Global Essay Competition 2025

Title: An integrative approach to the regenerative agriculture transition amidst shifting global powers

Essay:

Introduction

The global food and agriculture system is uniquely situated at the intersection of numerous United Nations (UN) Sustainable Development Goals (SDGs). Over time, developing countries have increasingly leveraged this opportunity, through strategic investments in upgrading agricultural activities to reduce hunger and create economic opportunities (Fuglie et al., 2020). This has also contributed to a shift in global powers, with developing countries increasing their share in the global agrifood export market from 32% to 46% between 1990 to 2019, while developed countries saw a decrease from 67% to 49% over the same time period (Poonyth, 2021). This growth is projected to continue rising primarily due to population growth, with developing countries needing to double food production from 2005-2007 levels to meet demand in 2050 (Food and Agriculture Organization of the UN [FAO], 2009).

Despite its contributions to socio-economic development through increased food availability and employment opportunities, the agrifood sector is a significant contributor to the two critical planetary crises of climate change and biodiversity loss. At the same time, the sector is reliant on stable and predictable ecological conditions, which are being destabilized by these very crises it contributes to. Furthermore, developing regions are more vulnerable to the resultant prolonged droughts, storms, and other adverse effects, which can have cascading socio-economic consequences, especially due to these countries' relatively high economic dependence on agriculture. Beyond physical impacts, transition risks, such as increasingly stringent environmental regulations, also pose a threat and disproportionately harm the competitiveness of developing countries' agrifood exports and their market access.

Given the rising trajectory of developing countries' presence in global agrifood systems coupled with their growing exposure to environment-related risks, fostering a transition to sustainable food systems in these regions presents a critical opportunity to strengthen the sector's resilience and leverage its unique positioning to drive progress towards the SDGs. However, this transition is quite complex due to the interdependence of various elements, in addition to the involvement of a diverse set of stakeholders. As such, addressing the challenge requires holistic analysis to uncover partnerships across the entire agrifood ecosystem, allowing for the mobilization of knowledge and resources to overcome the various barriers to the sustainable agrifood transition.

Interrelations Between Nature and Agricultural Activities

Historically, the environmental protection aspect of agriculture has generally been overlooked, often due to prioritizing other factors such as income, or having perceptions that environmental aspects are distant issues and therefore not urgent (Yazdanpanah et al, 2023). However, nature and agriculture are critically interdependent, and therefore an understanding of this relationship is fundamental for the transition to sustainable agrifood systems.

Physical Impacts

The Earth system is currently at risk of destabilization, with six of nine planetary boundaries having been crossed (Richardson et al., 2023). Furthermore, two of these six, climate change and biosphere integrity, are considered the "core" planetary boundaries, where the persistent transgression of either could result in the Earth system being driven into an altered state (Steffen et al., 2015). Agriculture is simultaneously a significant contributor to these transgressions, while also being deeply impacted by the resultant environmental changes.

Firstly, modern agriculture is a significant contributor to global greenhouse gas (GHG) emissions, with around 21% of global GHG emissions coming from the agrifood sector, primarily

through activities such as deforestation and livestock farming (FAO, 2016). This issue is more critical for developing countries, who have higher cropland GHG emissions when compared to developed countries, largely due to technology gaps in agricultural processes (Gao et al., 2024). To illustrate, Brazil, Indonesia, and India are the largest contributors to global agricultural GHG emissions, accounting for roughly 30% (FAO, 2020). At the same time, the impacts from climate change pose significant threats to agriculture, such as through the increasing intensity of droughts and storms. These impacts disproportionately affect developing countries, whose geographic locations cause them to face higher projected climate change related crop yield losses than developed countries (FAO, 2016).

With regards to biosphere integrity, the main threats from the agrifood sector come from land use change, where natural environments are destroyed for use as agricultural land. Furthermore, the use of certain inputs, such as chemical pesticides, damages ecosystems through pollution. In return, this weakened biosphere integrity negatively impacts soil health, pollinators, water systems, and more, all of which are critical for the success of agricultural activity. This issue has become increasingly important for developing regions in recent years. Given the shift in global agrifood market dynamics, developed countries are increasingly importing agricultural products from developing regions and therefore essentially "outsourcing" their negative impacts on biodiversity (Ortiz et al., 2021). This is especially concerning due to most of Earth's biodiversity hotspots being located in developing regions (Habel et al., 2019). A lack of sufficient, timely intervention could have severe implications for planetary resilience and its ability to support agricultural activities (Richardson et al., 2023).

Due these interdependencies with the two critical planetary boundaries, agrifood systems are central actors in the challenge to remain within a safe planetary operating zone, while simultaneously defending against risks to agricultural activity. While these two boundaries are the most critical, they are also interrelated with other aspects, such freshwater availability (Richardson et al., 2023), which further highlights the need for holistic analysis to ensure environmental impacts are sufficiently accounted for.

Transitional Impacts

As societies react and adapt to these physical impacts, countries and organizations are increasingly implementing strategies to improve their environmental footprints. However, some of these strategies can disproportionately threaten developing countries' access to global agrifood markets. One significant example is the European Union's (EU's) Corporate Sustainability Reporting Directive (CSRD), requiring companies to report their GHG emissions, including their Scope 3 value chain emissions. Although the directive targets EU countries, it has far-reaching implications due to global supply chain networks. This is particularly consequential for the agriculture sector, due to its emissions-intensive activities. However, agricultural producers in developing regions have less access to the resources and capabilities needed to accurately measure, report, and reduce their emissions (Umemiya & White, 2023; Wilkes et al., 2017), which can harm their competitiveness in supplier selection processes. Losing access to large markets like the EU can have significant consequences for regions whose economies are highly dependent on agrifood exports.

Further compounding all aforementioned risks are gaps in financing and knowledge. Despite the sector's significant contributions to climate change, only 4% of climate finance is directed towards agriculture (World Bank Group, 2024). In addition to the limited availability of funds, producers in developing regions face greater challenges with access to finance, due to having less developed financial systems (Khan et al., 2024). Concurrently, limited access to knowledge, technology, and infrastructure are also commonly cited challenges for improving agricultural systems in developing regions (FAO et al., 2015). Together, these barriers limit the ability of agrifood systems to adapt to the increasingly severe environment-related challenges.

With this understanding of both physical and transitional risks, it is clear that the current state of global food systems is at risk—developing regions are highly vulnerable to various challenges, threatening the long-term success of their agrifood sectors with cascading consequences for sustainable development.

Recommendations

One key tool that leverages the unique relationship between agriculture and nature is the implementation of regenerative agriculture. Regenerative agriculture refers to a collection of practices focusing around improving soil health, such as cover cropping, no-till practices, integrated pest management, rotational grazing, and more. Soil health is a critical leverage point for both ecological health and agriculture. As one of nature's largest carbon sinks, soil has the ability to become a tool for fighting climate change. Improving soil health can increase its carbon sequestration capabilities, in addition to having co-benefits for biodiversity (Rehberger et al., 2023). In turn, producers see increased farm resilience, rising from improved ecological conditions. Beyond stabilizing food supplies, certain regenerative agriculture practices also allow for income diversification opportunities, further improving farmer livelihoods (Sher et al., 2024). If properly implemented, regenerative agriculture has the potential for enhancing environmental, social, and economic aspects and supporting sustainable development.

This transition however, due to the systemic pattern of insufficient consideration of environmental aspects, requires a paradigm shift in the way society understands its relationship with the natural environment. Agriculture should not be viewed as a tool that provides socio-economic benefits at the expense of ecological health, but rather one that can foster the simultaneous co-creation of environmental, social, and economic value. However, this type of systemic shift involves actors across the entire ecosystem, which naturally brings complexity into the challenge due to differing perspectives, capabilities, and motivations. Therefore, there needs to be a coordinated response to help manage the movement of knowledge, capital, and other resources to support the transition.

Considering these challenges, I am proposing the utilization of a quintuple helix innovation model to serve as a framework for guiding the transition to regenerative agriculture. This framework calls for ecosystem collaboration between the five helices of academia, government, industry, civil society, and the natural environment (Carayannis et al., 2021). By emphasizing holistic thinking, with the natural environment serving as the system's foundation, the proposal leverages cooperative dynamics to address complex challenges and work towards shared goals. A proposed usage of this model to address the regenerative agriculture transition in developing regions is shown in Figure 1.

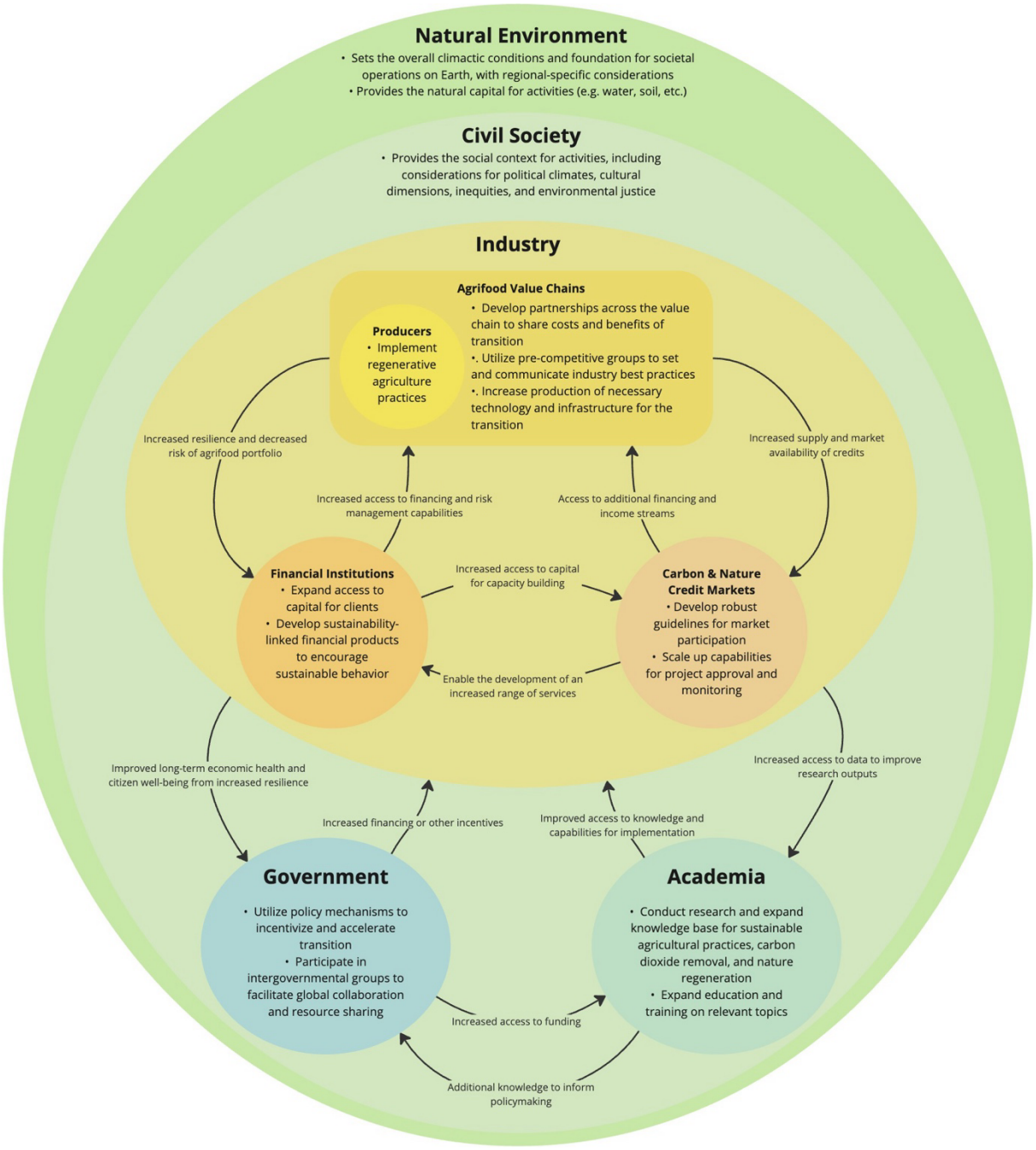

Figure 1. A proposed framework for ecosystem collaboration towards sustainable agrifood systems, inspired by Carayannis et al. (2021).

In this model, the natural environment serves as the overarching foundation for the system, highlighting the fact that all activities simultaneously impact and are impacted by nature. On the next level is civil society–together with the environment, they form the socio-ecological context for the system. Although developing regions face some similar challenges, there are specific considerations for each region. For instance, some regions may be more prone to certain physical risks, such as droughts or floods. Additionally, societal aspects, such as political climates, cultural dimensions, land ownership dynamics, community engagement, smallholder presence in markets, cooperative structures, and more, should be a significant consideration in strategy development. Despite these differences, a common theme still emerges–in today's world, where planetary crises and their resultant impacts are causing societal harm, actors within society are challenged and therefore driven to seek change.

Given this socio-ecological context, partnerships and multi-stakeholder initiatives between industry, government, and academia can form to overcome key barriers and unlock sustainable value creation. The example in Figure 1 demonstrates how various actors have individual contributions to the transition, in addition to how partnerships between actors can unlock additional value (denoted by arrows) for stakeholders. These partnerships are critical to overcoming complex barriers, such as access to financing and knowledge, which support and accelerate the transition to regenerative agriculture and allow for cascading socio-ecological benefits.

This diagram is not intended to be comprehensive, but rather an illustrative example of how holistic thinking and ecosystem cooperation are critical for driving the transition to regenerative agriculture. Each region and agrifood subsector has its own unique contextual factors, so the actors and value creation mechanisms would need to be adapted accordingly to account for socio-ecological conditions and stakeholder nuances. Regardless of the details in each case, the overall goal should be to drive a shift in how society utilizes the relationship between nature and agriculture, and promote coordination amongst a diverse network of stakeholders to leverage the power of the agrifood sector to drive progress towards all SDGs.

Conclusion

As developing regions establish their increased power in global agrifood systems, a shift towards ecological sustainability and regeneration are needed to ensure long-term sustainable development. Due to the interrelations between the various elements in the agrifood ecosystem, holistic analyses and collaborative solutions are required to overcome key barriers and drive the co-creation of environmental, social, and economic value. Therefore, a quintuple helix framework is proposed to not only highlight the importance of environmental aspects that are often overlooked, but also foster multi-stakeholder partnerships to support and accelerate the critical transition to sustainable food systems.

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