PISSN : 2615-2207 Agrosainstek, 7 (1) 2023: 39 - 46 EISSN : 2579-843X

AGROSAINSTEK

Jurnal Ilmu dan Teknologi Pertanian

Website jurnal : http://agrosainstek.ubb.ac.id

Research Article

Teknologi Budidaya Kedelai yang Adaptif pada Gawangan Tanaman Karet Belum Menghasilkan

Adaptive Soybean Cultivation Technology on Space Between Immature Rubber Plants

Siti Rosmanah[1], Miswarti[1], Alfayanti[2*], Tri Wahyuni[3], Taupik Rahman[3],Hertina Artanti[4], Herlena Bidi Astuti[4], Shannora Yuliasari[4], Yahumri[1], Wawan Eka Putra[5]

[1]*Research Center for Food Crops-National Research and Innovation Agency, Bogor 16911*
[2]*Research Center for Behavioral and Circular Economics-National Research and Innovation Agency, Jakarta 12710*
[3]*Research Center for Sustainable Production System and Life Cycle Assessment-National Research and Innovation Agency, Banten*
[4]*Indonesian Agency for Agricultural Instrument Standardization-Ministry of Agriculture, Bogor*
[5]*Research Center for Macroeconomics and Finance - National Research and Innovation Agency, Jakarta 12710*

Received: April 3, 2023 /Received in revised : May 10, 2023/ Accepted: May 23, 2023

ABSTRACT

Space between plant (Gawangan) of immature rubber plant is one of the potential locations for the development of soybean plants. This study aims to obtain recommendations for adaptive soybean cultivation technology packages for immature rubber plantations. The research was conducted in August-November 2018 on a three-year-old rubber plantation in Gardu Village, Armajaya District, North Bengkulu Regency, Bengkulu Province. The study was conducted using a randomized block design of 4 treatments which was repeated 5 times. The data collected included the components of growth and yield of soybeans as well as input and production costs for each technology package. The growth component and yield component data were analyzed using analysis of variance and if there was a difference, then Duncan Multiple Range (DMRT) was done. The feasibility of farming is calculated from the value of the cost of revenue (R/C ratio). The results showed that the treatment had a significant effect on the number of branches, empty pods, weight of filled pods, filled seeds, seed weight per plant. However, the treatment had no significant effect on plant height, filled pods, number of pods per plant, empty or damaged seeds, number of seeds per stem, percentage of empty or damaged seeds, 1000 grain weight of seeds. All technology packages are economically feasible to develop because they have an R/C ratio > 1.

Keywords: space between plant, rubber, technology package, soybean, intercroping

ABSTRAK

Gawangan tanaman karet belum menghasilkan merupakan salah satu lokasi yang berpotensi untuk pengembangan tanaman kedelai. Penelitian ini bertujuan untuk mendapatkan rekomendasi paket teknologi budidaya kedelai yang adaptif pada gawangan tanaman karet yang belum menghasilkan. Penelitian dilaksanakan pada bulan Agustus-November 2018 di lahan perkebunan karet berumur tiga tahun di Desa Gardu Kecamatan Armajaya Kabupaten Bengkulu Utara Provinsi Bengkulu. Penelitian dilakukan dengan menggunakan Rancangan Acak Kelompok 4 perlakuan yang diulang sebanyak 5 kali. Data yang dikumpulkan antara lain komponen pertumbuhan dan hasil tanaman kedelai serta biaya input dan produksi pada masing-masing paket teknologi. Data komponen

*Korespondensi Penulis.
E-mail : bundaqonita2012@gmail.com DOI: https://doi.org/10.33019/agrosainstek.v7i1.490

pertumbuhan dan komponen hasil dianalis menggunakan analisis varian dan bila terdapat perbedaan maka dilanjutkan dengan Duncan Multiple Range (DMRT). Kelayakan usahatani diukur dengan menghitung nilai imbalan penerimaan atas biaya (R/C ratio) dan imbalan pendapatan atas biaya (B/C ratio). Hasil penelitian menunjukkan perlakuan berpengaruh nyata terhadap jumlah cabang, ersen polong hampa, bobot polong isi, biji isi, bobot biji per tanaman. Namun perlakuan tidak berpengaruh nyata terhadap tinggi tanaman, polong isi, jumlah polong per tanaman, biji hampa atau sakit, jumlah biji per batang, persen biji hampa atau sakit, bobot biji 1000 butir. Semua paket teknologi layak secara teknis untuk dikembangkan karena memiliki nilai R/C rasio > 1.

Kata kunci: Gawangan, karet, paket teknologi, kedelai, tumpang sari

1. Introduction

Soybean is one of the strategic foodcrops in Indonesia after rice and corn. The high amino acid quality of its protein makes soybean used for various products in the food and animal feed industries (Zakaria, 2016). People's consumption patterns prioritizing low-carbohydrate foods with higher protein make soybeans superior (Anjani, 2019). The demand for various processed soybean products such as tempe, tofu and soy sauce is predicted to continue to increase along with the increase in population (Mahdoh & Risyanto, 2018).

The increasing demand for soybeans is not followed by an increase in domestic soybean production. The Ministry of Agriculture stated that domestic soybean production only covered less than 10 percent of the national soybean demand in 2021 (Pusdatin, 2022). Indonesia's soybean imports from 2014 to 2023 are forecasted to increase by 6,81 percent per year (Permadi, 2015). Nevertheless, Indonesia has the opportunity to become self-sufficient in soybeans as long as it can maintain production growth above consumption growth (Aldillah, 2015).

Soybean production growth can be increased by utilizing sources of production growth. One source of production growth is the expansion of the planting area by increasing the Planting Index (Adnyana & Kariyasa, 1999). The expansion of planting areas can utilize irrigated paddy fields, rain-fed paddy fields and dry land, including immature plantation land (oil palm and rubber) as intercrops. Rubber plantation areas that can be utilized for intercrops are around 50-60% of the land area (Rodrigo et al., 2001; Xianhai et al., 2012; Sahuri et al., 2016). Short-term intercropping in rubber plantations is usually done when the rubber is 1-2 years old after planting. This condition will provide additional income when there is no latex produced and can protect farmers from fluctuating rubber prices if done sustainably (Huang et al., 2020; Sahuri, 2019).

Soybean cultivation on gawangan of immature rubber plant will not only provide benefits for farmers but also the main crop. Tistama et al. (2016) reported that the intercropping of sorghum and soybean on gawangan of immature rubber plant could increase the content of P, N, pH and CEC and can inhibit the development of white root fungus (Rigidoporus microporus). Rhizobium sp symbiosis with soybean can help improve soil biology in marginal drylands (Watkins et al., 2012).

Rubber is the primary commodity after oil palm, which plays a crucial role in the people's economy in Bengkulu Province. Based on data from the Central Bureau of Statistics in 2016, the area of rubber plants in Bengkulu Province reached 117,064 ha consisting of Mature Plants 72,320 ha, immature Plants 37,945 ha and old/dead plants/damaged plants 6,799 ha. The amount of immature plant area is still quite large, so it has the potential to cultivate soybean in the area. However, there is a need for soybean production technology that can increase productivity and be profitable for farmers. This study aims to obtain a package of adaptive soybean cultivation technology in the gawangan of immature rubber plant.

2. Material dan Methods

The research was conducted in Gardu Village, Arma Jaya Sub-district, North Bengkulu, Bengkulu. The research was conducted using an on-farm research approach involving farmers. The varieties used were Dena 1 and Anjasmoro, with fertilizer doses based on Information System of Integrated Planting Calendar (Katam) recommendations and Upland soil test kit (PUTK). Fertiliser doses based on Katam. recommendations at the research location were Urea 50 kg ha^{-1}, SP-36 100 kg ha^{-1}, KCl 75 kg ha^{-1} equivalent to N = 23 kg ha^{-1}, P_2O_5=36 kg ha^{-1}, K_2O = 45 kg ha^{-1}. Fertiliser recommendations from PUTK analysis are Urea 25 kg ha^{-1}, SP-36 100 kg ha^{-1}, KCl 75 kg ha^{-1} equivalent to N = 11,5 kg ha^{-1}, P_2O_5 = 36 kg ha^{-1}, K_2O = 45 kg ha^{-1}. The design used was Completely Randomized Block Design with one-factor and five replications (Table 1).

The technology applied consisted of complete tillage, Rhizhoplus seed treatment 40 g/8 kg of seed, planting method by direct sowing, with a spacing of 40 cm x 20 cm, fertilizer according to the treatment, weed control two times before fertilization, hilling together with weeding, pest management by applying integrated pest management, harvest time was marked by fallen leaves and yellow pods.

Table 1. Soybean technology package (P) in gawangan of immature rubber plant

Technology Package (P)	Description
1	Dena 1 variety, fertilizer recommendation based on Katam recommendation
2	Dena 1 variety, fertilizer recommendation based on PUTK analysis
3	Anjasmoro variety, fertilizer recommendation based on Katam recommendation
4	Anjasmoro variety, fertilizer recommendation PUTK analysis

Data collected consisted of growth components (plant height), yields and yield components (number of branches, number of pods, number of filled pods, number of empty/damaged pods, weight of filled pods, number of filled seeds, number of empty/damaged seeds, number of seeds per plant), input costs and output costs of each technology package. Data on growth and yield components were analyzed using analysis of variance with the model

$$Y_{ij} = \mu + \tau_i + \beta_i + \epsilon_{ij}$$

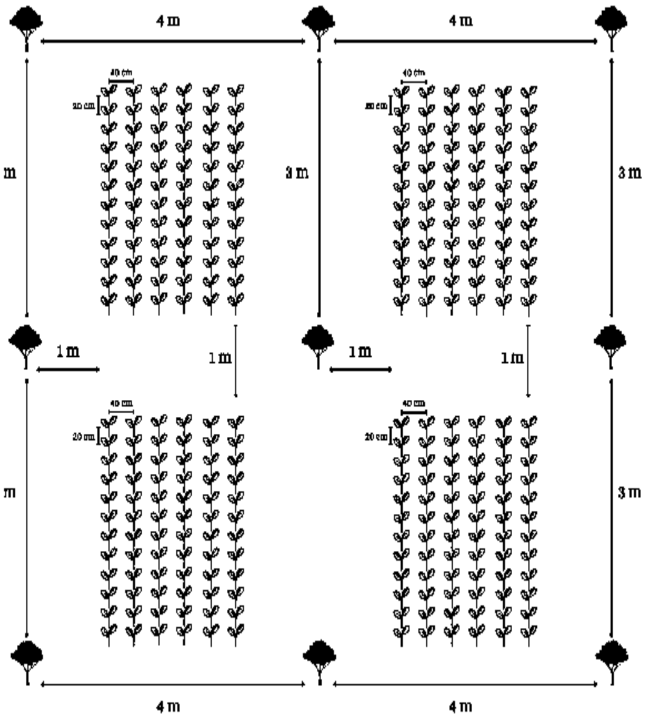
and if there were differences, it was followed by Duncan Multiple Range Test (DMRT).

The technical feasibility of soybean cultivation farming was measured using the analysis of revenue return on cost (R/C ratio) based on the formula,

$$R/C\,ratio = \frac{TR}{TC}$$

Where:
R/C = ratio of revenue and cost
TR = total revenue (Rp/ha)
TC = total cost (Rp/ha)

with decision:
R/C > 1, the farming business is feasible to develop
R/C = 1, farm business is at break-even point (BEP)
R/C < 1, the farming business is not worth developing



Description:
 = Soybean planting
 = Rubber planting

Figure 1. Diagram of rubber and soybean planting

3. Result

Gardu Village is one of the villages in the administrative area of Arma Jaya Sub-district, North Bengkulu Regency. The research area land is located at an altitude of 106 m above sea level (ASL) with undulating flat land conditions. Soil testing using the Dry Soil Test Device (PUTK) shows that the research soil is in zones I and II which have low available P nutrient status, medium available K, slightly acidic pH, and medium C-Organic (Table 2).

Table 2. Actual soil condition of rubber plantation land in Gardu Village, Arma Jaya Subdistrict, North Bengkulu Regency

No	Zone	Test results			
		P	K	pH	C-Org
1	I	Low	Moderate	Slightly acidic	Moderate
2	II	Low	Moderate	Slightly acidic	Moderate

The research area has a marginally suitable P nutrient status (S3), a moderately suitable K status (S2), and a suitable C-Organic nutrient status (S1), according to the parameters of the nutrient status. The C-Organic content falls within the medium category, which is 2 to 3%. In comparison, the slightly acidic pH status shows that the soil at the research site has a pH value range between 5,6 – 6,5 (Ritung *et al*.,2011). The nutrient status of this soil can be improved using the recommendations of the PUTK (Table 3).

Table 3. Fertilization Recommendations Based on Dry Soil Test Device (PUTK)

Recommendation					Desc.
Urea (Kg)	**SP-36 (Kg)**	**KCl (Kg)**	**Lime (Kg)**	**Compost (Kg)**	
50*)	200	100	-	1.000	2 ha
25	200	100	1.000	1.000 ha^{-1}	1 ha

The components of growth and yield of soybean plants grown on immature rubber spacings showed significant and insignificant results. The components of number of branches, number of empty pods, weight of filled pods per plant (g), number of filled seeds, and seed weight per plant showed significant results. In contrast, plant height, number of filled pods, number of pods, number of empty or damaged seeds, number of seeds, and percent of empty or damaged seeds showed insignificant results (Table 4). DMRT further analysis test at the 5% level on components that showed different results showed P3 and P4 gave the best results (Table 5).

Table 4. Recapitulation of F-test results on growth and yield components of soybean activities in *gawangan* of immature rubber plant

No.	Observed variables	Treatments
1	Plant height	Ns
2	Number of branches	*
3	Number of filled pods	Ns
4	Number of empty/damaged pods	*
5	Number of pods	Ns
7	Weight of filled pods per plant (g)	*
8	Number of filled seeds	*
9	Number of empty/damaged seeds	Ns
10	Number of seeds	Ns
11	Percent of empty/damaged seeds	Ns
12	Seed weight per plant	*

Table 5. Mean values of technology treatment package effects on yield and yield components

Treatment	The number of branches	Number of empty/ damaged pods	Weight of filled pods per plant (g)	Number of filled seeds	Seed weight per plant (g)
P1	1.56a	1.89b	7.81a	23.96a	3.72a
P2	2.33ab	2.21b	13.89ab	47.20ab	8.47ab
P3	3.68c	2.07b	19.43b	82.82bc	14.10b
P4	3.08bc	0.00a	22.95b	96.03c	15.10b

The calculation of the farm business also shows that P3 and P4 have higher R/C ratio values, although all technology packages are technically feasible to develop because they have R/C ratio values > 1 (Table 6). The similarity between P3 and P4 is that both use the Anjasmoro variety. This shows that the Anjasmoro variety has better performance compared to the Dena 1 variety. Even with different fertiliser recommendations, the Anjasmoro variety is able to produce higher yields than the Dena 1 variety.

Table 6. Analysis of soybean farming on *gawangan* of immature rubber plant in Gardu Village, Armajaya Sub-district, North Bengkulu Regency, Bengkulu Province, 2018.

Description	Treatment (P)			
	P1	**P2**	**P3**	**P4**
Cost (Rp ha^{-1})	4.976.600	4.884.350	4.976.600	4.884.350
Production (kg ha^{-1})	950	1.040	1.300	1.090
Selling price (Rp.)	6.000	6.000	6.000	6.000
Revenue (Rp.)	5.700.000	6.240.000	7.800.000	6.540.000
Income (Rp.)	723.400	1.355.650	2.823.400	1.655.650
R/C	1,15	1,28	1,57	1,34

4. Discussion

The rubber planted at the research area is approximately two years old and comes from the superior clone PB260 with a planting distance of 5 x 4 m. Farmers generally do not utilise immature rubber plantations, leaving most of them unused. Some farmers utilise the *gawangan* for the cultivation of kencur plants but only for personal consumption. There are no obstructions from the rubber plant canopy around the research area. This condition causes unobstructed airflow, and sunlight can shine on the soybean plants because they are not yet covered by the plant canopy. Rubber plant crowns will cover each other at the age of 2 years (Sahuri, 2017). If the light intensity is reduced, it will reduce the leaf area even though the leaves play an important role in photosynthesis (Susanto & Sundari, 2010).

The application of fertilisers in accordance with PUTK recommendations can enhance soil nutrient status and potentially elevate the land suitability class from S3 to S2 or even S1, and from S2 to S1 . This circumstance demonstrates that if the land is processed in a way that and applying ameliorants to soils that react to acid before fertilization can overcome the deficiencies of each limiting component (Nurmegawati *et al*., 2021), it has the ability to grow and produce optimal results. The application of N, P and K fertilizer has its technical recommendations. According to Husnain et al. (2016), the application of N fertilizer can be done by mixing the fertilizer with the soil before spreading, buried in the soil so that it does not evaporate and giving it in stages 2-3 times in granule form for optimal absorption. P fertilizer is recommended to be applied according to the needs of plants, added organic fertilizer, at a soil pH of 6 - 7 and increased interaction with mycorrhiza. Meanwhile, K fertilizer can be applied at a distance of 2,5 cm beside the plant by burying it.

The number of branches in the P3 and P4 treatments showed significantly different results. This result shows there is no difference between the two treatments. The number of branches in the Anjasmoro variety was higher when compared to the Dena 1 variety. Regarding the component of empty or damaged pods, the Anjasmoro variety also showed the best results with fewer empty or damaged pods in the P4 treatment. The weight of filled pods, filled seeds and seed weight per plant also showed the highest results in the P4 treatment and were not significantly different from P3.

The significant difference in the number of branches in P3 and P4 compared to P1 and P2 is presumed due to genetic factors possessed by Anjasmoro varieties. Based on the description, the number of branches of Anjasmoro ranged from 2,9-5,6 higher when compared to Dena 1 which only ranged from 1-3 branches. So based on the description, the number of branches of the Dena 1 is less than that of the Anjasmoro. Branches on soybean plants are one of the yield components because the position of pods is on branches or leaf axils (Tamba et al., 2017). The pods produced depend on the number of branches produced. The more the number of branches produced, the more potential the pods will appear (Herawati et al., 2017). Fertilizer treatment also influenced the number of empty or damaged pods in each treatment. The number of empty or damaged pods per plant showed the lowest results in P3 and P4 treatments compared to P1 and P2. This shows that the P3 and P4 treatments produce more number of pithy seeds compared to P1 and P2. In the P1 and P2 treatments, in addition to empty seeds, there were also seeds that were damaged by pests. The low number of empty pods in the P4 treatment was probably due to a lower dose of N fertilizer.

Nitrogen is one of the essential nutrients for plants whose contents have an influence on insect development. Using nitrogen in large quantities can increase plant growth rapidly, especially in the stems and leaves that become dark green and the plants become succulent, making it easier for pests and diseases to attack (Trisnawati *et al*., 2017). In addition, the application of high amounts of N and rhizobium can suppress nodule growth and reduce nodule activity in tethering N from the air, thus affecting the number of pods formed (Meitasari dan Wicaksono, 2018).

The yield components that showed the highest yields in the P3 and P4 treatments showed that the Anjasmoro variety is a variety that is widely adapted to various environments. The adaptability of the Anjasmoro variety is better compared to the Dena 1 variety. Variations that arise in plant populations grown under the same environmental conditions are caused by variations in the genotypes of individual members of the population. In addition, the application of urea fertilizer could support appropriate growth so that the growth and development of plant vegetative organs becomes optimal, that also help generative development growth. The provision of nitrogen in small amounts with inoculation from rhizobium bacteria and sufficient water availability can increase the production of seed weight of soybean plants (Meitasari dan Wicaksono, 2018).

The use of Anjasmoro varieties in P3 and P4 significantly affected the production and R/C value. Despite applying different fertilizer recommendations, P3 and P4 still produced higher production and R/C value than P1 and P2. These results are in line with the results of research by Kuncahyo *et al.* (2019) who planted nine varieties of soybean on paddy fields in the dry season; Novianto *et al.* (2022) on palm-soybean intercropping pattern and Somantri et al. (2019) in monoculture pattern. The farming R/C ratio of Anjasmoro variety in this study was also higher compared to several studies with different varieties. Nuswantara *et al.* (2019) reported an R/C value of 1,47 for the Grobogan variety with a selling price of IDR 7.916 kg^{-1}. In line with the research of Farikin *et al.* (2016) who also used the Grobogan variety with a selling price of Rp 6.940/kg obtained an R/C ratio of 1,73. Arifin dan Sahrawi (2014) who conducted research in Pakong District, Pamekasan Regency on the Wilis soybean variety obtained an R/C ratio of 1,56. The technology packages that apply fertilizer based on KATAM recommendations (P1 and P3) have higher costs. This is because the amount of urea fertilizer used in this recommendation is higher than the fertilizer based on the PUTK analysis. The higher amount of fertilizer also results in higher fertilizer purchase costs. However, using more fertilizer is not directly proportional to the production. Not all technology packages that applied fertilizer based on the Katam recommendations resulted in higher production compared to the fertilizer technology package with the PUTK recommendations.

The difference in fertilizer recommendations based on Katam recommendations and PUTK analysis lies only in the amount of urea fertilizer dosage. Urea fertilizer is closely related to the availability of N elements that plants will utilize. Prakoso *et al.* (2018) reported that urea fertilization had no effect on the growth and yield of Anjasmoro cultivar soybean. According to Purnamasari dan Tarbiyatul (2016), root nodules formed optimally in soybean can reduce the need for N elements when symbiotic with rhizobium. Root nodules can function as N fixers from the air through N_2 fixation, so these plants only require a small amount of additional N fertilizer.

5. Conclusion

Technology package 3 (P3), which uses the Anjasmoro variety with fertiliser doses based on KATAM recommendations, produces the highest production compared to the other technology packages. Although all technology packages are technically feasible to develop because they have an R/C ratio value >1, this technology package is not only the most feasible to develop because of its better yields, but also because it has the highest R/C ratio value.

The Anjasmoro variety also showed a better performance in comparison to the Dena 1 variety in this study. The Anjasmoro variety still produced higher yields than the Dena 1 variety, despite being grown with different recommended fertiliser doses (KATAM and PUTK). This suggests that compared to Dena 1, the Anjasmoro variety has a better adaptability.

6. Acknowledgement

We would like to thank the Agricultural Research and Development Agency of the Ministry of Agriculture for funding this research, Darkam Musaddad as head of the Assessment Institute for Agriculture Technology Bengkulu and also Mr. Ir. Syahrial A., M.S for his guidance when writing the manuscript.

7. Declaration of Conflicting Interests

The authors have declared no potential conflicts of interest concerning the study, authorship, and/or publication of this article.

8. References

Adnyana MO, Kariyasa K. 1999. Potensi Peningkatan Produksi Kedelai di Indonesia Melalui Penelitian Pengembangan dan Pemanfaatan Sumber Pertumbuhan Produksi. *Forum Agro Ekonomi*, 17(1), 38–48.

Aldillah R. 2015. Proyeksi Produksi dan Konsumsi Kedelai Indonesia. *Ekonomi Kuantitatif Terapan*, 8(1), 9–23. https://doi.org/10.24198/kultivasi.v19i2.26469

Anjani SR. 2019. Permintaan Kedelai Indonesia. *Jurnal Pemasaran Kompetitif*, 2(2), 1. https://doi.org/10.32493/jpkpk.v2i2.2455

Arifin Z, Sahrawi. 2014. Analisa Usahatani Kedelai Varietas Wilis Pada Lahan Sawah Tadah Hujan Di Desa Klompang Barat Kecamatan Pakong Kabupaten Pamekasan. *Agromix*, 5(2), 26–37. https://doi.org/10.35891/agx.v5i2.721

Atman. 2009. Strategi peningkatan produksi kedelai di Indonesia. *Jurnal Ilmiah Tambua*, *8*, 39–45.

Farikin M, Saparto, Suharyono E. 2016. Analisis Usahatani Kedelai Varietas Grobogan di Desa Pandanharum Kabupaten Grobogan. *Agromedia*, 34(1), 56–63.

Herawati N, Hipi A, Aisah, AR, Tantawizal. 2017. Keragaan Pertumbuhan dan Hasil Beberapa Varietas Kedelai pada Berbagai Pupuk Organik Cair di Lahan Kering Beriklim Kering. Dalam: Pratiwi H, Sulistyo A, Lestari SAD, Sari KP, Kristiono A, Rahajeng W (eds). *Prosiding Seminar Nasional Hasil Penelitian Tanaman Aneka Kacang dan Umbi*. 26 Juli. 2017. hlm165-174.

Huang J, Pan J, Zhou L, Zheng D, Yuan S, Chen J, Li J, Gui Q, Lin W. 2020. An Improved Double-row Rubber (Hevea brasiliensis) Plantation System Increases Land Use Efficiency by Allowing Intercropping with Yam Bean, Common Bean, Soybean, Peanut, and Coffee : A 17-year Case Study on Hainan Island, China. *Journal of Cleaner Production*, *263*, 121493. https://doi.org/10.1016/j.jclepro.2020.121493

Husnain, Kasno A, Rochayati S. 2016. Pengelolaan Hara dan Tenologi Pemupukan Mendukung Swasembada Pangan di Indonesia. *Jurnal Sumberdaya Lahan*, 10(1), 25–36.

Kuncahyo A, Agustiansyah A, Ermawati E, Pramono E. 2019. Studi Pertumbuhan, Produksi, dan Mutu Benih Sembilan Varietas Kedelai (Glycine max[L.] Merrill) Yang ditanam di Lahan Sawah Musim Kemarau. *Jurnal Agrotek Tropika*, 7(2), 343–349. https://doi.org/10.23960/jat.v7i2.3257

Mahdoh, Risyanto H. 2018. Analisis Pengaruh Konsumsi Kedelai, Produksi Kedelai Dan Cadangan Devisa Terhadap Impor Kedelai Di Indonesia. *I-ECONOMICS: A Research Journal on Islamic Economics*, 4(2), 180–193. https://doi.org/10.19109/ieconomics.v4i2.2736

Mawarni L. 2011. Kajian Awal Varietas Kedelai Tahan Naungan untuk Tanaman Sela pada Perkebunan Kelapa Sawit The Early Study of Shading Tolerance of Soybean Varieties for Oil Palm Plantation Pendahuluan Bahan dan Metode. *Jurnal Ilmu Pertanian KULTIVAR*, 5(2), 54–59.

Meitasari AD, Wicaksono KP. 2018. Inokulasi Rhizobium dan Perimbangan Nitrogen pada Tanaman Kedelai (Glycine max (l) merrill) varietas Wilis. *PLANTROPICA Journal of Agricultural Science*, 2(1), 55–63.

Purnamasari M, Tarbiyatul M. 2016. Pengaruh Pemupukan Terhadap Peningkatan Produksi Kedelai di Kabupaten Kutai Kartanegara. Dalam: Surahman M, dkk (eds). *Prosiding Seminar Nasional Hasil-Hasil Penelitian dan Pengabdian Masyarakat Institut Pertanian Bogor 2016.* Bogor 1 Desember. 2016. hlm54–61.

Novianto, Effendy I, Bahri S. 2022. Pengaruh Pemotongan Ujung Pelepah Kelapa Sawit Terhadap Produksi Berbagai Varietas Kedelai Melalui Pola Intercropping Sawit-Kedelai. *Gontor AGROTECH Science Journal*, 8(1), 9–17. https://doi.org/10.21111/agrotech.v7i1.4545

Nurmegawati, Sari WM, Damiri A, Wahyuni T, Calista I, Sastro Y, Oktavia Y, Yahumri, Yartiwi. (2021). Soil fertility management of rainfed rice fields in Bengkulu Province, Indonesia. *E3S Web of Conferences*, *306*, 1–7. https://doi.org/10.1051/e3sconf/202130604025

Nuswantara B, Prihtanti TM, Banjarnahor DRV, Suprihati S, Nadapdap HJ. 2019. Kelayakan Ekonomi Usahatani Kedelai Varietas Grobogan di Kabupaten Semarang. *Unri Conference Series: Agriculture and Food Security*, *1*, 134–141. https://doi.org/10.31258/unricsagr.1a18

Oktavia F, Panambangtua AP. 2019. Daya Hasil Kedelai Varietas Dena 1 dan Anjasmoro di Bawah Tegakan Kelapa Dalam dan Kelapa Genjah yang Telah Menghasilkan. *Prosiding Seminar Nasional Peran Komoditas Unggulan Daerah Mendukung Pencapaian Target Produksi Nasional*. Balai Besar Pengkajian dan Pengembangan Teknologi Pertanian. Badan Penelitian dan Pengambangan. Kementerian Pertanian. Hal : 303-310.

Permadi GS.2015. Analisis Permintaan Impor Kedelai Indonesia. *Ekonomi Regional*, 10(1), 23–31.

Pusat Data dan Sistem Informasi Pertanian. 2022. Statistik Konsumsi Pangan Tahun 2022. Jakrarta: Kementerian Pertanian.

Prakoso DI, Indradewa D, Sulistyaningsih E. 2018. Pengaruh Dosis Urea terhadap Pertumbuhan dan Hasil Kedelai (Glycine max L. Merr.) Kultivar Anjasmoro. *Vegetalika*, 7(3), 16. https://doi.org/10.22146/veg.35931

Ritung S, Nugroho K, Mulyani A, Suryani E. 2011. *Petunjuk Teknis Evaluasi Lahan untuk Komoditas Pertanian*. Bogor: Balai Besa Penelitian dan Pengembangan Sumberdaya Lahan Pertanian.

Rodrigo VH, Stirling C, Teklehaimanot Z, Nugawela A. 2001. Intercropping With Banana to Improve Fractional Interception and Radiation-use Efficiency of Immature Rubber Plantations. *Field Crops Research*, 69(3), 237–249. https://doi.org/https://doi.org/10.1016/S0378-4290(00)00147-7

Sahuri. 2017. Pengaturan Pola Tanam Karet (Hevea brasiliensis Muell . Arg .) untuk Tumpang Sari Jangka Panjang. *Jurnal Ilmu Pertanian Indonesia*, 22(1), 46–51. https://doi.org/10.18343/jipi.22.1.46

Sahuri. 2019. Teknologi Tumpangsari Karet-Tanaman Pangan: Kendala dan Peluang Pengembangan Berkelanjutan. *Jurnal Litbang Pertanian*, 38(1), 23–34. https://doi.org/10.21082/jp3.v38n1.2019.p23-34

Sahuri, Cahyo AN, Nugraha IS. 2016. Pola Tumpang Sari Karet-Padi Sawah Pada Tingkat Petani di Lahan Pasang Surut (Studi Kasus Di Desa Nusantara, Kecamatan Air Sugihan, Kabupaten OKI, Provinsi Sumatera Selatan). *Warta Perkaretan*, 35(2), 107–120.

Sitanggang KD, Rini CY. 2019. Produksi Kedelai Dena 1 (Glycine max (L) Merrill.) di Bawah Tegakan Kelapa Sawit. *Jurnal Agroplasma*, 6(1), 7–12. https://doi.org/10.36987/agr.v6i1.169

Somantri RU, Syahri S, Thamrin T. 2019. Keragaan Agronomis dan Kelayakan Usahatani Kedelai yang Dibudidayakan Secara Monokultur dan Polikultur di Sumatera Selatan. *Jurnal Lahan Suboptimal : Journal of Suboptimal Lands*, 8(2), 159–172. https://doi.org/10.33230/jlso.8.2.2019.426

Susanto G, Sundari T. 2010. Pengujian 15 Genotipe Kedelai Pada Kondisi Intensitas Cahaya 50% dan Penilaian Karakter Tanaman Berdasarkan Fenotipnya. *Indonesian Journal of Biology*, 6(3), 459–471.

Tamba H, Irmansyah T, Hasanah Y. 2017. Respons Pertumbuhan dan Produksi Kedelai (Glycine max (L.) Merill) Terhadap Aplikasi Pupuk Kandang Sapi dan Pupuk Organik Cair. *Agroekoteknologi*, 5(2), 307–315.

Tistama R, Dalimunthe CI, Sembiring YRV, Fauzi IR, Hastuti RD, Suharsono. 2016. Tumpangsari Sorgum dan Kedelai untuk Mendukung Produktivitas Lahan TBM Karet. *Jurnal Penelitian Karet*, 34(1), 61–76.

Trisnawati DW, Putra NS, Purwanto BH. 2017. Pengaruh Nitrogen dan Silika terhadap Pertumbuhan dan Perkembangan Spodoptera litura (Lepidoptera: Noctuidae) pada Kedelai. *Planta Tropika: Journal of Agro Science*, 5(1), 52–61. https://doi.org/10.18196/pt.2017.071.52-61

Watkins M, Castlehouse H, Hannah M, Nash DM. 2012. Nitrogen and Phosphorus Changes in Soil and Soil Water after Cultivation. *Applied and Environmental Soil Science*, vol. 2012, Article ID 157068, 10 pages, 2012. https://doi.org/10.1155/2012/157068

Xianhai Z, Mingdao C, Weifu L. 2012. Improving Planting Pattern for Intercropping in the Whole Production Span of Rubber Tree. *African Journal of Biotechnology*, 11(34), 8484–8490. https://doi.org/10.5897/AJB11.3811

Zakaria AK. 2016. Kebijakan Pengembangan Budi Daya Kedelai Menuju Swasembada Melalui Partisipasi Petani. *Analisis Kebijakan Pertanian*, 8(3), 259. https://doi.org/10.21082/akp.v8n3.2010.259-272