Regenerative Agriculture: A Systematic Review of Contributions to Social, Economic, and Environmental Sustainability, and Stakeholder Roles

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***Abstract* — Agriculture has a significant impact on the environment and is responsible for the change in landscape use worldwide. In response, new forms of agriculture have been proposed, such as Regenerative Agriculture (RA) to offer sustainable food production methods. Although there is no clear definition of what it is and what practices it encompasses, RA is now attracting a great deal of interest for all stakeholders, most importantly farmers and policy makers. The current systematic review aims to identify how do RA practices and standards foster economic, social and environmental sustainability and the impacts of stakeholders in accelerating or hindering the adoption of such practices. Results show a concentration of research in countries where large scale farming is very prominent. There is a lack of research into the social and economic viability of RA practices and standards. Thus, multidimensional studies are required to better guide, mainly policy makers, and help with the transition or adoption of regenerative agriculture practices.**

Keywords - Regenerative agriculture; Farming; Environment; Sustainable.

I. INTRODUCTION

Agriculture bears a considerable impact on the planet. It is associated with approximately a third of worldwide land use and is an important cause of land use change internationally, especially in the biodiverse tropics [1]. Food production also generates approximately 15% of global greenhouse gas emissions. Meanwhile, global food needs are expected to grow, as a result of increases in population and per capita consumption [2]. In response to these various pressures, stakeholders are seeking more sustainable ways of producing food [3].

The Regenerative Agriculture (RA) has been suggested as an alternative mean of producing food that may have lower—or even net positive environmental and/or social impacts [4]. Various assertions have been made by multiple stakeholders claiming the potential of Regenerative Agriculture to improve the sustainability of the agrifood scene, including the idea that it may be adopted as a strategy to mitigate climate change, satisfy people's needs and sustain farmers livelihoods [5][6]. However, there is a lack of consensus around a common definition to draw a clear distinction between regenerative, organic and other 'alternative' agricultures [7] and how does it align with sustainability and agroecological practices [7].

Therefore, the current systematic review will: i) Identify existing agricultural standards and practices based on their contributions to social, economic, and environmental factors, ii) and define the specific roles played by various stakeholders involved in the shift towards Regenerative Agriculture.

The remainder of the abstract is structured as follows. Section 2 presents the search and selection process of the articles used for the review conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) system. Section 3 discusses the results that emerged with regard to the economic, social and environmental spheres plus the role that stakeholders play with regard to RA. Section 4 expresses conclusions and gaps for future research.

II. METHODOLOGY

The search for articles has been performed using two online databases: Web of Science and Scopus [8][9]. They both feature high-quality, peer-reviewed journal publications as well as contributions to scientific conferences. The review focused only on peer-reviewed articles. The possibility of extending the review to publications from other sources has also been explored; yet it was deemed that these publications would not meet the scientific requirements of this review due to a lack of an independent revision process.

The following algorithm has been applied: ("regenerative" OR "conservative") AND "agriculture" AND ("environment*" OR "economic*" OR "soci*" OR "sustain*" OR " develop*" OR "ecosystem services"). An asterisk (*) has been attached to most word stems to find all articles which include terms starting with that word stem.

The search was limited to the title, abstract and keywords, and constrained to publications from 2014 to 2024. The entire search and analysis process was undertaken following the PRISMA Statement for Reporting Systematic Reviews and meta-Analyses [10][11]; and thus the 27-items checklist structure [12].

As there is no common definition for RA, in this study we based our selection criteria based on the definitions provided in [7]. All evidence from studies dealing with RA standards and practices and its contribution to social, environmental, and economic development have been collected. Specific inclusion and exclusion criteria have been set following the research questions, to strictly define the eligibility of the articles to be included in the database. In detail, inclusion criteria were:

- Papers published in the last 10 years (from 2014 to 2024). The literature search was concluded on the 7th of June 2024.
- Papers written in English.
- Papers published on peer-reviewed scientific journals.
- Papers that focus only on RA impacts and standards, excluding studies only on biological effects.
- Papers that provide information to our research questions.
- Papers that did not deal with the multidimensional benefits and trade-offs associated with RA practices were instead excluded.

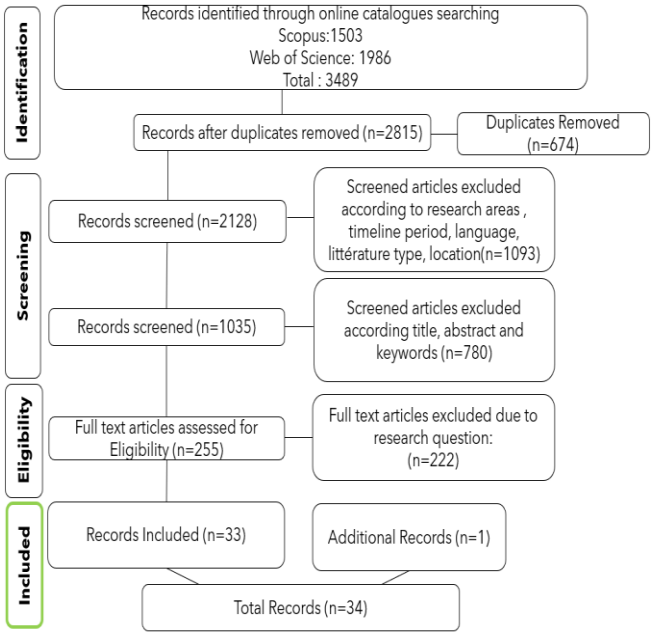

Figure 1. Article selection process.f

A total of 3,489 papers were identified at the first step: 1,986 from Web of Science and 1,503 from Scopus. Then, duplicates (n=674) were removed from the dataset. Afterwards, studies that were not relevant to the specific research areas, timeline period, language, literature type and location were excluded (n=2,128). Notably, the time span from 2014 to 2024 has been chosen to investigate and offer an overview of the latest studies. It also included most of the relevant literature. Subsequently, a three-step screening procedure was applied: i) 1,093 articles were excluded on the basis of search area, publication period, language and article type; ii) 780 articles were excluded on the basis of title, abstract reading and keywords; iii) a total of 255 publications required full-text review. Of these, 222 were excluded due to irrelevance to the research questions and an additional article was identified through cross-referencing, resulting in a final selection of 34 articles. The selection process is illustrated in Figure 1.

III. RESULTS

The final papers that were included in this review were summarized, and the essential data including article information (title, authors, year of publication), study characteristics (study design, sample size, category of participant(s), country of interest), and major findings were gathered (impact on stakeholders, standards/practices treated, relevance to social contribution, relevance to economic, relevance to environmental). Then, in this review we categorized the insights based on the sustainability pillars defined by [13]. Our objectives were twofold: first, to categorize current standards and practices, according to their social, economic, and environmental contribution; and second, the respective roles of diverse stakeholders engaged in the transition towards RA. Economic sustainability refers to practices that support long-term economic growth without negatively impacting social, environmental, and cultural aspects of the community [14]. Social sustainability encompasses the human rights, labour rights, social cohesion, and inclusion and social justice issues that impact the quality of life. It includes providing fair access to resources, ensuring community participation and empowerment, and fostering healthy, just, and resilient societies [15]. Environmental sustainability is about the responsible interaction with the environment to avoid the depletion or degradation of natural resources and allow for long-term environmental quality and it involves the maintenance of ecosystem integrity, natural resource management, and the reduction of waste and pollution [16].

Results marked a concentration of research pertaining to Regenerative Agriculture within specific geographical regions, notably the United States, Australia, and Canada. This concentration underscores a potential limitation in the global understanding of RA's applicability and efficacy across diverse agricultural landscapes. Notably, the prevalence of RA practices on a large scale in these regions contrasts with the dominance of small and medium-sized farming in areas like the European Union (EU). This disparity highlights the need for nuanced investigations into the adaptability and effectiveness of Regenerative Agriculture within varying agricultural contexts worldwide. While existing research predominantly emphasizes the

environmental dimensions of RA, including its impacts and benefits, there is a lack of understanding regarding its social and economic ramifications. This knowledge gap represents a critical barrier to fully comprehending the implications of Regenerative Agriculture adoption and implementation. As such, multidisciplinary studies are imperative to define the broader spectrum of impacts associated with Regenerative Agriculture practices, encompassing social, economic, and environmental dimensions.

RA presents a significant avenue for fostering economic sustainability, particularly for farmers. That is where carbon markets step in, offering farmers a chance to earn more by adopting practices that lock carbon into the soil and cut down on emissions [17]. But for those doing mixed farming, especially on a smaller scale, it's not always easy to turn a profit—especially in years when cereal prices are down. That's where Regenerative Agriculture comes into play [18]. Farmers consider RA to give their products a boost in new markets where people really care about quality [19]. By using agroecological methods, they can keep costs low, produce top-notch goods that fetch a premium price, and even sell directly to customers [20]. Plus, diversifying what they grow helps them stay resilient in the face of unpredictable weather and market ups and downs. RA also contributes to the social sustainability of agricultural landscapes by promoting community engagement, biodiversity, and healthy ecosystems. For instance, practices like agroforestry provide habitat for wildlife while improving soil fertility [21]. Collaborative efforts, such as Community-Supported Agriculture (CSA), strengthen connections between farmers and consumers, fostering local resilience [22][23].

By reducing chemical use and promoting healthier environments, Regenerative Agriculture also enhances public health and fosters a sense of responsibility towards the land. RA significantly contributes to environmental sustainability within agricultural settings by prioritizing soil health and biodiversity [24][25]. Integrating agroforestry not only boosts biodiversity but also aids in carbon storage, mitigating the impacts of climate change [27]. Moreover, by minimizing chemical inputs and promoting natural pest control methods, Regenerative Agriculture reduces pollution and safeguards water quality [28][29].

IV. CONCLUSION

An examination of stakeholder engagement and roles within the context of Regenerative Agriculture adoption reveals a gap in current literature. Understanding the dynamics and contributions of diverse stakeholders, including farmers, policymakers, researchers, and consumers, is therefore paramount to fostering the successful integration of Regenerative Agriculture practices into existing agricultural systems. Yet, existing studies often overlook the intricate interplay between stakeholders and fail to comprehensively assess their respective roles in facilitating or hindering the uptake of RA practices.

Addressing these knowledge gaps necessitates a concerted effort to embrace interdisciplinary research approaches and methodologies. By utilizing frameworks such as the Agricultural Knowledge and Innovation System (AKIS) [30], participatory action research throughout cocreation processes, researchers can enhance collaboration and knowledge exchange among stakeholders, thereby facilitating the adoption and dissemination of RA practices.

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