Factsheet

Kanoppi Phase 2

Research Trial: Silvicultural practices for improving teak growth in Gunungkidul

1. Background

- In general, farm forestry practices in Gunungkidul can be divided into two types: (1) homegardens (*pekarangan*), located next to the homestead, often dominated by timber trees, but also including fruit trees and medicinal plants; and (2) upland farms (*tegalan*), areas located at some distance from the homestead, where annual crops are the main component and timber trees are grown along the borders and terraces (Sabastian et al. 2014).
- Teak-based agroforestry management is the main activity of smallholder farmers in Gunungkidul district. Silvicultural management leads farmers to gain benefits from pruning, thinning, germplasm quality, intercropping, and biodiversity conservation. Teakwood generated 34% of total on-farm income. On-farm, including forest-extraction incomes, averaged IDR 17.9 million/year (USD 1498/year in 2014) and off-farm activities, such as running small kiosks, industrialized labor, carpentry, and government employment contributed to annual incomes by around IDR 9.29 million/year (USD 775/year in 2014). Land area managed by each household was approximately 0.5 ha, commonly separated into three different farms, with each farm planted with 4–5 priority species of timber and NTFPs (Sabastian et al. 2017).
- Pruning is the management practice with the largest influence on productivity and profitability of teak agroforestry because it affects the growth rate and quality of timber produced as well as light transmission and root competition with intercrops. Meeting household needs for fuelwood is the main reason that farmers prune the branches of teak and other timber trees. In general, they pruned the branches up to 50% of the total height of teak trees; with the average height of teak trees at 9.5 m. The form of branch pruning practiced on over 60% of teak-based farms in Gunungkidul leaves a 10 to 15 cm branch stub. More than 36% of the teak-based plots were not pruned at all. Only on less than 2% of farms was pruning practiced that left no branch stubs. Timber trees with no pruning or with pruning that leaves branch stubs reduces the quality and price of future logs because of knots in the timber (Sabastian et al. 2017).

a) Thinning practice for misformed trees; b) Pruning 50% of the total tree height; c) Teak trial after pruning and thinning practices

- Thinning of teak is not commonly practiced in teak agroforestry although most farmers practice some form of sequential harvesting. As long as they do not need urgent cash, or their cash need can be derived from other sources, the farmers will not cut the trees. Selling timber trees is a last option for households to realize financial assets. Selling standing trees, when money is urgently needed to meet urgent household needs is locally called "Tebang-Butuh". (Kurniawan et al. 2008 and Sabastian et al 2009).

2. Objective

- To demonstrate the feasibility of using various silvicultural regimes (thinning and pruning) in teak agroforestry (2008 – present). The trial is exploring feasibility of farmers adopting pruning and thinning – so part demonstration and part discovery.

3. Method

- The demonstration trial was established in three teak farms in 2008; where the age of teak trees grown on the farms varied from 3 to 5 years old and had been established by farmers following their normal practice, without regular spacing but an overall tree density of about 1834 trees per ha.
- The treatments imposed were:

No.	Treatment label	Definition
1	NP - NT	No Pruning – No Thinning
2	P50% - NT	Pruning 50% – No Thinning
3	P60% - NT	Pruning 60% – No Thinning
4	NP - T	No Pruning – Thinning
5	P50% - T	Pruning 50% – Thinning
6	P60% - T	Pruning 60% – Thinning

- There is only one plot (400 m^2 per plot) of each treatment per farm, so the replication is between farms. The number of tree in each 400 m^2 plot was about 45 trees. Trees that were crooked and or presented disease symptoms were prioritized for removal at thinning.
- Post-thinning:
  - Trees per sample unit area 38 trees
  - Tree density 950 trees per ha with planting spacing 3.24 m x 3.24 m
  - First thinning regime is 16% (2008 – 2017)
- Second thinning regime is about 20% (2018 – present) as permitted by land owners

4. Results

The DBH increment performance of teak trees for all treatments are shown in Figures 1 and 2. In the six year period from 2008 – 2014 (Figure 1), the growth performance of trees in the 50% and 60% pruning regimes without thinning practice (0.19-0.23 cm/tree/year) appears to be slightly lower than the pruning regimes with thinning practice (0.28-0.31 cm/tree/year). However, in the first six months of the 2nd thinning (Sept 2018 – Mar 2019) (Figure 2), the growth performance of trees in the pruning regimes with thinning practice reached up to 0.32 cm/tree/year; while the performance in the pruning regimes without thinning practice in the range of 0.27-0.30 cm/tree/year.

The ANOVA analysis of DBH increment in first thinning and second thinning is shown in Table 1 and Table 2.

This indicates that treatments had no significant effect at first thinning but that the thinning treatment had an impact at second thinning. This is a bit surprising as the DBH increment for first thinning is for 6 years where as for the second thinning it is only 1 year. Hence, there is a need to look more closely.

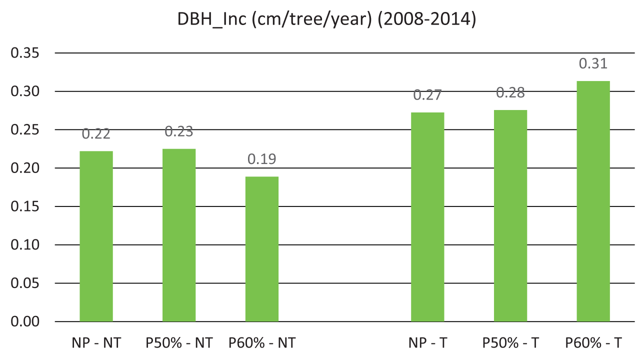

Figure 1. Thinning practice for misformed trees

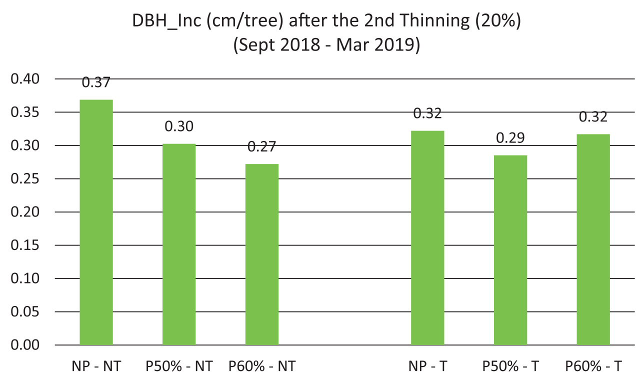

Figure 2. The DBH increment performance of trees for all treatments in 6 months of 2nd thinning

Table 1. DBH increment during the first thinning

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Farmer	2	0.083	0.042	2.769	0.122
Thinning	1	0.027	0.027	1.802	0.216
Pruning	2	0.003	0.002	0.108	0.899
Thinning: Pruning	2	0.024	0.012	0.785	0.488

Table 2. DBH increment during the second thinning

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Farmer	2	0.049	0.025	3.319	0.097
Thinning	1	0.056	0.056	7.596	0.028**
Pruning	2	0.002	0.001	0.119	0.889
Thinning:Pruning	2	0.004	0.002	0.258	0.780

5. Thinning and diameter distribution

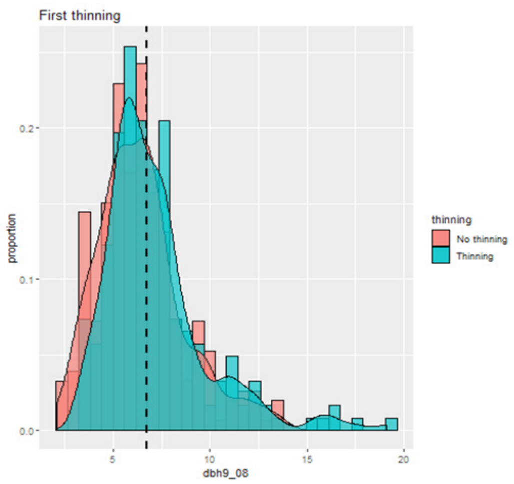

Figure 3.

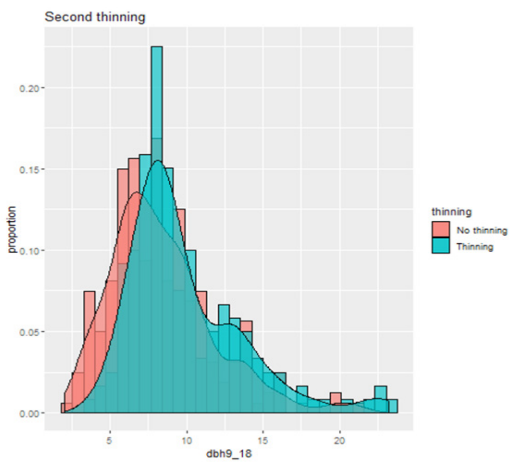

Figure 4.

Figure 3 shows the diameter distribution (histogram plus smooth curve) for the thinned and non-thinned plots at the first measurement. Two things are noticeable

1. The thinning has not changed the distribution much. Typically, small trees are removed, which would be reflected in a truncation of the diameter distribution on the left, but the evidence of this is slight. This is probably because (a) thinning was only 16%, which is minimal, and (b) the focus was on removing diseased or misformed trees, not the smallest.
2. The range in diameters is large.

The first point is consistent with little effect being evident. The second suggests that it might be more informative to look at a variable other than diameter increment – see Figure 4.

Figure 4 shows more evidence of the expected shift in diameter distribution. Presumably this is not only because of the second selective thinning, but is also contributed to by a possible cumulative effect of the first thinning.

6. Relative rather than absolute increments

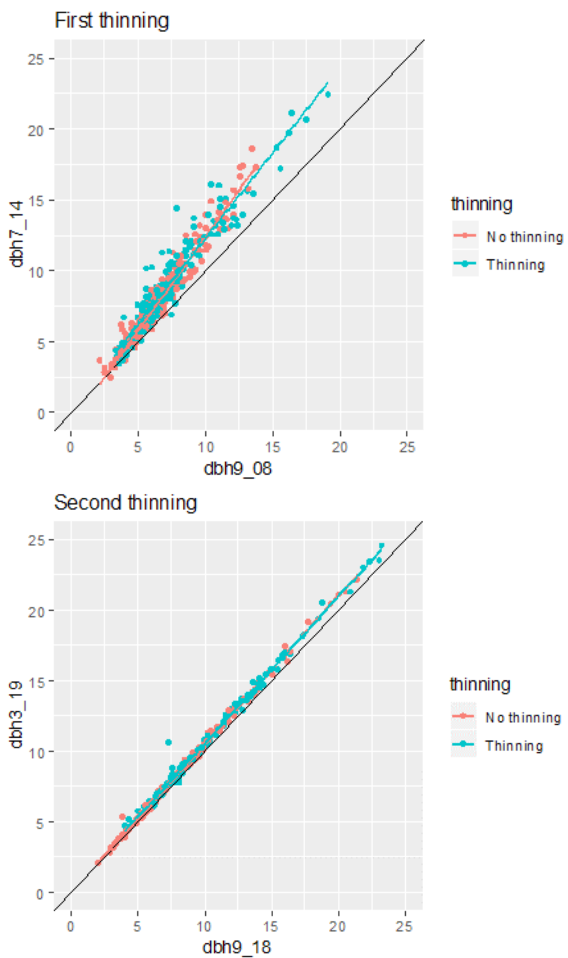

Figure 5.

Table 3. Relative DBH increment during the first thinning

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Farmer	2	0.083	0.042	2.769	0.122
Thinning	1	0.027	0.027	1.802	0.216
Pruning	2	0.003	0.002	0.108	0.899
Thinning:Pruning	2	0.024	0.012	0.785	0.488

Table 4. Relative DBH increment during the second thinning

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Farmer	2	0.017	0.009	6.050	0.043**
Thinning	1	0.007	0.007	5.087	0.072*
Pruning	2	0.004	0.002	1.475	0.311
Thinning:Pruning	2	0.013	0.006	4.367	0.079*

Figure 5 shows the diameters of each tree at the start and of the assessment period. The black line is the line through the origin with slope 1.

The ANOVA model used above assumes that the effect of treatment (if any) is a constant. This is clearly not valid. A constant change in diameter increment would approach as a line of points parallel to the black line. Clearly, diameter increments are small for trees that start small and large for trees that start large. If one treatment group happens to start with more large trees in it then the treatment effect will seem to be large – creating a bias.

A line though the points in Figure 5 goes through the origin showing that RELATIVE increment = increment/initial is an appropriate measure to use.

Now, there is no evidence of treatment effects at the first thinning.

At the second thinning there is a hint of a consistent effect of thinning and an interaction with pruning. Hence, we look at the means:

The implication is that thinning only increases relative diameter increment if there is no pruning. This is reasonable – a tree can make use of the additional growth resources available after thinning if its branches (and hence leaves) have not been pruned.

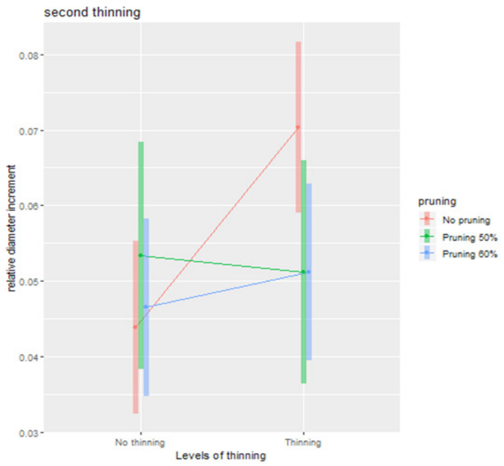

Figure 6 shows the means with 95% confidence intervals.

However, the effects are small – a change in relative diameter increment from 5% to 7% in a year. The period of assessment of the second thinning is short, so it is not surprising if it is hard to see large effects.

References

Kurniawan I, Roshetko J, Anggakusuma D. 2008. Community teak wood marketing in Gunungkidul district, Yogyakarta province: Current practice, Problems and Opportunities. ACIAR Project Report. Improving economic outcomes for smallholders growing teak in agroforestry systems in Indonesia. ACIAR, World Agroforestry Centre, and Winrock International, Indonesia

Sabastian G, Kanowski P, Race D, Williams E, Roshetko J. 2014. Household and farm attributes affecting adoption of smallholder timber management practices by tree growers in Gunungkidul region. Indonesia. Agrofor Syst 88(1):1–14. https://doi.org/10.1007/s10457-014-9673-x

Sabastian GE, Roshetko JM, Anggakusuma D, Pramono AA, Heriansyah I, Fauzi A. 2009. Smallholder teak-based farming management in Gunungkidul, Yogyakarta: current practice, obstacles and improvement options. ACIAR Project Report, Australian Centre for International Agricultural Research, Canberra, and World Agroforestry Centre Southeast Asia Regional Program, Bogor, Indonesia

Sabastian GE, Yumn A, Roshetko JM, Manalu P, Martini E, Perdana A. 2017. Adoption of silvicultural practices in smallholder timber and NTFPs production systems in Indonesia. Agroforestry Systems, DOI: 10.1007/s10457-017-0155-9

Gerhard Sabastian | World Agrforestry (ICRAF)
g.manurung@cgiar.org
James M Roshetko | World Agrforestry (ICRAF)
j.roshetko

Australian Government
Australian Center for International Agricultural Research