Multifunctionality of Farming Systems
A case study in Hanoi peri-urban, Vietnam

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CONTENTS

1. Introduction

- Agriculture plays the vital roles in field of food security, poverty reduction, etc. It is facing many challenges *(FAO 2018).*
- Multifunctionality (MF): Agriculture could provide multiple outputs beyond food and fiber, such as environmental protection, biodiversity and cultural preservation, etc. *(Wilson, 2007).* MF has principles to achieve the balance of objectives in economy, society and environment.
- Agroecology: A science/ movement/ approach/ application of ecological concepts and principles in agriculture to design and manage agriculture systems *(Altieri et al. 2015).*
- Promotion of agroecology in public policies, research and extension is still limited *(Silici 2014).* MF researchers currently pay their attention in areas such as the EU, US, Australia, Japan, New Zealand *(Brummel and Nelson 2014).* Studies less focus on MF of agroecological farming systems (AFS) *(Le and Dung 2018)*.
- The study aims to assess the MF of farming systems, focus the AFS including organic farming system (OFS) and integrated farming system (IFS), and conventional cropping system (CCS), provides an overview of farming systems' MF from the perspective of farmers.

2. Materials and Methods

2.1. Study Area

2.2. Data collection

2.3. Data Analysis

2.1 Study Area

- Soc Son district, Ha Noi, Vietnam
- Over 97% of population lives in rural area, range from 404 people/km2 in upland to over 2,000 people/km2 (lowland)
- 1) Low mountainous terrain; 2) Hills and hilly plains; 3) plain terrain

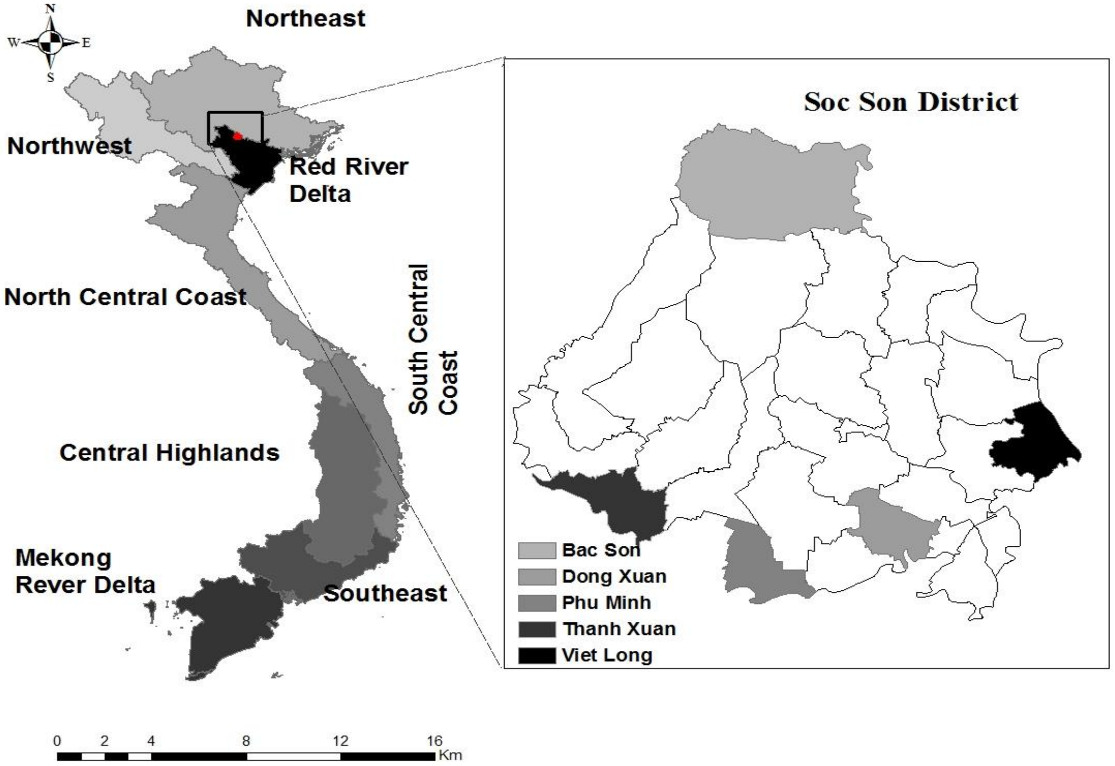
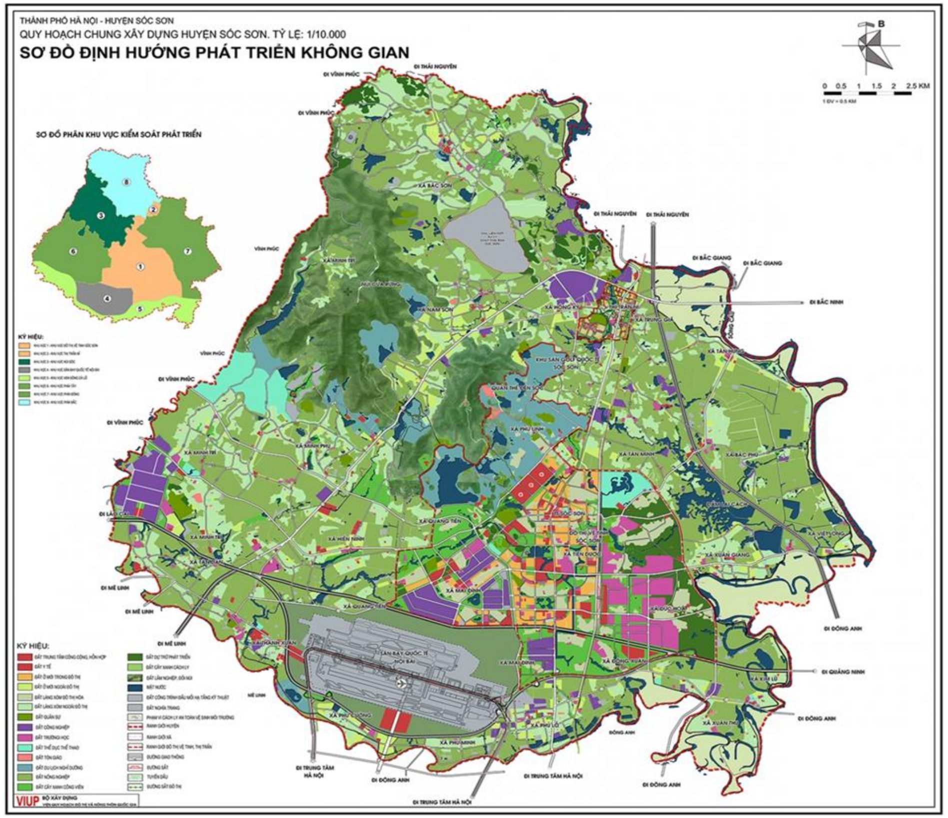


Figure 1: Map of Study Area



- Agriculture land area accounts more than 60.54%
- Agriculture systems are diverse

2.2 Data Collection Methods

- **Secondary Data Collection**

Information	Material	Source
Theory and data related to AFS, MF and sustainability of AFS	+ Articles, journals, books + Previous theses	Library, Websites
Socio- economic and environmental characteristics of the study area General information on households and AFS in study areas	+ Articles, journals, books + Policy documents + Published and unpublished reports	+ Library, Websites + Websites; + District offices + District offices (Department of Agricultural Extension, Department of Agriculture)

Primary Data Collection

- **Key Informant Interviews:** 4 local authorities and agricultural officers ; To carry out the overview of data related to research topic.
- **Group discussion:** local government officers and farmers, indicators were discussed and consolidated, and listed in three levels, including themes (economic, social, and environmental), sub-themes, and default indicators.
- **Expert Judgments**: Experts who represent for socio-economic and ecological fields, from university, NGOs and government offices. Rating the importance of indicators on a scale of 0-10, least to most important respectively.

weight wi of indicator i was calculated by the following formula Eq.1.

$$w_{\mathrm{i}} = \frac{\sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{w_j}}{n} \qquad \text{(Eq. 1)}$$

where wj is the weight given by expert j (wj=(0,10)), and n is the total of experts (n=15).

Households survey

- To investigate households' agriculture background, the MF performance of the farming systems including OFS, IFS, and CCS
- **Sample size**

$$n = \frac{N}{(1+Ne^2)} \quad \text{(Eq.2)}$$

(Yamane, 1967)

  - Where, n is the sample size, N is the population size, and e represents error tolerance.
  - The minimum sample size is 100 at 10% of margin of error and n = 56,485
  - Total responded sample size is 120 farm households. In case the purpose happens to be to compare the differences among the strata, then equal sample selection from each stratum would be efficient even if the strata differ in sizes (Kothri, 2004)

→120 farm households which divides equal to 40 farm households for each stratum is acceptable.

- Through face-to-face interview, farmers provide the HH's background information and give score of 0-10 for outcomes contribution of their production

2.3 Data Analysis Methods

Multi-Criteria Analysis (MCA)

Calculation of each aggregated indicator

$$I_{Ci.j} = \frac{\sum_{k=1}^{n} w_k * V_k}{\sum_{k=1}^{n} w_k} \qquad \text{(eq.3)}$$

Calculation of each criteria

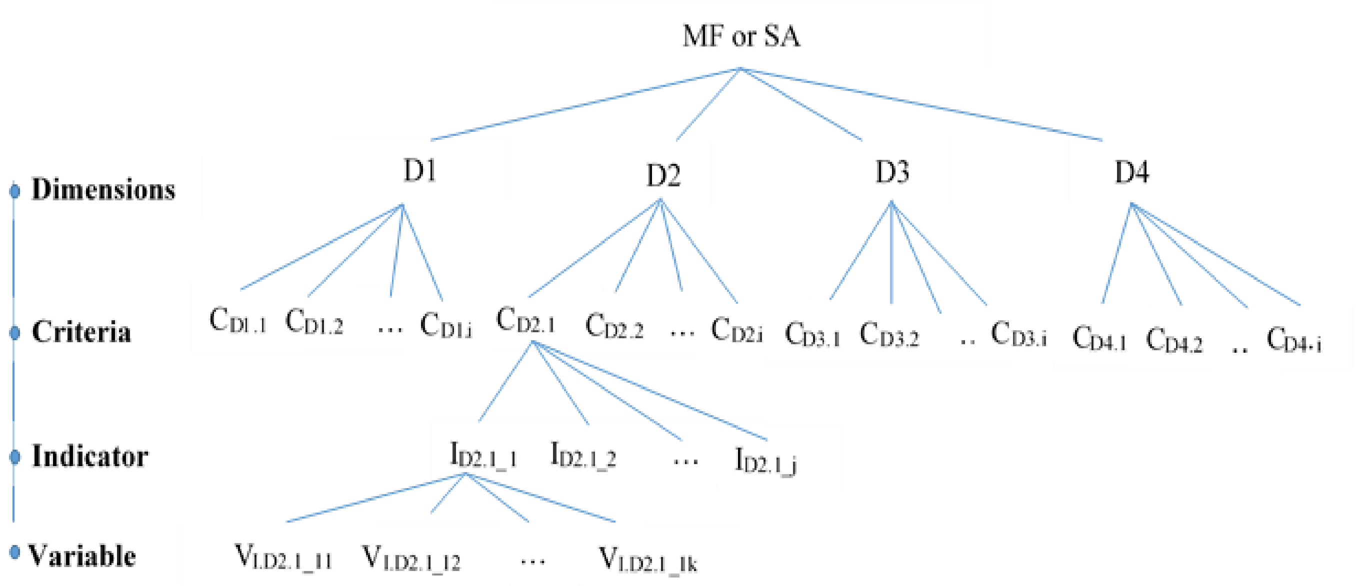
$$C_i = \frac{\sum_{j=1}^{n} w_j * I_{ij}}{\sum_{j=1}^{n} w_j} \qquad \text{(eq.4)}$$

Calculation of each dimension

$$D_i = \frac{\sum_{j=1}^{n} w_j * C_{ij}}{\sum_{j=1}^{n} w_j} \qquad \text{(eq.5)}$$

Aggregate index:

$$AI = \frac{\sum_{i=1}^{n} w_i * D_i}{\sum_{i=1}^{n} w_i} \qquad \text{(eq.6)}$$



Where

- AI = Aggregate index
- D = Dimensions; V= Variables; W=weightage
- i, j and k represents number of dimensions, number of indicators within in each dimensions and number of variables within each indicators respectively.

Assessing Multifunctionality of Farming Systems

- **Variables for assessing MF:**
  - Economic outputs: Products diversification, food safety, food security, income, low production cost, material for industry, yield, independence of external support, etc.
  - Social outputs: employment, health and welfare concerns, gender equality, cultural inheritance, livelihood security, land right security, social network
  - Environmental outputs: soil/ water/ air quality, nature and landscape quality, biodiversity and natural habitats protection, GHGs reduce, renewable energy
- **Each analytical variable is assigned a value in the eleven-point Likert scale of the performance level** (0=no and 1 to 10 as least to best)
- **MF assessing follows the steps of MCA method**
- **Index of Multifunctionality (MF):**
  - $$\mathrm{MF} = \frac{\sum_{i=1}^{n} w_i * D_i}{\sum_{i=1}^{n} w_i} \qquad \text{(eq.7)}$$

3. Results and Discussion

3.1 Socio-economic Characteristics of Agroecological Farming Systems

3.2 Reliability of Multifunctionality Assessing Instrument

3.3 Assessing the Multifunctionality of Farming Systems

3.1 Socio-economic Characteristics

Table 1 Socio-economic characteristics of farm-households

Socio-economic characteristics	Unit	Organic farming system	Integrated farming system	Conventional cropping system	Average	F-value
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Gender of head (Male)	%	80.00	87.50	65.00	77.50	3.091**
Age of head	years	54.30 (6.62)	55.25 (8.01)	60.30 (8.17)	56.62 (8.01)	7.147***
Education level of head						
None	%	0.00	0.00	5.00	1.67	0.672
Primary school	%	17.50	20.00	12.50	16.67	
Secondary school	%	42.50	57.50	52.50	50.83	
High school	%	40.00	22.50	22.50	28.33	
Higher education	%	0.00	0.00	7.50	2.50	
Farming experience	years	34.60 (8.18)	34.40 (10.07)	41.23 (12.21)	36.74 (10.69)	5.702***
Agroecological farming experience	years	10.23 (2.54)	16.05 (11.78)	0.00 (0.00)	8.76 (9.59)	54.556***
Household member	persons	5.13 (1.65)	5.48 (1.85)	4.83 (2.00)	5.14 (1.84)	1.250
Household labors	persons	3.38 (1.05)	3.55 (1.13)	3.13 (1.11)	3.35 (1.10)	1.507
On-farm labors	persons	2.20 (0.79)	1.90 (0.38)	1.83 (0.71)	1.98 (0.67)	3.702**
Farm area	ha	0.23 (0.12)	0.61 (0.37)	0.18 (0.09)	0.34 (0.30)	42.827***
Average agricultural income	Million VND/ ha	348.89 (262.75)	376.38 (422.08)	113.75 (148.66)	279.67 (319.79)	9.286***

3.2 Reliability of Multifunctionality Assessing Instrument

The average value of the important scores of MF indicators ranged from high (6.53) to very high level (9.53), relatively close to each other → the indicators are almost equally important. Cronbach's Alpha values > 0.6, and the Corrected Item – Total Correlation values > 0.3 → the instrument is reliable

3.3 Assessing the Multifunctionality of Farming Systems

3.3.1 Economic Functions of Farming Systems

3.3.2 Social Functions of Farming Systems

3.3.3 Environmental Functions of Farming Systems

3.3.4 Aggregated Assessment of Farming Systems’ Multifunctionality

Economic Functions

- OFS: farmers rated the outcome contributions higher than the rest groups → finding fits with meta-analysis of Reganold and Wachter (2016).
- High score in AFS groups: food safety, food quality.
- Low score: Cost reduction, inputs use reduction
- CCS: high score for food self-sufficiency. Most functions were rated at medium level with a range of scores in four to six scales

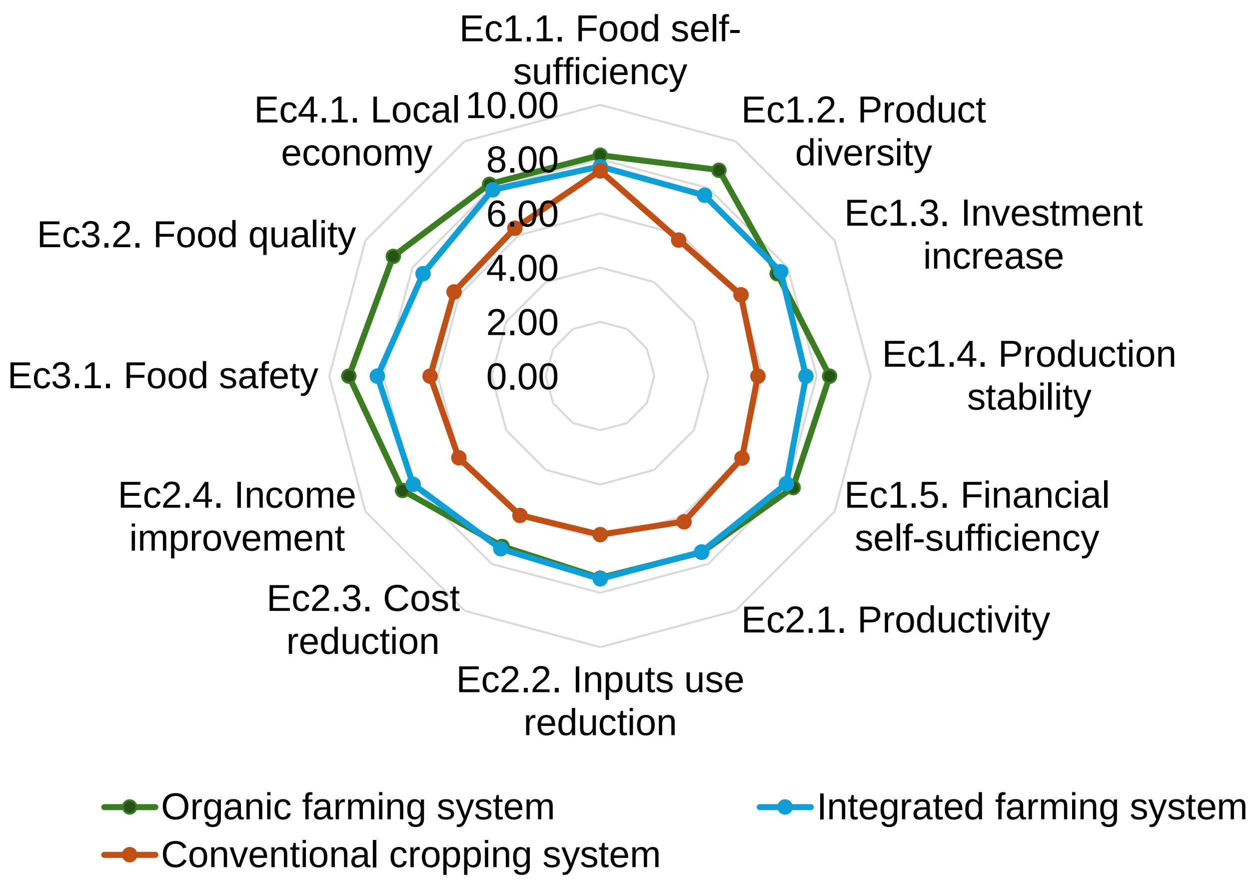


Figure 2. Score rating economic functions of farming systems

Social Functions

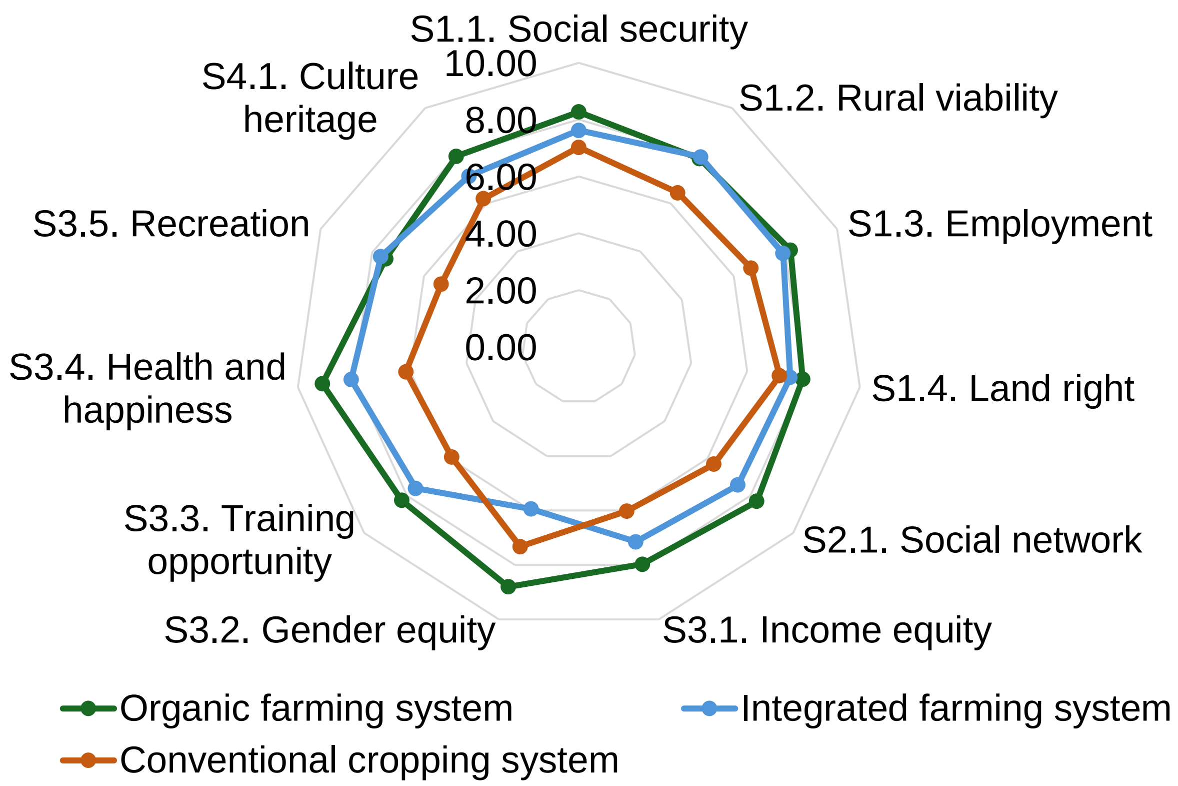


Figure 3. Score rating social functions of farming systems

- IFS: Gender equity was evaluated at lowest score among three groups

  → The gender-based norms of favors men in agriculture, "men usually own more valuable livestock compared to women, play an important role in herding" *(Kariukia et al., 2022)*.

- OFS: High evaluation for health and happiness, gender equity, employment, training opportunity, and social network improving. Low score for recreation
- Land right maintenance: high score in all of three groups.

Environmental Functions

- OFS: high evaluation on biodiversity, soil protection, water management, waste treatment, air pollution & GHGs reduction
- IFS: high score of waste recycle, soil protection, less air pollution, chemical inputs use reduction
- Genes conservation, less water consumption, plastic use reduction, and recycled energy: low score

→ Buying high-yielding seeds in the market (including farmers who drive OFS)

→ Plastic use has been increasing, lead to soil degradation, plastic residues, and micro-plastics *(Maraveas, 2020).*

→ Few IFS households applied biogas system; few farmers reused the gas from biogas system

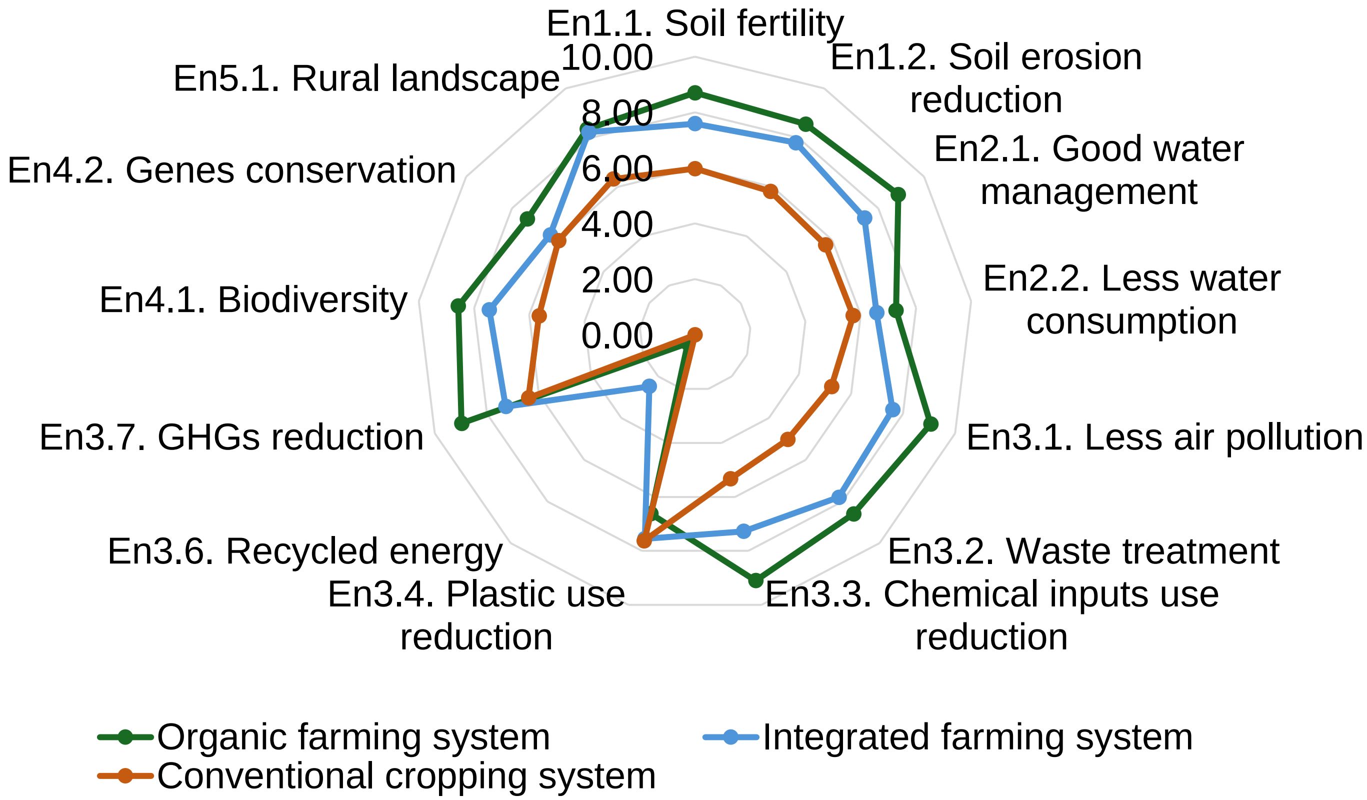


Figure 4. Score rating environmental functions of farming systems

Aggregated Assessment

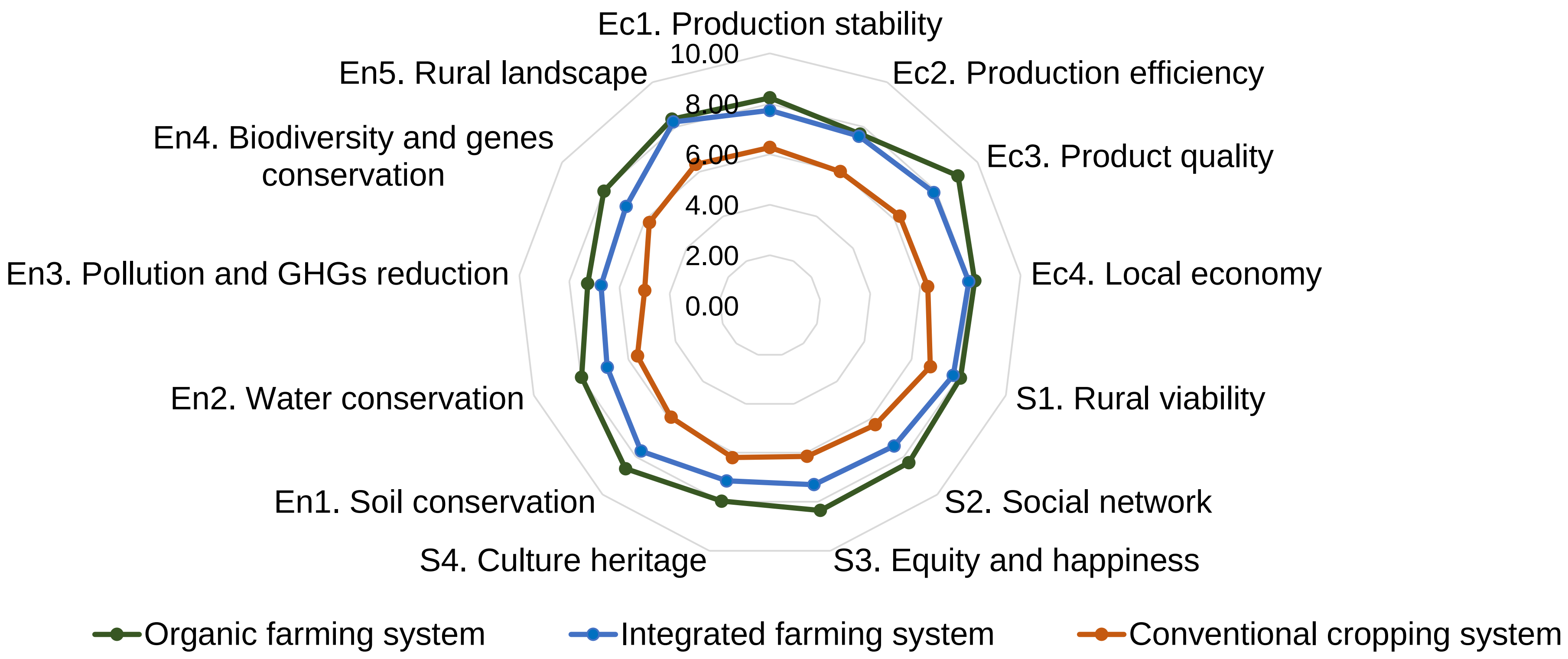


Figure 5. Aggregate scores rating functions of farming systems

- AFS: best scores for product quality, equity and happiness, soil conservation, rural landscape
- OFS: high scores of production stability, product quality, equity & happiness, social network, soil conservation
- Pollutions and GHGs reduction: lowest score in all systems
- MF_{OFS} = 8.17; MF_{IFS} = 7.09; MF_{CCS} = 6.08 (F test-value =79.598***) → in line with earlier study that agroecological farming provided more benefits than conventional farming *(Kerr et al., 2019)*

4. Conclusions

- Superior average scores of economic, social, and environmental functions of AFS, especially of the OFS, compared to CCS
- With the larger agricultural land area, farm households can take advantage of implementing IFS
- Small-scale farm households could gain high benefits if they practice OFS
- OFS: Costly production with external certified inputs, low recreation, more groundwater consumption, and plastic overuse were the remarkable issues
- IFS: Gender inequality with production favoring men and less recycled energy are the most prominent issues

→ Policies and development programs should pay more attention to promoting agroecological practices for more outcomes of farming systems

→ Future studies could compare the score of farmers’ judgment and the objective indicators to see perceived and actual performances.

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