www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

Insect Diversity Pests and Natural Enemies in Soybean (Glycine max (l.) Merrill) Fields Manggoapi Experimental Garden Manokwari to Increase Community Income

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Abstract

Soybean is one of the food crops that are high in protein. The protein content of Indonesian soybean varieties varies from 36.9 to 45.6%, 33% calories and 18% fat, while some soybean varieties in the world contain up to 50% protein and more than 20% oil. Yellow soybeans are generally used as raw materials for tempeh and tofu, while black soybeans are used as raw materials for soy sauce. This plant is widely used as a food ingredient as well as industrial raw material and animal feed. One of the obstacles to efforts to increase production is the attack of various pests that can damage plants from growing until harvest time. In Indonesia, more than 111 species of arthropods are pests, 53 species are not targeted, 61 species are predators and 41 species are parasitoids. Pests are an obstacle in maintaining and increasing agricultural production, both in terms of quality and quantity, even to the point of thwarting harvests. Pests are nuisance organisms that cause economic impacts or losses and cause yield losses. Natural enemies in a good balance of nature are always successful in controlling pest populations. The method used is purposive sampling method and time series data from the Central Statistics Agency (BPS) and the Food and Angricultural Organization (FAO); tabulated analysis. The results of the research on types of insect pests and natural enemies in the vegetative and reproductive phases, there were 13 types of insect pests and 5 types of natural enemies found in soybean plantations. One of the approaches to increasing soybean production for people in Indonesia is through integrated pest control (IPM).

Keywords

Diversity; pests; natural enemies; soybeans; community income

I. Introduction

Soybean (Glycine max (L.) Merrill) is a plant that belongs to the legume family (Leguminoceae). This plant comes from mainland China and has been cultivated since 2500 years BC. The spread of this plant occurs due to the development of international trade to Indonesia (Sugeng, 2001). The protein content of Indonesian soybean varieties varies from 36.9 to 45.6%. (Ginting and Tastra, 2007; Widowati, 2013), other researchers note that soybeans contain 35% protein, 33% calories and 18% fat (Atman, 2014). Whereas some soybean varieties in the world contain up to 50% protein and more than 20% oil (Friedman and Brandon, 2001). Soybeans have become the preferred source of vegetable protein, because they are much cheaper than animal proteins (Yun et al. 2005). The high protein content and relatively lower price of soybeans than other protein sources are the main factors influencing the demand for soybeans. Yellow soybeans are generally used as

raw materials for tempeh and tofu, while black soybeans are used as raw materials for soy sauce. This plant is widely used as a food ingredient as well as industrial raw material and animal feed. This condition shows that soybean is a food crop that is needed always in large quantities (Atman, 2014). These factors also provide a basis for the government to choose soybeans as the main affordable option to meet the protein needs of the community.

Soybean is a food crop which every year has an increasing demand. The increase in demand is always related to the increase in population, but until now, the rate of increase in soybean production has not been able to keep up with the rate of demand. This condition causes the need for domestic consumption of soybean commodities is still lacking and needs to be imported. Director General of Food Crops (2008), predicts that soybean consumption in Indonesia. Until 2010 experienced a demand rate of up to 2.8 million tons/year. The Central Bureau of Statistics (2016), shows that (2013-2017) in West Papua there has been a decline in production from 669 tons/year to 461 tons/year

One of the obstacles to efforts to increase production is the attack of various pests that can damage plants from growing until harvest time. In Indonesia, more than 111 species of Arthtopoda are pests, 53 species are not targeted, 61 species are predators and 41 species are parasitoids (Okada et al., 1988). Arthropods serve as useful disturbance bioindicators due to their short generation time and rapid response to environmental changes (Ghannem et al. 2018). Pests are nuisance organisms that cause economic impacts or losses and cause yield losses (Nonci and Ladja, 2006). Pests are an obstacle in maintaining and increasing agricultural production, both in terms of quality and quantity, even to the point of thwarting harvests. Anonymous (1992) noted that there are 17 types of pests that can cause damage and loss to soybean plants, including peanut fly (Ophyomyia phaseoli), armyworm (Spodoptera litura), tembukur leaf beetle (Phaedonia inclusa), pod borer (Etiella zinckenela), pod sucker (Riptortus linearis), and pod sucker and borer (Nezara viridula). Marwoto and Indiati (2009), important pests that cause detrimental effects at the beginning of the soybean planting period are seed flies (Ophyomnya phaseoli), soil caterpillars (Agrotis sp.), armyworms (Spodoptera litura), leaf beetles (Phaedonia inclusa) and green ladybugs. (Nazara virudula). While the results of Adisarwanto's research (2005), it is known that several important pests on soybean plants, including the pod borer (Etiella zinckenella), soybean leafhopper (Phaedonia inclusa), peanut fly (Agromyza sp.), sucker and pod borer (Nezara viridula). Untung (2005) said that IPM prioritizes control by utilizing natural enemies of pests. Natural enemies in a good balance of nature are always successful in controlling the pest population, remaining below the economic threshold level. Considering that the role of parasites and predators in suppressing pest populations naturally is quite important, it is necessary to pay attention to the conservation of natural enemies in the field.

Control measures against pest attacks in an area can be carried out if the pest has been identified through exploration and identification. Therefore, this research needs to be carried out with the aim of knowing the presence of pests and natural enemies that exist and favor soybean plants in the Manggoapi Manokwari experimental garden.

II. Research Method

Research done on the experimental field of Manggoapi Manokwari which is located at an altitude of 110 m above sea level. This research was conducted for four months, from March 10, 2017 to June 13, 2017. The research method used in this study was purposive sampling method.

The land area to be used is 15 mx 25 m, then loosened using a hoe and made a plot with a size of 2 mx 3 m. Observation of insect pests and natural enemies in sample plots taken diagonally as many as 10 plots, with a plant population of 85 plants.

Insect sampling Pests are carried out in 2 phases of plant growth, namely the vegetative phase, namely from the time the plant emerges from the soil until the beginning of flowering, and the reproductive phase, which is from entering the flowering time until the pods are ripe.

Sampling in the sample plots was carried out in the morning from 07.00 – 09.00 WIT, and in the afternoon at 12.00 – 14.00 WIT. For insects flying in the plots, samples were taken with insect nets, while those attached to the stems and leaves were taken using hands and tweezers. Sampling at night at 19.00-21.00 WIT. Insects in the soybean planted area were caught using light traps, tile (nets) and containers filled with water, soap and salt, which were installed in the middle of the research area. Insect sampling was carried out weekly on all selected sample plants.

Insect identification was carried out on all insects found in the observation plots using the key books of determination, among others, Agricultural Entomology (Jumar, 2000), Plant Pests and Control Techniques (Rachmat and Sugandi, 1997), the insect identification key book Boror et al (1992).) and Kalshoven, LGE (1981). Identification was carried out on insect morphology in the form of insect color and insect body shape.

The variables observed in this study include the main variables, namely the type and number of insectspests and natural enemies of soybeans, while supporting variables include climate data, including temperature, rainfall and humidity at the study site. The data obtained from the results of the study were analyzed by tabulation.

Research for the application of integrated pest control (IPM) on soybeans uses time series data from the Central Statistics Agency (BPS) and the Food and Angricultural Organization (FAO). Harvested area, production, and productivity of soybeans using data for the period 1961-2015. The volume of exports, imports and soybean needs uses data for the period 1961-2013.

III. Results and Discussion

3.1 Types of Insect Pests and Natural Enemies in the Vegetative and Reproductive Growth Phases of Soybean Plants

The results of observations of insect pests and natural enemies on soybean plantations in the experimental garden of Manggoapi Manokwari, from the beginning of observation (2 weeks) to the end of observation (12 weeks) are presented in table 1.

Table 1. Insect typepests and natural enemies in the vegetative and reproductive phases

No	Insect Type	Scientific name	Growth Phase					
			Vegetative			reproductive		
			P	S	M	P	S	M
	Insect pests							
1	Green grasshopper	*Oxya sp*	√	√	-	√	√	√
2	wooden grasshopper	*Valanga migricornis*	√	√	-	√	√	√
3	Cricket	*Gryllus simillis*	√	√	√	√	√	√
4	Soya leaf beetle	*Phaedonia inclusa*	√	√	√	√	√	√
5	Green ladybug	*Nezara viridula*	√	√	√	√	√	√
6	aphids	*Aphis glycine*	-	-	-	√	√	-
7	Pod-sucking ladybug	*Ryptortus linearis*	√	√	-	√	√	√

8	Peanut fly/seed fly	*Ophiomyia phaseoli*	√	√	√	√	√	√
9	Stem borer fly	*Melanagromyza sojae*	√	√	-	√	√	-
10	Leaf rolling caterpillar	*Lamprosema indicate*	√	√	-	√	√	-
11	caterpillar span	*Plusia chalcites*	-	√	-	√	-	-
12	Army caterpillar	*Spodoptera litura*	-	√	-	-	-	√
13	Pod borer caterpillar	*Etiella zinkenella*	-	-	-	√	√	-
	Natural enemy insects							
1	Stray dogs	*Gryllotapa Africana*	√	√	-	√	√	-
2	Praying mantis	*Hymenopus coronatus*	-	-	√	√	√	√
3	Spider	*aranea sp*	-	-	-	√	√	-
4	Rangrang ants	*Oecophylla smaragdina*	√	√	-	√	√	-

Description: P=Morning, S=Afternoon and M=Night

Based on observations of insect pests and natural enemies in the vegetative and reproductive phases, there were 13 types of insect pests and 5 types of natural enemies. 13 types of insect pests found in soybean plantations, including green grasshoppers, brown grasshoppers, crickets, soybean leaf beetles, green ladybugs, aphids, green ladybugs, pod-sucking ladybugs, stem borer flies, leaf roller caterpillars, span caterpillars, armyworms and pod borer caterpillars, and 5 types of natural enemies encountered, namely ground dogs, praying mantises, koksi beetles, spiders and weaver ants.

Based on the results in table 1, it can also be seen that of the 13 types of insect pests that are present in the soybean planting area, there are types of insect pests that are only present in the morning, during the day and only at night, but there are also insect pests that are always present at night. morning, noon and night. The presence of these insect pests is influenced by 2 factors, namely internal factors (the nature of the insect itself such as the ability to reproduce, the nature/how to defend itself and also the age of the insect) and external factors that are around (climatic and environmental factors). climate, including temperature, humidity and rainfall (Jumar, 2000). The effect of air temperature on pests and plant diseases, among others, can control the development of survival and the spread of individual insects (Yonny, 1991). Meanwhile, according to Rakhmat and Sugandi (1997), environmental factors include soil as a place to live and plants as a host and are preferred as a place for insects to live. These factors affect the development and presence of insect pests.

3.2 Number of Insect Pests and Natural Enemies in the Vegetative Growth Phase of Soybean Plants

The results of observations of the number of insect pests and natural enemies in the vegetative growth phase of soybean plants are presented in table 2.

Table 2. Number of insectspests and natural enemies in the vegetative phase

No	Insect Type	Scientific name	Number of Insects (tail)			Amount
			P	S	M	
	Insect pests					
1	Green grasshopper	*Oxya sp*	12	10	-	22
2	wooden grasshopper	*Valanga migricornis*	6	6	-	12
3	Cricket	*Gryllus simillis*	13	6	4	23

4	Soya leaf beetle	*Phaedonia inclusa*	334	309	2	655
5	Green ladybug	*Nezara viridula*	111	64	7	182
6	Pod-sucking ladybug	*Ryptortus linearis*	27	59	-	96
7	Peanut fly/seed fly	*Ophiomyia phaseoli*	4	2	1	7
8	Stem borer fly	*Melanagromyza sojae*	1	1	-	2
9	Leaf rolling caterpillar	*Lamprosema indicate*	4	6	-	10
10	caterpillar span	*Plusia chalcites*	-	1	-	1
11	Army caterpillar	*Spodoptera litura*	-	1	-	1
	Natural enemy insects					
1	Stray dogs	*Gryllotapa Africana*	8	2	-	10
2	Praying mantis	*Hymenopus coronatus*	-	-	1	1
3	Rangrang ants	*Oecophylla smaragdina*	30	30	-	60

Description: P = Morning, S = Afternoon and M = Night

Table 2 shows that the number of insect pests and natural enemies found in soybean planting in the vegetative phase are 11 types of insect pests and 3 types of natural enemies, 13 types of insect pests encountered include green grasshoppers, brown grasshoppers, crickets, leaf beetles. soybeans, green ladybugs, green ladybugs, pod-sucking ladybugs, stem borer flies, leaf-rolling caterpillars, span caterpillars and armyworms, while the 3 types of natural enemies encountered were ground dogs, praying mantis and weaver ants.

The number of insect pests in this phase varies in the morning, afternoon and evening. In this phase, the largest pest population in the morning was soybean leaf beetle as many as 344 heads, because these insects carried out their activities more in the morning and evening. This is because light is very closely related to insect life, generally insects are very attracted to light and for their needs, insects need energy that comes from light (Yonny, 1991). The least pest population is 1 stem borer fly. The largest population of insect pests during the day was soybean leaf beetle, which was 309 heads, and the least pest population was stem borer fly, span caterpillar and armyworm each amounting to 1 tail. The largest population of insect pests at night was 7 green ladybugs and the least population of insect pests was peanut flies/seedlings as much as 1 tail. The largest insect pest population overall in the vegetative phase was the soybean leaf beetle, which was 655 individuals. The least population of insect pests is the span caterpillar and the armyworm as much as 1 tail.

In table 2, the highest natural enemy population in the morning is weaver ants as many as 30 individuals, while the natural enemy population at least is 8 dogs. The highest population of natural enemies during the day were weaver ants as many as 30 individuals and the population of natural enemies at least was 2 tails of ground dogs. The natural enemy population encountered at night in this phase is 1 praying mantis.

The results presented in table 2 show that the largest population of natural enemies in the vegetative growth phase is weaver ants with a total of 60 individuals and the smallest population is 1 praying mantis. The number of insect pests and natural enemies varied in the vagetative growth phase both in the morning, afternoon and evening. Factors that influence the variety of insect pests present are internal and external factors (Jumar, 2000). This effect is ascribed to possible differences in climatic conditions between geographic positions.

Table 3. Number of insect pests and natural enemies in the reproductive phase

No	Insect Type	Scientific name	Number of Insects (tail)			Amount
			P	S	M	
	Insect pests					
1	Green grasshopper	*Oxya sp*	49	73	1	123
2	wooden grasshopper	*Valanga migricornis*	7	13	1	21
3	Cricket	*Gryllus simillis*	35	28	9	72
4	Soya leaf beetle	*Phaedonia inclusa*	3602	3815	3	7420
5	Green ladybug	*Nezara viridula*	459	366	11	836
6	aphids	*Aphis glycine*	127	127	-	254
7	Pod-sucking ladybug	*Ryptortus linearis*	140	135	25	300
8	Peanut fly/seed fly	*Ophiomyia phaseoli*	11	17	1	29
9	Stem borer fly	*Melanagromyza sojae*	3	1	-	4
10	Leaf rolling caterpillar	*Lamprosema indicate*	102	89	-	191
11	caterpillar span	*Plusia chalcites*	-	-	1	1
12	Army caterpillar	*Spodoptera litura*	1	-	-	1
13	Pod borer caterpillar	*Etiella zinkenella*	17	13	-	30
	Natural enemy insects					
1	Stray dogs	*Gryllotapa Africana*	12	7	-	19
2	Praying mantis	*Hymenopus coronatus*	1	1	3	5
3	Spider	*aranea sp*	7	2	-	9
4	Rangrang ants	*Oecophylla smaragdina*	110	95	-	205

Description: P = Morning, S = Afternoon and M = Night

In table 3, it can be seen that there were 13 types of insect pests and 5 types of natural enemies. The types of insect pests encountered included green grasshoppers, brown grasshoppers, crickets, soybean leaf beetles, green ladybugs, aphids, green ladybugs, pod-sucking ladybugs, stem borer flies, leaf-rolling caterpillars, span caterpillars, armyworms and pod borer caterpillars. . And the types of natural enemies encountered were ground dogs, praying mantises, koksi beetles, spiders and weaver ants. Number of insect pests and natural enemies. varies in the morning, afternoon and evening.

In this phase, the largest pest population in the morning was 3602 soybean leaf beetles. The least pest population is 1 inch caterpillar. The highest pest population during the day was soybean leaf beetle, which was 3815 heads, while the least pest population was stem borer fly with 1 tail. The highest pest population at night was the pod-sucking ladybug, as many as 25, and the least pest population was bean flies/seedlings, green grasshoppers and wood grasshoppers, each with 1 tail. The largest insect pest population overall in the reproductive phase was the soybean leaf beetle, which was as many as 7420 individuals. And the population of insect pests with the least is the span caterpillar and the armyworm, which is 1 tail each. This further emphasizes the conservation value of the site as this entomophagous species depends on the habitat provided by the boundary zone and natural habitat in the agroecosystem (Botha et al. 2017).

The population of insect pests in this phase shows that the number of insect pests increases when compared to the vegetative phase. Climatic factors such as temperature, humidity and rainfall have a major influence on the development and number of insect pests in soybean plantations. An average temperature of 26oC to 30oC is a factor supporting pests in breeding, such as soybean leaf beetles, green ladybugs, pod-sucking ladybugs, aphids, leaf-rolling caterpillars and pod borer caterpillars are types of insect pests that usually lay eggs or breed when it rains. low below 100mm and an average humidity of 70% to 80%, at the time of the study that is from March to June has an average rainfall between 5.9mm to 28.42 mm, thus making these types of insect pests to produce quickly and attack soybean plants. Insects are cold-blooded organisms, where their body temperature is strongly influenced by environmental temperature. Each insect has a certain temperature range, where if it is outside the ideal temperature range, the insect will die of cold or overheating. Near the minimum or maximum point the insect can still live but is not active. Meanwhile, when humidity is in accordance with the needs of insects, insects tend to be resistant to extreme temperatures (Yos F. 2017). The least number of insect pests are seed flies, stem borer flies, span caterpillars and armyworms. These types of pests are more often active at a temperature of 20oC with medium rainfall between 100mm to 300mm when humidity is more than 90%. Thus the number of insect pests in the reproductive phase varies because it is influenced by adaptation to the environment, namely housing, food availability and climate which includes temperature, humidity and rainfall as well as the ability of insect pests to reproduce.

The population of natural enemies (table 3) found the most in the morning, namely weaver ants as many as 110 tails, while the least natural enemy was a praying mantis with 1 tail. The largest population of natural enemies during the day was weaver ants, namely 95 individuals, while the least natural enemy was praying mantis with 1 tail. The highest population of natural enemies at night is the koksi beetle as many as 9 tails, while the least natural enemy is the praying mantis as much as 3 tails.

The largest natural enemy population in the reproductive phase was weaver ants as many as 205 individuals and the least natural enemy population was praying mantis as many as 5 individuals. The increasing number of praying mantis in this phase is caused by the availability of food, Sureshan and Sambath (2009) stated that the praying mantis acts as a predator for moths, flies, aphids and other grasshoppers.

The number of natural enemies that increases in the reproductive phase is also influenced by the amount of food for these natural enemies where at a normal temperature of 25oC to 30oC natural enemy insects are actively looking for food and also productively breed. Previously in the vegetative phase the presence and number of natural enemy insects such as spiders and koksi beetles were not yet present, but in the reproductive phase they were present in numbers as in the table above. This is reinforced by the increased activity of insect pests that provide opportunities for natural enemies such as spiders and koksi beetles to find food. With the number of spider weaver ants, praying mantises, koksi beetles and ground dogs, each will adjust to the amount of food available. Some natural enemies such as praying mantis and koksi beetle are active at night because they can defend themselves from other natural enemies which often depend on the availability of light in the soybean planting area. In contrast to the number of weaver ants, ground dogs and spiders who prefer to be active in the morning and afternoon according to their body's adaptation to temperature and humidity.

The presence of insect pest populations in both the high vegetative and reproductive phases is thought to be influenced by climatic conditions, as stated by Jumar (2000), that the most effective temperature range for insects is a minimum temperature of 15oC, an

optimum temperature of 25oC and a maximum temperature of 45oC. Outside this temperature range, insects will die of cold and heat. At the optimum temperature, insects live normally, the activity and development of insects is normal (maximum). In Manokwari district in 2017 from March to June (the time of the study) the average rainfall was 5.92mm to 28.42mm per month, the average temperature was 27oC to 28oC and the average humidity was 81% to 85 %. The detrimental effects of agriculture on patterns of arthropod diversity are ascribed to management and cultivation practices (agrochemical applications and tillage) (Pereira et al. 2010). This is supported by various studies which show that a decrease in plant species richness and diversity causes a decrease in arthropod diversity and species richness (Haddad et al. 2009; Bennet and Gratton 2013; Botha et al. 2017).

Arthropod species composition was similar to plant diversity results, a different set of arthropod species was observed for each plant. This is to be expected because plant diversity and composition are widely considered to be important determinants of arthropod diversity and composition (Haddad et al. 2009; Bennet and Gratton 2013; Botha et al. 2017). Some herbivores exhibit a degree of host plant specificity, which is the reason that an assemblage of plant species will directly affect the herbivores that depend on this species. Assemblages of plant species also determine vegetation structure, plant chemical complexity, and microclimate which can further influence phytophagous arthropods and higher trophic groups such as parasitoids and predators (Randlkofer et al. 2010; Ratnadass et al. 2011).

3.3 Application of Integrated Pest Control of Soybean Plants in Communities in Indonesia

Soybean as a source of protein for most Indonesians, since the 1980s, the increase in soybean production has been met through two main strategies: increasing productivity and planting area. In 1970, a decade before this program was implemented, soybeans were planted on 0.69 million hectares with an average yield of 0.72 tonnes/ha. In 1990, a decade after implementing the program, the planted area for soybeans reached 1.33 million hectares with an average yield of 1.11 tons/ha (Sudaryanto and Swastika, 2007; Sumarno and Adie, 2010).

Soybean production reached its highest level in 1992 by producing 1.9 million tons of soybean seeds from 1.67 million ha of harvested area (Table 4). There are two main factors influencing this achievement: soybean productivity and local cultivation. Soybean productivity is one of the key determinants in soybean development in Indonesia. The Indonesian government has realized the importance of regulations on high-yielding varieties since the 1960s and has tried various efforts to create new varieties with superiority in productivity (Arsyad et al. 2007).

Table 4. Soybean Production in Indonesia, 1962 – 2012

Year	Harvested Area (ha)	Production (tons)	Yield (tonnes/ha)
1962	594,000	396,800	0.67
1972	698,000	518,229	0.74
1982	607,788	521,394	0.86
1992	1,665,000	1,869,713	1.12
2002	544.522	673,056	1.24
2012	567,624	843,153	1.49

Source: FAO (2017)

Continuous efforts by the government have contributed greatly to the national program through increasing soybean yields. Soybean productivity has always increased from 0.68 tons/ha in 1961 to 1.5 tons/ha in 2014 (Figure 1). This increase shows good results in the government's program in providing high yielding varieties as one of the best strategies in increasing production.

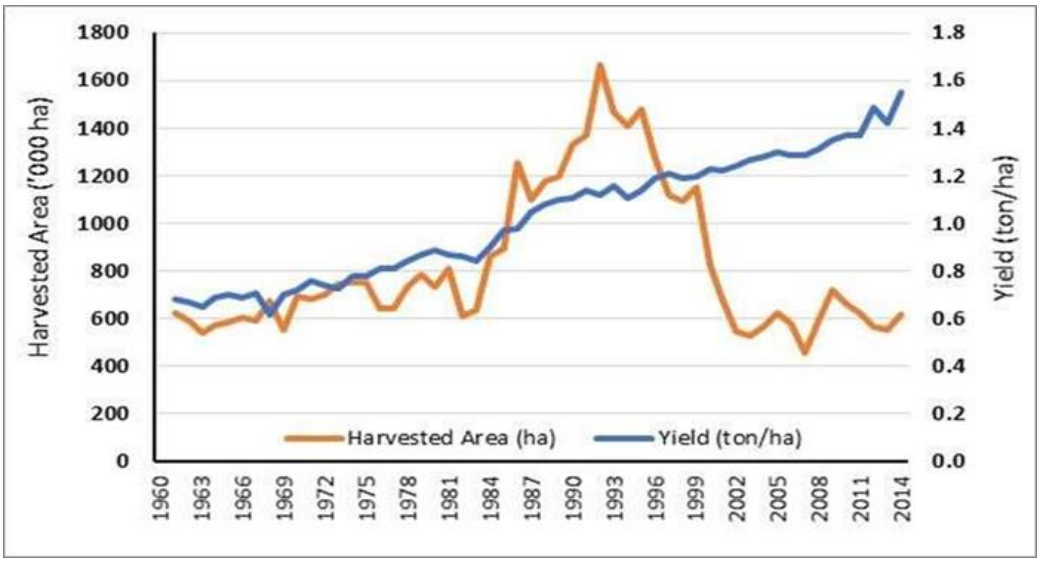
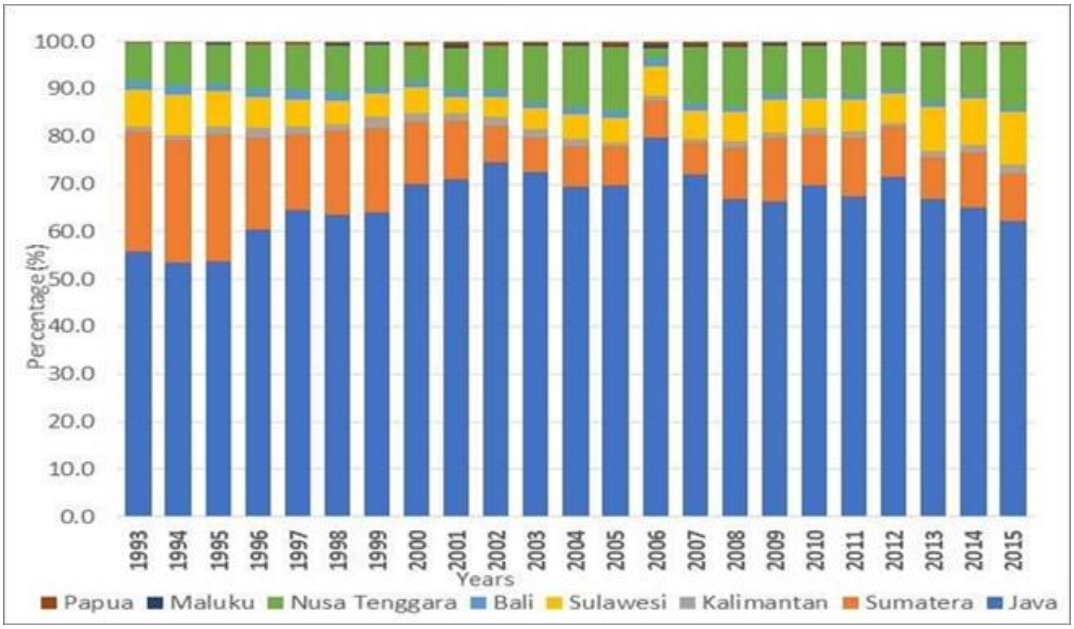


Figure 1. *Harvested area and soybean yield in Indonesia, 1961 – 2014*
Source: FAO 2017

In 1992, soybeans were planted in 1.7 million hectares of planted area spread across Indonesia, with Java being the highest followed by Sumatra, Nusa Tenggara and Sulawesi (Figure 2). Java is likely to be the largest contribution to soybean production in Indonesia for the next few years (Table 5).



Source: Statistics Indonesia (BPS) 2017

Table 5. Soybean harvested area in Indonesia's main islands, 2010 – 2015

Island	Harvested Area (ha)					
	2010	2011	2012	2013	2014	2015
Java	633,212	574,118	603.641	521,954	622,155	599,843
Sumatra	97,536	104.285	88.149	68,872	111.163	95.726
Borneo	12,254	11,507	8,263	8,919	14,729	18,347
Sulawesi	56,694	57,637	51.496	73.314	92,613	107.367
Bali	5.554	8,503	8,210	7,433	8.187	7,259
Nusa Tenggara	94.902	89,477	76,937	92,740	99,882	128,651
Maluku	2,127	1.397	1,651	1,481	1,340	1.182
Papua	4,752	4,362	4,806	5,279	4,928	4,724
Indonesia	**907.031**	**851,286**	**843,153**	**779.992**	**954,997**	**963,099**

Source: BPS (2017)

Agricultural land is increasingly narrow due to the shifting of the function of agricultural land into industrial areas, so that hydroponic cultivation is considered appropriate to utilize available land because this cultivation system does not require soil media. The hydroponic system uses a variety of planting media other than soil, among others, with media such as fuel husk, husk, sand, zeolite, rockwoll, peat (peat moss) and coconut husk powder (Prihmantoro in Zalilani, M. et al. 2019)

Indonesia has a great opportunity to increase soybean production and meet the needs of the community. This opportunity can be seen from several conditions such as market demand, availability of land and superior varieties, as well as the strong government demand for soybeans as food and feed which continues to increase and is expected to increase in the following years. The highest portion of demand comes from processed foods, especially tempeh and tofu (Figure 3). Another high demand comes from industrial animal feed which is expected to continue to increase as part of the increase in livestock production. Therefore, the government increasingly wants to meet these demands by using national production and reducing imports.

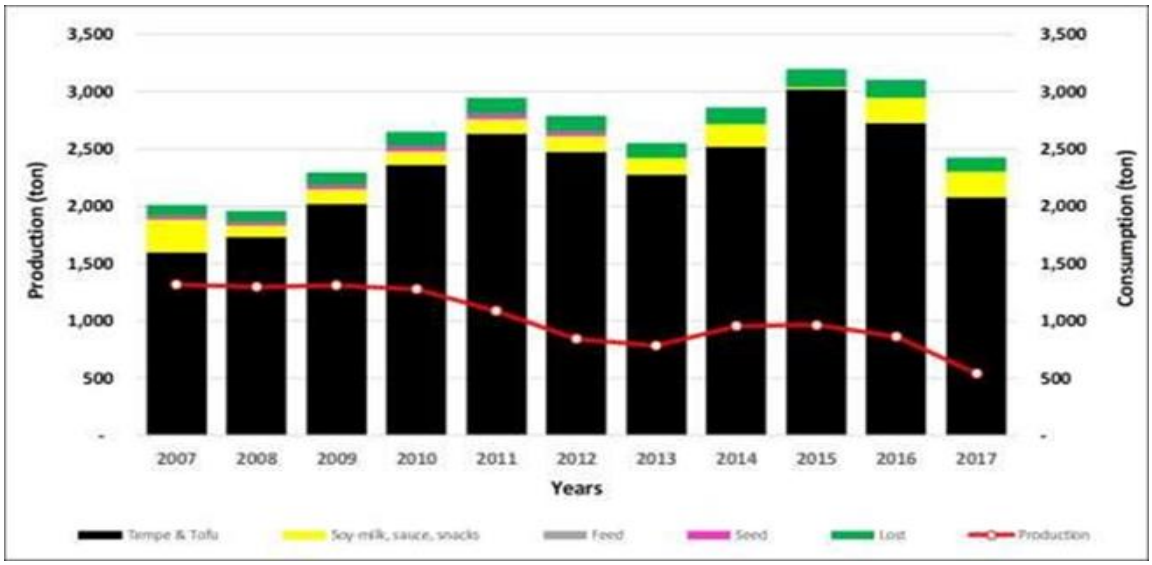


Figure 3. *Soybean Production and Demand in Indonesia, 2007 – 2017*
Source: Ministry of Agriculture Republic of Indonesia (MoA) (2018

Opportunities to increase soybean production, the government and other related parties need to develop the most appropriate strategy and may be implemented by farmers. These strategies are needed to seize the opportunities and face the challenges that exist in soybean production in Indonesia. Based on the country's long experience in managing soybeans, there are several strategies that can be proposed related to land availability, technology use, and domestic market openness for local varieties. This strategy includes the use of high-yielding varieties and agronomic approaches, the application of integrated pest control, the use of specific and appropriate machines to increase crop stands, reduce grain loss, and improve grain quality. Third, provide and strengthen the market-producer network. This includes postharvest management, ensuring a sustainable supply to the market, a process that is good for both parties, and producing seeds that meet market demands (Aldillah, 2015; Brata and Yasa, 2015).

The IPM strategy is to integrate compatiblely all effective and efficient techniques or pest control methods based on ecological and economic principles without neglecting the socio-cultural side. Traditional pest management technologies such as the "Pranata Mangsa" system in Java and "Kerta Masa" in Bali and Lombok, crop rotation patterns, effective, inexpensive, and understandable sanitation are appropriate when nl is increasingly being forgotten and not implemented, so it should be re-integrated into According to Baliadi et al 2008 that there are four approaches to IPM strategies in the community, namely: 1) Utilization of natural control processes by reducing actions that can harm or kill the development of natural enemies (predators, parasitoids, insect pathogens), 2) . Ecosystem management through farming, which aims to make the plant environment unsuitable for life and to clear or grow pests as well as to encourage the breeding of natural enemies, 3). Physical and mechanical control aimed at reducing pest populations, disrupting normal biological activities of pests, and changing the physical environment to be less suitable for the life and development of pests, and 4). Selective use of insecticides to control pest populations at the equilibrium level. The selectivity of an insecticide is based on its physiological, ecological, and mode of application. Furthermore, Indiati and Marwoto (2017) found that the IPM approach strategy for soybean pests is control by technical culture through environmental sanitation before planting, setting the right planting time, and cultivating healthy plants.

IV. Conclusion

Based on the results of the study, the types of insect pests and natural enemies found in soybean cultivation in the vegetative and reproductive phases obtained the following results:

1. There were 13 species of insect pests that attacked soybeans, namely green grasshopper (Oxya sp.), wood grasshopper (Valanga nigricornis), crickets (Gryllus asimillis), soybean leaf beetle (Phaedonia inclusa), green ladybug (Nezara viridula), aphids (Aphis glycine), pod-sucking ladybug (Ryptortus linearis), peanut fly/seedling fly (Ophiomyia phaseoli), stem borer fly (Melanagromyza sojae), leaf curler caterpillar (Lamprosema indicate), span caterpillar (Plusia chalcites), armyworm (Spodoptera) litura) and pod borer (Etiella zinckenella).
2. The presence of natural enemy insect populations found included ground dogs (Gryllotapa africana), praying mantis (Hymenopus coronatus), koksi beetle (Epilachna sparsa), spiders (Aranea sp.) and weaver ants (Oecophylla smaragdina).
3. Opportunities to increase soybean production by the government in Indonesian society, it is necessary to approach an integrated pest control strategy (IPM), based on ecological and economic principles without neglecting the socio-cultural side.

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