and it is crucial to consider the time that it will take and costs, which also change depending on the location.

How much time it takes and how much it costs in different areas still needs to be well documented (research ongoing or to be done).[6] According to Rabobank, the transition cost can vary from 0 to 238,00 euros per hectare in Europe[xix]. The most detailed study found the cost per practice per hectare at the farm level was done in France in 2019 (Annex 7), with a cost of no-till of 28 euros per hectare per year, for example. It does not include the machinery. In Normandie, France, the machinery used to no-tillage in the farms visited by the author was imported from Brazil. In this context, financing the transition is an important aspect, and the lack of it is a significant barrier.

Other vital barriers include human and technical resources, such as technical assistance, technology, and innovation[7]. According to Sylvain Hypolite, a new sustainable practice can have worse results if poorly managed. According to him, at Agro D'OC in France, their leading practices are based on agronomic management to increase the organic matter in the soil without drastically reducing productivity. He pointed out that it is not only by adding cover crops to the system that the farmers in Occitane will have good results: a poorly managed cover crop could result in 50% of losses, whereas farmers that have been well-managing cover crops have obtained a 10% increase in productivity. They have also been working on reducing inputs (20-30%) for emissions mitigation, but the effects on productivity are challenging to compensate for.

"A sustainable practice can have worse results in terms of productivity if poorly managed." (Sylvain Hypolite, R&D Director at Agro D'OC - France)

Reducing the use of inputs is, therefore, one of the challenges in the sector, including from a political-economic perspective. Europe, for example, wants to reduce by 50% the use of fertilizers by 2030. According to Rabobank[xx], if such a rule, part of the block's Green Deal, is

[6] For example, I asked for the "transition time" and costs in Australia and New Zealand from farmers and research centers and could not have the data.

[7] In this regard, France has an excellent example of farmers as researchers (*paysant chercheurs).* Some cooperatives have centers of technical studies in agriculture in which farmers get together with engineers to share experiences, best practices, challenges, and success cases.

implemented in Europe, that would mean producing less 60 million tons of food.
The agriculture sector in Europe represents 10% of the GHG emissions, which must be reduced by 55% and sequester 310 Mt CO2eq until 2030[xxi]. This is a big issue for discussions, where increasing productivity and producing more is not even a consensus among farmers. In the French Cereals Producers Assembly in Paris (May 2023), it was noted that "increasing productivity" needed to be explained and justified, with agriculture being responsible for 19% of the country's GHG emissions.

The sector is estimated to have to decrease its emissions from 180 kg of CO2/kg of wheat to 100 kg of CO2/kg of wheat. According to Richard Health, Executive Director of the Australian Farm Institute, with the other sectors of the economy's path to decarbonization, the participation of agriculture in the total emissions will increase. He says using fertilizers inefficiently is losing money and more GHG into the atmosphere. Still, the farming sector will need advocacy sciences to explain that some emissions are unavoidable if we have to produce food.

"Using fertilizers inefficiently is losing money and more GHG, but the farming sector will need advocacy sciences to explain that some emissions are unavoidable if we have to produce food." (Richard Health, Executive Director of the Australian Farm Institute)

In Brazil's case, the country established the climate ambition target or **nationally determined contributions (NDCs)** under the Paris Agreement to reduce its emissions by 50% by 2030. On the one hand, it focuses on lowering illegal deforestation (target of zero illegal deforestation by 2028). On the other hand, it prioritizes the role of agriculture in carbon sequestration while increasing productivity through the Adaptation and Low Carbon Emission Plan in Agriculture (ABC+ Plan), several technologies and practices that aim to increase productivity with positive impacts on farm resilience to climate change and environmental benefits at the same time (Annex 8).

In a country like Brazil, where over 60% of the territory is native forests (20% of it is inside private farms), productivity is vital to reducing the need for deforestation. According to Renato Rodrigues from EMBRAPA[xxii], while Brazilian production has risen by 390% since the 1980s', the expansion in the agricultural area had an increase of 60%, saving around 200 million hectares. In the country, 28% of the area planted with grains and pulses supports two harvests per year.

In addition, one of the priorities of the 2024-2028 Lula government is to recover degraded pastures in Brazil (50% of the 180 million hectares of pasture are degraded in Brazil). According to Professor Cerri,[xxiii] one hectare of degraded pasture emits around 2 tons of C annually. When recovered, it could sequester up to 4 tons/C/hectare/year.

The secretary of development of Mato Grosso do Sul State, Jaime Verruck[xxiv], said that it is difficult for Brazil to make the Europeans understand that sustainable agriculture in the country is productive. Indeed, the Ministry of Agriculture of France said during the French Cereals Producers Assembly in Paris (May 2023) that Brazil would increase its production by 40 million hectares, meaning more deforestation. The government plan is to recover 40 million hectares of degraded land instead. This leads to the topic of compliance risks.

"It is difficult for Europeans to understand that sustainable agriculture in Brazil is also productive." (Jaime Verruck,

Secretary of Development of Mato Grosso do Sul State, Brazil)

2.4. Adaptation at the farm level (examples from farms visited)

In this scenario of increased risks, changing agricultural practices to respond to the impacts of climate change is a systemic adaptation[8] to manage risks at the local level, increasing the protection against natural and financial capital erosion. According to Liz Riley[xxv], farmer and consultant in the wine industry in Australia, the challenge now is not to make more profits, but to lose less in difficult times".

Practices need to be adequate to the soil, the environment, the precipitation index, the crop, the size of the business, and its finances (machinery needed for new practices can be cost-prohibitive, for example) to increase soil and plant health and resilience without significantly compromising productivity (BOX 1). Sometimes, the same practice may only apply to some parts of the same farm. In Bundaberg, Australia, Simon Gonzalez (technical officer at Stahmann Webster) said the mulching practice that reduced the need for herbicides and irrigation (up to 50%) in some parts of the farm was not beneficial in other regions where soils were heavy (they were taking it off).

"The challenge now is not to make more profit, but to lose less in difficult times." (Liz Riley from the wine industry in Australia)

That is why regenerative agriculture[9], which has soil restoration and health as a bishop principle, has not only one definition and is not the same everywhere. João Roseiro[xxvi], Agronomist Engineer Consultant in the development of new investment opportunities in sustainable permanent crops in Portugal and Spain for SLM Partners, explains that regenerative agriculture is used as a transition for organic production, restoring soils, increasing biodiversity, and better using water resources, which reduces costs and increases resilience in the long run (they work with long-term investments - 25 years). The company, named Real Assets Manager of the Year in the Environmental Finance Sustainable Investment Award 2023, focuses on enhancing natural capital to sustainable financial returns. Practices typically include (depending on location and crop), and their expected benefits are:

- No-till or minimum-till labor/fuel reduction, productivity;
- Cover crops: nutrient fixation, reduced soil temperatures, water retention;
- Mulching with the pruning trees: water retention, nutrient fixation, inputs efficiency;
- Integrate pest management: fertilizer efficiency, reduces input costs;

[8] Adaptation can be a reactive response during extreme climate events; it can also be progressive to reduce vulnerabilities, and it can be systemic, transforming the way we produce and consume, for example.

[9] OP2B's Definition of Regenerative Agriculture: a holistic outcome-based farming approach that aims to promote simultaneously- and belowground carbon sequestration, reduce greenhouse gas emissions, protect and enhance biodiversity in and around farms, improve water retention in the soil, reduce the use of pesticides, improve nutrient use efficiency, and support farming livelihoods.

- Increased use of organic matter and biologics: fertilizer efficiency, productivity;
- Fewer uses of synthetic fertilizers (benefits soil health, reduces input costs)

In the Normandie region in France, farmers that have been producing with conservative methods (no-till or minimum till, cover crops, crop rotation, etc.) for over 20-30 years declared that they have lower costs and better productivity because of better soil conditions in comparison to their neighbors that are still working with conventional agriculture. This was their primary motivation to be early adopters years ago.

Indeed, Boston Consulting Group (2023) found that while the long-run business case for regenerative agriculture is strong, the economic risks of changing farming practices are significant. According to BCG (page 5), it is crucial to "find new and better ways to support farmers through consolidated financial, technical, and educational support systems that both de-risk farmers' efforts to move toward more regenerative landscapes and secure the longevity of these impacts on our ecosystem" — theme for the next section.

BOX 1 - Case examples from climate change impacts and adaptation in the vineyard industry

The first case is from the Vineyards in the Hunter Valley, Australia. According to Liz Riley, their farm has had to use helicopters to spray pesticides to avoid compacting the soils in extreme weather circumstances. According to her, they have decreased losses under challenging moments by prioritizing soil health to adapt to climate change. In the last drought, they had a decrease of 30% in productivity whereas their neighbors not invested in soil management experienced a 50% loss. They have recovered and are back to standard production rates, but their neighbors continue to experience a 34% loss. Liz says that with this new climate change scenario impacting farmers' business, investing in sustainable practices and managing risks is essential to reduce losses and increase resilience. Other drivers for practice change or improving their carbon footprint are to demonstrate sustainability objectives as part of participating in Sustainable Winegrowing Australia (the Australian Wine Industry's sustainability program).

Another case is from vineyards in the Mclaren Valley in Australia. Richard Leask[xxvii] (farmer and consultant) has been using different practices to adapt to his farm's rising temperatures and dry weather. He has been replacing some varieties with others more adapted to the new climate (mainly from Italy). He is replacing at least one hectare annually for an average of AU$50.000. His farm already has 17 varieties with different levels of disease pressure. According to him, this variety diversification is also a way to diversify risks. He is already having positive results with this business decision. In the last extreme events in the region, he had a decrease of 5% in production, whereas his neighbors (on average with three varieties), had a loss of 30% in production. In addition to covering crops in the row between trees, he has stopped using herbicides to eliminate the weeds under the plants (sheep and cattle come to graze). According to Liz, grazing would not be an option for them in the Hunter Valley, which is more humid, and animals are subject to hard-to-manage diseases. Farmers in New Zealand's Marlborough Valley have also managed the weeds under the wine without grazing, using pest, biological and mechanical management.

Managing the cover under the vines (or other permanent fruit tree plants) is an example of a practice that is at different stages of development, depending on where you are. Dr. Irina Brown, a neighboring farmer from Richard Leask in Mclaren Valley, has also been doing some experiments through the plantation of a mix of cover crops along with the vines. João Barroso (responsible for the sustainability program for the wines of Alentejo - Portugal) explained of the topics of different crops under the vines, that even cover crops in the middle of the trees still have no conclusive results about the benefits on their region (very dry and has poor soils), and weeds/cover crops under the vines could reduce productivity.

2.5. Increase in requirements (or transition risks) to the farming sector

In addition to physical risks, the farming sector must also be attentive to transition risks to a low-carbon economy, such as regulatory, market, and financial risks. According to Richard Health, these requirements directly impact business, and those anticipating them and getting prepared will be in a better position, including access to markets and financing.

"Transition risks may directly impact business, and those anticipating them and getting prepared will probably be in a better position, including access to markets and financing." (Richard Health, Executive Director of the Australian Farm Institute)

Regulations relate to additional costs to companies about new requirements or government policies, such as taxation of GHG emissions. For example, New Zealand, where the agriculture sector represents over 50% of the country's GHG emissions, is expected in 2025 to be the first country in the world to tax emissions from agriculture at the farm level (carbon taxes). According to a grower interviewed in the country (March 2023), they are considering it as a new tax and are calculating an increase of around 5% in their costs. In Europe, farmers must adopt more sustainable practices in a system of points to continue accessing the subventions of the agricultural policy (CAP). Those who already achieved the needed points (such as organic farmers) receive the same amount (based on the farm size - by hectare), not more. According to Gaëtan Delacroix, an organic farmer in the Normandie region in France, CAP contributes around 25% of the farm's income.

Political and economic forces in Brazil are raising the debate on such requirements. There were disagreements between the 2024-2028 Lula government Ministry of Agriculture and the Ministry of the Environment about the federal government agribusiness financing plan (*Plano Safra*), through which farmers access credit programs with lower interest rates than market rates. The latter wanted the BRL 340.8 billion (~ US$68 billion) in credit package designated only to low carbon emission programs[xxviii].

The program launched is in the format proposed by the Ministry of Agriculture: not only low carbon agriculture but also a design that considers that transition is a process that requires a time of adaptation and skills, as Renata Miranda, Secretary of Innovation at the Ministry of Agriculture, declared in a meeting in Brasilia in March 2023. Currently, the debate is about including big emitter companies from the agricultural sector in the regulated carbon market scheme, which is the aim of the Ministry of Environment (This will be discussed in the next section). Brazil would be going in a different direction from other existing schemes, in which the agriculture

sector is almost always not included. According to the World Bank (2023, p. 25):

> "Expanding carbon pricing to agricultural emissions comes with its own set of challenges, with stakeholders raising concerns about impacts on food security, limited opportunities to reduce emissions from agricultural activities (and associated risks of carbon leakage), interactions with preexisting market distortions, and difficulties ensuring robust monitoring, reporting, and verification. Others argue customers are seeking more sustainable alternatives, new approaches to reducing agricultural emissions are emerging, and carbon pricing could ensure greater investment in further developing new ways to reduce agricultural emissions".

Access to markets is the other challenge to be considered, with pressure coming from importing countries, such as Europe with the Deforestation Regulation[10], supply chains, and consumers. Big corporations in the food industry, like Danone and Nestlé (Annex 9), have been establishing emission reduction targets, including indirect emissions from Brazilian suppliers. In Australia, for example, the leading retailer, Coles, expects 75% of its suppliers to set science-based emissions targets, increasing the pressure on farms to report their carbon footprint[xxix] According to Richard Health[xxx], requirements for farmers in Australia to demonstrate their carbon balance will be then driven by multi-capital risk disclosure about sustainability to inform investment decisions through the financial system and supply chains[11]. This results from a rising demand from investors for companies to demonstrate their capacity to manage ESG risks, including emissions, and, therefore, their ability to preserve their capital in the future. An investment risk issue affects a company's share price and capacity to raise money. This applies to Australia and other countries like Brazil, where funds and big corporations operate.

Banks are going in the same direction. In Brazil, from December 2022, banks must measure the impact of climate change on their capital risk management[xxxi]. The largest bank by assets in Brazil and Latin America, Itaú Unibanco, for example, takes part in the global Net-Zero Banking Alliance, currently representing over 40% of global banking assets, which is committed to aligning their lending and investment portfolios with net-zero emissions by 2050. Rabobank does not finance projects in recently deforested areas, even if legal.

Today, for a farmer to be funded in a bank in Brazil, he must have several documents, including the rural environmental registry (called CAR), in which his rural property is georeferenced with information on compliance with the Brazilian Forest Code. Through it, banks can track the supply

10: "Companies must confirm that the product has been produced on land that has not been subject to deforestation or forest degradation, including of primary forests, after 31 December 2020. While no country or commodity will be banned, all relevant companies will have to conduct strict due diligence if they export or place on the EU market palm oil, cattle, soy, coffee, cocoa, timber, and rubber, as well as derived products such as beef, furniture, or chocolate listed in the Annex to the Regulation upon the entry into application of the new rules in 18 months. The list of covered commodities will be regularly reviewed and updated, considering new data such as changing deforestation patterns. Companies will also have to verify that these products comply with the relevant legislation of the country of production, including on human rights, and that the rights of affected indigenous peoples have been respected". Source: European Commission

11 A new accounting standard from the IFRS Foundation's International Sustainability Standards Board (ISSB) is expected to form the basis for emerging sustainability reporting requirements by regulators worldwide, marking a significant step towards integrating sustainability reporting into the broader financial reporting process. The new standards will apply for annual reporting periods beginning in January 2024, with companies starting to issue disclosures against the standards in 2025. For the first time, the bars create a common language for disclosing the effect of climate-related risks and opportunities on a company's prospects. In Brazil, the Securities and Exchange Commission have decided to adopt the sustainability report in 2025.

chain. In soybeans, supply chain companies do not buy from illegally deforested areas in the Amazon. They will start not buying from illegally deforested areas in the Cerrado biome from the 2023/2024 harvest[xxxii] (*Moratoria da soja,* it is called in Portuguese).

In addition to regulatory, market, and financial requirements, other risks need to be mentioned[xxxiii]:

- legal, such as lawsuits for concealing relevant business information from investors and consumers;
- technological: the incorporation of new technologies into production processes, such as investment in alternative energy sources;
- and reputational risks, such as loss of credibility and negative publicity or transparency of the information disclosed, for example, cases of greenwashing[12]. This is an essential issue in the voluntary carbon markets that will be addressed in the next section.

2.6. How are farmers around the world getting prepared to demonstrate their carbon balance?

Farmers abroad and in Brazil are not getting prepared the same way since they are not exposed to the same pressure or requirements depending on where they are, the products they grow, or for whom they sell. In the case of Asian countries (Indonesia and Japan were visited), the central pressure is to produce (food security) despite environmental concerns.

Farmers' concern is maintaining market access, the primary motivation for compliance with new requirements in occidental countries, such as New Zealand and Australia. In these agricultural exporter countries, the term "social license" was very present in the discussions: they work to demonstrate the sustainability and quality of products to continue to have a "social license" to sell their products abroad, such as through certifications in each sector, like the Sustainability Certification in Australia and New Zealand that have also started to include carbon emissions in their guides to growers[13].

The first step, in any case, and any country, is baselining the current carbon emissions of the farm business through the analysis of the steps involved in an activity, product, or process, according to Willian Marchió. The result approximates its carbon footprint or the carbon balance: is it carbon positive (more emissions than sequestration), carbon neutral (emissions = sequestration), or carbon negative (sequestration more than emitting)?

"The first step is baselining the current carbon emissions of the farm business." (Willian Marchió, veterinary and consultant for sustainable projects in the agricultural sector in Brazil).

[12] Greenwashing can be defined as "poor environmental performance and positive communication about environmental performance." Delmas and Burbano's definition in Netto and All (2020)

[13] As an example, the work done by Sustainable Wine Australia: https://www.wineaustralia.com/sustainability/emissions-reduction-roadmap

GHG Protocol[14] is the primary reference used[15], and the emissions are divided into 3 Scopes: 1) Scope 1: refers to direct emissions in a company/farm; 2) Scope 2: refers to indirect emissions from purchased electricity and other power sources; 3) Scope 3: refers to indirect emissions in the supply chain, such as transportation, inputs, etc.

Doing this first step may not be straightforward. Bernhard Kiep, who received support from Corteva (*Programa Plataforma S pecuarista sustentável*) to do the emissions inventory using the GHG protocol at his farm, said that without the help of specialists, it would be difficult for him to do this kind of measurement at his farm. Measuring Scope 3 is considered the most challenging for companies.

"Without the help of specialists, it would be difficult to demonstrate the carbon balance of my farm." (Bernhard Kiep, farmer and investor in agriculture

The participation of farmers' associations and cooperatives, supply chains, and other big companies in the sector to help farmers prepare for changes is vital. For example, in Brazil, some organizations have been doing pilots to quantify the carbon footprint of their products and respond to market demands. One example is from the Brazilian Coffee Exporters Council CECAFE, which conducted a study to determine the carbon footprint of coffee farms in Brazil, resulting in a negative footprint (more sequestration than emissions). Carbon in the soils and plants was measured[16].

Another example is from the Brazilian citriculture, which has obtained international funds to map carbon stocks and wildlife (conducted by Embrapa)[17]. The study's goal is not to access carbon credit markets but to improve the product's image in international markets (95% exported). During the Global Agribusiness Forum in São Paulo in July 2022, it was mentioned a few times the difficulty of showing that not everything is produced in the Amazon, as in the case of citrus fruits. Improving the image of Brazilian agriculture is imperative.

The soybean sector also has done this type of study in different States. According to André Dobashi[xxxiv], president of the Brazilian Soybean Association in the State of Mato Grosso do Sul, the need is to partner with international organizations to validate these studies to the global market. In Australia, some companies visited have been working with the NGO Leading Harvest[18].

Many things could be improved about how to prepare for new requirements (including for the EU), such as what traceability tools, methodologies to use, and certifications to have. The costs of them can be barriers as well.

[14] 20-year partnership between World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), GHG Protocol "establishes comprehensive global standardized frameworks to measure and manage greenhouse gas (GHG) emissions from private and public sector operations, value chains and mitigation actions". It works with governments, industry associations, NGOs, businesses, and other organizations. Source: https://ghgprotocol.org/about-us

[15] Other methods that can be used: ISO 14064 and 14067, Carbon Trust Standard, etc

[16] The study is available in the link: https://www.cecafe.com.br/site/wp-content/uploads/2022/05/cecafe_relatorio_imaflora_vf.pdf

[17] For further information: https://www.embrapa.br/en/busca-de-noticias/-/noticia/69139029/citricultura-tera-mapeamento-de-estoques-de-carbono-e-fauna-silvestre

[18] For further information, access: https://www.leadingharvest.org/

The tools farmers have available also differ significantly from country to country. Tools like startup platforms and software can help in the task, such as My EasyFarm or Sysfarm calculator in France[19]. In Peru, there is a public toll called *"Huella de Carbono Peru"*[20], through which each company, including from the farming sector, can report emissions and be verified by an international third party, such as SGS.

The most used tool to measure carbon emissions from the agricultural sector in Brazil is called "Brazilian Program GHG Protocol[21]." Registering the emissions in a public database can also be verified by a third party qualified by the Brazilian body responsible for establishing conformity assessment programs, Inmetro. Brazilian farmers interested in learning more about the tool can access the website: https://registropublicodeemissoes.fgv.br/. Several companies offer the service of calculating emissions if a specialist's help is needed (Annex 10).

With this tool, it is possible to account for agricultural sequestration as biogenic removals, but they must be reported in another outside file. For the moment, it still needs to calculate this type of removal. The GHG Protocol is still working on guidance for agricultural sequestration, which lacks significant direction, and is expected to release "Land Sectors and Removals Guidance" in February 2024[22]. The lack of this guidance is one of the reasons why companies have been reporting only emissions and not including sequestration in their carbon footprint.

According to Wade Needham from PSP in Australia[xxxv], they are waiting for this guide to be released to have recognized global frameworks to account for the sequestration of their agricultural investments (today only emissions are reported), which is also expected to help open opportunities in carbon financing. It will be necessary for their strategy of transitioning to less carbon-intensive activities, such as investing in more permanent tree crops instead of meat production.

The lack of inclusion of sequestration (plants and soil) in the carbon balancing in the agricultural sector is a big complaint of farmers in different countries, including Australia and New Zealand, that only account for their emissions. For example, the government's carbon-neutral program in Australia only accounts for emissions in the farming business, and they must compensate for emissions offsetting elsewhere (usually in foreign countries).

Richard Leask's farm in Australia is carbon neutral. He decided to be an early adopter even if sequestration was not included. He is offsetting his carbon emissions in projects in India and other countries. Keith Tulloch Wines (KTW) in the Hunter Valley is certified carbon neutral. According to the company, the cost is high. They pay around AUD$15,000-20,000 per year to be certified carbon neutral, not including the cost of offsetting.

This example shows that in addition to the external environment, choices depend on the internal environment in the farm business, whether growers want to be early adopters, take risks or not, etc. In this respect, the Australian Farmers Institute has created a questionnaire based on business situations, risk appetite, plans, and attitude to help farmers decide the best option with pros and cons regarding carbon. It is called

[19] For further information, access: My easyfarm - https://www.myeasyfarm.com/en/ ; and Sysfarm - https://www.sysfarm.fr/

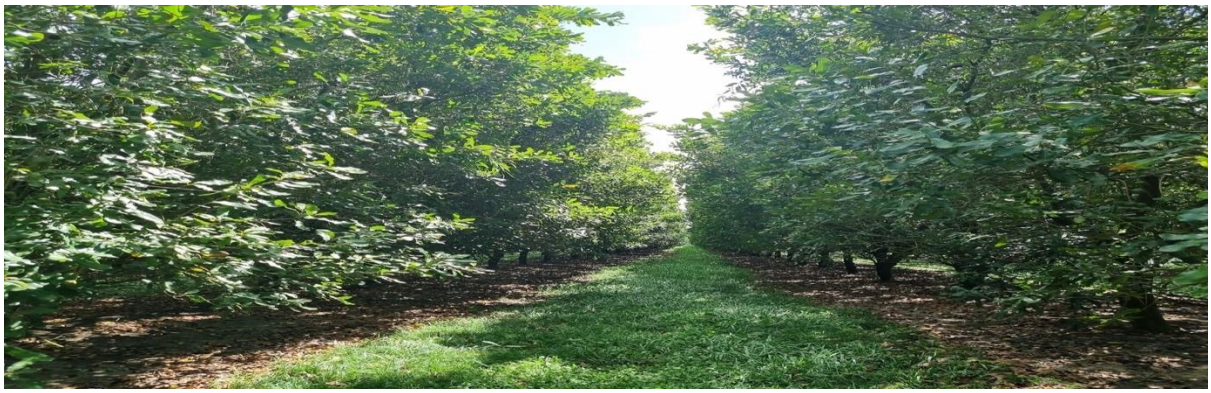
[20] For further information, access: https://huellacarbonoperu.minam.gob.pe/huellaperu/#/inicio

[21] Access to the tool: https://eaesp.fgv.br/sites/eaesp.fgv.br/files/u641/ferramenta_ghg_protocol_v2022.1.1.xlsx.

[22] For further information, access: https://ghgprotocol.org/sites/default/files/2023-06/Project%20Overview_16%20June%202023.pdf

"Carbon Opportunity Tool Australia" and can be accessed at https://carbontool.farminstitute.org.au/. They have potential opportunities there yet to be available in Brazil. Some questions include:

- *Are you willing to be in a long-term contractual agreement with a third party (e.g., between 25-100 years)?*
- *Are you prepared to wait for payments (e.g., up to several years)?*
- *Are you willing to undertake new practices that are additional to your current management?*
- *Are you prepared to undertake regular benchmarking and ongoing sampling/measurement activities?*
- *Are you willing to be liable (legally responsible) for maintaining the permanence of contracted emissions reduction?*
- *Would you have the capability to undertake and manage a carbon project yourself?*



Macadamia fields in Bundaberg, Australia

3. PERSPECTIVES OF CARBON MARKETS AND SUPPLY CHAINS IN FINANCING SUSTAINABLE AND RESILIENT AGRICULTURE

In front of the risks mentioned in the last section, access to financing is essential to decarbonize the agricultural sector while it adapts to climate change. The challenge is how. Are (or will) carbon markets an option for farmers? What is the role of supply chains in this context? To start, it is essential to have a better understanding of carbon markets (offsetting) and the part of supply chains in this context (insetting) to, in the sequence, talk about the experiences in the agriculture sector abroad and the perspectives of Brazil.

3.1 Carbon markets (offsetting)

One carbon credit equals one ton of CO2 or the equivalent amount of a different GHG (t CO_2-e). It can be tradable in two types of **carbon markets**: **mandatory** and **voluntary**. The first relates to regulatory requirements established by governments (can be sub-national, national, or regional) and international agreements (Kyoto Protocol, Paris Agreement).

The second, worth less than 0.01% of the amount traded in regulated markets, can be national or international. It is the market where companies, organizations, or individuals voluntarily offset their carbon direct carbon emissions (Scope 1) by buying credits generated from projects outside their direct supply chains that reduce, sequester, or avoid GHG emissions (reforestation and sustainable agriculture practices included).

Both markets can be connected, and one does not exclude the other since the voluntary one allows the participation of entities not included in government regulations focused on specific sectors. In addition, regulated markets (around half of them) can accept a portion of credits generated in the voluntary market as

'offsets' for their target obligations under eligibility criteria[xxxvi].

In the two markets, transparent, verifiable by an independent third party, and environmentally robust Measurement, Reporting, and Verification (MRV)[23] standards are essential. MRV aims to prove that activity has avoided or removed GHG emissions to be converted into credits with monetary value[xxxvii], reducing the risks of greenwashing.

Mandatory carbon markets

Mandatory carbon markets relate to governments and companies regulated with a maximum emissions limit at international, regional, national, or subnational levels.

Carbon taxation is another modality generally classified as a regulated market, even if it does not generate carbon credits to trade.

International Mandatory Carbon Markets[24]

The international level regulates the carbon market through the **Clean Development Mechanism (CDM)** under the **Kyoto Protocol[25]** (1997), which established the legal foundations for carbon markets. It allowed developed countries to invest in emission reduction projects in developing countries to receive carbon credits (or CERs - Certified Emission Reductions) in return for meeting part of their reduction targets. It is the world's most significant carbon crediting mechanism, with around 8,000 registered projects and more than 2.3 billion certified CERs issued.[xxxviii]

In 2021, the **Paris Agreement** replaced the Kyoto Protocol[26]. It goes beyond the latter setting more ambitious targets, with countries (including developing ones) having to submit their nationally determined contributions (NDCs) to emissions reductions and describe how they will achieve it[27].

Article 6 of the Paris Agreement established basic rules for the operation of carbon market instruments at the global level. Countries can buy voluntary carbon credits if Article 6 rules are respected. Two mechanisms were created, presented in articles 6.2 and 6.4 (Figure 1).

The first one, **Article 6.2**, regulates bilateral exchanges between countries, creating a negotiation unit called Internationally Transferred Mitigation Outcomes (ITMOs) to transfer emission reduction results (mitigation) among themselves. Governments can then make bilateral agreements to promote initiatives to reduce emissions or remove GHGs in one country, helping the other reach its NDC[xxxix]. According to the Nature Conservancy Article 6 Explainer (page 5),

[23] "Measurement, Reporting, and Verification (MRV) refers to the multi-step process to *measure* the amount of greenhouse gas (GHG) emissions reduced by a specific mitigation activity, such as reducing emissions from deforestation and forest degradation, over some time and *report* these findings to an accredited third party. The third party then *verifies* the report so that the results can be certified, and carbon credits can be issued". (Source: The World Bank, 2022)

[24] The countries that take part in these markets have accepted and adopted the emission limits established in the Framework of the United Nations Convention on Climate Change (UNFCCC).

[25] The Kyoto Protocol had a limited participation, not including the United States, China, and India. Only developed countries had GHG reduction emissions targets.

[26] New CDM projects have not been implemented since 2021 (Source: NexoJornal, 2023), but carbon credits generated by the mechanism still exist and continue to be negotiated under certain conditions that will also allow them to do the transition to the new international rules. Credits generated from CDM registered after January 1, 2013, are eligible to be used to meet countries' first NDC target, and projects after 2020 that have still not issued credits are eligible to be transferred to the Paris Agreement.

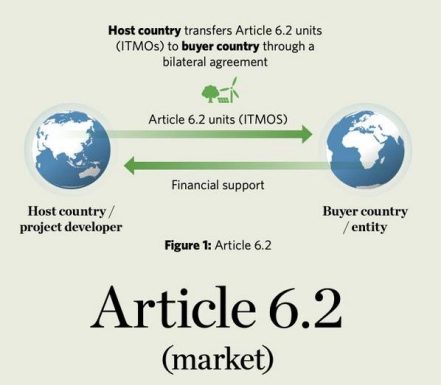
[27] "89 countries,13 representing 86% of global emissions, had adopted net-zero commitments at the end of 2022, with target dates ranging from 2035 to 2060". (The World Bank, 2023).

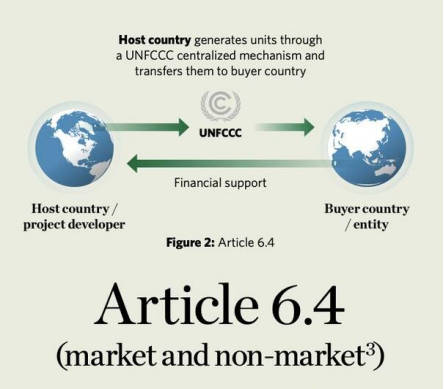
"Several Article 6.2 pilots have been signed, but bilateral trades still need to be completed. This is partially due to host countries still lacking domestic frameworks to operationalize Article 6 and the need for more guidance on reporting and tracking from the negotiations".

New Zealand, for example, is willing to develop projects to offset their emissions in countries like Brazil, as they state they have low margins to do it locally[xl]. However, host countries, like Brazil, are cautious when authorizing emissions reductions because of the potential impacts of corresponding adjustments on the country's capability to meet its NDC target[xli].

The second one, **Article 6.4**, regulates exchanges between private entities to meet national mitigation targets[28]. Projects are like how the CDM worked for the Kyoto Protocol, allowing countries to trade units approved by a centralized mechanism supervised by a United Nations (UN) body, called Article 6.4 Supervisory Body. The idea is to certify GHG mitigation units based on activities and methodologies that reduce emissions about a baseline of projected emissions that buyer countries can use to meet their targets[xlii].

Figure 1: Paris Agreement Articles 6.2 and 6.4 explained.





Source: The Nature Conservancy, 'Article 6 Explainer', page 5

A relevant difference between the Kyoto Protocol and the Paris Agreement relates to including emission reductions or removals in Article 6.2. It opens opportunities for Reducing Emissions from Deforestation and Degradation (**REDD+**)[29] and Nature Based Solutions (**NbS**)[30] that include land use emissions; land sector; land-use, land-

[28] Projects can be entirely from the private sector, but need the approval from the government of the country where they are hosted (similar to CDM of the Kyoto Protocol). To avoid double counting, "when a credit is sold to another country or a company internationally, the host country must subtract that unit from its own accounting as the buyer adds the same units to its commitments" (The Nature Conservancy, page 6).

[29] "REDD+, a specific UNFCCC mechanism that focuses on reducing emissions from deforestation and forest degradation, especially in tropical countries, includes five activities: reducing emissions from deforestation, reducing emissions from forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stock" (The Nature Conservancy, page 8)

[30] "Nature-based solutions include protecting, restoring and managing natural ecosystems such as forests, mangroves, croplands, grasslands, and peatlands – all of which fall under the IPCC definitions of emissions reductions or removals". "The term NbS was referred to for the first time in the UNFCCC context in 2022, in the cover text of COP27, which encouraged countries to consider NbS or ecosystem-based approaches for their mitigation and adaptation actions while ensuring relevant social and environmental safeguards". (The Nature Conservancy, page 8)

use change and forestry (LULUCF); and Agriculture, Forestry and Other Land Use (AFOLU).

Countries hosting carbon projects must demonstrate if their REDD+ programs fulfill Article 6 requirements and define the activities to include in their bilateral agreements under Article 6.2[xliii]. One central discussion is whether deforestation effectively threatens protected forest areas. The lack of additionality in this regard would not have a genuine environmental impact[xliv]. This is a significant point for countries like Brazil and for farmers in the country that must maintain by law a minimum rate of vegetation in their lands.

Article 6 was regulated at the Glasgow Conference (COP) in 2021, but specialists believe it will be operational in several years[xlv]. According to the Nature Conservancy, uncertainties around the operationalization of Article 6 and domestic implementation are the causes holding back countries from conducting any trade to date. The challenge is technical, such as process flows, procedures, document models, and infrastructure with tools for reporting quantitative information in a standardized electronic format, which will be essential to the effectiveness of these markets.[xlvi]

Regional, national, and subnational mandatory carbon markets

In parallel with international agreements, mandatory carbon market certification standards mechanisms emerged at regional, national, and subnational levels. "The direct carbon price instrument and coverage choice depend on domestic circumstances, priorities, and needs." (The World Bank, 2023, p. 51). Carbon pricing instruments in these markets that provide "a clear price signal to reduce GHG emissions" are **emissions trading systems (ETS)** and **carbon taxes[xlvii]**. According to the World Bank (2023), as of April 2023, there were 73 carbon taxes or ETSs in operation (Figure 2). They cover around 23% of global emissions and focus primarily on energy and industrial emissions. The agriculture sector is almost always not included.

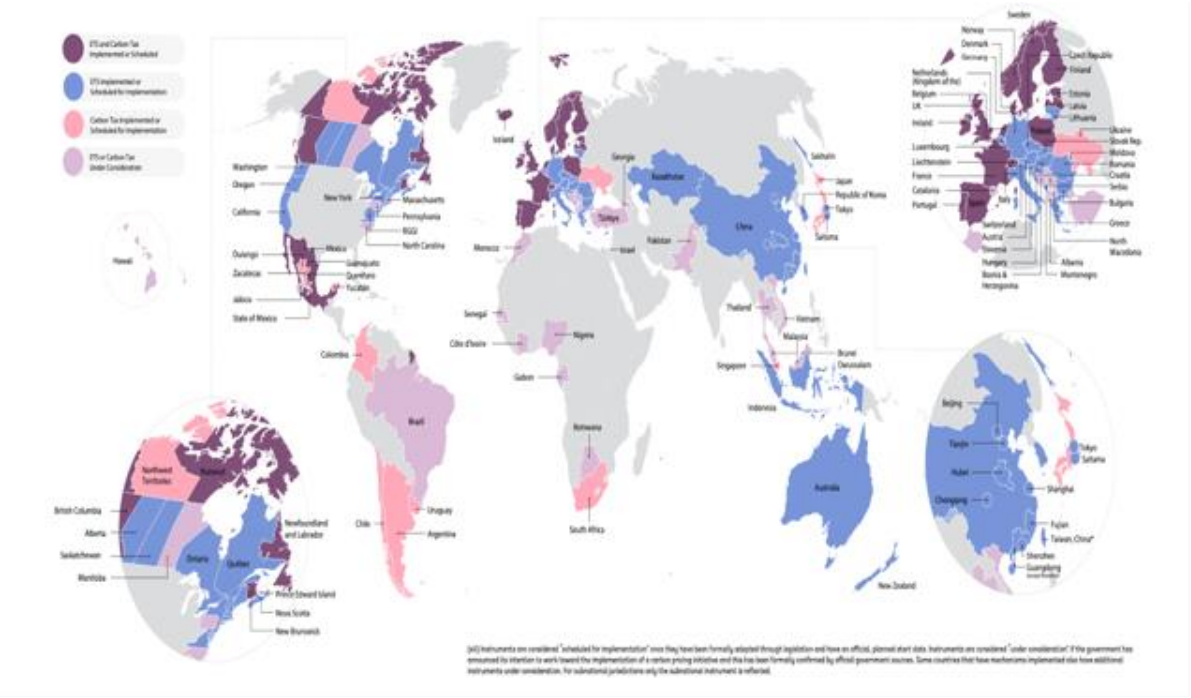
EMISSIONS TRADING SCHEMES (ETS)

The most common design of **ETS** is the **"cap-and-trade"** policy, in which a limit (or cap) is placed on the total volume of GHG emissions of covered sectors of the economy, generating an equivalent amount of emission allowances (right to emit). The **European Union** launched the world's first international ETS in 2005[31], representing 87% of the global total value in regulated carbon markets (around 751 billion euros in 2022) and having the highest carbon prices (average over 80 euros per ton in 2022)[xlviii]. In 2021, **China** launched the world's largest one.

The cap-and-trade works as follows: a government distributes or auctions these tradable "right to emit " to entities included in the cap. The emission allowances can also be tradable between companies legally obliged to have the same number of allowances for their verified emissions during compliance. The entities evaluate opportunities according to market price (not fixed by a government but determined by the supply and demand) and their internal mitigation costs. They can buy additional allowances if needed or sell allowances in excess (trade)[xlix]

[31] The European Union Emissions Trading System (EU ETS) operates in the 28 EU Member States and Iceland, Liechtenstein, and Norway. Agriculture is not covered in the EU ETS, but some countries, such as Austria have national ETS that include the sector.

Figure 2: Map of carbon taxes and ETS



Source: The World Bank, "State and Trends of Carbon Pricing 2023"

For example, there is no nationally regulated market in the United States, but States can have their own programs, such as **California,** with a formal cap-and-trade mechanism. According to Sierra View Solutions and American Farmland Trust (2023), California's cap-and-trade program will allow 107 MtCO2e of offsets between 2023 and 2030, including from agriculture and forestry (not covered in the program). Companies can use only a tiny percentage of offsets for compliance obligation[32]. The State has developed rigorous MRV methodologies to certify how much carbon these projects store or reduce (a minimum of 100 years for forest projects, for example)[i]. Agriculture has generated 9.6 MtCO2e of offsets from agriculture under the livestock CH4 Digester protocol approved by the California Air Resources Board (CARB). Dairy producers are paid to install equipment that traps CH4 from leaving manure lagoons. Other existing approved agricultural carbon protocols, such as the
rice adopted in 2015 has yet to generate credits.

In **Australia**'s carbon-intensive economy with large coal and gas export industries, "climate policy has been highly politicized." (The Financial Times, 2022)[ii]. In the country, an ETS from 2007 was dismantled in 2015 after a public debate resistant to carbon pricing. After almost ten years, in July 2023, the new Labor government of Australia introduced a new ETS built on the existing "safeguard mechanism"[33], which sets the baseline for the country's biggest emitters. The new

[32] Offsets are slightly cheaper than buying allowances from State auctions. (Source: California and Resources Board)

[33] "The Safeguard Mechanism has been in place since 1 July 2016. It requires Australia's highest greenhouse gas emitting facilities (more than 100,000 tonnes of t CO_2-e) to keep their emissions

ETS only applies to industrial emitters such as smelters, miners, and manufacturers (agriculture is excluded). According to the Financial Times, it is much weaker than the previous scheme compared to the EU's ETS. In the Australian case, businesses must buy permits for emissions above a particular baseline rather than for every ton of carbon they emit, as under the EU's ETS. Still, the Labor government aims to bring more businesses to the mechanism and reduce the baseline yearly, reaching zero in 2050.

In **Brazil,** the compliance market implementation is still in the initial phase. The regulation of a national carbon market is one of the priorities of the Brazilian Congress and of the Ecological Transition Plan of the Lula Government that was launched in August 2023 and has the ambition to start operations in 2025[lii]. Productive sectors are debating the text of the law, the Federal Government, and the Congress. To enter into force, it needs to go through three stages: approval by the National Congress, definition of intralegal acts, and a one-year deadline for the transition of companies. The estimation is that it will take between three years to start operating after Congress liii approves it.

The Brazilian compulsory market is planned to be a "cap-and-trade" model with capped emissions at 25,000 metric tons per year, impacting around 4,000 companies. In principle, companies emitting between 10,000 and 25,000 metric tons of GHG will need to report emissions to the State. Farms and ranches will not be covered in the Brazilian program. Still, the country's agribusiness, such as large meatpackers, "is likely to be affected, as the food industry is forced to curb emissions across its supply chain" (Source: WSJ Pro, 2023).

Adding the agriculture sector to the scheme is not a consensus between the actors, starting with the high baseline already in place for the industry (including the Forest Code) and other questions concerning MRV to be used for tropical agriculture, the impacts on production costs and food prices, for example. In a more recent development of the discussions September 26, 2023), it was decided that the agriculture industry will not be included, at least at this first moment, because the text restricted it to the sectors that have a "consolidated methodology" to measure carbon emissions, which is not the case for the agriculture[liii]. However, agriculture could be added as a generator of credits, such as in the case of California, where a part of the compliance market accepts credits from the volunteer market.

Carbon Tax

Concerning a **carbon tax** policy (which does not create a carbon market), the government taxes GHG emissions by setting a carbon price, and the market determines the level of emission reductions incentivized by the price. It places a higher cost on those who emit, encouraging companies to look for cleaner production processes[liv]. **New Zealand**, where the agriculture sector represents over 50% of the country`s GHG emissions, is expected to become the first country in the world to tax emissions from agriculture at the farm level by 2025.

Carbon Border Adjustment Mechanism (CBAM)

Jurisdictions that price carbon (ETS or carbon tax) can also establish a border carbon adjustment for imports and exports to equalize the price of carbon across

below an emissions limit (baseline). A Safeguard facility must manage its excess emissions if it exceeds its baseline. They can become liable to pay a financial penalty if they fail to comply with the Safeguard Mechanism". Source: Clean Energy Regulator Australia

countries. The **Carbon Border Adjustment Mechanism (CBAM)** in the EU[34], the first in the world, will be applied to iron and steel, cement, aluminum, electricity, fertilizers, and hydrogen imported into the EU from 2026. It is a measure to avoid the risk of the so-called **'carbon leakage,'** which relates to carbon-intensive production moving abroad to countries with less rigorous climate policies than the EU or when EU products get replaced by more carbon-intensive imports[lv].

The **CBAM** is designed to be compatible with WTO rules, but it has been raising the debate worldwide on using the environmental agenda to implement protectionist measures in global trade. In this regard, the EU plans to grant reduced charges if emissions have already been subject to a direct carbon price in their country of origin. For countries that export to Europe, the question is whether carbon price revenues will go to the EU or stay in the country. If they decide on the latter, they must put in place the infrastructure of monitoring, reporting, verification, and compliance systems for the EU ETS[lvi].

Carbon pricing

In times of high inflation and global energy crises, as seen after the COVID-19 pandemic and because of the Russia-Ukraine war, the political economy of carbon pricing has become more complex. According to the OECD (2023), carbon prices and coverage are still too low to achieve the Paris Agreement's targets. According to the High-Level Commission on Carbon Prices (2017), adjusting to inflation, prices would need to reach USD 61/tCO2 to USD 122/t CO2 by 2030 to be on track to keep temperatures below 2oC. As of April 1, 2023, less than 5% of GHG emissions were covered by a price at or above the range, with most of the high prices in Europe[lvii]. According to McKinsey & Company, in developed economies, the cost can be above US$100, but in Brazil, a price near US$20/t CO2 Brazil would activate 95% of the necessary levers for investment, including preventing deforestation in the Amazon[lviii].

Voluntary Carbon Markets

Voluntary carbon markets (VCM) are very "fragmented and complex" (UNDP, 2023, page 8). Unlike regulated markets, where businesses must pay for emitting based on unified criteria established by governments or international authorities, in VCM, companies, and individuals choose to acquire carbon credits to offset their emissions. ESG, reputation, and market goals are the primary demand drivers from companies in this market, "but compliance demand could become more important" (The World Bank, 2023, page 9).

Carbon credits generated can come from **avoidance projects** that reduce the volume of GHG emitted or **removal projects** that sequester carbon from the atmosphere and store it. In the first one, examples can be the efficient use of fertilizers, renewable energy, avoided deforestation (REDD+), regenerative agriculture practices, etc. Second, we have reforestation and afforestation, the recovery of degraded land, agroforestry, etc.

VCM players, process, and principles

Governments (regional, national, or subnational) can establish voluntary carbon credit standards, such as the California Compliance Offset Program and independent nongovernmental entities. The latter dominate the supply of credits,

[34] For further information, access: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

accounting for almost 60% of the total offsets issued in 2022.

Verra's Verified Carbon Standard (VCS) is the most significant independent crediting standard mechanism over 80% of credits issued), followed by **Gold Standard**[lix]. They certify that a project meets its objectives and its target volume of emissions. **"Standards"** are the leading **players** that comprise voluntary markets' structure and engine.

Along with standards, other players are **project developers**, the upstream part of the market, which must complete a rigorous process to generate offsets, including validation of the Project Design Document by a third-party auditor and then verification by organizations like Verra that assesses the delivery of GHG mitigation after the project has been implemented and monitored over a period—several well-known project developers in Brazil, such as Biofilica, Waycarbon, and Future Carbon.

As explained in the previous section, for a crediting mechanism to certify that a particular project has its stated volume of emissions impact, the first step is determining a "baseline" or "reference level" against which performance is measured periodically. The baseline assumptions and accounting methodologies to calculate emission reductions vary by sector and program scale[lx], but principles need to be followed for all of them:

- ***Additionality:*** determines that projects can only be validated if efforts to reduce emissions would not have happened in a "business as usual" environment and would not have occurred without the incentive created by carbon credit revenues. Efforts undertaken because of legislation requirements, such as compliance with the Brazilian Forest Code in Brazil, are not considered additional. The baseline in Brazil is already high for farmers[lxi], and the additionality can exclude farmers who have already put sustainable measures in their farms in place. It will depend on the baseline adopted (for example, what year of adoption the methodology will consider). In such cases, other types of financing would better suit these farmers since an offset credit enables the buyer to emit the same quantity of carbon, which could harm the overall carbon balance and the environment.
- ***Permanence:*** "The GHG emission reductions or removals from the mitigation activity shall be permanent or, where there is a risk of reversal, there shall be measures to address those risks and compensate reversals." In the case of carbon farming, permanence is an essential issue for farmers. Carbon contracts generally have at least five years (or even more – 10, 20), and growers must consider this with possible risks for their business.
- ***No double counting:*** the GHG emission reductions or removals from the mitigation activity "shall only be counted once towards achieving mitigation targets or goals." It must include proof of the credit retirement upon project maturation, then becoming an offset at retirement (Source: PNUD, 2023).
- ***Robust quantification of emission reductions and removals:*** "The GHG emission reductions or removals from the mitigation activity shall be robustly quantified, based on conservative approaches, completeness, and scientific methods." Each type of carbon project has its requirements. For example, in a reforestation project, specific rules need to be followed to calculate the level of CO2

sequestration and the number of carbon credits it produces over time. While this is an essential requirement, it can be costly and depend on the price of carbon to be worth it. Generally, the amount paid for carbon storage in soils in Brazil is still below the quantification costs.

- ***Leakage avoidance**:* if the project only displaces the emissions to a different location, it is considered leakage. As an example, a forestry project that resulted in deforestation elsewhere.

Then, when a project developer issues offsets, they can be sold. "With no centralized voluntary marketplace, finding a buyer can be a multi-step, challenging process" (UNDP, 2023, pg. 19). Project developers can sell credits to end buyers.

Some companies, such as Future Carbon, develop projects and trade them. Project developers can also work with **Brokers/traders/retailers** to link supply and demand, which can be done in bilateral private arrangements, over-the-counter deals, and exchange platforms, such as the New York-based Xpansiv CBL and Singapore-based AirCarbon Exchange (ACX).

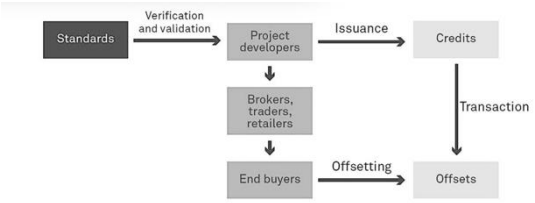
Finally, **end buyers** (consumers, individual consumers) are the downstream market. Once an end buyer claims an offset against their emissions, it must be retired, and they can no longer be traded representing. Emissions that are permanently "removed" from the atmosphere.

End buyers can also finance their carbon project and decide to sell or keep the issued credits for offsetting needs. "All these juxtapositions can impact price and ultimately affect market transparency." (Source: UNDP, 2023, p.9).

Issuing credits is very costly (around US$500.000 through Verra, the standard that international buyers typically require for projects in Brazil), and it can take time (2-3 years). So, projects need a specific scale to be worth it (at least 25-30 thousand hectares in Brazil). According to the World Bank (page 42), "Emission-reduction projects often face challenges in financing upfront development costs, as revenues from selling carbon credits are often uncertain and only start flowing years after the project is implemented." Even before beginning the project, having an end buyer to reduce the risks of not selling the credit or for a lower price than expected is interesting.

Transparent prices in VCM are essential for project developers to assess investments and buyers to manage their price risks. In this market, credits follow free market pricing, which depends on factors such as the volume of credits acquired, where it is located, the year of generation, the delivery time, if they generate other co-benefits (such as social, and other SDG goals) that result in better prices, etc. Removal credits are generally traded at a premium price compared to avoidance because they require a higher level of investment; it is also more in demand as it is considered a better tool against climate change[lxii].

Figure 3: Main Players of the VCM



Source: UNDP, 2023

VCM Challenges and Perspectives

One of the main challenges of the VCM is that it is done through more flexible MRV standards from different organizations, which have different levels of criteria or

rigor, needing more transparency and efficiency. This is a central point of criticism about voluntary credits, as there are doubts regarding their practical environmental benefits, especially about forestry projects (REDD+). In February 2023, The Guardian[lxiii] published an article suggesting that over 90% of rainforest carbon offsets by the most prominent certifier, Verra, were worthless. Additional studies stated the same.

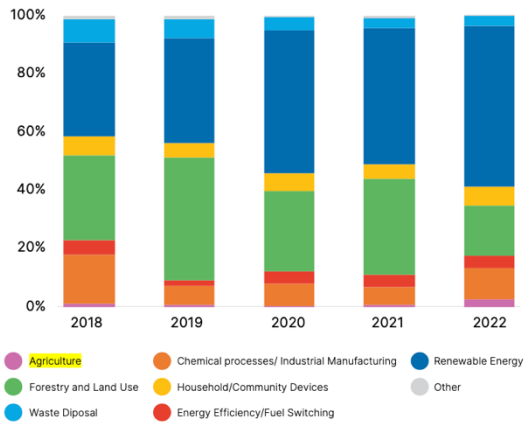
According to the World Bank (2023), in addition to macroeconomic challenges, the integrity of these credits, continued uncertainty around greenwashing, and bottlenecks in issuance because of a scarcity of accredited validators and verifiers were apparent causes for the market's 4% retraction in 2022, after a sharp increase in 2021 achieving a US$ 2 billion in value. The VCM has significantly developed since the ratification of the Paris Agreement, having tripled since 2019 (but in Brazil, the number is still tiny: 159 projects certified - April 2023).

To tackle such risks, different voluntary initiatives (ICVCM, VCMI, SBTi, etc.) seek to promote high-integrity standardization and improve transparency in the market to help buyers of credits to reduce risks; efforts accompanied by growing regulatory interest (Annex 11). Rating agencies (BeZero Carbon, Calyx Global, and Sylvera are the biggest ones) also offer ratings for individual projects using several criteria and utilizing advances in machine learning and geospatial data[lxiv]. Furthermore, according to the World Bank (2023, p. 9), the VCM continues to evolve and is becoming more diversified and sophisticated "with new investors, financial products, technological platforms, and service providers laying the foundations for what some expect will be a decade of significant growth."

According to the leading global financial actors, there are significant differences in projections for market growth (Annex 12). From 10 billion dollars in 2030 (BCG) to 100 billion dollars in 2030 (Credit Suisse and Morgan Stanley). The project developer, Biofilica[lxv], is more skeptical about the market's growth and believes it will not achieve 2 billion dollars this year, after the market decrease. The problem is on the demand side. Big companies like Nestle and Sodexo are backing away from offset schemes, pleading they will divert originally offset funds into their decarbonization projects.

The other challenge of the voluntary carbon markets is the price, which is considered low to advance in decarbonization projects. According to the World Bank (2023), futures contracts suggest modest price increases in the coming years. Prices fell in 2022 and are still below those seen in 2021. Nature-based credits experienced the most significant drop, from around 16 US dollars to under 5 US dollars in 2022.

Figure 4 - Percentage of total issuance by project category and year



Source: The World Bank, "State and Trends of Carbon Pricing 2023"

Nature-based credit projects' evolution was not constant in the last years and declined in 2022. Carbon offset credits originating from agricultural projects are still less than 1% on the voluntary market, but they

increased in 2022. Another trend is the search for local carbon credit projects, with companies buying land to develop their projects. This is seen in Australia since end buyers can finance their carbon project and decide if they are keeping all or part of the credits for offsetting targets.

In addition, there is an increase in the search for premium projects that are not only focused on carbon but could generate **co-benefits** valued by buyers on biodiversity, water, and the communities, for example. Projects in agriculture are expected to be well positioned in this sense.

Finally, according to the World Bank (2023), the implications of developing Article 6 of the Paris Agreement to the VCM still need to be clarified. Still, the requirements of different buyers could converge with the guidance and conditions specified by independent initiatives like ICVCM and VCMI. "Ultimately, it will be up to individual companies and other buyers to decide on desirable credit attributes (e.g., project type, vintage, quality, etc.) and whether they source credits with or without a corresponding adjustment to meet voluntary commitments. As such, the size of voluntary demand for correspondingly adjusted credits, as distinct from mitigation contribution A6.4ERs or other carbon credits entirely outside of the Article 6 framework, remains to be seen". (The World Bank, 2023, pg. 48)

3.2 Offsetting x Insetting

There are some essential differences between offsetting and insetting. As explained, offsetting is the market where companies, organizations, or individuals voluntarily offset their carbon direct carbon emissions (Scope 1) by buying credits generated from projects outside their direct supply chains that reduce, sequester, or avoid GHG emissions. Generally, they are from a different sector from the company purchasing them.

Insetting is a reduction in indirect GHG emissions (Scope 3) not in the control of a business, but it is part of its supply chain (Figure 5). Insetting "keep emissions reductions by farmers within the agricultural sector, and they can be claimed by multiple companies that use or process the agricultural commodity" (Sierra View Solutions and American Farmland Trust, 2023, page 14), different from offsetting. SBTIs and other target-setting initiatives are the reference.

Scope 3 emissions are much higher in the food industry than in the other two scopes. For example, in the case of Nestlé, Scope 3 represents 95% of the company's GHG emissions; Scope 1 is 3%, and Scope 2 is 2%.[lxvi] These large agri-food companies have increased responsibility in decarbonizing supply chains to effectively achieve reduction target emissions, with regenerative agriculture becoming a primary feature in their sustainability disclosure (Annex 9). According to representatives of PepsiCo, Ambev, and Nespresso at the GAF event in São Paulo in July 2022, their companies have a significant role to play in Scope 3 emissions, and they know that they will reach their net zero targets if they work with the producer in the field.

Insetting programs are relatively new, and most are still in pilot phases, with rules being defined and shaped with more flexibility and less rigorous MRV compared to offsetting, which does not always require third-party verification. Insetting is evolving mainly in two different activities in the agriculture sector, according to Sierra View Solutions and American Farmland Trust (2023, page 14):

- No additionality needed: companies pay farmers who have already implemented regenerative practices, such as no-till and cover crops, minimizing their Scope 3 GHG

emissions baseline. The reference is the inventory method under the draft Land Sector and Removals Guidance from the GHG Protocol.

- Additionality needed: when a company has established its Scope 3 emissions baseline and emission reduction targets. Companies can incentivize farmers to adopt new regenerative practices and claim reductions through the crediting mechanism (Section 13 of the draft Land Sector and Removals Guidance). According to Sierra View Solutions and American Farmland Trust (2023, page 14): "It is still too early to determine if the reduction in MMRV requirements will significantly reduce the transaction costs of implementing agricultural conservation practices or if it will translate into larger payments to producers."

According to FAIRR (2023)[lxvii], only 4 four companies have dedicated funding to support farmers in implementing regenerative practices:

- JBS: USD$100 million by 2030
- Nestlé: USD $1.3 billion by 2025
- PepsiCo: At least USD 216 million by 2030
- Sodexo: 15% of Good Eating Company (GEC) food budget by 2025

Indeed, companies need to be more transparent toward farmers concerning payments. Sylvain Hypolite, from France, mentioned that a buyer offered a premium for good practices one year, and a year later, they were paying only half of the previous year's premium. At their cooperative, Agro D'OC from Occitaine, they prefer the offset market to have an "exchange money method" not linked to the price of their products because buyers would have the power to decide about it. They want the growers to be at the center of the carbon credit payment, even if insetting could be easier than generating credits to offset for them. "Freedom has no price," he said.

Choosing a program can depend on different factors, including the appetite from the farmers for risk and how it fits the farmer`s business strategy. For example, farmers in Normandie were satisfied with the premium price they received for sustainable rapeseed production (even though they agreed that the premium could be better). They sign contracts yearly with the company and are paid based on standards available in the European Union, around 60 euros more per ton of good results.

Marjorie Lambert, one of the farmers in Normandie, prefers to take fewer risks in one-year contracts instead of 5-year contracts proposed in offsetting programs, for example. In addition to price/ payment transparency, the lack of independent and consistent standards for such programs, even with the draft guidance from the GHG Protocol, may result in "weak programs that do not reduce GHG emissions or credit practices that are not new." (Sierra View Solutions and American Farmland Trust, 2023, page 15).

Recently, some important companies, such as SODEXO and Nestlé, in the face of high-profile criticisms of carbon offsetting schemes, have backed away from them to fund their decarbonization projects. However, as in the case of offsetting, experts are also divided about insetting programs in delivering emissions reduction goals, as regenerative practices can have different definitions[lxviii]. According to Sierra View Solutions and American Farmland Trust (2023), no publication is available with information on the volume of GHG reductions insetting programs have generated to date. The transparency in measuring and publicizing the outcomes of adopting sustainable/regenerative practices must increase. SBTi has recently released new guidance for forestry, land use, and agriculture companies.[lxix]

3.3. Farmers' access to carbon programs

Farmers in countries like France, the USA, and Australia already have some options to sign contracts to receive carbon payments. In the agriculture sector, most of such initiatives are concentrated on adopting sustainable/regenerative practices in temporary crops. These initiatives still need to include permanent tree crops, such as vineyards. There are a few exceptions with methodologies available, such as the Label Bas Carbone in France for permanent tree crops and a Verra method under validation for Orchards in Australia.

However, the path between growers who sequester more carbon than emit (carbon negative) and their compensation with carbon credit payments can be complex, costly, and time-consuming depending on the mechanism, making it difficult for growers to access these financial mechanisms, especially for smallholders and medium farmers.

They are also not always clear about the costs and revenues to be generated; they can depend on a complex chain of intermediaries from farmers to buyers that decrease the amount paid to farmers, and they can demand a great engagement (duration of contract, documentation, and data, management), etc.

According to Demenois and al. (2022), certification standards for soil organic carbon are still a jungle because they are essentially not clear to farmers the costs and benefits of each of them. From an inventory done by them of 22 standards available, only 3 gave information on the costs and expected benefits from certification.

Carbon Farming Models

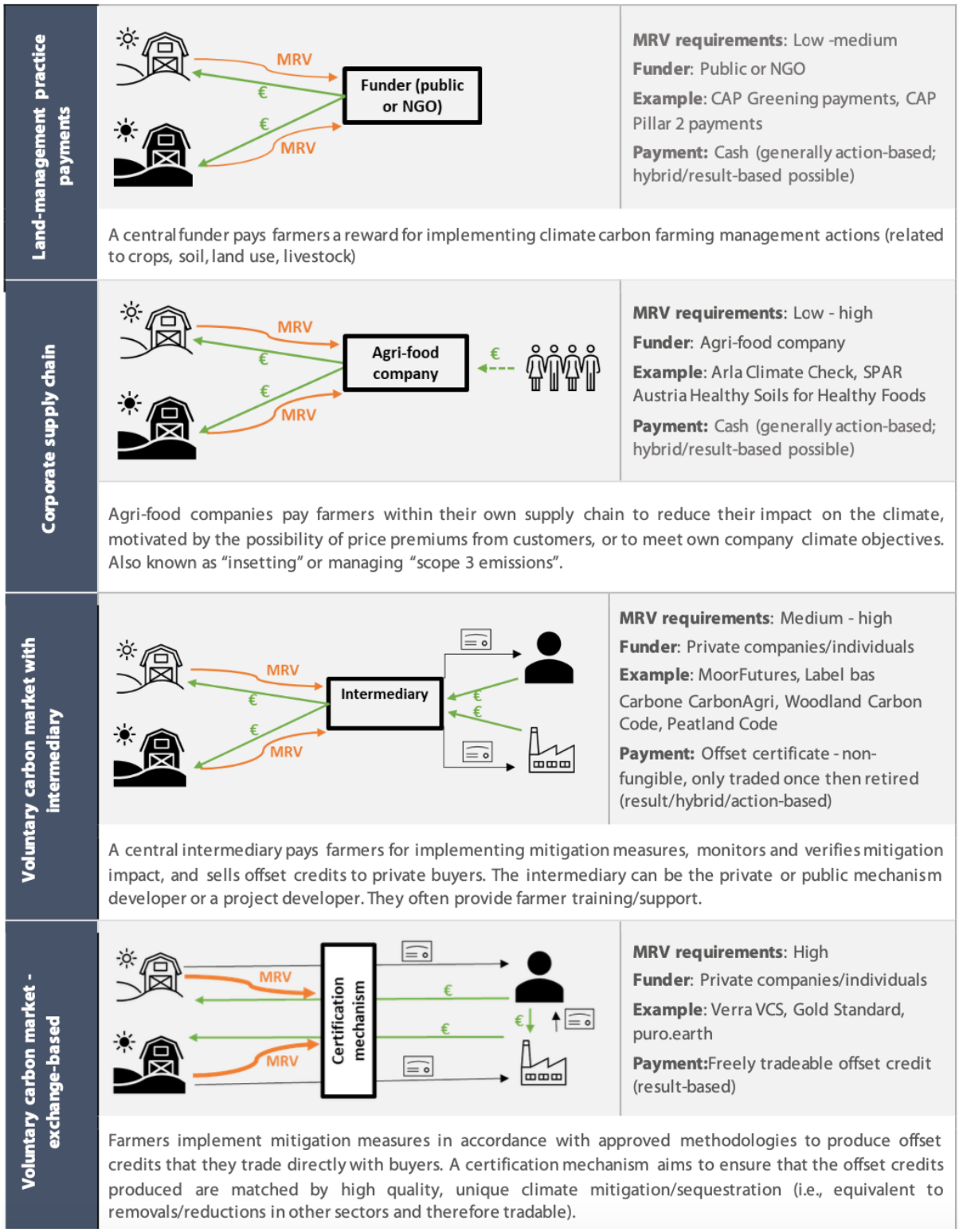
In the publication "Carbon Farming, Making Agriculture Fit for 2030" from the European Parliament, there is an exemplification of 4 standard models of carbon farming mechanisms through which carbon payments can be made (Figure 5) through different mechanism types: 1) Land management practice payments; 2) Supply chain (as discussed previously); 3) VCM with an intermediary; and 4) VCM exchange-based. The differences between them include who pays the farmer, what kind of payment they receive (cash or an offset credit tradeable for payment), and, primarily, the level of MRV required.

The existing methods need help conciliating a robust methodology with implementation. Less robust may be easier and less expensive to implement but may not contribute to neutralizing buyers of credit emissions, resulting in a worse scenario in the fight against climate change. Stricter the MRV, it is more complex and costly for farmers to participate, but it can reduce the uncertainties concerning determining GHG emissions mitigation.

According to Parkhust and all (2023), in addition to the critical barrier of the programs' economics, additionality, permanence requirements, and the immaturity of the technology, associated data protections are essential impediments to implementing these programs in the USA.

In the case of European CAP, which requires low monitoring requirements for farmers and administrators, farmers receive payments in an action-based mechanism when complying with a defined farming practice or implementing specific technologies.

Figure 5: Models for carbon farming mechanism



Source: European Parliament, "Carbon farming Making agriculture fit for 2030", 2021, page 28

In a result-based mechanism, payment depends on the delivered mitigation outcome regardless of the specific actions taken. The results must be quantified and verified, which requires costly and complex MRV. If prices and mitigation are uncertain, it also poses uncertainty for farmers, who may advance the money for the initial costs, including baselining carbon.

Payments can also be made through a hybrid mechanism combining up-front costs for farmers to implement specific farm management actions with additional charges based on measured mitigation results, such as in some VCM with intermediaries' initiatives. "Hybrid models can increase farmer uptake by lowering risk and removing upfront financial barriers while still providing flexibility to farmers to implement optimal actions for their farms and guarantee real climate results for society." (European Parliament, 2021, page 27) However, the costs of the intermediary (commonly farming consultants) have to be taken into account, and what is the final proposed price for farmers?

Example 1: Government-operated *Label Bas Carbone* in France

In 2018, the Ministry of Ecological Transition in France created the low carbon label (*label bas Carbone*) that certifies projects that reduce greenhouse gas emissions and/or sequestrate carbon to generate carbon credits in the voluntary market in France. The French label is the leading standard in Europe for carbon farming, but it can only be applied in France. A methodology for carbon farming credits in the European Union is still under development. Verra is not commonly used in Europe, as in other parts of the world, where it is the leading certifier, including Brazil.

The *Label Bas Carbone* methodologies are submitted to the Ministry for approval. The cost of developing a new methodology is estimated to be between €30 000 and €50 000 (or more), depending on its complexity[lxx]. In agriculture, six methods have been validated so far[lxxi].

Table 1 – Label Bas Carbone approved methodologies

Methodology	Developer	Project duration	Baseline	Practices
CarbonAgri for cattle and arable farming reductions[lxxii].	Livestock Institute (Idele)	5 years, renewable.	Specific reference scenario: individual diagnosis for each farm involved in the project, at the time or at most four years before the farm enters the project. 2. Generic reference scenario: established by production system and large	Reduced farm energy consumption; Soil carbon storage; Carbon storage in aboveground biomass; Organic nitrogen fertilization and manure management; Mineral fertilization; Organic and mineral nitrogen fertilization; Improved protein autonomy; Optimization of animal feed; Livestock management; Optimization of tech technical routes.

			geographical area. A 10% discount is applied in the case of a generic reference scenario.	
Sustainable management of hedges[lxxiii]	Pays de la Loire Chamber of Agriculture	5 years, renewable twice (i.e., 15 years). The calculation of the emission reductions that the project can generate is carried out over 15 years.	follows the national trend of degradation of the line of hedges in France. It is based on the initial diagnosis of the (Sustainable Hedge Management Plan, carried out by an approved adviser for a maximum of one year before the project is submitted.	planting and sustainable management of the hedge.
SOBAC'ECOTMM management of inputs[lxxiv]	SOBAC	5 years, renewable	specific to each farm built on the continuation of cropping or livestock practices preexisting in the project. Input consumption is considered five years preceding the notification of the project.	reduced inputs and better management of nitrogen fertilization to reduce nitrogen fertilizers by 30% at constant yield.
Ecomethane for the reduction of methane emissions of digestive origin through the feeding of dairy cattle	Bleu Blanc Cœur	5 years, renewable	1.Specific: reference scenario: enteric methane emissions measured on the feed ration of the herd before the project. Data for at least the 12 months before the	Improvement of protein autonomy and optimization of food autonomy.

			project's start are necessary (quantities of milk produced, fatty acids present in the milk, and the number of dairy cows). 2. Generic reference scenario: in the case of system changes when the operation enters the project. The enteric methane emissions data from French forage systems, established through various studies, serve as a reference. A 10% discount is applied.	
Field crops for emission reductions on field crop farms	Arvalis, Terres Inovia, ITB, ARTB, and Agrosolutions.	5 years, renewable	1. A Specific reference scenario is chosen by default unless the data for the three pre-project years (installation, recovery, etc.) is unavailable. 2. Generic scenario: based on regional average data, a 10% discount is applied.	Nitrogen fertilization (mineral and organic); Reduction of farm energy consumption (fuel, electricity, etc.); Practices to store carbon in the soil.
Plantation of orchards for	Compagnie des Amandes and Agrosolutions	20 years (average lifespan of an orchard), with a 5-year audit stage allowing recognition of the	In the absence of the orchard, the previous use of the plot is continued. The reference scenario is based on the use of the field during the three years preceding	plantation of dried fruit (almond, chestnut, hazel, walnut), pome fruit (apple, pear, quince, fig), stone fruit (apricot, cherry, peach, nectarine and nectarine, plum). Berry crops (raspberries, blueberries, gooseberries) on land currently not cultivated for this purpose

		reductions in emissions. -	the project (arable land, viticulture, permanent grassland).	in the South of France. The orchard must be permanently covered over at least 50% of its surface.

Source: France Ministry of Environment

Concerning the Plantation of Orchards methodology (one of the few current methodologies available worldwide for this kind of crop), scientifically published data on permanent crop sequestration in France was used as the baseline for all crops. Soil carbon relevant to the regions was also included. According to the method, the Mediterranean region was where the implantation of orchards had positive results in carbon sequestration compared to the baseline. In the other areas with permanent pastures in France (rich in carbon), around half of the soil carbon would be lost instead of increasing, as in the Mediterranean. The reasoning of the methodology is the following:

CARBON BALANCE OF PREVIOUS CROP =

+/- CARBON CONSUMPTION OF THE CROP

+ CAPTURE CAPACITY OF A TREE x DENSITY

The methodology only applies to new plantations in the Mediterranean region, not existing ones, because the goal is to use the mechanism of carbon credits to finance the implantation of new orchards in the country, paying 50% of recognition in the first year and the other 50% in the year 5. The company created a carbon intermediation platform precisely to carry out these transactions. However, buyers' interest in this kind of carbon credit could not be verified with the company's staff. According to an article from the press,[lxxv] to finance its orchards, La Compagnie des Amandes is opting to raise funds through convertible bonds.

To date, 13 agricultural projects (around 1,300 farms) have been labeled "bas carbone" in France with the methods available. This number is still small because methodologies have been released recently (4 of them in 2021). Farmers and developers of projects interviewed in May 2023 also pointed out some other challenges to scale up the *label bas carbone*, such as:

- the interest of farmers to engage in the process that may not be willing to change practices and/or take risks because of data issues and/or uncertainties linked to the lack of knowledge, costs of change, management, potential yield decrease, etc;
- the costs of the label that can be more important than the amount paid for the credits (all methodologies require independent or external audits; some can be only documentation or also require field visits), including the value to be paid to intermediaries that may be needed (such as project developers / credit sellers);
- the price paid for carbon credits (currently around 30-35 euros/ 1 ton of C in most initiatives);
- difficulties finding buyers for the credits in the national volunteer market, etc. (credits bought in France are only 3% of total credits bought by national companies. Lower price is the first driver for buying carbon credits abroad, according to Terrasolis[lxxvi]).

To overcome such difficulties, some cooperatives in France, such as AGRO

D'OC from the Occitanie region with over 1,000 members, have supported farmers in the carbon market, including the technical aspects of the field. At their cooperative, they have a center of specialized studies in agriculture in which farmers get together with the engineers to share experiences, best practices, challenges, and success cases. AGRO D' OC has a project to label around 100 farmers (15,000 ha) and generate 15,000 tons in carbon credits (1 ton/ha).

For the *label bas carbone*, they have opted to conduct the process without intermediaries and sell the credits on their own, expecting to increase the amount paid to the farmers for the credits they generate (at least 50 euros per credit, Sylvain said). They are using the CarbonAgri methodology with a specific baseline (not the generic one) not to have reductions in their carbon credits and to increase the biomass in the system, which is the goal in a context where resilience to climate change is critical. As a tool, they are using the Sysfarm calculator.

According to Sylvain Hypolite, the cost to generate one credit is 65 euros, and to compensate for it, they plan to sell their project as local premium high-quality credits that create other benefits. The process is ongoing at the Cooperative, and they still need buyers for the credits (June 2023).

For those wanting to pass through an intermediary, France Carbon Agri Association "sells emissions reduction certificates to corporate and private buyers. The revenue from the sales of emissions reduction certificates is used to pay farmers per t CO2-e emissions reduced, as well as cover training and administrative costs" (European Parliament, 2021, page 34).

The start-up Carbone Farmers, for example, proposes to support farms to get their *label bas carbone* in 2 steps: 1) doing a preliminary study on the farm`s carbon balance, costs of practices to be adopted, and additional benefits that could result; and 2) project implementation to be sent to the Ministry for certification. For that, the farmer must pay in advance (500 hundred euros for the audit), and it needs clarity about how much he will be paid for the credits. It also has the risk of decreasing yields with new practices.

In addition to *label bas carbone* methods, start-ups offer different carbon programs in France, such as Soil Capital[35] based on ISO 14064-2, which combines aspects of compliance and voluntary offset markets and insetting programs. The company uses Cool Farm Tool's[36] greenhouse gas model to measure the greenhouse gas balance across the farm. ReGeneration[37] has a different methodology: paying farmers initially and measuring carbon during the project period. Big companies like Cargill are also working with insetting programs in France.

[35] For further information: https://www.soilcapital.com

[36] For further information, https://coolfarm.org

[37] For further information: https://regeneration.eu

Example 2: Verra carbon credits for permanent tree crops in Australia

Permanent crops, like vineyards and fruit orchards, have structural characteristics, such as long-life cycles and permanent organs. Depending on plant age and species, water availability, nutrients, temperature, and system management, this allows them to sequester and accumulate significant carbon. However, the access to remuneration via carbon trading to permanent corps growers is minimal compared to forest and plantation crops[lxxvii].

These kinds of crops are not included in the existing methodologies for carbon farming under Australia's compliance-based Emissions Reduction Fund (ERF) carbon market scheme, in which the Australian government is the leading purchaser of credits. They have to access carbon markets through private operators of VCM, such as Verra. According to Oli Madgett, head of special projects at Farmlab in Australia[lxxviii], a methodology that aims to integrate methods to all vegetation is still under development in Australia for the ERS.

In the ERS, established methodology determination (methods) provides the rules for several activities crediting Australian carbon credit units, or ACCUs, including for carbon sequestration in the soils and afforestation. Some public tools help farmers choose the methodology, such as the Clean Energy Regulator Soil & Vegetation Sequestration Decision Tree (Annex 13). One ACCU is equal to one tCO2-e stored or avoided by a project. Examples of carbon farming practices include cover cropping, the prevention of overgrazing, and no-till cropping.

The number of carbon farming projects in soils in Australia has increased between 2021 and 2023 with the release of a new methodology that combines measurement and modeling to quantify soil carbon changes, even if its efficacy is not unanimous between market participants.[lxxix] As of 13 April 2023, 450 soil carbon projects were registered under the ERS since 2015, but only one project has been issued credits. Soil carbon projects in Australia require a carbon price of AU$30+ to be viable[lxxx]. Some methodologies also demand a certain level of scale. It takes around three years for projects to begin generating ACCUs, and it is a very rigid methodology, with extensive project management and an obligation of permanence for 25 years. According to Madgett, this carbon contract must be dealt with when a farm is sold, which could interfere with the property's value.

Other reforestation cases from Australia show some problems in the super evaluation of carbon sequestered in the MRV, paying much less than expected to growers three years after engaging in the project. Oli explains that, for the moment, there are a lot of challenges and risks in accessing this kind of carbon financing. The significance of it to the business depends on risk appetite and how the risk is managed and offset, such as using insurance[lxxxi].

In the case of fruit orchards and vineyards, which still need methodology in the Australian ERF, the company Carbon Friendly[38] has developed a methodology called *Ground-Truth Australian Orchards* that was submitted to Verra and is under validation[39]. Carbon sequestration or

[38] For further information: https://carbonfriendly.com.au/

[39] Methodology approval process is bottom-up (created by developers). Steps (Source: Environment Agency of Austria) :
1) The developer submits a methodology concept, which Verra reviews and accepts into the entire approval process if it meets evaluation criteria. 2) The methodology developer develops the complete method and submits it. 3)Verra review: initial review to ensure "sufficient quality" – professionally written, aligned with rules, etc. Verra charges USD 2,000 at this point (an additional USD 6,000 is set if the method is accepted). 4) Public stakeholder: The method is published online for 30 days for public comment. 5) Validation/verification body (VVB) assessment and final approval: Verra contracts eligible experts to review. The project developer pays them directly (in addition to Verra fees). They review; the project developer responds to any comments and can amend. The VVB produces a final assessment

avoidance has to be measured and verified, and tradeable carbon units will be issued. The project is expected to have 17,000 hectares throughout Australia, including the macadamia plantation. One of the project's requirements is that the area must not have been cleared of native ecosystems within ten years before the project's start date. The carbon is only accounted for in trees when they meet additionality requirements. When trees do not meet the criteria, they are not measured (i.e., mature orchards). A combination of the following practices must be implemented[lxxxii]:

- Reducing the use of synthetic fertilizers by incorporating organic amendments and reducing the use of chemical pesticides via improved integrated pest management;
- Cover cropping, including promoting inter-row biomass generation and the establishment of multi-species cover crops;
- Establishment of new permanent tree crops and associated canopy growth;
- Promoting specific regeneration of soil and the increase of soil organic carbon (SOC);
- Reducing water consumption and energy use through improved irrigation management;
- Promote carbon sequestration in the above-ground biomass;
- Improved crop residue management by reincorporating pruning and crop waste into the soil.

According to Carbon Friendly[lxxxiii], attracting farmers to participate in the project is one of the main difficulties. First, they must pay to sign up (the initial cost is essential). In addition, the macadamia prices are meager now (farmers are losing between AU$0.30 – 0.50 per kilo), and they are using less organic matter in the soil, reducing the improvement of the soil carbon. One of the companies visited used to compost the almond shells in piles, but because of the low prices of macadamia and operation costs, they are composting the shells directly under the trees. It is an example that it is hard to be green if the business is in red.

"You can't be green if you're in the red" (Richard Leask, farmer and consultant, Australia)

Example 3: Start-up carbon farming programs in the USA

In the USA, there are more than 20 agricultural carbon programs (Annex 14), with "different eligibility criteria, crediting practices, data requirements, contracting obligations, costs, and potential returns." (Sierra View Solutions and American Farmland Trust, 2023, page iii). Despite the number of programs available and market efforts to increase farmers' participation, it remains extremely low. According to Sierra View Solutions and the American Farmland Trust report, the most critical barriers are the economics of the programs, concerns about additionality, requirements for permanence, and data and technology barriers.

According to Ruth McCabe, a Conservation Agronomist from the USA, the average price farms are receiving is US$ 20 per ton of carbon. The amount they will be paid per acre will depend on the sequestration capacity of the soils and practices adopted, varying from US$5 -12 per year. On average, farms are sequestering 0.5 tons of carbon per acre per year by adopting no-till and cover crops. Still, according to Ruth, there are a lot of controversies regarding these carbon programs, including applying

report, which Verra will review and accept/reject accordingly. For further information: https://registry.verra.org/app/projectDetail/VCS/4118

for carbon programs without the authorization of the owners of the lands. Or if, in the 5-year sample, farmers received money in advance and did not sequester what was expected, do they have to pay the company back? As well as other issues.

One of the platforms available in the USA for carbon offsets from carbon sequestration in soils is the marketplace **NORI**[40], created in 2018. The business uses blockchain technology to replace an offset market registry. They are in a pilot phase and target US farmers with over 1000 acres. Nori counts as additional farms that adopted new practices in the last ten years if they can demonstrate at least three years of pre-switch operating data to support their claim. The cost of entry in their carbon market platform is US$ 3,500 – 5,000. Farmers must sign a contract of at least ten years, fulfill other conditions, and do several practices, including no-till and cover crops. According to Nori, in one of their demo days in 2022, on average, an acre could sequester 0.56 tons of carbon per year, with a price ranging around US$ 15.

Another company proposing carbon programs in the USA is **Indigo**[41]**,** the world leader in the sales of carbon credits from soil carbon sequestration in agriculture. The company operates in an Exchange-based voluntary carbon market structure, having developed a Verra Voluntary Carbon Standard methodology for quantifying soil carbon increases on croplands. The project duration is ten years, and sequestration is estimated by a hybrid model, either by direct measurement or modeling using farm data. Baselines are set using direct measurement. There are uncertainties concerning the robustness of the methodology. They have paid up to US$30 per acre for implementing practices (one of the highest values), but the average price is US$15. Even though, according to Sierra View Solutions and American Farmland Trust, 2023, page 17):

"A carbon program payment of $30 per acre is a fraction of a corn producer's revenue for growing corn. Assuming the average 2022 yield of 172 bushels of corn per acre (Schnitkey, Paulson, Baltz, & Zulauf, Weekly Farm Economics: Corn and Soybean Yields in 2022, 2022) and an average price of $6.86 per bushel (Schnitkey, Paulson, Baltz, & Zulauf, 2022 Harvest Prices: Payments for 2022 and Indications for 2023 Projected Prices, 2022), a corn producer's gross revenue per acre is approximately $1,180. A carbon payment of $30 per acre is only an additional 2.5% of gross income per acre. If implementing the practices reduces yield by more than four bushels per acre, producers lose revenue".

That said, the amount paid to farmers need to be higher to pay back the investments, in addition to all risks linked to these contracts. These are barriers to increasing the participation of farmers in these carbon offset markets. Sierra View Solutions and American Farmland Trust propose several recommendations to overcome such challenges, including supporting policies that increase the price of carbon, and include early adopters to provide peer-to-peer training and reward them.

3.4 Access to carbon financing for Brazilian agriculture

In Brazil, in addition to the potential of carbon markets for agricultural practices, there is a significant amount of native vegetation inside farms, as explained previously, that can still be legally deforested. Are farmers able to access carbon markets for agricultural activities? Can they access financial benefits to keep native vegetation through carbon markets?

Carbon markets for agricultural activities

[40] For further information: nori.com

[41] For further information:. The company lost 92% of its market value in 2023, from US$ 3 billion to US$ 250 million.

Regarding carbon markets for agricultural practices in Brazil, specialists believe that they will still take some time to develop, and growers should focus on better practices that can contribute to carbon sequestration to foster productivity, cost reduction, and resilience in the first place.

In the Globo Rural meeting in São Paulo in October 2022[lxxxiv] about carbon, the message was "carbon markets will be only the cherry on top"; not even a premium price is expected (for coffee, a bit different – a premium of 10%). In addition, non-tariff barriers, such as from the EU, are expected to be intensified, and growers must be prepared to be in the market (transition risks). According to the panelists, farmers should improve their practices (intensification, carbon in the soil, etc.) without thinking they will be rewarded financially.

According to Bayer[lxxxv], which has been implementing the Pro-Carbono program in Brazil that aims to help farmers intensify sustainable agricultural practices that will increase their resilience and profitability, reducing costs; the average productivity increase in farmers participating in the program was around 7%. Pro-Carbono practices can include No-till, cover cropping, crop rotation, high-performance genetics and biotechnology, optimization of fertilizers, digital agriculture, and monitoring. According to General Mills, the productivity increase in their regenerative farming projects in Brazil was about 10%.

The Indian company UPL aims to sequestrate 1G ton of carbon in agriculture globally, including Brazil. The additional practice they are working with is using biologicals that reduce the need for chemical fertilizers. According to Rogerio Mello, the company was working with partners to develop methodologies adapted to Brazilian agriculture, but it was a complex task. Their contracts with farmers will be 5 years (+5 years renewable). They were engaging farmers in the project and developing the metrics (October 2022).

As seen in other countries, methodology is a real issue in developing this market because robustness is needed to guarantee emissions reductions that will be offset. But the costs are high. In Brazil, the cost of soil sampling is still not worth the prices paid for carbon. Embrapa has been working on the result of the use of induced plasma laser (LIPS) for tropical soil that aims to reduce by 50% the costs of sampling. Verra approved the technology. According to the World Bank[lxxxvi]:

"Innovations in MRV can help expand climate action worldwide and unleash the potential of climate finance and the carbon marketplace to combat climate change. Digital MRV will be a game-changer! Current methods to measure, report, and verify emission reductions can be costly and time-consuming, often relying on manual operations". Digital technologies can streamline data collection, processing, and quality control in MRV processes, helping to reduce the cost and time to ERC issuance".

Brazilian methodologies[42] must also be recognized by international scientific bodies to have credibility. Today, the global metrics approved internationally are based on the agriculture context of temperate countries and do not represent the reality of Brazil's tropical agriculture. The country needs to have a voice in the definition of global methodologies. Climate, soils, and management affect carbon footprint. This will also be crucial for the Brazilian Regulated Carbon Market.

In the case of the voluntary market, another challenge to develop it in Brazil is the dependency on international certifiers, mainly Verra, to have access to international carbon credit buyers.

[42] For futher information, access: https://agro.fgv.br/publicacao/ocbio-quantificacao-das-emissoes-de-gee-no-setor-agropecuario-fatores-de-emissao

Developing a carbon project with Verra costs around US$ 500.000, and it must have a vital scale to be worth it. Creating subnational level certification that has lower costs and deadlines, which can be audited internally in the country to verify good quality credits, is essential.

In addition, in the case of Brazilian agriculture, which has been using no-till for decades and other sustainable practices, the additionality needed to access carbon markets is also an issue. At Verra, to be additional, a practice needs to be adopted for less than 20% of farmers in a region. Early adopters are not rewarded with this kind of financing. Alternative instruments to reward these farmers need to be developed.

Carbon markets for vegetation inside farms

In the case of farmers in Nova Mutum – MT, and other productivity regions of Brazil, a significant number has additional vegetation to the Forest Code rules. With the pressure of markets on deforestation, growers must carefully analyze the cleaning of new areas so as not to have difficulties selling their products. Products with high carbon emissions are already having market access problems. Eduardo Bastos and Willian Marchio[lxxxvii] recommend not clearing additional areas. It is more difficult each day to be authorized for deforestation in Brazil. Are farmers with additional areas of vegetation being paid for it?

First, carbon credit buyers increasingly seek Premium projects (not just carbon). For example, that has forest management or carbon stock, and that part of the resources (like 10%) goes to projects such as preserving water resources or surrounding communities. In addition, being paid through carbon mechanisms, such as the VCM, still demands a significant scale (at least 25,000-30,000 ha) to be developed by companies such as Biofilica and validated by Verra, as the project's costs are substantial.

Companies, such as Future Carbon, propose to work with farmers (or groups of farmers in the same region) from 5,000 hectares. According to Cinthia Caetano Carvalho, VP at Future Carbon, now it is possible to be rewarded for additional vegetation to the Forest Code and the whole native vegetation in areas with deforestation pressure, including the Cerrados. Farmers can skip paying in advance to analyze the project's viability and register it in their business model. They use financial tools such as *CRA verde (green bonds)* and *CPR verde* to pay in advance for the future carbon flow. They charge the farmer a percentage when they receive the credits.

Other mechanisms, such as funds, are emerging. The Simflor fund with BV from Rio pays R$ 300/ha/year for additional legal reserve in some regions of Brazil. They are searching for at least 250ha of land with all the documentation such as CAR, and SIGET. In the Nova Mutum region, it would be difficult for farmers to consider participating in this type of contract because today, growers usually have higher revenue/ ha/year.

Banks in Brazil started offering benefits for taking credit for clients with additional vegetation in their farms through *CPR Verde*. The access is still limited but is growing. Banks are essential as intermediaries in the country to increase sustainable financing access to farming and instruments that incentivize sustainable practices, such as lower interest rates, blended finance[43], etc.

[43] In September 2023, The VOX VERT Low-Carbon Agriculture Transition Mechanism (LATM) was released, which aims to channel blended finance investments to sustainable agriculture in Brazil with long-term loans, a transition guarantee facility, and

ILPF at Embrapa gado de corte in Mato Grosso do Sul, Brazil

4. CONCLUSION AND RECOMMENDATIONS TO THE FARMING SECTOR IN BRAZIL

Carbon markets will likely be limited in financing agriculture abroad and in Brazil, at least in the short/medium run. On the one hand, the demand for voluntary credits has yet to take off and faces reputational issues. On the other hand, there are challenges in terms of regulations, methodology, costs of access, etc. The market is under construction and will take time to develop. It also depends on innovation and technology to permit access on a larger scale while delivering robust reduction emissions results. In Brazil, farmers should focus on better practices that can contribute to carbon sequestration to foster productivity, cost reduction, and resilience in the first place, adapting to risks.

On the other hand, supply chains should play a critical role in agriculture decarbonization. Agri-food companies must be engaged and be more transparent in measuring and publicizing the outcomes of adopting sustainable practices and toward farmers concerning payments. Promising a premium price one year, then reducing it by half the following year, or even stopping buying from farmers who are not ready, seems to be a strategy that will not support farming livelihoods, one of the outcome-based principles of regenerative agriculture, especially in the case of smallholder farmers.

Farmers play a critical role in the climate agenda, and de-risking production through developing and scaling up mechanisms that include financial support (if not carbon markets, others, such as lower interest rates for sustainable practices) is essential for more sustainable, resilient agriculture and food security. Policymakers, investors, and consumers must increase their understanding of farmers' challenges (advocacy is necessary). More and more bridges need to

technical assistance. Credit lines: Pasture Recovery, Sustainable Livestock Intensification, Integrated Systems, and Agroforestry and Bioeconomy. (Source: The Lab)

be constructed efficiently between the capital and the production. Financial, technological, and knowledge resources, added to market access, are critical to sustainable agriculture with social inclusion and poverty reduction.

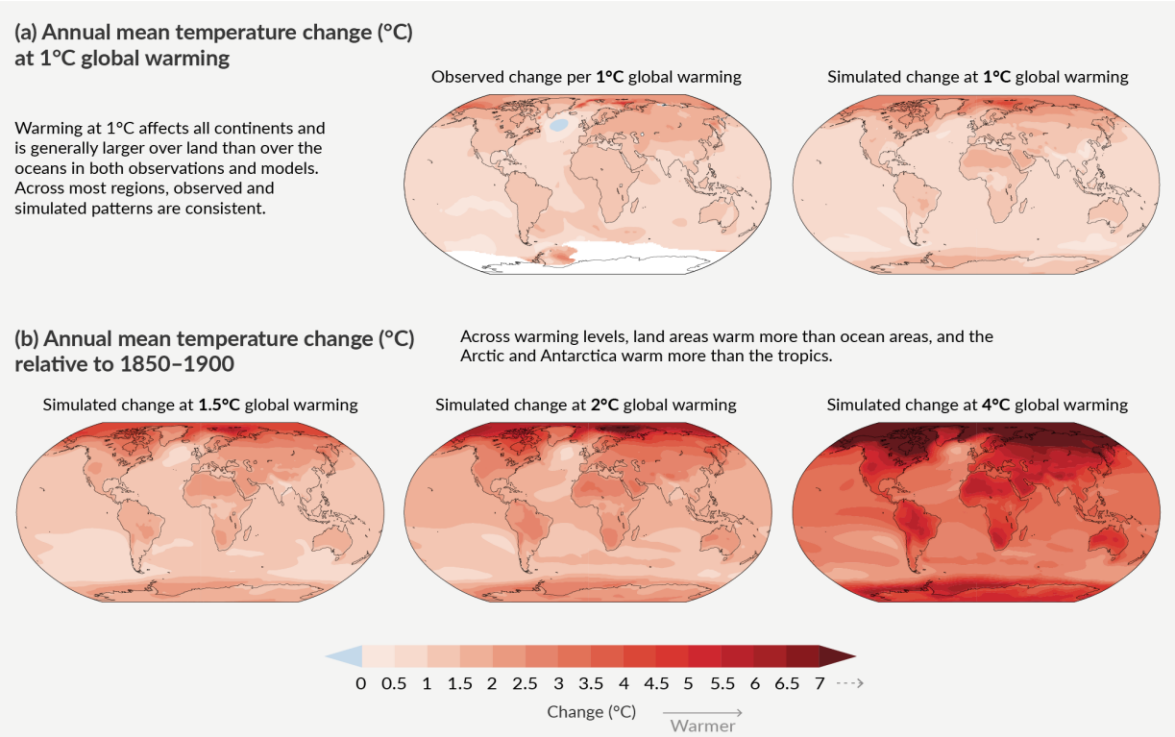
RECOMMENDATIONS:

- Farmers must continue adapting to climate change and transitional risks (with or without carbon payments).
- Focus on better practices that can contribute to soil health and carbon sequestration to foster productivity, cost reduction, and resilience in the first place, adapting to risks.
- If you have additional vegetation on your land, analyze it carefully before clearing it (the environmental role it may play in your business, market access – such as European Union restrictions and companies not buying soybean from deforested areas in the Amazon and the Cerrados, financial incentives, etc.).
- Ask for advice from other farmers, associations, and technical assistants. Each context is different and demands solutions and practices shaped for the climate, soil, market, and type of business. Practices to be adopted depend on that.
- Evaluate and monitor your business's climate and transitional risks, plan to mitigate and reduce your vulnerabilities, and increase your resilience. The challenge is also to lose less in difficult moments.
- Be attentive to rules and market demands. Get closer to your buyers/consumers to define the next steps. In many cases, the reward will be market access.
- Refrain from trusting solutions that seem easy and demand a lot of money. Access to carbon markets is complex and can be costly and risky. Read contracts carefully before signing.
- Choices also depend on the farm business's internal environment, whether you want to be an early adopter, take risks, etc.
- Early adopters should be rewarded and be included in the efforts of decarbonizing the sector. However, carbon markets may not be the best option because of the additionality needed to offset credits.
- If you have the means to do your carbon balance, it will help you to have indicators to manage your business better. Depending on your buyers and legislation, it can become an obligation, along with traceability.
- Be attentive to potential opportunities, including from supply chains and financial institutions. But take your time with doing a proper analysis.
- Scaling the carbon market and other opportunities will require resources and capacity. Cooperatives and farmers' associations have an essential role to play concerning the capacity building of farmers to navigate this scenario of increased risks and potential opportunities, including those related to supply chains.
- Farmers' voices have often been neglected in these transition discussions. Advocacy is critical to be at the table of negotiations to bring the perspective of agriculture as a solution and the most vulnerable sector with direct impacts on food security, including in international negotiations, legislation, and financing.
- Suppose the agriculture sector is included in the Brazilian Compliance Carbon Market. In that case, it can become an additional expense for the industry and a risk depending on its law and function. The sector needs more sustainable incentives, including reduced interest rates for adopting sustainable and resilient practices and no other costs.
- Nevertheless, everything is open at the moment and is evolving. Disruptions can occur and change the access to carbon markets in the future, making it more accessible. But the sector needs to be active and not reactive, having a place on the table of negotiations.

ANNEX

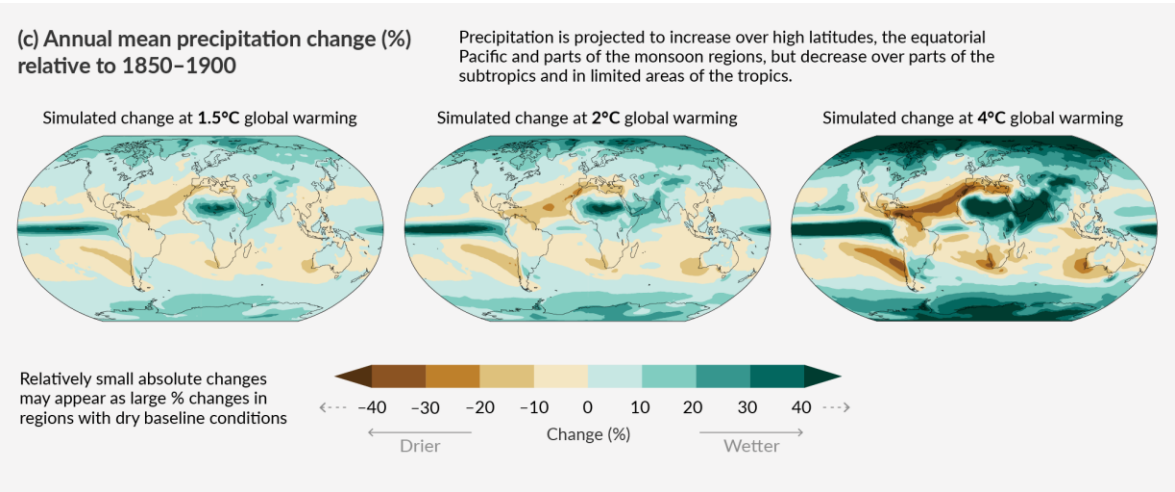
Annex 1 - IPCC scenarios for temperature, precipitation, and soil moisture because of global warming

Temperature



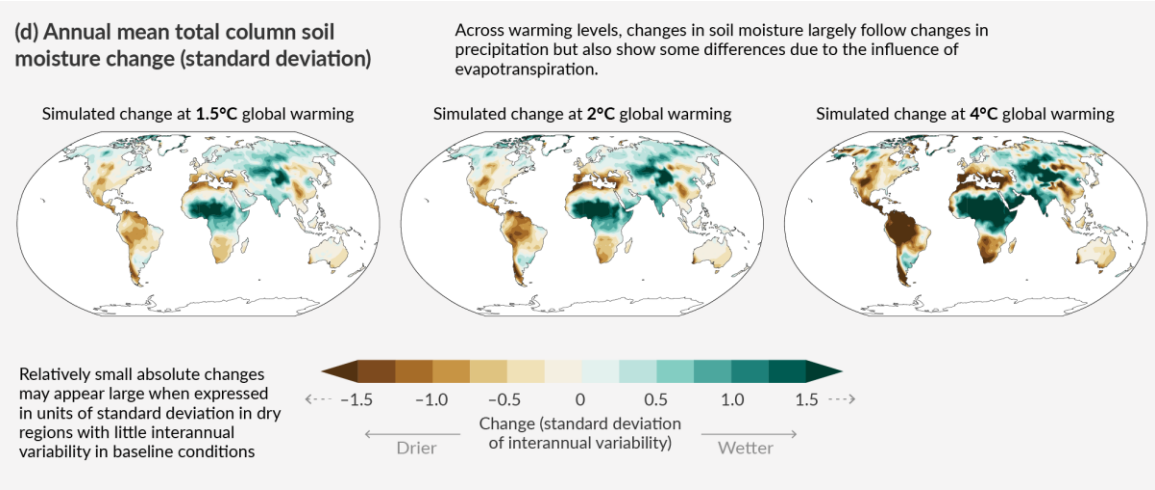
Source: IPCC - https://www.ipcc.ch/report/ar6/wg1/figures/summary-for-policymakers/figure-spm-5

Precipitation



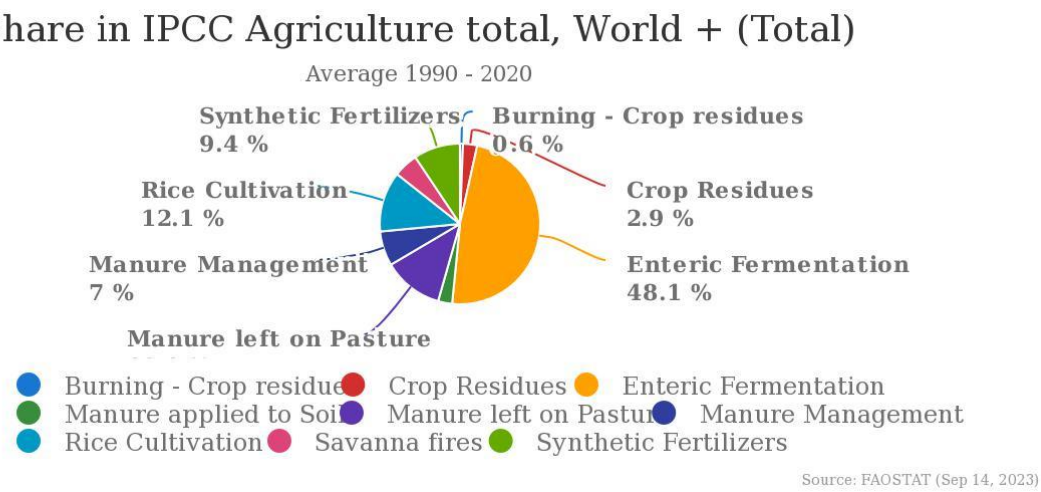
Source: IPCC - https://www.ipcc.ch/report/ar6/wg1/figures/summary-for-policymakers/figure-spm-5

Soil Moisture



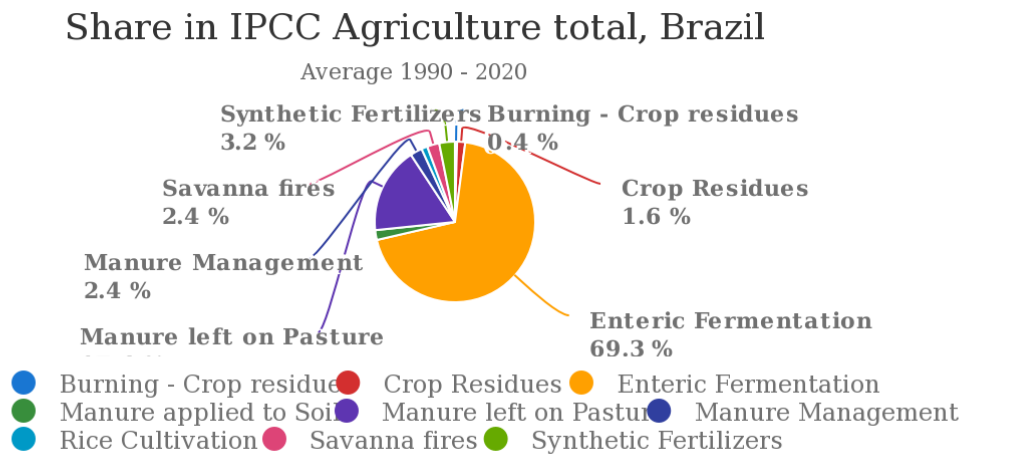
Source: IPCC - https://www.ipcc.ch/report/ar6/wg1/figures/summary-for-policymakers/figure-spm-5

Annex 2 - Agriculture GHG emissions in the world by activity



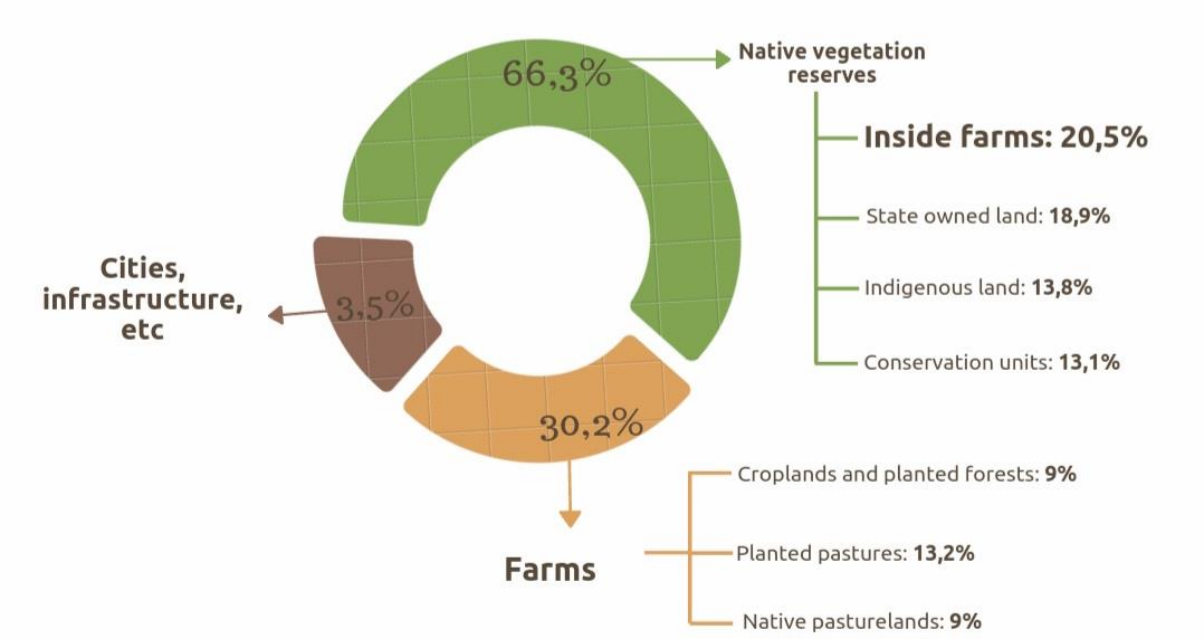
Source: FAOSTAT (Sep 14, 2023)

Annex 3 - Agriculture GHG emissions in Brazil by activity



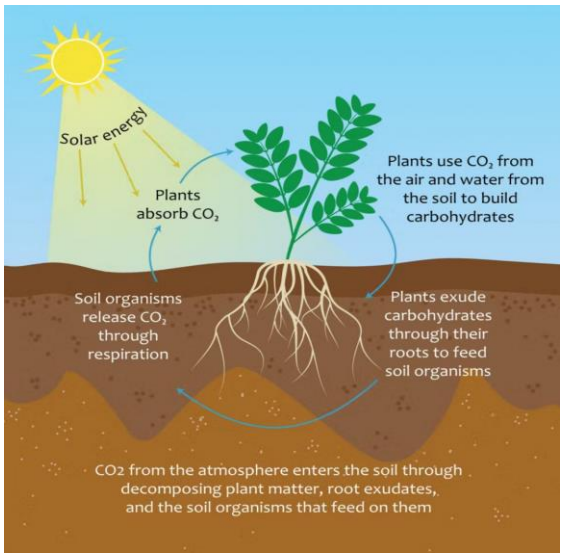
Source: FAOSTAT (Sep 14, 2023)

Annex 4 - Land use in Brazil



Source: Embrapa, 2017 - Brazilian Nuffield Scholars presentation on Brazil at CSC 2022

Annex 5 - Carbon cycles into and out of the soil



Source: Jocelyn Lavallee, The Conversation, CC BY-ND, at: https://www.cleanenergywire.org/factsheets/carbon-farming-explained-pros-cons-and-eus-plans

Annex 6- "4 per 1000 initiative" recommended practices

Source: 4 per 1000

Annex 7 - ABC+ goals and their mitigation potential

Sustainable Production Systems, Practices, Products and Processes	**Target (in million of hectares)***	**Mitigation Potential (million Mg CO2eq)**
Practices for the Recovery of Degraded Pastures (PRPD)	30	113,7
Crop-Livestock-Forest Integration (ILPF)	10	34,11
Agroforestry Systems (SAF)	0,10	37,9
Direct Grain Planting System (no-till)	12,50	46,71

Vegetable Direct Planting System (no-till)	0,08	0,88
Planted Forests	4	510
Bio inputs	13	23
Irrigated Systems	3	50
Intensive Termination	5	16,24
Animal Production Waste Management (MRPA)	208,40	277,8
Range in hectares, millions of cubic meters, and number of animals	*72,68 + 208,40 million + 5 million animals	1.110,34

Source: MAPA, 2021. Plano Setorial para Adaptação à Mudança do Clima e Baixa Emissão de Carbono na Agropecuária, com vistas ao Desenvolvimento Sustentável.

Annex 8 - Costs per practice at farm level in France (2019)

Storage practices	Technical cost (€/ha/year)	Regional extremes (€/ha/year)
Extension of intermediate crops	39	12 à 147 depending on region
No-till	13	-23 à 40 depending on region
New organic resources	-52	-117 à -8 depending on region
Insertion and extension of temporary meadows	91	- 40 à 263 depending on region
Intra-plot agroforestry	118	63 à 179 depending on region
Plantation of hedges	73	54 à 87 depending on region
Moderate additional fertilization of permanent meadows	28	12 à 38 depending on region
Pasture mowing replacement in permanent meadows	73	-85 à 146 depending on region
Permanent grassing of vineyards	-26	
Winter grassing of vineyards	-15	

Source: Inra, 2019

Annex 9 – Examples of regenerative agriculture commitments by leading agri-food sector across the value chain

Company	Target	Commodities targeted	Geographical scope	Commitment type	Practices encouraged	Outcomes sought
DANONE	Source 30% of key ingredients from farms transitioning to regenerative agriculture by 2025	Livestock products, strawberries, cereals and ground crops	Global	Volume	• Reduced tillage intensity • Increase soil coverage • Implement weed and pest control strategies • Increase the proportion of natural habitats on agricultural lands • Integrate buffer zones	
General Mills	Regenerative agriculture practices on 1 million acres of farmland by 2030	The target is not commodity specific, but mentions grain and dairy	Global	Area	• Reduce physical disturbance • Keep the soil covered year-round • Maintain a living root year-round • Integrate grazing livestock wherever possible • Maximise diversity in plants and animals	
Mondelēz International	Produce 100% of wheat for European poduction through regenerative agriculture by 2030	Wheat	European Union	Volume	• Diversify crop rotation to include legumes • Optimise fertiliser use • Eliminate use of damaging pesticides	
Nestlé	Source 20% and 50% of its key ingredients through regenerative agriculture by 2025 and 2030, respectively	The target includes key ingredients, which are not disclosed	Global	Volume Financial support for supply chain	• Diversified production through crop rotation and intercropping • Optimised organic fertiliser application • Minimise tillage • Water quality and biological pest control through hedgerows	
Walmart	A collaborative effort with PepsiCo to spread regenerative farming across 2 million acres, eliminating 4 million tons of greenhouse gases The company's 2030 goal includes improving the livelihoods of 250,000 people in its agricultural supply chain	Although no specific crops are mentioned, the company highlights its supply chain coverage of potatoes, oats, corn, wheat, soybeans and rice	United States	Area Emissions Farmers	• Cover crops and crop rotation • Conservation tillage • Nutrient management • Integrated pest management • Manage riparian corridors, grassed waterways and constructed wetlands • Prevent conversion of habitats • Irrigation efficiency	

Source: FAIRR 2023

Key: Outcomes Sought

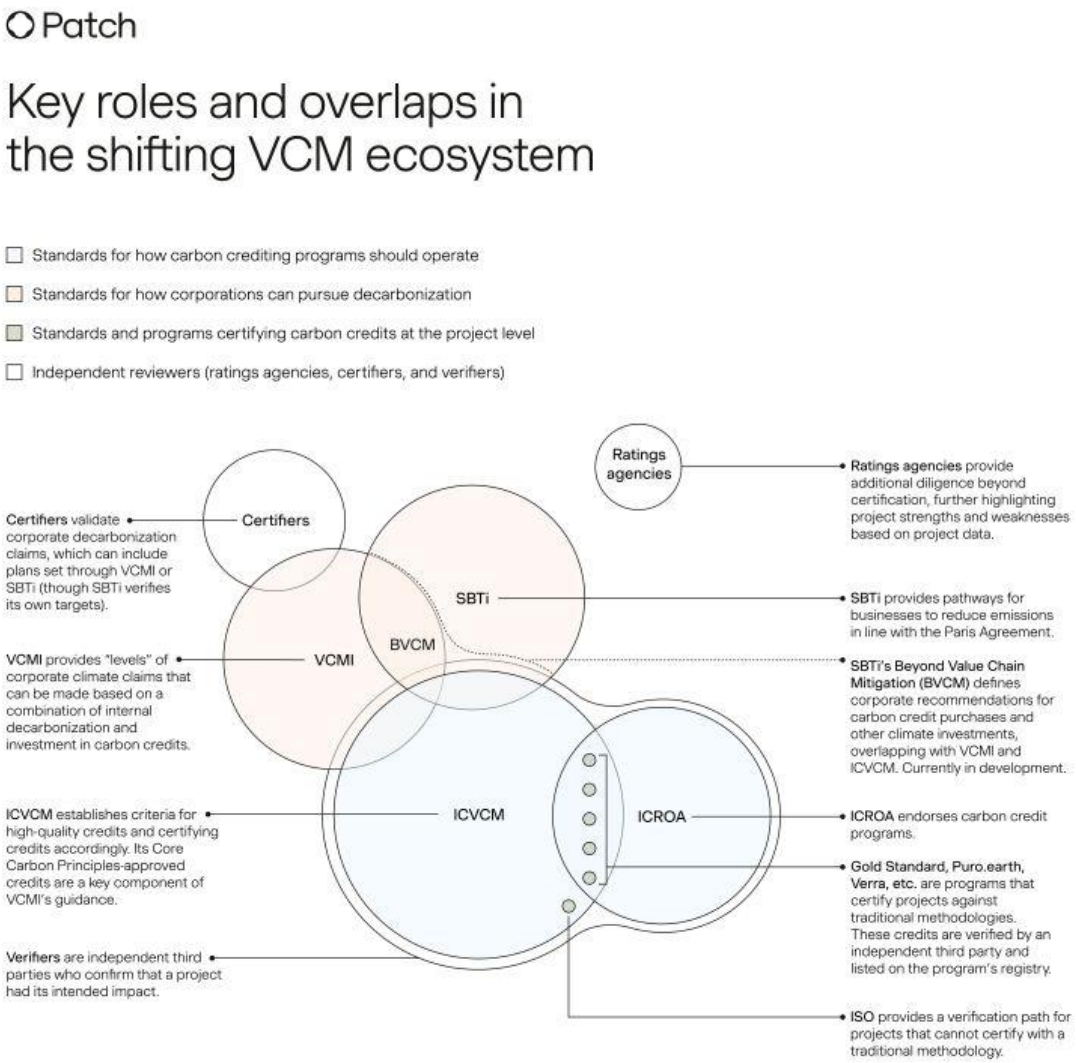
Carbon reduction, removals and sequestration | Improved soil health | Biodiversity improvements | Water quality, filtration and cycle improvements | Improved farmer income and/or costs, yields, livelihoods and other economic factors | Reduced use of agrochemical inputs

Source: FAIRR, 2023

Annex 10 - Companies and organizations offering carbon balance measurement services in the agricultural sector (this is a reference list, not an extensive one, based on information from the media and direct contact with actors in the industry, not a recommendation list):

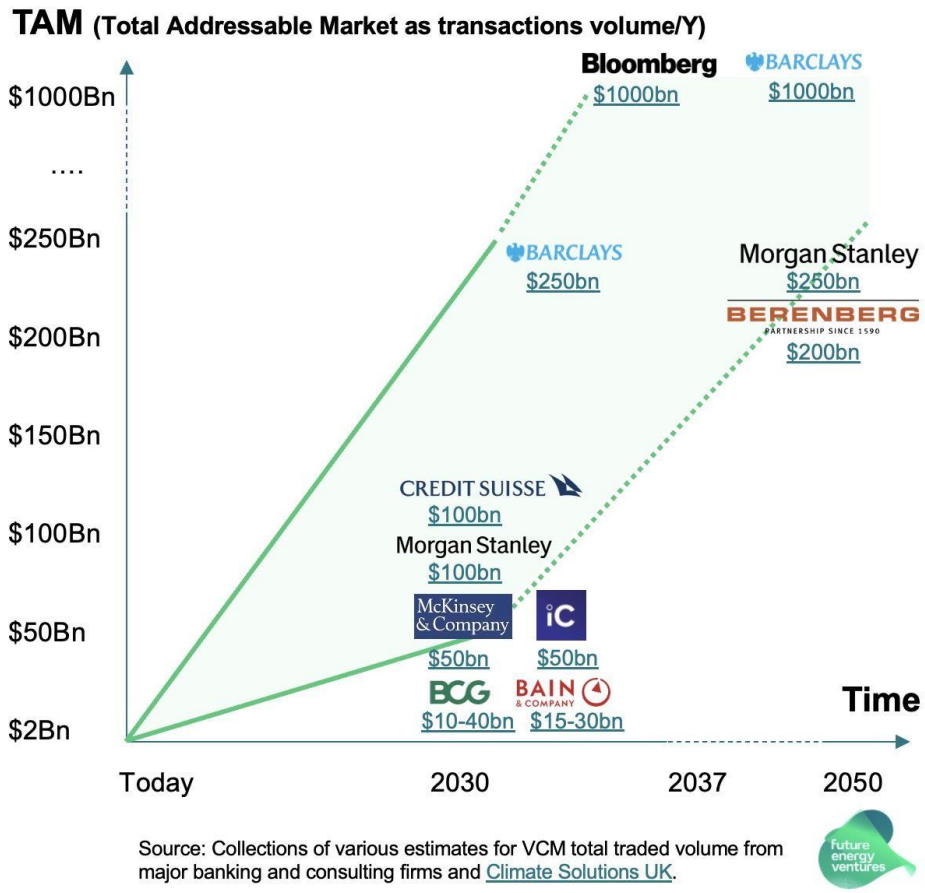
- EMBRAPA - https://www.embrapa.br/
- IMAFLORA- https://www.imaflora.org/
- CCARBON ESALQ (Prof Cerri) - https://www.esalq.usp.br/banco-de-noticias/centro-de-estudos-de-carbono-em-agricultura-tropical-ter%C3%A1-apoio-financeiro-da
- CRIATEC - https://www.linkedin.com/in/william-marchi%C3%B3-15180330/?originalSubdomain=br
- GEOCARBON - https://www.geocarbon.com.br/
- FAU CONSULTORIA - https://www.fauconsultoria.com

Annex 11 - Different roles of standard bodies in defining integrity and creating trust in the VCM



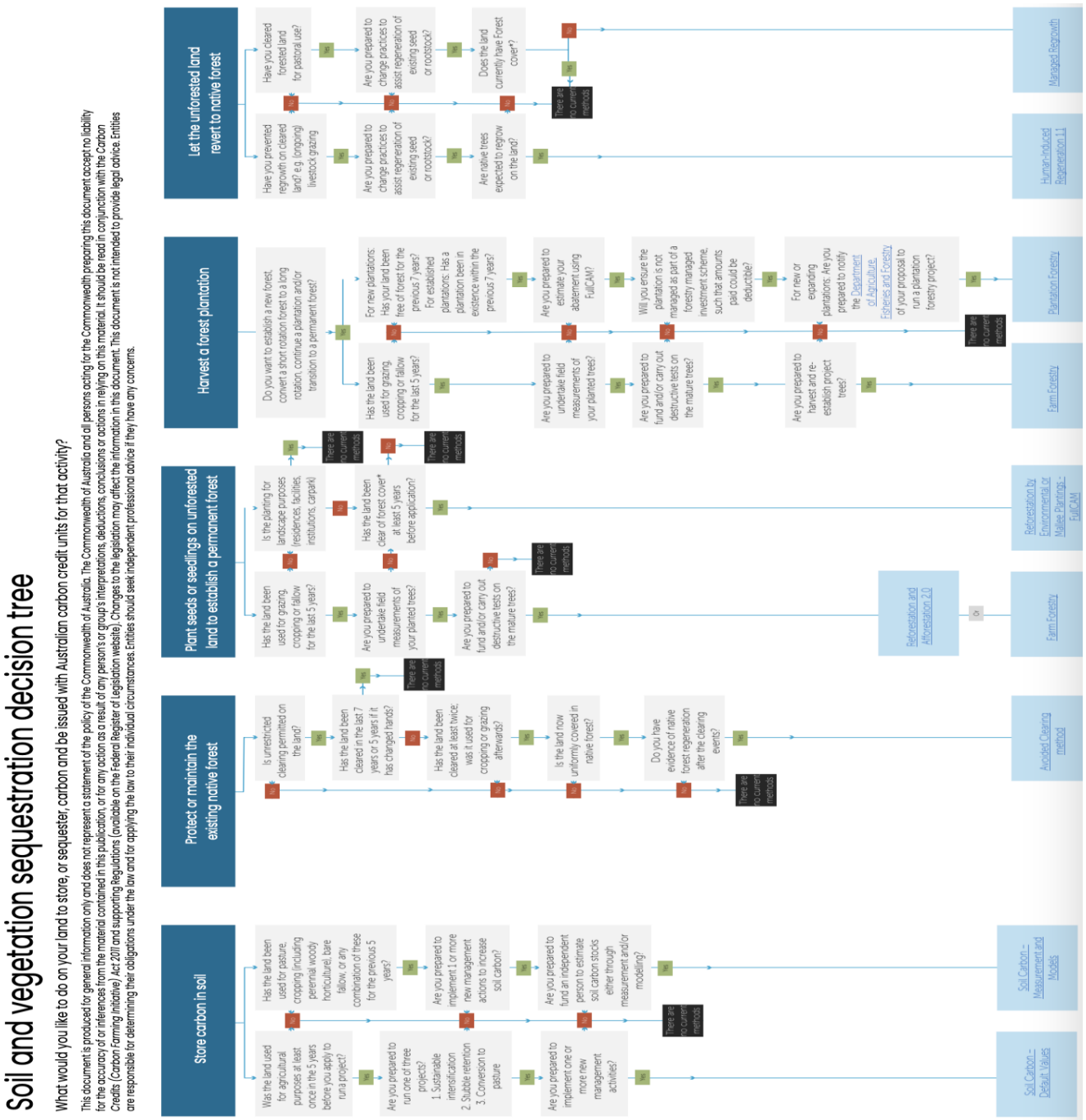
Source: Patch

Annex 12 – VCM projections



Source: https://www.linkedin.com/feed/update/urn:li:activity:7104660442609799168/

Annex 13 – Soil and vegetation sequestration decision tree



Source: Australian Government, Clean Energy Regulator - https://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Soil%20and%20vegetation%20sequestration%20decision%20tree.pdf

Annex 14

COMPLIANCE OFFSET MARKETS	
LAUNCH YEAR	PROGRAM
2009	Regional Greenhouse Gas Initiative (RGGI) — 1 agricultural (ag) protocol*
2010	California Air Resources Board's (CARB) Cap & Trade Program — 2 ag protocols*
2024	ICAO for CORSIA — ag protocols under ACR, CAR, & Verra are included

VOLUNTARY OFFSET MARKETS	
LAUNCH YEAR	PROGRAM
1995	American Carbon Registry (ACR) — 3 active ag protocols*
2003	Chicago Climate Exchange (discontinued in 2010)
2006	Verra's Verified Carbon Standard (VCS) Program — 8 active ag protocols*
2007	Climate Action Reserve (CAR) — 6 ag protocols*

AGRICULTURAL CARBON PROGRAMS**		
LAUNCH YEAR	PROGRAM	TYPE OF PROGRAM
2016	CIBO	Both offset & inset
2016	Truterra	Both offset & inset
2018	Corteva	Offset
2018	Nori	Offset
2019	Carbon by Indigo Ag	Offset
2019	Indigo Ag: Market + Source	Inset
2020	Soil & Water Outcomes Fund (SWOF)	Inset
2021	Agoro Carbon	Offset
2021	Cargill RegenConnect	Inset
2021	Locus Ag's CarbonNOW	Offset
2022	ADM re:generations	Inset
2022	Bayer Carbon Program	Offset
2022	Ecosystem Services Markets Consortium's (ESMC) Eco-Harvest	Inset
2022	Nutrien	Offset
2022	PepsiCo-PCM	Inset

Source: Sierra View Solutions and American Farmland Trust

END NOTES

[i] Source: https://seeg.eco.br/wp-content/uploads/2023/03/SEEG-10-anos-v4.pdf
[ii] Source: "Agricultural Carbon Programs FROM CHAOS TO SYSTEMS CHANGE ", and "Surviving the Jungle of soil organic carbon certification standards: an analytic and critical review."
[iii] SOURCE: https://www.weforum.org/agenda/2022/03/carbon-insetting-vs-offsetting-an-explainer/
[iv] Source: IPCC, 2021
[v] Source: Painel Brasileiro de Mudanças Climáticas (PBMC), 2020
[vi] Source: Sierra View Solutions and American Farmland Trust, 2023
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[xi] Source: https://valor.globo.com/agronegocios/noticia/2023/06/16/perdas-elevadas-reduzem-apetite-de-seguradoras.ghtml
[xii]Source: https://valor.globo.com/financas/noticia/2023/09/26/eventos-climaticos-causaram-perdas-de-mais-de-us-500-bi-em-2022-e-50percent-nao-eram-seguradas.ghtml
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[xvi] Source: https://valor.globo.com/publicacoes/suplementos/noticia/2022/09/21/estoques-vitais.ghtml
[xvii] Source, Carvalho and all, 2009
[xviii xviii] Interview in March 2023
[xix] Source: Rabobank - Euro Cycles
[xx] Nuffield CSC 2022
[xxi] Source: Congres des Ceraliers, Paris, 2023
[xxii] Source: CSC Nuffield 2023
[xxiii] Source: https://blog.solloagro.com.br/webinar-agricultura-de-baixa-emissao-de-carbono/
[xxiv] Meeting in march 2023
[xxv] Visit in May, 2023.
[xxvi] Meeting in June 2023
[xxvii] Visit in May, 2023.
[xxviii] Source: https://valor.globo.com/agronegocios/noticia/2023/05/31/plano-safra-sera-todo-agricultura-de-baixo-carbono-diz-marina.ghtml
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[xxxiii] Source: http://adaptaclima.mma.gov.br/adaptacao-a-mudanca-do-clima
[xxxiv] Meeting in March 2023 in Mato Grosso do Sul
[xxxv] Meeting in May 2023
[xxxv] Source: LACLIMA, 2021
[xxxv] Source: The World Bank, 2022
[xxxv] Source: The World Bank, 2023
[xxxv] Source: LACLIMA, 2021
[xxxv] Source: Meeting with representatives from the New Zealand government in March 2023
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xxxv Source: https://www.reuters.com/business/sustainable-business/global-carbon-markets-value-hit-record-909-bln-last-year-2023-02-07/\
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xxxv For further information, access: https://www.regrow.ag/post/sbti-flag-guidance-what-you-need-to-know?utm_content=262922254&utm_medium=social&utm_source=linkedin&hss_channel=lcp-71505804
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