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# Diversity and abundance of spiders and insects in organic and inorganic rice fields in Sumber Rejo village, Percut Sei Tuan district

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**Abstract**
Arthropod diversity and abundance, particularly spiders and insects are key markers of agricultural ecosystem health because they serve as biological control agents, pollinators, and trophic chain components. Agricultural intensification through the use of synthetic inputs frequently diminishes biodiversity, necessitating an evaluation of the merits of organic farming practices in sustaining agroecosystem stability. This research examine the diversity and richness of spiders and insects in organic and inorganic rice fields in Sumber Rejo Village, Percut Sei Tuan Subdistrict, Deli Serdang Regency, North Sumatra. The study was carried out over three months, from May to July 2025, using Yellow Sticky Trap (YST) and sweep net technologies that were strategically put in both types of rice fields. The obtained data were evaluated using the Shannon-Wiener index (H′) for diversity, the Shannon-Wiener for abundance, the Evenness index (E) for evenness, and the Dominance index (C) to assess community structure. Differences between systems were examined using the t-test. The results demonstrated that organic rice fields are more diverse and abundant than inorganic rice fields. The spider diversity index in organic rice fields was 1.77, whereas in inorganic rice fields it was just 1.36, both in the moderate range. Similarly, the insect diversity index in organic rice fields was 2.37, greater than in inorganic rice fields (2.00). Spider and insect abundance values are also greater in organic rice fields (1.21 and 2.26) than in inorganic rice fields (0.87% and 1.57%). Meanwhile, spiders and insects have a relatively balanced distribution in both systems, with organic rice fields being slightly more stable, and the dominance index in both environments is low, indicating that neither species dominates significantly. Overall, these data show that organic farming practices promote biodiversity and ecosystem resilience, whereas synthetic inputs in inorganic farming reduce natural ecological processes and increase sensitivity to pest disturbances.

**Keywords:** Arthropod diversity, organic farming, rice agroecosystem

## Introduction
Arthropods, particularly spiders and insects, play an important role in maintaining the balance of the ecosystem. Insects function in the processes of pollination, decomposition of organic matter, and control of pest populations through predator-prey interactions, making them bioindicators of the health and sustainability of agroecosystems (Abid *et al*., 2024) [1].
However, intensified management with the use of pesticides and chemical pesticides in conventional systems has resulted in reduced arthropod biodiversity, decreased soil quality, and increased crop vulnerability to pest outbreaks (Supriyadi *et al*., 2021; Fürst *et al*., 2023) [14, 7]. In contrast, an organic farming system that prioritizes organic inputs and minimizes synthetic materials is believed to be capable of maintaining soil quality, improving soil fertility, and preserving ecosystem stability (Arianti *et al*., 2022; Rahmadi *et al*., 2023) [2, 13].
Rice fields, as the primary ecosystem in the Southeast Asian tropical region, are a complex habitat that supports arthropod life. Spiders function as natural predators of major pests, such as leafhoppers and stem borers, with various other insect species serving as pollinators or natural enemies (Isnawan & Ramadhanti, 2021) [9]. Previous studies have shown that organic rice fields can support larger and more diverse arthropod communities compared to inorganic rice fields (DELA PEÑA & RATILLA, 2022) [5]. However, local research comparing the diversity and abundance of spiders, as well as insects, at the village level is limited, necessitating further study.

## Materials and Methods

This study employs a comparative design to compare the variety, quantity, evenness, and dominance of arthropods, specifically spiders and insects, under two distinct rice field management systems, organic and inorganic. The research site was chosen in Sumber Rejo Village, Percut Sei Tuan Subdistrict, Deli Serdang Regency, which reflects rice agroecosystem conditions with varying agricultural management. The site was chosen based on the existence of organic rice fields that do not use synthetic fertilizers or pesticides, as well as inorganic rice farms that habitually employ chemical inputs. This research methodology enables the investigation of the influence of management strategies on the organization of arthropod communities in rice field ecosystems.

The data collection procedure lasted three months and coincided with the rice growth phase. Arthropod specimens were gathered using Yellow Sticky Traps (YST), which were strategically placed at various points along rice field transects to catch flying insects. The collected specimens were then identified in the laboratory using taxonomic keys to determine their group and species. This technique was developed to capture species variety in a representative manner, including both predator groups and other insects that play a role in the rice field ecology.

The identification results were examined using a variety of ecological criteria. The Shannon-Wiener index (H′) was used to assess diversity, the Menhinick index (Dmn) to assess abundance, the Evenness index (E) to measure the evenness of individual distribution among species, and the Dominance index (C) to determine the level of dominance of specific species within the community. In addition, an independent two-sample t-test was used to identify significant differences between organic and inorganic rice fields. This technique allows for a thorough evaluation of how organic and inorganic farming systems alter the organization of arthropod communities, as well as the degree to which these changes are statistically significant.

### a) Diversity Index

The Shannon-Wiener index assesses species diversity in a community by considering the number of species and the fraction of their individuals. The larger the index value, the more diversified and stable the community.

$$H' = -\sum_{r=t}^{s} p_i\,(ln p_i)\,;\; p_i = \frac{n_i}{N}$$

**Description**

H' = Shannon Wiener diversity index.
S = Number of species
ni = Number of individuals within a species
N = Total number of individuals from all species.
ln = natural logarithm.
Pi = The ratio of the number of individuals in each species to the overall number of individuals.

According to Hutcheson's (1970) Diversity Index Assessment Criteria,

1) Low, if the diversity index H' < 1.
2) Medium, if the diversity index 1 < H' < 3.
3) High, if the diversity index H' > 3.

### b) Abundance Index

The Menhinick index compares species abundance or richness to the total number of people. This index allows you to compare abundance between groups, even if the number of individuals seen varies (Odum, 1993; Atmodjo *et al*., 2024) [3].

$$Dmn = \frac{S}{\sqrt{N}}$$

**Description**

S = number of species.
N = the total number of individuals.

### c) Evenness Index

The Evenness index measures how evenly distributed people are across species in a group. A score close to 1 suggests a balanced distribution of people with no dominant species (Ludwig & Reynolds, 1988) [10].

$$E = \frac{H'}{In\ S}$$

**Description**

E = Evenness Index.
H′ = Species Diversity Index.
ln = natural logarithm.
S = Number of recorded species.

The criteria for evaluating the evenness index are as follows:

1) 0 < E ≤ 0.5 indicates low evenness.
2) 0.6 < E ≤ 0.75 indicates moderate evenness.

### d) Domination Index

The dominance index measures how much one species dominates a group in comparison to others. A high number suggests dominance of one or more species, whereas a low value indicates a more balanced community.

$$c = \sum\left(\frac{ni}{N}\right)2$$

**Description**

C = Dominance index
i = Number of individuals of a single species
N = Total number of individuals of all species

According to the criteria for assessing the Dominance Index (Manurung, 2020):

1) C value between 0 and 0.4 indicates low dominance and no pressure on the ecosystem.
2) C value between 0.4 and 0.6 indicates moderate dominance, meaning the environment is still fairly stable.
3) C value between 0.6 and 1 indicates high dominance, so the ecosystem is under pressure.

### e) T-test

The independent two-sample test is used to see if there is a significant difference between two data sets, in this case, organic and inorganic rice fields. This test is necessary to guarantee that the changes in ecological index values obtained are not coincidental, but rather reflect a genuine difference caused by the various agricultural management techniques.

$$t_{hitung} = \frac{H'1 - H'2}{S_{H1-H2}}$$

The following formula can be applied to the variable values:

$$Sp = \frac{\sum(X-\mu)^2}{N}$$

The following formula can be used to find the level of defiance used to look up the t-table:

$$df = \frac{(Var\ H'1 + H'2\ )^2}{\frac{(Var\ H'1)^2}{N1} + \frac{(Var\ H'2)^2}{N2}}$$

**Explanation**
H'1 = Diversity of spiders and insects in organic rice fields
H'2 = Diversity of spiders and insects in inorganic rice fields
Var H'1 = Variation values of spiders and insects in organic rice fields
Var H'2 = Variation values of spiders and insects in inorganic rice fields
N = Total number of individuals
X = Number of individuals per species
µ = Average
Sp = Variation index
S = Number of species
Df = Degrees of freedom

## Results

### Diversity and Abundance Index of Spiders in Organic and Conventional Rice Fields.

Research conducted in the organic and anorganic areas of Sumber Rejo revealed significant variations in the occurrence and distribution of laba-laba (Araneae) and serangga (Insecta).

**Table 1:** Spider Diversity Index in Organic and Inorganic Rice Fields.

| No | Species | Organic Rice Field | Inorganic Rice Field |
|---|---|---|---|
| 1. | *Argiope versicolor* | 9 | 0 |
| 2. | *Emathis weyersi* | 10 | 6 |
| 3. | *Gea spinipes* | 10 | 7 |
| 4. | *Lycosa* | 9 | 7 |
| 5. | *Oxyopes javanus* | 15 | 11 |
| 6. | *Tetragnatha* | 10 | 0 |
| Total | | 63 | 31 |
| Diversity Index (H') | | 1,77 | 1,36 |
| Category | | Moderate | Moderate |

The results of the Shannon-Wiener (H′) index analysis show that organic sawah has higher keanekaragaman compared to anorganic sawah. The number of laba-labas found in organic soil was 1.77, whereas in anorganic soil it was just 1.36.

**Table 2:** Spider Abundance Index in Organic and Inorganic Rice Fields.

| No | Habitat | Abundance Index | Catagory |
|---|---|---|---|
| 1 | Organic Rice Fields | 1,21 | Low |
| 2 | Inorganic Rice Fields | 0.87 | Low |

Spider abundance was assessed using the Margalef index (Dmg) and found to be 1.21 in organic rice fields and 0.87 in inorganic rice fields. These findings suggest that organic rice fields may provide a more suitable environment for arthropod populations

### Diversity and Abundance Index of Insects in Organic and Inorganic Rice Fields

The Shannon-Wiener index (H′) revealed considerable differences in insect diversity between organic and inorganic rice fields in Sumber Rejo village.

**Table 3:** Insects Diversity Index in Organic and Inorganic Rice Fields.

| No | Species | Organic Rice Field | Inorganic Rice Field |
|---|---|---|---|
| 1. | *Agriocnemis pygmaea* | 67 | 48 |
| 2. | *Atherigona oryza* | 15 | 10 |
| 3. | *Coccinella transversalis* | 14 | 0 |
| 4. | *Chilo suppressalis* | 13 | 11 |
| 5. | *Conocephalus sp* | 68 | 58 |
| 6. | *Eurema hecabe* | 12 | 0 |
| 7. | *Gryllus mitratus* | 19 | 0 |
| 8. | *Leptocorisa oratorius L.* | 11 | 11 |
| 9. | *Micraspis discolor* | 10 | 4 |
| 10. | *Neurothemis terminata* | 72 | 52 |
| 11. | *Nephotettix virescens* | 17 | 0 |
| 12. | *Nilaparvata lugens(wereng)* | 11 | 0 |
| 13. | *Oxya chinensis* | 76 | 58 |
| 14. | *Pantala flavescens* | 71 | 0 |
| 15. | *Sceliphron caementarium* | 8 | 6 |
| Total | | 484 | 309 |
| Diversity Index (H') | | 2,37 | 2,00 |
| Category | | Moderate | Moderate |

The study's findings show that insect variety in organic rice fields is higher (H′ = 2.37) than in inorganic rice fields (H′ = 2.00), yet both are still considered modest. This discrepancy shows that the organic approach promotes insect species variety better since it uses less chemicals, allowing natural enemies and other beneficial insects to thrive more effectively.

**Table 4:** Insects Abundance Index in Organic and Inorganic Rice Fields.

| No | Habitat | Abundance Index | Catagory |
|---|---|---|---|
| 1 | Organic Rice Fields | 2,26 | Moderate |
| 2 | Inorganic Rice Fields | 1,57 | Low |

The abundance of insects in organic rice fields was found to be higher (Dmg = 2.26) than in inorganic rice fields (Dmg = 1.57), yet both were still considered low. This suggests that the ecological circumstances in organic rice fields promote the availability of supplies and habitats for insects, resulting in a bigger population than in inorganic systems.

### Evennes Index of Spider in Organic and Inorganic Rice Fields

The spider evenness index was used to assess how equally individuals are dispersed across species in organic and inorganic rice fields.

**Table 5:** Evennes Index of Spider in Organic and Inorganic Rice Fields.

| No | Habitat | Evennes Index (E) | Category |
|---|---|---|---|
| 1. | Organic Rice Fields | 0.99 | High |
| 2. | Inorganic Rice Fields | 0.98 | High |

The spider evenness index in organic (E = 0.99) and inorganic (E = 0.98) rice fields is both high, indicating that individuals are distributed quite evenly among species. This finding indicates that no single spider species dominates significantly, resulting in a stable community structure in both agricultural contexts.

**Insect Evenness Index in Organic and Inorganic Rice Fields.**

The insect evenness index is used to determine the degree of balance in the distribution of individuals across species in both rice field systems.

**Table 6:** Evennes Index of Insects in Organic and Inorganic Rice Fields.

| No | Habitat | Evennes Index (E) | Category |
|---|---|---|---|
| 1 | Organic Rice Fields | 0,88 | High |
| 2 | Inorganic Rice Fields | 0.87 | High |

The insect evenness index in organic (E = 0.88) and inorganic (E = 0.87) rice fields is relatively high, indicating that individuals are distributed fairly evenly among species. This shows that, despite differences in the number of species between the two systems, the insect community is reasonably fairly distributed, with no dominant species.

**Dominance Index of Spiders in Organic and Inorganic Rice Fields.**

The spider dominance index was used to assess the degree to which a species dominates the community in organic and inorganic rice fields.

**Table 7:** Dominance Index of Spiders in Organic and Inorganic Rice Fields.

| No | Habitat | Dominance Index (C) | Category |
|---|---|---|---|
| 1 | Organic Rice Fields | 0,173 | Low |
| 2 | Inorganic Rice Fields | 0.265 | Low |

The spider dominance index in organic (C = 0.173) and inorganic (C = 0.265) rice fields falls into the low category, indicating that no species dominates significantly within the community. These findings suggest that the spider community structure in both systems is relatively balanced, with inorganic rice fields having somewhat higher dominance values than organic ones.

**Dominance Index of Insects in Organic and Inorganic Rice Fields:** The insect dominance index was used to determine the extent of a species' control over the community in organic and inorganic rice fields.

**Table 8:** Dominance Indexof Insects in Organic and Inorganic Rice Fields.

| No | Habitat | Dominance Index (C) | Category |
|---|---|---|---|
| 1 | Organic Rice Fields | 0,106 | Low |
| 2 | Inorganic Rice Fields | 0.154 | Low |

The insect dominance indexes in organic (C = 0.106) and inorganic (C = 0.154) rice fields are also low, indicating that no single species dominates the community. This condition indicates that the insect population structure in both systems is reasonably balanced, with inorganic rice fields having somewhat greater dominance values than organic rice fields.

The spider species that were successfully captured during sampling are also documented in this study to bolster the identification results. As an illustration of the current morphological diversity, the following images show a number of spider specimens that were discovered in both organic and inorganic rice fields. In addition to providing visual proof, this documentation supports the taxonomy analysis's conclusions.

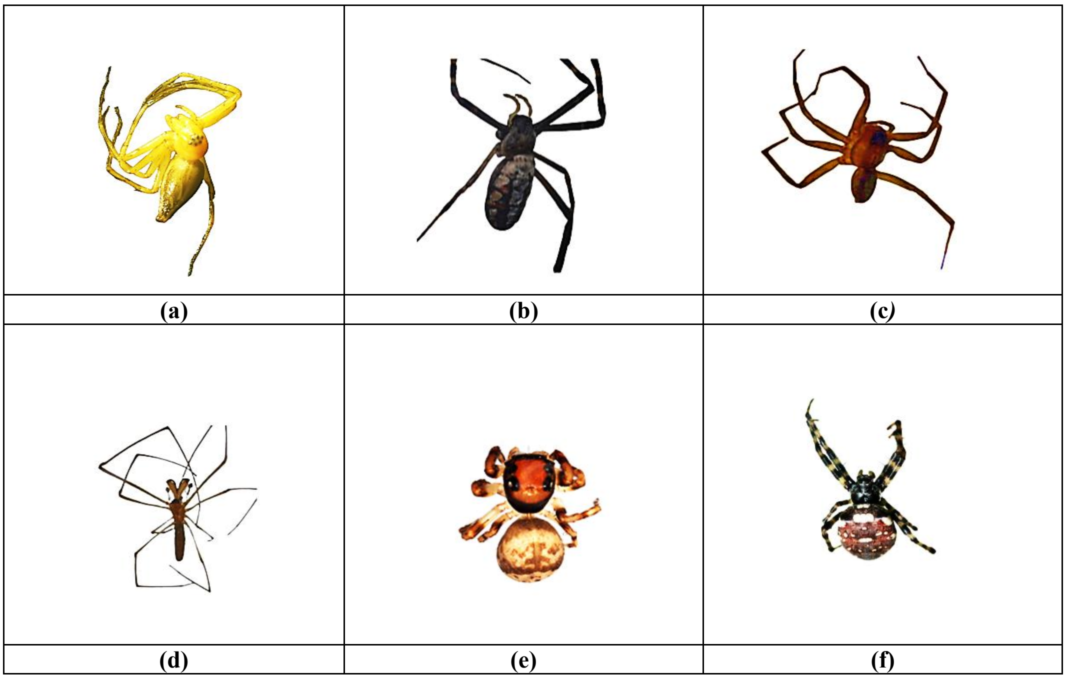


**Figure 4.1:** a) *Oxyopes javanus,* b) *Argiope versicolor,* c) *Lycosa sp.* d) *Tetragnatha sp,* e) *Emathis weyersi*, f) *Gea spinipes*

Several insect species were successfully observed in both organic and inorganic rice fields as part of the study's findings. An overview of the bug species discovered and their functions within the rice field ecosystem community are given in the visual documentation that follows. The physical differences of insects that support biodiversity in different agricultural systems are also depicted in these photos.

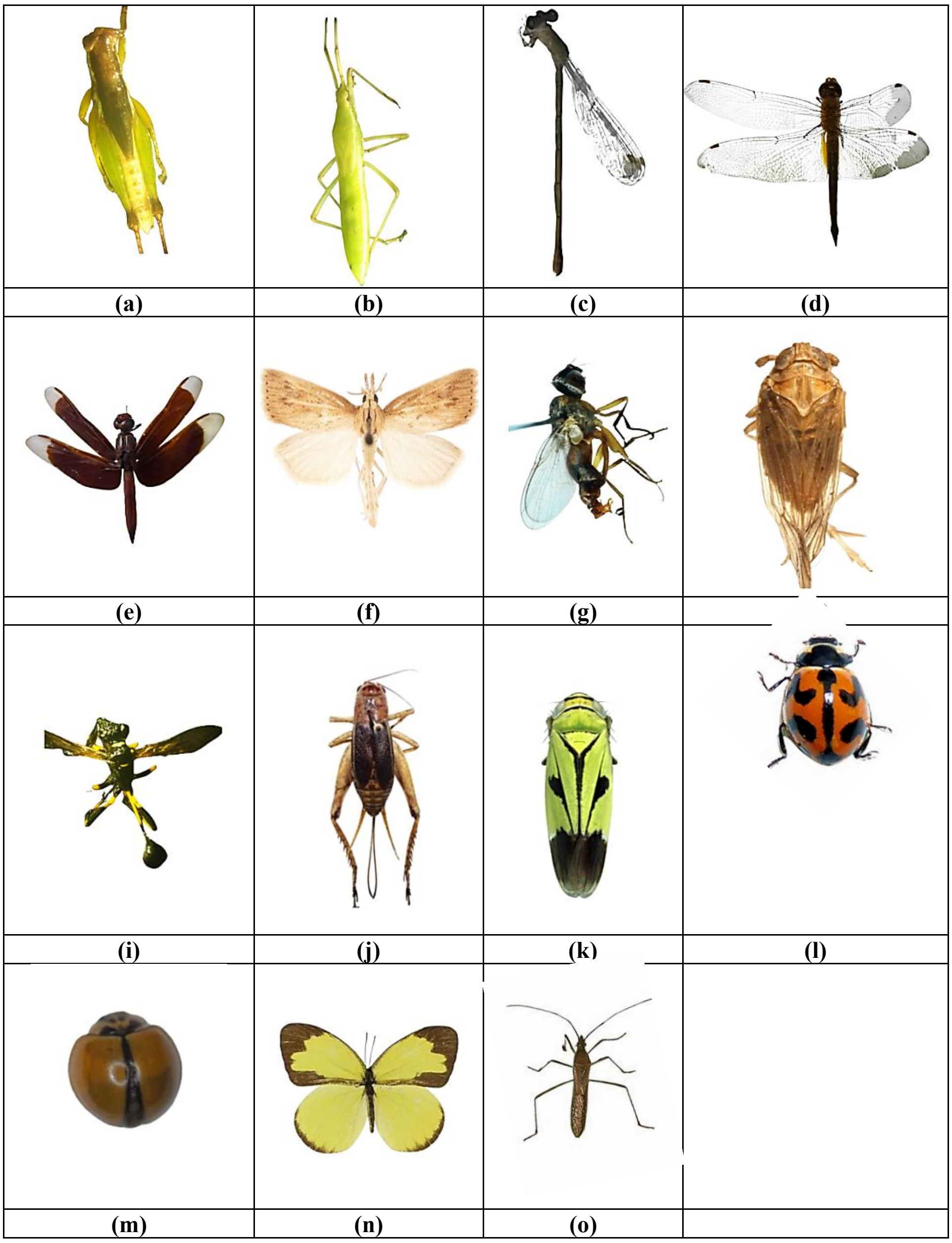


**Fig 2:** (a)**.** *Oxya chinensis, (b). Conocephalus sp,* c) *Agriocnemis Pygmaea,* d) *Pantala flavescens,* e) *Neurothemis terminate,* f) *Chilo suppressalis,* g) *Atherigona oryza,* h) *Nilaparvata lugens,* i) *Sceliphron caementarium,* j) *Gryllus mitratus, (k) Nephoterrix virescens,(l) Coccinella transversalis,* m) *Micraspis discolor,* n) *Eurema hecabe,* o) *Leptocorisa Oratorius*

## Discussion

### Diversity and Abundance of Spiders and Insects in Organic and Inorganic Rice Fields

The study's findings demonstrate that organic rice fields have a higher diversity and quantity of spiders and insects than inorganic rice fields. The Shannon-Wiener index (H′) for spiders was 1.77 in organic rice fields and 1.36 in inorganic rice fields, but the values for insects were 2.37 in organic rice fields and 2.00 in inorganic rice fields, both in the moderate range. Organic rice fields also have higher Menhinick index (Dmn) values spiders 0.76 and insects 0.68 than inorganic rice fields. This is consistent with research by Rahman *et al*. (2017), which demonstrates that studies conducted in different regions show that insect diversity and abundance vary with seasons and agricultural practices, while overuse of pesticides frequently causes ecological imbalance and reduces beneficial populations. These results offer a foundation for comprehending how the communities of spiders and insects in organic and non-organic rice fields differ. The results show that the diversity of insects and spiders in organic and anorganic rice fields differs significantly. These results demonstrate the ecological advantages of organic farming in fostering biodiversity and lowering environmental risks related to intensive pesticide usage and monoculture.

This difference demonstrates that organic management can offer a more suitable ecosystem, with improved soil conditions, flora, and prey availability, hence encouraging arthropod diversity and abundance. In contrast, the use of synthetic fertilizers and insecticides in inorganic systems tends to decrease non-target organism populations, resulting in fewer species and individuals. Spider population growth is frequently influenced by both biotic and abiotic environmental elements (Chandra *et al*., 2017) [4]. This is consistent with prior study, which found that organic agricultural practices can increase ecosystem complexity and raise ecological resilience to external perturbations.

**Evenness of Spiders and Insects in Organic and Inorganic Rice Fields**

Spiders' evenness index (E) is high in both systems organic 0.99 and inorganic 0.98, indicating that individuals are distributed quite evenly throughout species. Insects exhibit a similar trend, with evenness values of 0.88 in organic rice fields and 0.87 in inorganic rice fields. These high evenness values indicate that, while the number of species varies between organic and inorganic systems, individual populations are quite uniformly distributed. This uniform distribution is critical for the maintenance of the rice field ecosystem because no single species dominates unduly, allowing trophic interactions to occur in an orderly manner. According to Taufiqullathif *et al*., 2023 [15], the Synthetic Treatment (St) strategy produced the least amount of variety among arthropods when compared to other sampling techniques. It differed significantly from the majority of methods but not from vacuum traps. A balanced agroecosystem was indicated by the classification of the diversity, dominance, and evenness indices as moderate, low, and moderate, respectively. These results are in line with the current investigation, which found that both organic and inorganic rice fields showed stable community structures and modest fluctuation. This suggests that arthropod dynamics are influenced by both management strategies and sampling techniques.

High evenness also indicates that communities in organic and inorganic rice fields may preserve ecological balance despite being impacted by a variety of management elements. This demonstrates the presence of ecological resilience, in which, despite variations in the number of species and individuals, each species continues to play a relatively proportional function in the ecosystem. Organic rice fields have a greater diversity of morphospecies and arthropods than inorganic rice fields (Dewi *et al*., 2020) [6]. Thus, steady homogeneity helps rice agroecosystems withstand environmental changes and external pressures.

**Dominance of Spiders and Insects in Organic and Inorganic Rice Fields**

The dominance index (C) for spiders in organic 0.173 and inorganic 0.265 and insects in organic 0.106 and inorganic 0.154 is low. These figures show that the communities in both systems are relatively balanced, with no species dominating significantly. Low dominance is a favorable indicator since groups with a balanced distribution are more environmentally stable. However, somewhat increased dominance in inorganic rice fields suggests that chemical use may have suppressed some species, though not enough to generate a severe imbalance. Climate, agricultural methods, plant phenology, and the careless use of pesticides can all contribute to the high frequency of pest assaults (Yanti *et al*., 2024) [16]. Thus, low dominance in both systems indicates that the rice field ecology retains a relatively stable community structure, with an advantage in organic rice fields.

The low dominance values also suggest that natural enemies, such as predatory spiders and beneficial insects, continue to play an active role in keeping pest populations in check. Various control strategies may result in variations in diversity index values, dominance, and evenness (Taufiqullathif *et al*., 2023) [15]. In organic systems, this condition strengthens the inherent biological regulating mechanisms, increasing the ecosystem's sustainability. In contrast, somewhat higher dominance in inorganic rice fields may be an early symptom of decreased functional diversity, which, in the long run, has the potential to undermine ecological stability if pesticide dependence persists.

**Differences in Spider and Insect Diversity and Abundance in Organic and Inorganic Rice Fields**

The t-test revealed a significant difference between organic and inorganic rice fields in spiders and insects ($p < 0.05$). This suggests that organic management is more effective in increasing diversity and abundance than inorganic systems. The distinction reflects the tangible impact of agricultural practices on arthropod community structure, with organic rice fields providing better conditions for the conservation of natural enemies and beneficial insects, whereas inorganic fields with pesticide and chemical fertilizer use limit natural ecological processes. Thus, this large difference demonstrates that organic systems help to improve ecosystem resilience and biodiversity conservation, but inorganic systems tend to undermine rice field ecological stability. Yanti *et al*. (2024) [16] discovered ten species of rice pest insects at four rice field locations in Merangin, including *Nephotettix virescens, Cofana spectra, Sogatella furcifera, Leptocorisa acuta, Atractomorpha crenulata, Cnaphalocrocis medinalis, Scirpophaga incertulas, Aulacapora indica, Chrysochus cobaltinus,* and *Silba capsicarum*. In this field, insect diversity was rated as moderate, with continuous uniformity and minimal dominance, indicating a healthy communal structure. These findings are consistent with recent research, which has demonstrated moderate variety and low dominance in both organic and inorganic rice fields, implying that the rice ecosystem is robust despite changes in management practices.

This large difference demonstrates that the choice of agricultural management methods has a direct impact on the quality of the rice field ecosystem. Organic systems not only increase biodiversity, but they also promote predator-prey relationships, acting as a natural barrier against pest outbreaks. The complicated dynamics within agricultural ecosystems by studying many aspects of insect abundance, dispersal, and interactions with temperature and relative humidity. Meanwhile, inorganic systems create more fragile ecological circumstances, with the loss of species diversity making rice fields more vulnerable to population imbalances and environmental harm.

**Conclusion**

This study found that organic rice farming techniques regularly sustain greater diversity and quantity of spiders and insects than inorganic systems. The ecological index values obtained show that organic rice fields provide more favorable conditions for the survival of arthropod communities, with generally uniform individual distribution and low dominance levels. Statistical test findings also show a substantial difference between the two systems, implying that organic farming practices have a major role in increasing biodiversity, maintaining ecosystem stability, and boosting natural ecological functions in rice fields. In contrast, inorganic systems that rely on synthetic inputs have been shown to depress ecological processes and diminish arthropod community resilience. These findings underscore the relevance of organic management as a long-term strategy for biodiversity conservation and rice agroecosystem resilience.

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