Sustainable transition, transformation, and disruption in agroecology

Rosewine Joy1, 2

1 Assistant Professor, School of Management, Presidency University, Bangalore, India
2 Founding Coordinator, SDG Centre, Presidency University, Bangalore, India

Email: rosewinesamuel@gmail.com

Abstract. Agroecological systems are increasingly becoming volatile with climatic changes and development pressures, uncertain productivity, management complexity, ambiguous sustainability approaches. With this background, the main aim of this conceptual paper is to identify various transitions, transformations, and disruptions in the agroecological space for food production. The review identifies these discourses as a flow concept related and translucent. Agroecology case studies from across the world are analyzed to identify the approaches as transitional, transformational, and disruptive and to compare the sustainable strategies adopted in each approach. The study points out that differential approaches could lead to sustainable food production in a VUCA world.

Keywords: Climate Change, Food security, Sustainable strategies, VUCA

1. Introduction

Hunger and extreme poverty remain a critical global challenge in the 21st century [1]. Intensification of food scarcity is anticipated due to climatic variability, development pressures, and the impact of pollution on various agricultural systems [2]. The sustainability of such systems is being questioned as the current industrial agriculture production systems are found to be unhealthy for the ecosystem as well as for humans [3]. These agriculture systems are increasingly becoming volatile with climatic changes and development pressures that lead to uncertainty and low productivity in food production[4]. Increasing incidences of pest attacks and diseases due to varying climatic conditions and blockages in the ecosystem services are making the management of these ecosystems complex. Ambiguous approaches to maintain the sustainability of these food production systems are leading to the collapse of many farming systems [5]. Meanwhile, agroecological approaches are now considered as an alternative approach [6] that could manage predictable and unpredictable disturbances [7]. These approaches could lead to food, nutritional, and livelihood security among communities; especially, farming communities in low and middle-income countries [8]. As 70% of food production comes from small and medium farmers, the impact of these approaches on socio-economic conditions can be substantial [9]. Across the world, various system flows and decisions in the agroecological space could bring positive changes in food production and security [10]. These system flows could be conceptually differentiated as transitional, transformational, and disruptive. Strategies are designed based on these system flows to manage food insecurities. With this background, the main aim of this conceptual paper is to identify various flows in the agroecological system that could be in the form of transitions, transformations and disruptions in food production.
2. Materials and methods

Agroecological systems support various system properties such as productivity, stability, sustainability and equitable distribution that could be analyzed over space, time, flows and decisions. This study focuses on agroecological system flows and decisions for sustainability from the perspective of transition, transformation, and disruption. The study employs the literature review method and identified 122 papers published in Scopus Indexed journals between the period 2008-2020 for the study. The keywords used were “technology and agroecology”, “agroecology and transition”, “agroecology and transformation”. Also, reports published by international organizations on agroecology are reviewed and to understand the system flows in agroecology. Only thirty studies that could be segregated as transition, transformation, and disruption studies aligning to flow concept were further focused to develop the concept. The study used cases from across the world to understand the system flows. Since the agroecological approach flows are reviewed as transitional, transformative, and disruptive, the variation is to a great extent conceptualized as the increased degree of scientific knowledge in comparison to traditional know-how which is localized.

3. Result

Bringing food to the tables of 10 billion people by 2050 is a challenge [11]. Agroecology is a sustainable agricultural approach propagated widely as a solution to increasing food insecurity and hunger. Agroecology includes scientific knowledge and traditional know-how evolved by mimicking natural processes and co-created by knowledge from the bottom to top [12]. With the increased involvement of policymakers and governance in sustainable food production discourse, it's expected that the agroecological approach will receive increasing acceptance instead of industrial agriculture. Industrial agriculture by corporates houses with resource intensification for increased output is already identified as unsustainable. However, the agroecological systems are often considered complex. Therefore, a perspective to simplify the approach is the way forward. This study viewed these perspectives through the lenses of transitional, transformative, or disruptive changes that are introduced by the agroecological approach.

3.1 Sustainable Transitions in Agroecology

The transitions in agroecological systems are occurring in the form of process changes [13]. Industrial agriculture uses resource intensification with external inputs for improved output that lead to higher externalities [14]. In agroecology, the focus is on circular inputs to improve the output. This brings more diversification in farm products by capturing synergies evolving out of mixing trees, crops, livestock and fish as input-output agents [15]. This is only possible with a higher level of information flows at the local level to capture traditional knowledge systems on what works best locally [16]. Scientists can co-create these systems by understanding local realities by using participatory processes [17]. These co-created systems are innovative, efficient and sustainable as they recycle input-output and enhance the resilience of people, communities, and ecosystems as the dependency on external inputs are limited[18]. These approaches bring back people as the focus of the system of food production [19]. Although technology plays a vital role in the transitional process, the human or social values are the values that determine how the system flow evolves[20].

These values are embedded in the cultural norms and food traditions followed by the community that protects rural livelihoods with multiple levels of governance. An important aspect of such agroecological systems is that they are not new but a new perspective[21]. They existed in all farming communities that do not pursue industrial food production. However, scientific involvement in the transition from industrial agriculture to agroecological approaches for sustainable agriculture is picking up momentum. For example, rotational Pokkali(indigenous variety) rice-fish farming of Kerala in India has a history of 400 years. However, the system evolved to dominantly fish farming systems from a rice farming system over this period based on market conditions. Similarly, we can see that in vegetable farming in Karnataka in India, marigold plants are used for pest control. The intercrop cultivation of marigold plants has led to reduced use of pesticides in farms that are centered
on agroecological approaches. The liaison between producer organizations and research institutes has led to many best practice knowledge-sharing initiatives through books and papers. If such transitions in processes can be locally captured and disseminated, food production can be scaled up without industrialization of food production.

3.2 Sustainable Transformations in Agroecology
Transformations in the agroecological space could be in the form of changes in the various functions of the resources to receive virtually equal value as industrial agriculture production[22]. Sustainable transformations in agroecology mainly center on changes in resource functions to generate the same value as industrial agriculture [23]. These transformations evolve when the agriculture systems have already moved to industrial production and their impact has led to the degradation of resources. Sustainable transformations in agroecology are also required in conditions where climatic variability impacts the current agrarian practices. In this approach, the traditional practices and scientific knowledge are equally important [24]. Such system flows are evident in various agroecological systems across the world today, as increasingly the sustainability of industrial production of food is being questioned. A major development in sustainable transformations can be found in irrigation – the small water system innovations that increase water table and soil moisture. IoT-based disease detection among agroecological systems can help in the early detection of epidemic diseases, which in turn reduces the usage of pesticides [25] Similarly, the use of technology for soil remediation can help sustainably retain the soil quality.

3.3 Sustainable Disruptions in Agroecology
Disruptions in the agroecological space are radical changes in the way agroecology functions with technological intervention [26]. Sustainable disruptions in agroecology are more technology-driven. In this case, scientific knowledge leads the system flows, enhancing the sustainability of the system. As such sustainable disruptions in agroecology are in the initial stages of application, their impact at the community level is yet to be evaluated. Soil-less agriculture such as hydroponic culture, water culture [27], or nutrient culture can be disruptive and technically remove the conventional resource inputs and their combinations. LED lights replacing sunlight for photosynthesis [28], compatible genetic engineering[29], and agroecology [30] are some of the new agroecological systems flows that we can be viewed as disruptive.

While we move from transitions to disruption, we can identify that the scientific know-how and intensity are increasing between the ecosystem's flows. The major challenge when we approach system flows in agroecology from industrial agriculture is the initial investment to initiate these system flows. The governance models are yet to address these issues, although there is an increased commitment from across the world to shift food production to a more agroecology-based approach.

4. Conclusions
An agroecological approach with farming communities as the center of the food production system could be the best pathway for sustainable agriculture.

Conflicts of interest
There is no conflict of interest concerning this paper.

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