# How to promote tree planting as an agricultural technology that generates positive environmental effects? Evidence from Jambi, Indonesia

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# How to promote agricultural technologies that generate positive environmental effects? Evidence on tree planting in Indonesia

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## Introduction

Agricultural technologies frequently have been introduced via subsidies to accelerate diffusion and spur adoption where market inefficiencies or missing information have been present (Knowler and Bradshaw 2007; Aker 2011; Romero et al. 2019)

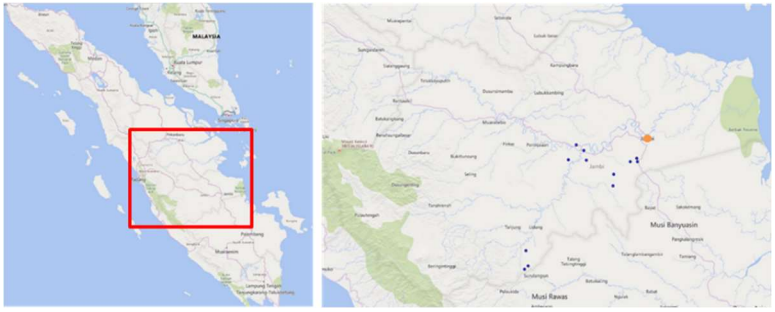
Yet, for agricultural technologies that mainly generate positive environmental effects such as native trees, it is not clear how to encourage adoption, tree survival, and additional investments most effectively.

## Hypotheses

H1: The subsidy treatment, where farmers receive tree seedlings for free, has a positive effect on the adoption decision and the number of trees planted, compared to the price treatment where farmers have the opportunity to buy tree seedlings.

H2: Six months after the intervention, the number of surviving trees is lower in the subsidy treatment compared to the price treatment.

H3: The subsidy treatment has a negative effect on additional tree planting (beyond the three distributed trees) compared to the price treatment.







## Data

Data came from 12 villages in three oil palm growing districts in the lowland region of Jambi Province, Sumatra, Indonesia. In each village, between 25 and 40 oil palm farmers were randomly selected and interviewed.

## Methods

**Treatments:**

T1: Oil palm farmers receive information about native tree planting and three different native tree seedlings for free (subsidy treatment).

T2: Oil palm farmers receive the same information and the opportunity to buy three different native tree seedlings through an auction mechanism (price treatment).

We are interested in the Intent-To-Treat (ITT) effects on the decision to plant, the number of trees planted, tree survival, and additional planting efforts.

$$Y_{hi} = ß_0 + ß_1 T1_i + ß_2 X_{hi} + ß_3 Y_{hi}^{PRE} + \varepsilon_{hi}$$

$Y_{hi}$: Number of trees planted by farmer h in village i

$T1_i$: =1 - Assignment to treatment arm T1 (subsidy treatment)
=0 - Assignment to treatment arm T2 (price treatment)

$X_{hi}$: Baseline control variables

$Y_{hi}^{PRE}$: Baseline dependent variable

$\varepsilon_{hi}$: Random error term clustered at village level

- Probit model for binary adoption decision of planting trees (Long 1997)
- Negative binomial model for the number of trees planted, tree survival, and additional planting efforts (Long and Freese 2006; Hilbe 2011)

| | Adoption decision | Number of trees planted | Number of trees alive | Adoption decision to obtain more tree seedlings | Number of trees planted that were obtained by farmers |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Subsidy treatment (T1) | 0.17*** (0.05) | 0.46*** (0.13) | 0.25*** (0.08) | -0.03 (0.02) | -3.26 (3.75) |
| Control variables included | yes | yes | yes | yes | yes |
| N | 397 | 397 | 397 | 397 | 397 |

*Standard errors in parentheses;*
*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

## Results

**Subsidy treatment:** Higher probability to plant tree seedlings + higher number of tree seedlings planted -> Higher number of tree seedlings that survived

**Price treatment:** Tendency towards more additional planting efforts

**Cost-effectiveness analysis** reflects these results when focussing only on the trees that were provided by us. The price treatment is more cost-effective when including additional planting efforts. Yet, results rely on a few farmers only who obtained additional tree seedlings.

## Implications

Considering these results, we refrain from a policy recommendation favoring one approach over another. It rather seems that a policy mix consisting of the distribution of subsidized tree seedlings in combination with value chain development is likely to be more effective and address multiple barriers to native tree planting.

- Subsidies may be critical to overcome the gap between farmers' WTP for native tree seedlings and actual market prices. Also, in-kind subsidies offer the opportunity to influence which tree species farmers plant and accordingly the extent of biodiversity and associated environmental effects.
- Value chain development is essential to enhance market access to high-quality tree seedlings in the villages and may lead to lower market prices for native tree seedlings.
- From the demand side, farmers' WTP for native tree seedlings may also increase as they gain more knowledge.