

# Is Understory Vegetable Production in Smallholder Agroforestry Systems a Viable Option?

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## BACKGROUND

Farmers in Nanggung, West Java traditionally cultivate vegetables under full sunlight. Few farmers (11%) have experience with intercropping vegetables and tree crops. An on-farm trial was implemented to evaluate the production of seven commercial vegetable species under three light levels as the treatment in a nested design.

**Data Analysis** Vegetable growth and yield data were analyzed using Multiple Regression analysis to quantify how the independent variables affected growth and production of the vegetable species.

**Light Levels and Traditional Agroforestry Systems** The trial evaluated vegetable production under: i) full sunlight (127 – 603 \*1000 lux), ii) medium light (95 – 245 \*1000 lux), and iii) low light (75 – 135 \*1000 lux). Full sunlight corresponds to areas commonly used by farmers for vegetable production. Medium light correspondence to conditions found under traditional *mixed fruit-timber-banana-annual crop* agroforestry systems (400 trees/ha). Low light correspondence to conditions found under traditional *fruit-timber agroforestry* systems (625 trees/ha). Traditional agroforestry systems are called *dudukuhan*.

**Study Site** Nanggung is located in West Java. Annual rainfall varies between 3,000 mm and 4,000 mm and temperature range between 22°C and 24°C.

## VEGETABLE PRODUCTION

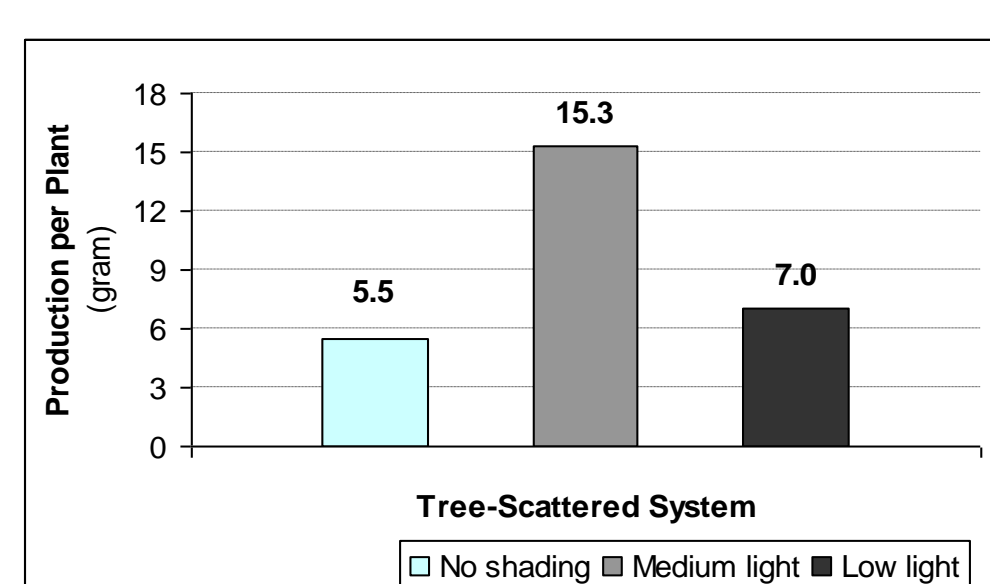


Figure 1. Amaranth production during 4 weeks after planting

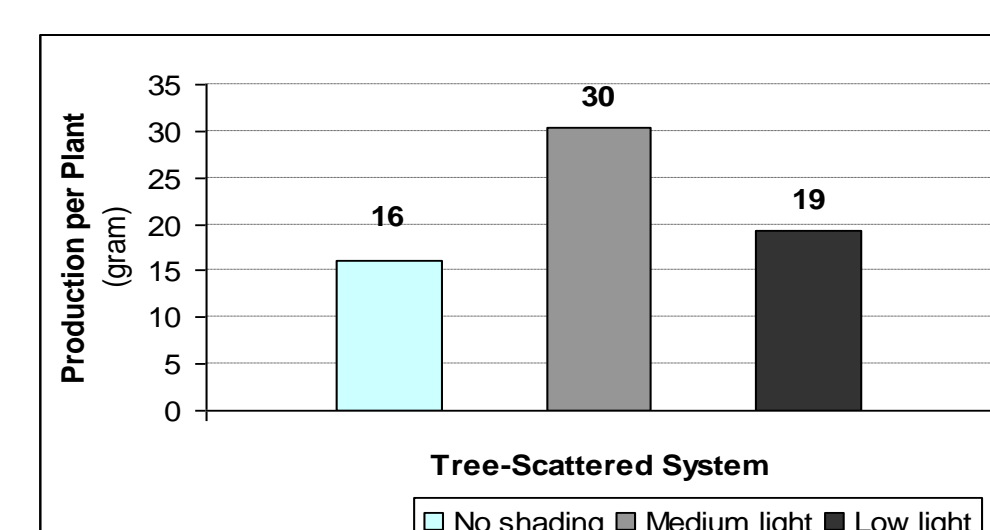


Figure 2. Kangkung production 4 weeks after planting

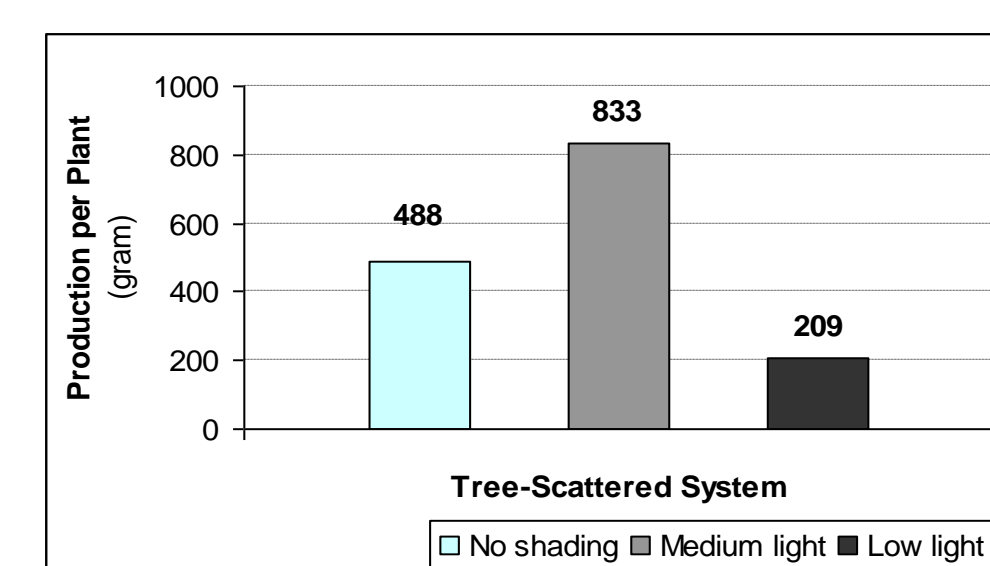


Figure 3. Eggplant production 10 weeks after planting

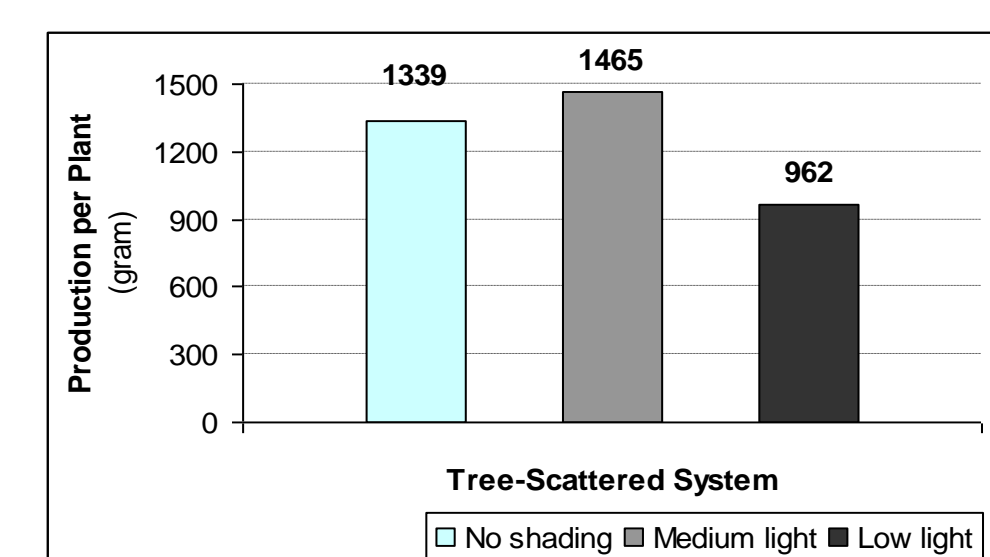


Figure 4. Chili production 10 weeks after planting

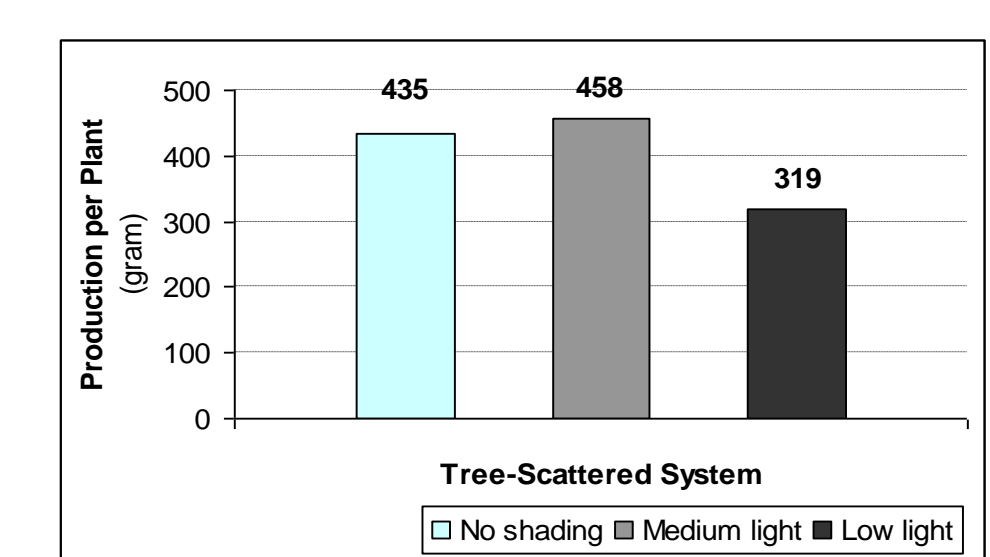


Figure 5. Tomato production 10 weeks after planting

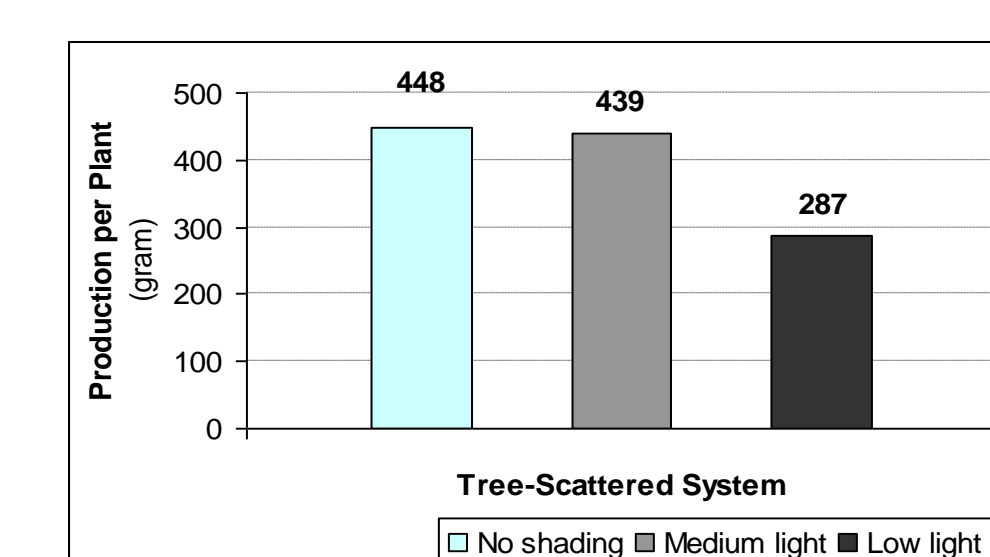


Figure 6. Longbean production 10 weeks after planting

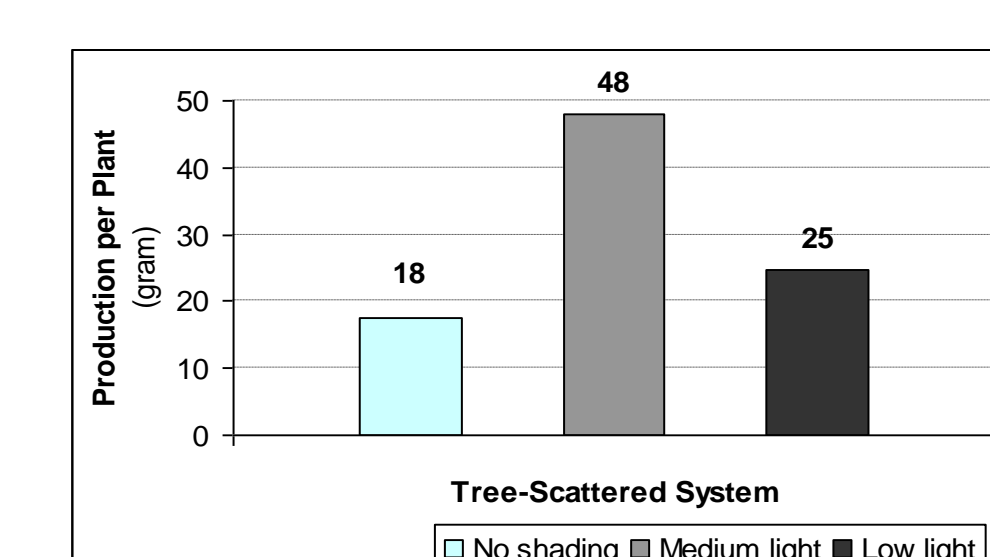


Figure 7. Katuk production 10 weeks after planting

**Trial Details** The species included in the trial were katuk (*Sauropus androgynus* (L.) Merrill), kangkung (*Ipomoea aquatica* Forsskal), amaranth (*Amaranthus* sp.), chili (*Capsicum annum* L.), egg plant (*Solanum melongena* L.), long bean (*Vigna unguiculata* (L.) Walp.), and tomato (*Lycopersicon esculentum* Miller). The trial was established August 2007. Growth and production data were collected weekly over 10 weeks. Plot size per species and treatment was 1000 m<sup>2</sup>.

**Labor Input** Total labor input required for vegetable production under each light level treatment is provided in Figure 8. Labor requirement positively correlates to the effective planting area. Vegetable cultivation in the full sunlight treatments required the greatest labor input, followed by medium light treatments, and low light treatment.

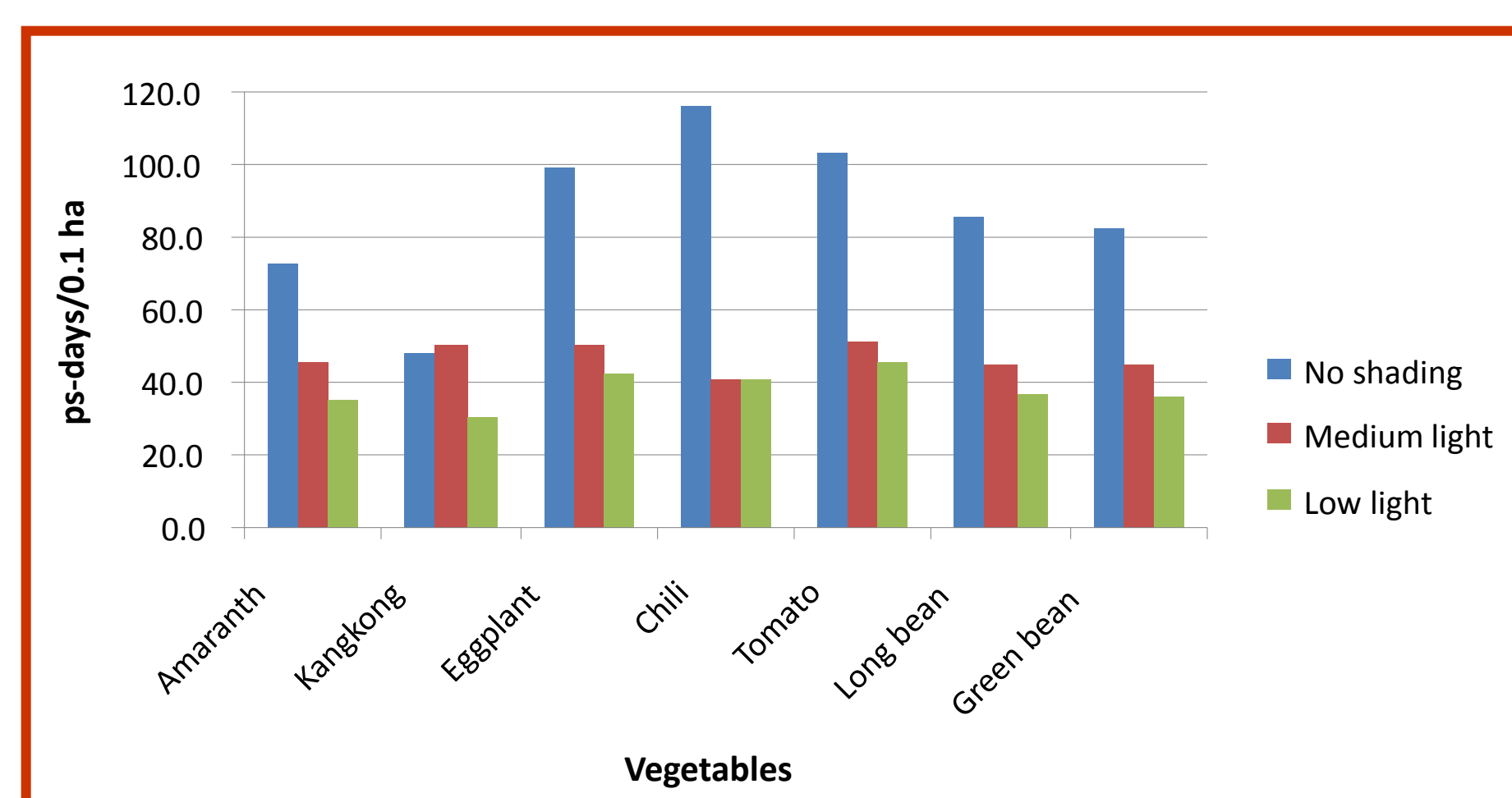


Figure 8. Labor inputs for vegetable production (ps-day/1,000 m<sup>2</sup>)

**Production per Plant and per Area** Production on a per plant basis and on a per area basis are provided in Table 1 and Table 2, respectively. On either basis, vegetable production was generally best under the medium light treatment. Vegetable production under low light treatments was generally lowest on both bases. Production per area was generally lower than national averages, with exception of amaranth and chili under the medium light treatment.

Table 1. Production of vegetable species per plant under each light level

Vegetable Species	Light Level Treatment (g/plant)		
	Full sunlight	Medium light	Low light
Amaranth	5.5	15.3	7.0
Kangkung	16	30	19
Eggplant	488	833	209
Chili	1339	1465	962
Tomato	435	458	319
Long Bean	448	439	287
Katuk	18	48	25

Table 2. Production of vegetable species per area under each light level with comparison to national averages

Vegetable Species	Light Level Treatment (kg/0.1ha)			National Average kg/0.1ha
	Full sunlight	Medium light	Low light	
Amaranth	253	472	84	339
Kangkung	222	280	140	647
Eggplant	556	499	79	750
Chili	556	775	403	648
Tomato	204	137	91	1270
Long Bean	221	164	73	543
Katuk	39	70	28	n.a

**Production Costs per Kilogram** Production costs per kg of vegetable are summarized in Table 3. The table is illustrative but not representative of smallholder conditions, as the trial was managed with hired labor. Production costs/kg are lowest for all vegetables under medium light levels, only 31% to 84% of production costs under full sunlight. Production costs under low light levels always exceed those under medium light conditions, being 25% higher for tomatoes, roughly 60% higher for kangkung and chili, but 535% higher for eggplant.

Table 3. Illustrative vegetable production cost in the three trial plots versus market price

Vegetables	Production cost Rp/kg			Commodity Price	
	No shading	Medium light	Low light	Nanggung	West Java 2005
Amaranth	12,267	3,783	18,479	800	
Kangkung	10,559	5,333	8,823	2,500	
Eggplant	6,893	3,992	21,354	1,500	1,300
Chili	4,235	3,292	5,284	6,000	9,400
Tomato	19,622	16,424	21,069	4,000	2,000
Long bean	18,540	14,474	26,635	4,000	
Katuk	90,074	33,760	67,801	2,200	

## CONCLUSION

Understory vegetable production is a viable option for smallholder agroforestry systems. The medium light levels of mixed fruit-timber-banana-annual crop systems are most conducive to vegetable productivity and profitability. Full sunlight treatments have greater *effective planting areas* requiring more labor input, but did not always produce the greatest yields. Medium and low light treatments require less labor input, but have smaller effective planting areas. Labor input, effective planting area, and light intensity interact to determine production potential.

Production/plant is greatest in medium light levels; production/area is generally best under medium light levels, but better for a few species under full sunlight (chili, tomato, and long bean). High production/plant is significant in smallholder agroforestry systems where plant management may approximate a per plant basis. Significantly, vegetable production costs/kg are lowest under medium light levels. The production costs/kg under low light levels for some vegetables (tomato, kangkung, and chili) are only slightly higher than production costs under medium light levels.

Understory light level is the only parameter of the 25 site and overstory characteristics assessed to have a significant and consistent effect on understory production of all species. The appropriateness of understory sites for vegetable production can be assessed by evaluating light levels.

This study yielded valuable information, demonstrating the viability of understory vegetable production. Further research is required to address question of vegetable quality and seasonal variation, cropping rotation, tree-vegetable-site matching, labor input requirements, and overall profitability under varies light levels. The knowledge gained from such research would provide key input to the development of efficient and effective practices for understory vegetable production in smallholder agroforestry systems.