# The Vegetation Model: An Environmentally Friendly Farming System in the Management of Rice Stem Borer in South Sulawesi

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**ABSTRACT**
Stem borer is one of the main pests of lowland rice in South Sulawesi. Types of stem borer found include white stem borer (*Scirpophaga innotata*, yellow stem borer (*S. incertulas*), and striped stem borer (*Chilo suppressalis*) and red rice stem borer guava (*Sesamia inferens* (Walker). The four types of stem borer pests that most attack and cause damage to lowland rice in South Sulawesi are white stem borer (*S. innotata*). This study aims to determine the best agroecosystem model for the management of rice stem borer in South Sulawesi. Inventory research on the level of damage and insecticide use in stem borer is carried out in 2018/2019 spread in four districts, namely Wajo, Sidrap, Maros, and Barru regencies. The combine between cropping system with planting times are 5 treatments and farmers as replications (3 replications). The treatments are monoculture with 2 planting times year$^{-1}$ in Sidrap Regency, monoculture with 1 planting times year$^{-1}$ (Wajo District), polyculture with 3 planting times in Maros Regency, polar vegetation with 2 planting times year$^{-1}$ (Barru Regency), polyculture with 1 planting times year$^{-1}$ (Pangkep Regency). The results showed that the highest level of attack of rice stem borer was found on monoculture with 2 planting times year$^{-1}$ (38.25%), then followed by polyculture vegetation with 3 times year$^{-1}$ (31.12%), monoculture with 1 planting times year$^{-1}$ (20.32%), and polyculture with 2 planting times year$^{-1}$ (15.68%), and polyculture with 1 planting times year$^{-1}$ (6.59%). The lowest use of insecticides is found in polyculture with 1 planting times year$^{-1}$ (1.10 l ha$^{-1}$ per season) and the highest in monoculars with 2 planting times year$^{-1}$ (5.5 l ha$^{-1}$ per season).
***Keywords:*** *stem borer, wetland rice, agroecosystem, attack intensity, insecticide*

## 1. INTRODUCTION

Rice stem borer is the main pest in rice. There are six types of rice stem borer that attack rice plants in Indonesia, five species from the Pyralidae family and one Noctuidae family. There are 5 types of stem borer pests from the Pyralidae family, namely *S. innotata, S. incertulas*, *Chilo suppressalis, Chilo auricilius*, *Chilo polychrysus* while those from the Noctuiedae family are *Sesamia inferences* [1]. The types of rice stem borer which predominantly attack rice plants in each region of Indonesia are different in Jambi Province the dominant is yellow rice stem borer *S.incertulas*, while in South Sulawesi the dominant is white rice stem borer *S.innotata*. According to Baeki [2], the rate of stem borer attacks in South Kalimantan in tidal areas is around 33-41% (sundep) and 25-44% (beluk), in West Java 26.9%, and Central Java 18.4%.

The intensity of damage due to attack by stem borers in Indonesia is around 10-30% [3]and varies in each region. According to Larioh *et al*. [4], the rate of loss in rice due to the attack of white rice stem borer is around 60-90 %. Afandi *et al.* [5], the level of damage caused by the attack of *S.innotata* white rice stem borer in Central Sulawesi in the vegetative phase (sundep) around 20.66-28.99%). In Jambi Province, the intensity of yellow rice stem borer attacks is around 28.00% -38.00% and in South Sulawesi around 25.00-55.00% [6].

Pests management carried out by paddy farmers in the control of stem borers is still dominantly relying on scheduled use of insecticides. There are several regions in South Sulawesi, farmers planting rice 2-3 times per year and the use of insecticides by farmers in the area is quite high (3-4 times per week) with high doses. In Central Java, the farmers have applied pesticides on rice plants 2-3 times per week at doses of 1.20-1.40 cm$^3$ per liter of water [7]. According to Wiyono *et a*l. [8], using chemical insecticides to control rice stem borers in Klaten, the farmers have applied insecticides 12 times per season. The use of chemical insecticides with a high frequency occurs because the mindset of farmers in overcoming pest attacks always chooses a finishing move, namely eradicating insects with insecticides [9]. The farmer's mindset considers the presence of pest insects in the plantations; he positions as the main opponent in the farming system. To overcome the presence of these pests, farmers always ask for help from formulators who roam a lot in the community and circulate various kinds of pesticide products with various brands of active ingredients imported from abroad.

Modern agriculture that is environmentally sound is an agricultural system that will provide solutions to overcome food availability in the long term by applying the management of environmental balance in an agroecosystem environment. Sustainable modern agriculture in principle develops environmentally friendly technologies and ecosystem management to produce food, feed, clothing material and energy to meet human needs. Agricultural ecosystems can be fragmented based on their scale, the smallest being a plot of plantations, then expanded into a stretch of agricultural land a collection of stretches will form a landscape, then form regional and global agriculture [10].

Crop productivity on a plot of crop or stretch of agricultural land is not only influenced by the plot conditions of the crop or the expanse of the land but also influenced by the ecosystems that are around it in the form of agricultural land and wild habitat. Wild habitats around agricultural land can provide food and shelter for pollinating insects and natural enemies. Therefore, agroecosystem management is not only aimed at agricultural land but also on non-agricultural land. One form of non-agricultural land management is planting flowering plants in paddy fields or on the edge of land to provide nectar or pollen for natural enemy food. Agroecosystem management can be carried out on a pilot scale of plantations to regional agricultural scales. This study aims to determine the best agroecosystem model in the management of rice stem borer to environmentally friendly agriculture.

## II. METHODS

Inventory research on the damage intensity and insecticide use in stem borer is carried out in 2018/2019 spread in four districts, namely Wajo, Sidrap, Maros, and Barru regencies. The four districts are centers of rice cultivation with various agroecosystems and planting times every year. The combine between cropping system with planting times are 5 treatments and farmers as replications (3 replications). The treatments are Monoculture with 2 planting times $year^{-1}$ (P1) in Sidrap Regency, monoculture with 1 planting times $year^{-1}$ (P2) in Wajo District, polyculture with 3 planting times $year^{-1}$ (P3) in Maros Regency, polar vegetation with 2 planting times $year^{-1}$ (P4) in Barru Regency, and polyculture with 1 planting times $year^{-1}$ (P5) in Pangkep Regency.

Parameters observed: the level of damage of lowland rice in the vegetative and generative phase due to stem borer. The vegetative phase (sundep damage) are 25 day after planting (dap), 35 dap, and 45 dap and the generative (75 dap) (beluk damage).
Leaf damage intensity is calculated based on the following formula:

$$I = \frac{a}{a+b} x\ 100\% \qquad (1)$$

I = Percentage of stem damage due to attack by rice stem borer
a = Number of stems damaged by rice stem borer
b = Number of stems observed

### *Statistical Analysis*

All observed data were analyzed using variance analysis (ANOVA). The comparison of mean leaf damage intensity caused by pests and other parameters was made using the Duncan test at a 5% probability level.

## III. RESULTS AND DISCUSSION

### *The intensity of damage due to the attack of stem borers in the vegetative and generative phase*

The intensity of rice stem damage due to the attack of rice stem borer on plant age 25 days after planting (dap) was highest in monoculture with 2 planting times $year^{-1}$ (25.38%) compared to polycultural with 1 planting times $year^{-1}$ (9.12%) . This is in line with Cahyoko *et al.* . [11], high pest abundance occurs in ecosystems with only one type of plant and vice versa, low pest abundance and high natural enemies occur in various vegetation ecosystems.

**Table 1.** Mean of damage intensity for vegetative phase and vegetative phase

| Vegetation Type | Damage intensity of stem borer (sundep) (%) | |
|---|---|---|
| | Vegetative phase (25 dap) | Vegetative phase (35 dap) |
| Monoculture with 2 planting times $year^{-1}$ | $25.38^{a}$ | $40.23^{a}$ |
| Monoculture with 1 planting times $year^{-1}$ | $20.01^{b}$ | $30.17^{b}$ |
| Policulture with 3 planting times $year^{-1}$ | $16.26^{c}$ | $26.65^{c}$ |
| Policulture with 2 planting times $year^{-1}$ | $11.15^{d}$ | $21.35^{d}$ |
| Policulture with 1 planting times $year^{-1}$ | $9.12^{e}$ | $19.29^{d}$ |

The column number (followed by the similar letter) has no significant difference at 5% Duncan Test
dap = days after planting

Vegetation polyculture with a 3 planting times year$^{-1}$ gives a high rate of stem borer attack compared to polyculture vegetation that grows rice only twice or once per year. This is caused by the rice planting pattern of rice (3 planting times year$^{-1}$) will provide a better survival for rice stem borer because there is always food available every year. This is according to Solikhin. [12], continuous rice planting on irrigated paddy fields (2-3 times per year) will provide food for stem borer over time so that it will cause high attacks on rice. Furthermore Usyati *et al*. [13], fluctuations in pest populations are largely determined by food availability and natural enemy populations.

**Table 2.** Mean of damage intensity for vegetative phase and generative phase

| Vegetation Type | Damage intensity of stem borer (%) | |
|---|---|---|
| | **Vegetative phase (45 dap)** | **Generative phase (75 dap)** |
| Monoculture with 2 planting times year$^{-1}$ | 46.30$^{a}$ | 38.25$^{a}$ |
| Monoculture with 1 planting times year$^{-1}$ | 35.19$^{b}$ | 20.32$^{c}$ |
| Policulture with 3 planting times year$^{-1}$ | 30.28$^{c}$ | 31.12$^{b}$ |
| Policulture with 2 planting times year$^{-1}$ | 25.12$^{d}$ | 15.68$^{d}$ |
| Policulture with 1 planting times year$^{-1}$ | 21.17$^{e}$ | 6.59$^{e}$ |

The column number (followed by a similar letter) has no significant difference at 5% Duncan Test
dap = days after planting

The intensity of damage due to the attack of the highest rice stem borer in the monoculture ecosystem compared to polyculture. This is due to the polyculture ecosystem the role of natural enemies to suppress pest populations higher than in monoculture ecosystems. The same is revealed by Hedrival *et al*. [14], the complexity of plant architecture will affect natural enemy populations in an ecosystem. The more complex the architecture of plants, the more stable the ecosystem because natural enemies will play a greater role in suppressing pest insect populations.

## *Vegetative and generative growth*

The highest number of macric tillers in the polyculture vegetation model with 1 planting (22.30 stems), and the lowest in monoculture with 2 times planting (15.35 stems) and polyculture 3 times planting per year (15.92). The high number of juveniles in polyculture with 1 planting per year due to more optimal plant growth supported by healthy soil conditions. According to Mungara *et al*. (2013) [15], an organic farming system provides a higher number of tillers (17.47 stems) at the age of 58 hst plants compared to conventional systems which only 15.38 stems per clump.

**Table 3.** Mean of number of tillers and number of productive tillers

| Vegetation type | Number of tillers (stems per clump) | Number of productive tillers (stems per clump) |
|---|---|---|
| Monoculture with 2 planting times year$^{-1}$ | 15.35$^{a}$ | 14.58$^{a}$ |
| Monoculture with 1 planting times year$^{-1}$ | 18.24$^{b}$ | 14.84$^{a}$ |
| Policulture with 3 planting times year$^{-1}$ | 15.92$^{a}$ | 17.94$^{b}$ |
| Policulture with 2 planting times year$^{-1}$ | 20.39$^{c}$ | 18.59$^{b}$ |
| Policulture with 1 planting times year$^{-1}$ | 22.30$^{d}$ | 20.29$^{c}$ |

The column number (followed by the similar letter) has no significant difference at 5% Duncan Test
dap = days after planting

Similar to the maximum number of tillers, the highest number of productive tillers in the polyculture model is 1 planting times year$^{-1}$. This is an indication that the polyculture model with 1 planting times year$^{-1}$ has a more stable soil structure than the monoculture model with 2 planting times year$^{-1}$. The stability of the soil in the model is caused by the contribution of organic material derived from the remnants of plants that are around the paddy field. In addition, the stability of the soil in the model is also caused by the soil undergoing respiratory processes when the land is not planted with rice or fallow land.

## *Use of chemical insecticides at the farm level and seed yield*

The use of insecticides to control stem borer pests in the highest paddy fields in vegetation monoculture with 2 planting times year$^{-1}$ (5.50 l ha$^{-1}$). The high use of insecticides in the ecosystem is caused by the high rate of attack on rice stem borer. The high level of damage caused by the attack of stem borer is caused by the low role of natural enemies including predators and parasitoids. So the high dose of chemical insecticides is directly related to the role of predators and parasitoids. This is according to Putra *et al*. [16], that the use of fibromil insecticides to control rice stem borer with a dose of 1.5 cm$^3$ per liter of water implies a low parasitoid population (11.5 tails) and egg groups (104 egg groups). while the use of insecticides is 0.50 cm$^3$ per liter water, the parasitoid population can reach 18.25 tails and 140 egg groups.

The use of high insecticides besides being able to kill insects directly is useful, it can also have a negative impact on other ecosystems including the fish ecosystem. Taufik's. [17] study revealed that high insecticide use in rice plantations in Sukabumi could cause pesticide residues from organon phosphate (Diazinon) of 0.0005 mg per liter of water, cypermethrin 0.0002-0.0005 mg per liter of water, and permethrin 0.0003-0.0005 mg per liter of water.

**Table 4.** Mean of using insectisides of farmers and seeds yiled of rice crop

| Vegetation type | Using of Insectiside of farmers ( l ha $^{-1}$ ) | Seeds yield (t ha$^{-1}$) |
|---|---|---|
| Monoculture with 2 planting times year$^{-1}$ | 5.50$^{a}$ | 4.86$^{c}$ |
| Monoculture with 1 planting times year$^{-1}$ | 4.21$^{b}$ | 5.51$^{b}$ |
| Policulture with 3 planting times year$^{-1}$ | 3.18$^{c}$ | 4.91$^{c}$ |
| Policulture with 2 planting times year$^{-1}$ | 2.38$^{d}$ | 6.05$^{a}$ |
| Policulture with 1 planting times year$^{-1}$ | 1.10$^{e}$ | 6.18$^{a}$ |

The column number (followed by a similar letter) has no significant difference at 5% Duncan Test

The highest seed yields achieved in the vegetation with polyculture with 1 planting times year$^{-1}$ and polyculture with 2 planting times year$^{-1}$ were respectively 6.18 t ha$^{-1}$ and 6.05 t ha$^{-1}$. The high yield of seeds achieved in both ecosystem models is caused not only by the low attack of stem borers but also by the high level of stability of the ecosystem including the large role of earthworms in improving soil quality. According to Nuryani *et al.* [18], soils containing a lot of organic matter and earthworms will cause higher root N uptake and P root (9.26 kg ha$^{-1}$ and 1.17 kg ha$^{-1}$) compared to soils which have low organic matter only having N uptake around 3.39 kg ha$^{-1}$ and root P uptake of about 0.73 kg ha$^{-1}$.

## IV. CONCLUSION

- The intensity of damage due to the attack of rice stem borer at the highest vegetative phase (Sundep) in the ecosystem with vegetation monoculture with 2 planting times year$^{-1}$ 25.38-46.30% and lowest in a vegetated ecosystem with polyculture with 1 planting times year$^{-1}$ 9.12-21.17%.
- The intensity of damage due to the attack of rice stem borer in the highest generative phase of the 38.25% monoculture with 2 planting times year$^{-1}$ ecosystem and the lowest on polyculture with 1 planting times year$^{-1}$ 6.59%.
- The use of insecticides to control the highest level of rice stem borer pests in the vegetation ecosystem monoculture with 2 planting times year$^{-1}$ 5.50 l ha$^{-1}$ and the lowest in the ecosystem polyculture with 1 planting times year$^{-1}$ 1.10 l ha$^{-1}$.
- The highest seed yield was reached on the ecosystem of the polyculture with 1 planting times year$^{-1}$ (8.18 t ha$^{-1}$) and polyculture with 2 planting times year$^{-1}$ (6.05 t ha$^{-1}$).

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