The role of agroecosystems diversity towards sustainability of agricultural systems

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Research goals

1) **review the existing scientific knowledge** about agroecosystems diversity, agroecology, traditional and alternative farming systems based on permaculture and bio-dynamical principles and their role on the sustainability of agriculture;

2) evaluate the "state of the art" pointing out **research needs** for scaling up **agroecological approaches**;

3) conclude on the **future developments** and actions needed at local, national and European levels to adapt agricultural practices **towards sustainability**.

Scientific methods

→ the study is based on a literature review

→ analysis and synthesis as scientific methods are used

What is agroecosystem diversity?

→ **Emrys and Ngau, (1991):** farm diversification (linked to crop diversification) & farm income diversification (diversification of on-farm activities)

→ **Ilbery (1991):** farm diversification (located within the farm activities in the agricultural sphere) & diversification of activities (income diversification from activities undertaken inside and outside the farm)

→ **Shome (2009):** employment diversification & crop diversification & resource diversification

→ **Singh (2000):** horizontal crop diversification & vertical crop diversification

→ **In our paper:** focusing on **crop diversification** or **horizontal crop diversification,** which is largely adopted by the permaculture and biodynamic agriculture.

Terminology for "alternative farming"

→ **Permaculture definitions:**

▪ **permanent, self-sustaining systems of agriculture**, adaptable to both rural and urban locations, designed to produce an **efficient, low-maintenance, optimally productive integration of trees, plants and animals**, structures and human activities within a specific environment, (Elkington, Hailes, 1988).

▪ **a movement**, notably implementing the development of diversified farming systems, and **a design system** and **best practices framework,** Ferguson and Lovell (2013)

Terminology for "alternative farming"

→ **Biodynamic agriculture:**

▪ holistic management practices addressing the environmental, social, and financial aspects of the farm (Diver, 1999).

▪ inspired by R. Steiner and maintaining: **sustainable soil fertility** and the **relationship between plant growth and cosmic rhythms.**

Agroecosystems diversity and climate change

1) **energy saving and soil resilience effects from crop diversification**

→ a study in Bangladesh (Rahman, Kazal, 2015) examines whether crop diversification provides economy in energy use. The results demonstrate economies of energy use in the diversified farms.

2) **multi-cropping approaches in production systems have benefits of increased production, effective pest, disease and weed control, and improved soil health**

→ Ehrmann and Ritz (2014) report numerous studies with yield advantages in mixed cropping systems compared to single crops

Agroecosystems diversity and climate change

3) a paradigm-shift and a more integrated approach in designing crop production systems needed

→ Permaculture could respond to the requirements of this "new paradigm". Case studies from Cuba, Brazil, Philippines, and Africa demonstrate how the agroecological development paradigm proves to be the only viable option.

→ Researchers reveal that the full organic farmers in the Philippines have considerably higher on-farm diversity, growing on average 50% more crops than conventional farmers, better soil fertility, less soil erosion, increased tolerance of crops to pests and diseases.

Agroecosystems diversity and economic effects

→ **A study from Ghana** indicates that diversified cocoa farms are more efficient than single (mono) crop farms. The estimations for the **economies of scope** parameter indicate possibilities for cost complementarities **between production of cocoa and other crops on the same plot.** Economies of scope theory could be connected to permaculture.

→ **FAO (2014) - small and medium size farms** tend to have **higher agricultural crop yields per hectare** than larger farms, but labour productivity is lower. Small-scale farming, especially using "**organic**" methods may be **two to four times more energy efficient** than large conventional farms.

Agroecosystems diversity and economic effects

→ **Gliessman, 1998** - integrated farming systems where **small farmers** produce simultaneously grains, fruits, vegetables, fodder, and animal products **out-produce yield per unit of single crops on large-scale farms**. Yield advantages can range from 20% to 60%.

→ **Cuba** - family farmers produce over 65% of the country's food, on only 25% of the land.

→ **Droogers and Bouma (1996)** compare biodynamic and conventional soils on two neighboring farms, for at least 70 years. The BD-farming practices expressed higher yield potential, long-term stability and sustainability than conventional soils

Identified research needs and pathways for agroecology

(1) The need of integration of science and traditional knowledge in engaging all the stakeholders towards a system-oriented thinking for sustainability of agricultural systems.

(2) The importance of educating and training farmers in professional design and management of their agricultural holdings.

(3) The access to professional advisory and extension services

Identified research needs and pathways for agroecology

(4) The access to funding for small-scale farmers

(5) The support of local community organizations

(6) The development of local and farmers' markets

(7) The increase of trust between contracting parties for lowering of transaction costs

Conclusion

→ the adoption of the principles of **diversification of crops, trees and animals increases the resilience of farms** to climate change **and improves their economic results**

→ **agroecosystems diversity across farms and regions in Europe** requires simultaneous **actions at the local, national and European levels** both in terms of **institutional and policy support and development of markets.**

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