DOI: 10.3217/978-3-85125-842-4-40

293 Emergy analysis of Biofactories destined to the production of healthy food in Peasant Agroecological

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Abstract

Humanity has drastically changed its relationship with food in recent years, since the complexity in the search for food, the physical effort that it took for millions of years to obtain it, in general terms, practically disappeared; this was achieved thanks to the evolution of agriculture to the conventional model that has currently been adopted, detaches the farmer from his innate job of producing from his traditional cognition, avoids the appropriation of knowledge of the productive system, typical of the art of agriculture, in most of the actors, it focuses on obtaining high productions, demands high amounts of agrochemicals, offers a low variety of foods and low nutritional values, and has a highly negative impact on nature. But, there are alternatives to conventional agriculture such as agroecological production systems, which pose a complex solution, supported by scientific research and which addresses the problems of current agriculture in a holistic way; within this production system there is a key subsystem that are biofactories, where the production of biopreparations is mediated, made from the farm´s own resources, complementing the balance of the productive system with the immersed environment, allowing the elimination of the use of synthetic agrochemicals, ensuring biodiverse and healthy products. As a methodology, an emergetical analysis of three biofactories located in three agroecological farms in the Valle del Cauca, Colombia was proposed, using the methodology of Odum (1996). I have incorporated the analysis of the emergy flow by Sociocultural Collection, according to the evaluation methodology of Rodriguez et al. (2021). The evaluation of the nutritional quality of its products is under development. Among the preliminary results, high values of renewability and socio-cultural heritage for agroecological farms were found, presenting themselves as the two most representative emergy flows in the studied biofactories, and the hypothesis of higher nutritional values is calculated for agroecological products in comparison with conventional productions. Finally, it is concluded that biofactories, in addition to being renewable and sustainable over time, a great flow of information that allows their maintenance and constant transformation

circulate in them according to the dynamics of agroecosystems; reinforcing the empowerment of communities that develop agroecological production systems, which is proposed as a necessary alternative to continue researching and promoting. These initiatives do not have real support from governments to favor their development, and from academy we must continue to show their benefits.

Keywords: Agroecological systems, Biofactory, Sociocultural heritage, Healthy food, Biopreparation.

Introduction

The man in his historical process of relationship with food has undergone many changes, but none as accelerated as in recent times, after the industrial revolution. Since the Arboreal period, through the Paleolithic and other stages of millions of years, there have always been some characteristics such as the complexity and the demand for a high physical effort to feed, in addition to a high variety of foods (Teaford & Ungar, 2000). Nowadays, the human diet in general is based mainly on cereals such as wheat, rice and corn. There is a false perception of variety, but the reality is that these three foods supply 50% of the energy needs of humanity (UNCSN, 2020) cited by (Altieri & Nicholls, 2020). This style of eating, with so little adaptation time and the great ease we have to acquire food, without any physical effort, has led us to have worrying rates of chronic diseases such as diabetes or hypertension among others (L Cordain, 1999).

But the evolution of the relationship between man and food, not only remains in the very fact of food. This relationship is influenced by the way of producing food and also generates feedback to it, this is how enormous changes have been generated in the way of obtaining food. Conventional agriculture is the most widely adopted production model in the world, it has been polished over time, but with a focus on achieving high quantities of food, this has led us to develop production methodologies with a high dependence. Food production under the current conventional model requires enormous amounts of products such as fertilizers, pesticides, and hormonal products, in addition to dependence on transgenic seeds and other genetically modified organisms (GMO) (Coleto Martínez, 2004). It has also led to the massive production of cereals due to their apparent high yields, generating a low variety of foods in the human diet, contamination of food with traces of synthesis products harmful to health that accumulate over time, a low nutritional quality in the diet and finally, it has a very high energy demand, supplied by non-renewable elements such as oil.

However, in the world there are other less dependent forms of food production such as agroecological production systems (FAO, 2021). Through agroecological production models, high amounts of food and biomass are achieved, food with higher nutritional quality and a high variety of products can be obtained (Raigón, 2008). Also, the energy requirement is much lower than in conventional production, since it restricts the entry into the system of external elements such as fertilizers, pesticides and other agro-inputs. This is achieved by generating dynamics with high energy recirculation, supported by practices such as the establishment of artisan bio-factories, which supply the nutritional needs of the crops with materials obtained from the same production spaces. One of the interesting things about agroecological production models is that they are proposals that are born from the communities, establishing a bottom-up political proposal that occurs naturally, and that it is expected in the future can be complemented with public policies of top-down type and achieve a more efficient overall feeding in every way.

Empowerment of societies in agroecology

Agroecology, as an alternative fundamental science in the production of healthy food, arises to guide the conversion of conventional agricultural production systems to more diversified and self-sufficient systems (Altieri, 2010) It analyzes agricultural processes in an interdisciplinary way, where environmental, social, political, cultural and technological sciences interact (Gliessman, 1998). Agroecology allows the analysis of all types of agrarian processes in its broad sense, where mineral cycles, energy transformation, biological processes and socioeconomic relationships are investigated and analyzed as a whole (Altieri, 1995).

Sarandón & Flores (2014) and M. Altieri & Nicholls (2000), describe a productive systems with a high agroecological degree when i) optimizes the use of locally available inputs by combining the different components of the farm system, for example, plants, animals, soil, water, climate, labor and people´s knowledge, achieving the recycling of nutrients, conservation of biodiversity in both wild and domesticated regions, making optimal use of the biological and genetic potential of the plant and animal species present within and around the agroecosystem. ii) it takes advantage of local knowledge and practices, including innovative approaches not always fully understood by scientists, although widely adopted by farmers.

The farms under study, correspond to agroecological producers in Family and Community Peasant Agriculture, in Southern Colombia, who have transformed land and where the “vocation” of agroecology is evident which, according to the definition of Altieri (1995, p.151-203), translates into the personal and generational conviction of the producers for the alternative of agroecological production, worrying about having a solid and diverse knowledge of agri-environmental sustainability, the food security and sovereignty and the conservation of biodiversity, traditions and customs in the management of agroecosystems and products.

Each Farmer conceives the spaces of the farm in a design of the diversified agroecosystem of increased production via the use of biodiversity and recycling, based on the understanding of nutrient cycles and interactions of multiple species including integrated crop-livestock-forest systems (Altieri, 2010, p.60).

The emergetic contribution by Sociocultural Heritage in agroecological farms is developed for the first time, in the study of (Rodríguez et al., 2021), for Colombian agroecological systems, with the purpose of numerically evaluating the essential energy that the family contributes so that agroecosystems work. The emergetic contributions, in continuous flow, by Sociocultural Heritage (H) since it counts: i) internal family labor given by the permanent stay and integration of the family with the agroecosystem. ii) The family´s interaction tasks with actors outside the farm. iii) It counts intangible tasks of appropriation of knowledge and generation of information, within the farms, achieved with the transfer of knowledge and agroecological culture and with actions of ingenuity in the operation of balanced agroecosystems.

The balance within the farms in their operation and control has a categorical foundation: family labor within the system that includes all members of the family group (women, children and the elderly) who, due to their continuous stay in the farms achieve such family-agroecosystem integration, with permanent holistic reading of the agroecosystem manifestations, and that allows them to take pertinent actions in favor of their efficiency and sustainability. This position of the family is transcribed in the study in the emergy amounts calculated by: the human metabolism in the permanent population on the farms -the families- (H1) and the transmission or carrying of memory of information that the families of the farms accomplish (H3) (Rodríguez et al., 2021).

Additionally, the family- agroecosystem cohesion generates the appropriation of knowledge within the farms (H4 y H5) and leads to the interaction of the family with actors outside the farm (H2) with various objectives among which are: promoting agroecological culture (between neighbours, linked to local and national Associations, and in the attention to academic communities that visit the farms), Exchange of seeds, approach producer-consumer creating bonds of trust, training and exchange of experiences, among others (Rodríguez et al., 2021).

It is the Sociocultural Heritage (H), which has allowed different strategies generated since millenary times, to maintain the natural balance in agriculture, today they are still kept, modified and implemented in family productive systems. Among these strategies is the recycling of materials for the production of own inputs. These inputs are known as “biopreparations or bioproducts” and are made on the study farms. They are solid or liquid preparations that are applied in crop systems, the results of digestion, fermentation or biological decomposition processes of organic materials, mostly considered waste. They are characterized by their high content of nutrients, organic matter, microorganisms and different substances that accelerate physiological processes in plants, provide a protective effect against diseases, repel some species and improve soil health (Castillo et al., 2007).

The facility where the biopreparations are made is known as a biofactory which, due to its characteristics and functionality, is a type of laboratory built with local materials. In this space, farmers test, improve and validate bioproducts, after a process of daily observation of their agroecosystems and the relationships that are generated in it over the years. The biofactory is one of the most striking experimentation technologies for people interested in knowing or implementing sustainable production systems, which generates a great flow and exchange of knowledge.

Biofactories require a high investment of labor, generally family, and mostly use local resources, which reduces the acquisition of external materials that are commonly high-cost. That implies that it is one of the cheapest technologies and that the most benefits the farmer (Terry et al., 2015). Among these external materials are the agricultural inputs commonly used in conventional agriculture, which are produced from chemical synthesis and the main use of fossil energy. That is to say, biofactories are constituted in systems that reduce the emission of greenhouse gases and prevent global warming, therefore, they do not only contribute to the sustainability of the producer families, but also to the environment from the local scale.

It should be taken into account that this technology also emerges as an innovation strategy to resist the absence of state policies that support alternative family farming, given that, in Colombia, for the majority of peasants and rural inhabitants, state models and policies that protect modern industrial agriculture have meant exclusion, indebtedness, competition with better equipped and more productive farmers, the decrease in the prices of agricultural products due to the increase in imports, unemployment, migration to urban areas, meagre salaries, vulnerability and poverty (Ceccon, 2008; FAO, 2000).

Although biopreparations are recognized worldwide in food production as effective substitutes for chemical synthesis inputs and, therefore, a useful strategy in agroecological production and in the reconversion processes of conventional agricultural systems (Bejarano et al., 2009), by themselves they do not generate the equilibrium dynamics of the system, and it is necessary to apply multiple cultural practices, which are different depending on the particularities of the context.

Methods

The three bio-factories evaluated in the present work are located in the Agroecological farms of the municipalities of Andalucia, Sevilla and Buga in the Valle del Cauca departament in southern Colombia, of the study carried out by Rodriguez et al., (2021). Biofactories are within a biodiverse system (farm) with a variety of interrelationships and inputs and outputs of flows of matter and energy, which together allow the application of bioproducts to be effective, as observed in Fig. 1 (Detail A). Within the input streams for the preparation of biopreparations, there are mainly the Agricultural Residual Biomass (ARB), Livestock Residual Biomass (LRB) and the labor and knowledge of the families, which allow the obtaining of bioproducts such as compost, worm humus, bioles, slurry, microorganism broths, mineral broths and different types of tea.

An emergetical análisis was carried out on the bio-factories according to the Odum methodology (1996) and, in addition, the emergy flow by Sociocultural Collection was incorporated into the analysis according to the evaluation methodology of Rodriguez et al., (2021). Thus, the emergent flows and their percentage equivalent were determined for renewable natural resources (R), non-renewable natural resources (N), sociocultural heritage (H) purchased materials (M) and contracted services (S) and consequently the total emergy of biofactories (U) which results from the sum of the partial flows of emergy U= R + N + H + M + S.

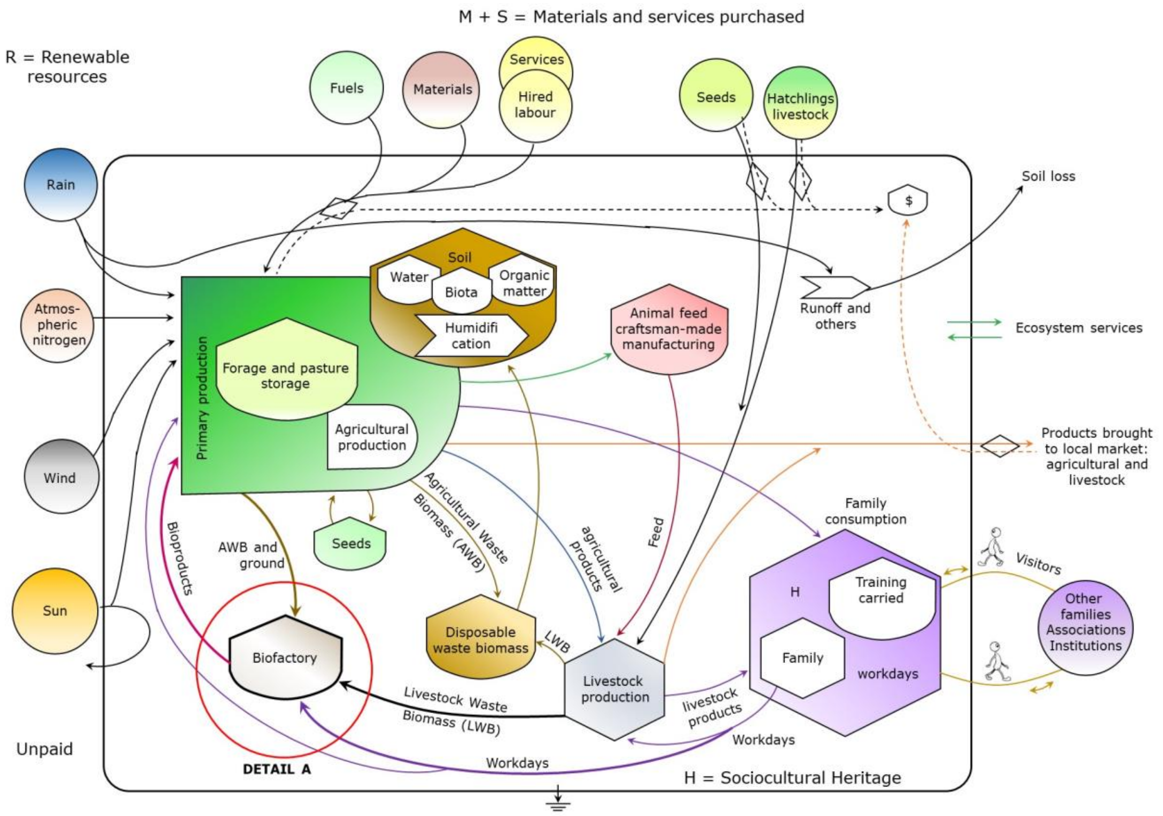

Figure 1. Emergy flow diagram, materials and information from an agroecological farm showing the flows related to the Biofactory.

Results and Discussion

The biofactories of the agroecological farms, some more specialized than others, both in infrastructure and in practices for the production of biopreparations, present values of Renewability (%R) higher than 48% and Sociocultural Heritage (%H) above 21%, these being the two most representative emergency flows in the process of making biopreparations (Fig.1), which even when added together reach close to 100%, in the so-called inclusive Renewability (%RH), as shown in Table 1. Given that the % R is the percentage of the total emergency that drives a process derived from renewable sources (Brown & Ulgiati, 1997), and that the %H represents the emergy due to the contribution of the family´s work and the appropriation of knowledge in a process (Rodríguez et al., 2021), the high %RH, indicate that biofactories, in addition to being renewable and sustainable over time, circulate a large flow of information that allows their maintenance and constant transformation according to the dynamics of agroecosystems.

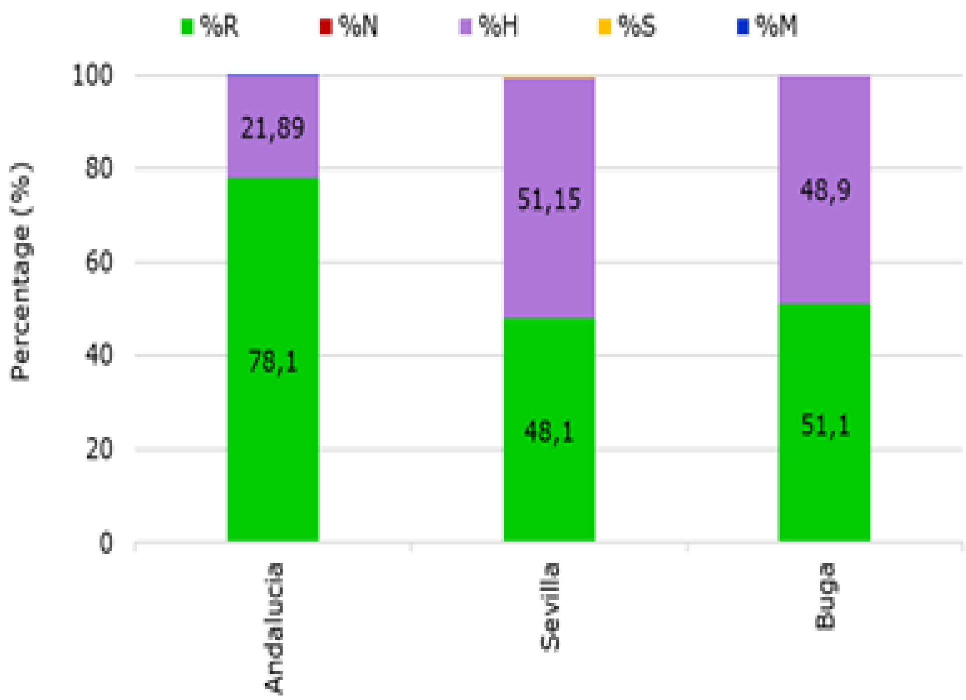

Figure 2. Percentage of the emergy flows for agroecological production systems in the municipalities Andalucia, Sevilla and Buga.

Conclusions

The results also reinforce the importance of empowering communities through alternative production systems, which translates into the generation of renewable technologies such as biofactories, which, if they are scaled up or overcrowded, can provide substantial contributions to face various current socio-environmental problems, derived from unsustainable food production, such as the excessive use of fossil fuels for the production of chemical synthesis inputs, on which they are dependant.

Additionally, the very low values of purchased Materials and hired Services (% M and %S) less than 1,0%, as observed in Table 1, do not imply that biofactories do not require external inputs and services, but of these flows, its operation is not depending.

Table 1. Emergy flows and their percentage of participation for agroecological production systems in the municipalities Andalucía, Sevilla and Buga.

Emergy Inputs	Resource	Andalucía		Sevilla		Buga	
		Sej	%	Sej	%	Sej	%
Renewable natural resources	R	8,43E+18	78,10	1,69E+17	48,13	9,22E+17	51,09
Nonrenewable natural resources	N	1,44E+12	0,00	4,29E+13	0,01	1,61E+13	0,00
Purchased materials	M	8,06E+14	0,01	2,37E+11	0,00	5,63E+14	0,03
Contrated services	S	9,26E+10	0,00	2,47E+15	0,70	6,26E+11	0,00
Sociocultural Heritage	H	2,36E+18	21,89	1,80E+17	51,15	8,82E+17	48,87
Total emergy	U	1,08E+19	100	3,51E+17	100	1,80E+18	100
Inclusive Renewability	%RH	99,99		99,28		99,97	

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