

The Effect of Intercropping Species on the Growth and Yield of Cashews (*Anacardium Occidentale* L.) in Dryland Farming

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ABSTRACT: This study aims to analyze the effects of intercrop types on the growth and yield of cashew trees in dryland areas of North Lombok Regency, West Nusa Tenggara. The study was conducted using a one-factor randomized block design (RBD) consisting of four treatments: cashew without intercrops, cashew with peanuts, cashew with corn, and cashew with upland rice, each repeated three times. The observed parameters included shoot length increase, number of new leaves, number of new shoots, branch diameter, leaf chlorophyll content, number of flowers, seed size, relative leaf water content, and cashew nut yield per tree. The data were analyzed using analysis of variance (ANOVA) at the 5% significance level, followed by a BNT test when significant differences were found between treatments. The results showed that the type of intercrop significantly affected vegetative growth, leaf chlorophyll content, and cashew yield. Intercropping with corn resulted in the highest growth and yield, as evidenced by a shoot length increase of 5.79 cm, 10.34 new shoots, a chlorophyll content of 46.46 SPAD units, and a cashew nut yield of 52.92 kg per tree. Therefore, corn is recommended as the most suitable intercrop for increasing cashew productivity on dryland.

KEYWORDS: cashew, intercrop, corn, dryland, intercropping.

1. INTRODUCTION

The cashew tree is a plantation crop that adapts well to dryland and low-rainfall areas, which is why it is widely cultivated in eastern Indonesia. The area under cashew cultivation in Indonesia in 2015 reached approximately 522,863 ha, with a production of 137,580 metric tons, highlighting the importance of this crop in supporting the local economy in Indonesia's arid regions (Directorate General of Plantations, 2016). North Lombok Regency is one of the districts in West Nusa Tenggara Province that has significant potential for cashew development and is beginning to be positioned as a regional export commodity. The dryland agroecosystem conditions in this region are highly suitable for cashew cultivation because the plant can withstand water stress and low soil fertility. Furthermore, the cashew tree's root system redistributes groundwater (hydraulic lift), helping maintain soil moisture in the surface layer during the dry season (Priyadarshan, 2018).

In cashew plantations—particularly during the pre-bearing phase or in orchards with relatively wide planting distances—there is still ample space between plants, which can be utilized through intercropping systems with annual food crops. Intercropping systems in plantation crops have been shown to improve the efficiency of light, water, and nutrient utilization and to provide additional income for farmers through crop diversification (Jiao et al., 2021). Intercrops such as peanuts, corn, and upland rice have different growth characteristics and resource requirements, so they are likely to have varying effects on cashew growth and yield. Leguminous crops such as peanuts have the potential to increase soil nitrogen availability through biological fixation. In contrast, corn and upland rice have relatively higher water and nutrient requirements, which may lead to competition with the main crop if not managed properly (Lithourgidis et al., 2011).

Research on intercropping systems in cashew plantations generally focuses on increasing farmers' incomes, landuse efficiency, and intercrop productivity. Most studies have also been conducted on specific intercrops or under agroecosystem conditions that differ from those in eastern Indonesia's drylands (Visalakshi et al., 2015). To date, there has been relatively little research specifically comparing the effects of several different types of intercrops—namely, peanuts, corn, and upland rice—on the vegetative growth and yield of cashew trees under dryland conditions in North Lombok Regency. Furthermore, information on the most suitable intercrops to support cashew growth without causing detrimental competition remains limited. These

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conditions indicate a research gap regarding the effects of intercropping with different physiological characteristics on the growth and yield of cashew trees under dryland conditions.

Given these conditions, this study was conducted to analyze the effects of intercropping peanuts, corn, and upland rice on cashew tree growth and yield in dryland areas. The novelty of this study lies in the direct comparison of three types of intercrops with different physiological characteristics—namely, legumes (peanuts), highly competitive cereals (corn), and dryland-adapted cereals (upland rice)—on the growth and yield of cashew trees under dryland conditions. Furthermore, this study places greater emphasis on the response of the main crop—the cashew. In contrast, most previous studies have focused on intercrop productivity or land-use efficiency in intercropping systems. This research was also conducted in the dryland agroecosystem of North Lombok Regency, which has distinct climatic characteristics and water availability compared to typical cashew research sites. The results of this study are expected to yield recommendations on the most suitable intercrop species to support cashew tree vegetative growth and yield, thereby serving as a model for more efficient and sustainable management of cashew orchards.

II. RESEARCH METHODOLOGY

Research Location and Time

The research was conducted on dryland cashew plantations in North Lombok Regency, West Nusa Tenggara Province, from January to May 2025. The research site is located in a dryland agroecosystem with a dry climate and relatively low rainfall, making it suitable for cultivating cashew trees and dryland food crops.

Materials and Equipment

The materials used in this study included cashew trees as the main crop, along with peanut, corn, and upland rice seeds as intercrops. In addition, fertilizers were applied according to local recommendations, along with other supporting materials for crop maintenance. The equipment used included a measuring tape, a vernier caliper, a chlorophyll meter, a digital scale, writing utensils, and other cultivation support tools.

Experimental Design

This study employed a field experiment using a one-factor Randomized Block Design (RBD), with the type of intercrop as the single factor, consisting of four treatment levels:

- T0 = Cashew without intercrops (control)
- T1 = Cashew + peanuts
- T2 = Cashew + corn
- T3 = Cashew + upland rice

Each treatment was replicated three times, resulting in 12 experimental units. Grouping was based on the uniformity of land conditions to minimize the influence of environmental factors not under study.

Research Implementation

Intercrops were planted in the spaces between cashew rows according to the planting distances used by local farmers. Crop maintenance included thinning, weeding, fertilization, and pest control, all carried out in accordance with the cultivation recommendations for each crop. Observations of the cashew trees were conducted periodically throughout the study period.

Observation Variables

The variables observed included parameters of vegetative growth and cashew yield, namely:

1. Shoot length (cm)
2. Number of new leaves (leaves)
3. Number of new shoots
4. Branch diameter (mm)
5. Leaf chlorophyll content (SPAD)
6. Cashew yield per plant (kg plant⁻¹)

Shoot length was measured using a tape measure from the base to the tip of the shoot. The number of new leaves and new shoots was counted directly on each sample plant. Branch diameter was measured using a vernier caliper at a predetermined point on the branch, while leaf chlorophyll content was measured using a chlorophyll meter. Cashew yield was determined by weighing the cashew nuts harvested from each sample plant.

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Data Analysis

The observational data were analyzed using analysis of variance (ANOVA) at a 5% significance level to determine the effect of the treatments on the observed variables. If the analysis results indicated a significant effect, a post hoc test was conducted using the Honest Significant Differences (HSD) test at the 5% significance level to determine differences among treatments. All statistical analyses were performed using appropriate statistical software.

III. RESULTS

The Effect of Cover Crop Types on the Vegetative Growth of Cashew Trees

Analysis of variance (ANOVA) results indicate that cover crop types have different effects on various growth parameters and cashew yields. The treatments had a highly significant effect on the number of new leaves and new shoots, and on the weight of the cashew nut harvest. In contrast, a significant effect was found on shoot length, the diameter of new branches, and leaf chlorophyll content. However, the treatments did not significantly affect the number of flowers per tree, nut size, or relative leaf water content.

Table 1. Results of Various Fingerprint Analyses of the Influence of Intermediate Plant Types on Cashew Growth and Yield

No	Observation Variables	Significance
1	Increase in shoot length	*
2	Growth of new leaves	**
3	Growth of new shoots	**
4	New twig diameter	*
5	Number of flowers per tree	tn
6	Seed size	tn
7	Weight of cashew seed harvest	**
8	Relative water content of leaves	tn
9	Chlorophyll content of leaves	*

Note: tn = unreal ($P \geq 0.05$); * = real ($P < 0.05$); ** = very real ($P < 0.01$).

The highest shoot length increase was observed in the cashew treatment with corn as a cover crop (5.79 cm), while the lowest shoot length increase was observed in the treatment without a cover crop (5.09 cm). These results indicate that certain cover crops can enhance the vegetative growth of cashew trees on dryland.

Table 2. Effect of Interplant Types on Vegetative Growth of Cashews

Tm (without intercrops)	5.09 b	5.09 b	6.08 c	6.08 c	6.67 p	6.67 p	0.70 ab
Tk (peanuts)	5.61 a	5.61 a	6.94 b	6.94 b	8.67 b	8.67 b	0.69 b
Tj (corn)	5.79 a	5.79 a	7.39 a	7.39 a	10.34 a	10.34 a	0.72 a
Tp (Gogo Priest)	5.52 a	5.52 a	6.55 b	6.55 b	7.67 c	7.67 c	0.70 ab
BNT 5%	0,33	0,33	0,43	0,43	0,22	0,22	0,02

Note: The number followed by the same letter in the same column shows no significant difference in the BNT test at 5%.

The intercropping treatment with corn resulted in the highest increases in new leaves and new shoots, at 7.39 leaves and 10.34 shoots, respectively. In contrast, the treatment without an intercrop resulted in the lowest vegetative growth. These results indicate that corn is the intercrop that most supports the vegetative growth of cashew trees compared to the other treatments.

Effect of Intercropping Crop Type on Cashew Yield

The number of flowers per tree and seed size were not significantly affected by the type of intercropping crop. However, descriptively, the corn intercropping treatment produced the highest number of flowers and the largest seed size among the treatments. Conversely, the weight of the cashew seed harvest was significantly affected by the treatment applied.

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Table 3. The Effect of Intercropping Types on Cashew Product Components

Tm (without intercrops)	1737.08 A	2.97 A	44.52 c
Tk (peanuts)	1813.41 to	3.00 to 3.00 to	48.07 b
Tj (corn)	2045.25 to	3.06 to	52.92 to
Tp (Gogo Priest)	1892.50 to	3.01 to	49.19 b
BNT 5%	405,47	0,06	2,18

Remarks: The number followed by the same letter in the same column shows no significant difference in the

The highest harvest weight was observed in the corn treatment, at 52.92 kg per tree, an increase of 18.88% over the treatment without intercrops, which yielded only 44.52 kg per tree. This increase indicates a positive interaction between corn and cashew trees in utilizing resources on dryland.

Effect of Intercropping Species on the Physiological Response of Cashew Trees

The type of intercrop had no significant effect on relative leaf water content but did have a significant effect on leaf chlorophyll content. The highest chlorophyll content was observed in the corn treatment at 46.46 SPAD units, while the lowest was in the no-intercrop treatment at 43.80 SPAD units.

Table 4. The Effect of Interplant Types on Physiological Parameters of Cashews

Tm (without intercrops)	79.64 A	43.80 b
Tk (peanuts)	79.95 A	45.90 A
Tj (corn)	80.42 A	46.46 to
Tp (Gogo Priest)	81.39 A	46.00 to
BNT 5%	2,26	1,26

Remarks: The number followed by the same letter in the same column indicates no significant difference in the BNT test at the 5% level.

IV. DISCUSSION

The results of this study indicate that the type of intercrop has different effects on the vegetative growth, yield, and several physiological parameters of cashew trees. The intercropping treatment with corn consistently produced the highest values for shoot length increase, new leaf formation, new shoot formation, leaf chlorophyll content, and cashew nut harvest weight compared to the other treatments. Conversely, treatments without intercrops generally showed lower growth and yields. This pattern is consistent with the findings of Nasar et al. (2025), who reported that intercropping systems can enhance plant growth and productivity by more efficiently using resources than monoculture systems.

The increase in vegetative growth of cashew trees under the corn intercropping treatment is believed to result from the efficient use of resources within the intercropping system. Intercropped plants can utilize different spatial and temporal niches, thereby optimizing the uptake of light, water, and nutrients, as well as growing space, while reducing direct competition among plants (Shao et al., 2025). In addition, the presence of intercrops can also improve soil conditions by increasing the availability of nutrients, organic matter, and microbial activity in the root zone (Zhang et al., 2024).

The greater increase in new leaves and shoots in the corn treatment indicates that cashew trees exhibit more intensive growth. Increased leaf area and the maintenance of a green canopy are important physiological foundations for enhancing photosynthetic capacity and plant biomass accumulation (Guo et al., 2026). Leaves are the primary organs in the photosynthesis process; therefore, an increase in the number of leaves expands the photosynthetic surface area and boosts the production of photosynthates, which are subsequently used for the formation of both vegetative and generative organs.

This was evident from the high leaf chlorophyll content in the corn treatment, which reached 46.46 SPAD units, compared to 43.80 SPAD units in the treatment without intercrops. Chlorophyll content is an important indicator of a plant's photosynthetic capacity; thus, an increase in chlorophyll is generally accompanied by an increase in photosynthetic productivity and plant growth (Wang et al., 2026).

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The intercropping treatment had no significant effect on the number of flowers per tree or the size of cashew nuts. These results suggest that the formation of reproductive organs in cashew trees is likely more influenced by genetic factors, plant age, and macroenvironmental conditions than by the presence of intercrops. Research by Akchaya et al. (2025) showed that intercropping systems more often affect vegetative growth and total yield than they do individual reproductive components.

The intercropping treatment with corn yielded the highest harvest weight of 52.92 kg per tree—an increase of approximately 18.88% compared to the treatment without intercrops, which yielded only 44.52 kg per tree. This increase in yield is consistent with the study by Pérez-Bernal et al. (2025), which reported that intercropping systems can increase crop yields by improving the efficiency of light, water, and nutrient use.

This increase in yield is believed to result from a combination of increased vegetative growth, greater leaf number, higher shoot number, and higher leaf chlorophyll content, thereby optimizing the plant's ability to produce and translocate photosynthates for seed formation. The relationship among photosynthesis, assimilate translocation, and crop yield has been explained by Yan et al. (2024), who stated that increased photosynthetic capacity enhances biomass accumulation and the filling of fruiting organs.

Relative leaf water content was not significantly affected by the type of intercrop, with values ranging from 79.64–81.39%. These results indicate that the intercropping system in this study did not cause excessive water competition for cashew trees. Similar findings were also reported by Tuure et al. (2025), who stated that the effect of intercropping on plant water status is highly dependent on crop configuration and environmental conditions. The cashew's ability to maintain its water status on dryland is also consistent with the findings of Mog et al. (2026), who reported that cashew possesses physiological adaptations to drought stress through osmotic adjustment and effective regulation.

Overall, the study results indicate that corn is the most effective intercrop for supporting cashew growth and yield on dryland, compared with peanuts and upland rice. Therefore, the use of corn as an intercrop can be recommended as a more productive and efficient alternative for dryland management in cashew cultivation in North Lombok Regency (Guo et al., 2026).

V. CONCLUSION

Different intercrop types have varying effects on the vegetative growth, physiological parameters, and yield of cashew trees under dryland conditions. Intercropping cashew trees with corn yielded the best results compared to peanuts, upland rice, or no intercrop, as indicated by the highest values for shoot length increase, number of new leaves, number of new shoots, leaf chlorophyll content, and cashew nut yield per tree. Conversely, the number of flowers, nut size, and relative leaf water content were not significantly affected by the type of intercrop used. The increase in cashew yield in the corn intercropping treatment is attributed to more efficient resource utilization, increased photosynthetic activity, and improved vegetative growth compared with the other treatments. Therefore, corn can be recommended as the most suitable intercrop for cashew cultivation systems on dryland in North Lombok Regency to enhance productivity and the sustainable efficiency of land use.

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