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Cost-Effective Systems for Seedling Production and Tree Farm Establishment

Eduardo O. Mangaoang, Edwin D. Cedamon and Arturo E. Pasa

College of Forestry and Natural Resources, Leyte State University, Baybay, Leyte, the Philippines

ABSTRACT

Experiences from the ACIAR Smallholder Forestry Project reveal that production and use of high quality seedlings is a critical consideration for successful tree farming and reforestation activity, considering that most reforestation activities have been largely dependent on nursery-produced seedlings. While the use of polyethylene bags has been the traditional technique for raising seedlings, planting stock produced often has a deformed or J-shape taproot and may develop to mature trees with poor anchorage in the field. The research project introduced the use of hiko tray as potting containers in seedling production as a way of resolving the problem of J -rooting and producing higher quality seedlings. An economic analysis was conducted to determine the comparative advantage and feasibility of the polybag and hiko tray techniques, with a view of promoting the adoption of the hiko technique among tree farmers, especially the smallholders. Results of the study revealed that the hiko tray technique is superior to the traditional polybag technique in terms of labour efficiency and cost in the nursery and field establishment, aside from the fact that higher quality seedlings are produced that provide the tree farmer a higher level of assurance of timber harvest and cash income from forestry.

Keywords: Hiko tray, J-rooting, windthrow, labour requirement, outplanting.

INTRODUCTION

In the Philippines, reforestation and tree planting have been promoted through a number of people-oriented programs and projects, as a means of alleviating poverty among smallholders, to increase domestic supply of wood, and eventually to rehabilitate the degraded upland environment. As a consequence, smallholder farmers have eventually became major timber producers in many parts of the Philippines (Garrity and Mercado, 1993).

Experiences in the ACIAR Smallholder Forestry Project reveal that one critical consideration for successful tree farming and reforestation activities, particularly involving the smallholder farmers, is the production of high quality seedlings or planting stock. Most reforestation activities have been largely dependent on seedlings produced in the nursery. While the use of wildlings has been a common alternative to

nursery-grown seedlings, survival after potting has been low, especially for indigenous tree species, due to stress involved from the time of collection to potting operation (Fernando *et al.,* 2002). Further, direct seeding as an alternative plantation establishment strategy has not gained popularity due to low germination and survival rates.

The usual seedling production technique is the raising of seedlings in polyethylene bags (polybags). Destructive sampling reveals that polybag seedlings have a high incidence of deformed or J-shape taproot (Cedamon *et al.*, this issue), and on outplanting these often develop to mature trees with poor anchorage. The ACIAR Smallholder Forestry Project has introduced the use of hiko trays in seedling production as a potential means of resolving the problem of J-root formation and producing higher quality seedlings with sound root formation and ground anchorage when outplanted.

This paper presents a simple comparative economic analysis of using polybags and hiko trays in seedling production, through the nursery and in the field. Some comments are made about the use of hiko trays in seedling production, in terms of feasibility and acceptability, particularly at the level of smallholder farmers.

RESEARCH METHOD

The nursery and field trial research, an early research activity of the ACIAR Smallholder Forestry Project, focused on assessing the growth of seedlings raised in polybags and hiko trays, both in the nursery and when outplanted (Cedamon and Mangaoang, 2003). Since the project is directed towards promoting farm and community forestry on Leyte Island, the Philippines, the study also considered analysing the economic feasibility of the seedling production techniques, particularly in terms of cost and prospects of their adoption by smallholder farmers. On-campus and field-site research was conducted for the nursery study while the field trial was undertaken in Barangay Conalum, Inopacan, in Valencia, Ormoc City and in Isabel. A participatory approach involving farmer-partners was adopted as the main framework of implementation for the on-site nursery and field trial research.

COMPARISON AT THE NURSERY SEEDLING PRODUCTION PHASE

As well as nursery setup costs, seedling production involves various operations, including a seed or wildling collection and storage and preparation of potting mix, up to potting and maintenance of seedlings in the nursery. The economic analysis for the nursery phase focused on establishing the nursery germination and transplant shed, potting mix preparation, bagging of potting mix, potting of seedlings, and watering as part of the maintenance activities. Seeds of tree species for the nursery study were assumed to be readily available for the research undertaking, and therefore labour for seed collection was not included in the analysis.

Species grown in the trials included *Terminalia microcarpa* (kalumpit) and *Eucalyptus pellita* (pellita) for on-farm research in Barangay Conalum, Inopacan, and *Acacia mangium* (mangium) and *Eucalyptus deglupta* (bagras) for on-campus research at LSU College of Forestry. Seeds of kalumpit used in Barangay Conalum nursery

came from the LSU forest reservation, pellita and mangium from Australia and bagras from Albuerra, Leyte.

Capital Costs of Nursery Establishment

Table 1 lists the materials and chemicals used in nursery establishment and seedling production and the corresponding costs using the polybag and hiko tray techniques. When planting at a 3 m × 3 m spacing, 1111 seedlings are required per hectare of tree farm. The cost per 4" x 6" polybag is estimated at PhP0.06, while one cell of the hiko tray costs PhP0.10. The cost per hiko tray cell was estimated based on the market price (in year 2000) and an expected useful tray life of 10 years. Producing the total number of seedlings for a hectare of tree farm requires PhP66.66 worth of polybags, or PhP111.10 equivalent worth of hiko cells. Taking cost of other materials for nursery establishment and seedling production as the same for both potting techniques, this would mean that when using hiko trays, an additional PhP44.44 is spent on materials.

Table 1. Cost of nursery materials and chemicals using the hiko tray and polybag techniques for 1 ha seedling requirement

Item	Quantity	Cost/unit (PhP)	Total cost (PhP)
Chicken wire (m)	16	59	944
Plastic acetate (m)	50	60	3000
Tie wire (kg)	2	35	70
Benlate (pack)	1	260	260
Plastic tray(pc)	3	30	90
Water container (pc)	1	30	30
Plain GI(sheet)	1	140	140
Bamboo (poles)	30	30	900
Container (hiko tray cell, polybag)	1111	0.10/0.06	111.10 or 66.66
Complete fertilizer for field trial (kg)	286.3	14	4008.2
Total cost (hiko tray)			9553.30
Total cost (polybag)			9508.86
Cost difference			44.44

As reflected in the table, the slight difference in the total cost of materials and chemicals is due to the higher cost of the hiko cells than polybags. This cost difference is, however, relatively small.

Labour Requirements for Construction of Germination Shed and Haulage of Potting Materials

Table 2 summarises labour requirements of seedling production, excluding those of potting up. These labour requirements are approximately equal for both container systems.

Table 2. Labour requirements for construction of germination shed and haulage of materials used in potting mix

Activity	Labour (mandays)
Building of germination/transplant shed	6
Installation of coconut leaves shade	3
Hauling of garden soil	5
Hauling of mudpress/rice hull	5
Hauling of sand	1
Sieving of garden soil and sand	1
Sterilization of sand and garden soil	1
Resieving of sand and garden soil	1
Total labour requirement	23

Relative Labour Efficiency in Bagging or Potting and Watering

Important differences occur in the labour requirement for bagging or filling of the potting mix in the container, potting of seedlings and watering, between the polybag and hiko tray potting techniques (Table 3). Using the traditional polybag technique (bag size of 4" x 6"), one person can produce an estimated 250 bags per working day during the bagging operation, while with the hiko tray (cell size of 4 cm x 8.5 cm), a total of 1333 cells can be filled with potting mix per day for a differential advantage of 1083 available containers ready for potting operation. This means that labour output in the bagging operation, when using the hiko tray, is 5.33 times that of the polybag technique. The greater bagging efficiency using hiko trays is largely due to the stocky and firm nature of the container. Another contributing factor is the volume of potting mix that each container type requires. In the trial, polybags required 425 cc of potting mix while the hiko cells required only 100 cc[1].

[1] While the container sizes are unequal, it was judged that the 4" x 6" (10 cm x 15 cm) polybag is the optimal size for seedling production of timber trees, while the hiko tray with cell size of 4 cm x 8.5 cm is well suited for seedling production for the species used in the study.

Table 3. Labour inputs for bagging, potting and watering operations using polybag and hiko tray, for 1 ha seedling requirement at 3 m × 3 m spacing

Activity	Polybag	Hiko tray
Bagging 1111 seedlings, mandays	4.4	0.8
Potting 1111 seedlings, mandays	2.32	0.92
Watering 1111 seedlings (over a 3-month period), mandays	58.5	29

Filling of containers with potting mix of 1111 seedlings to establish 1 ha of tree farm at 3 m x 3 m spacing with hiko trays requires only 0.8 mandays of labour, while 4.4 mandays are necessary when using polybags. That means a labour saving of 3.6 mandays when using hiko trays to produce sufficient seedlings to plant 1 ha.

Potting (or 'pricking out') of seedlings is also more efficient when using hiko trays. To pot 1111 young seedlings using hiko trays requires only 0.92 mandays, compared with 2.32 mandays when using polybags. This can be attributed to the firmness and well-organized cells of the hiko tray that make the potting operation easier and faster.

Watering of 1111 seedlings in hiko tray requires a total of 29 mandays before these are outplanted in the field. On the other hand, watering of seedlings in polybags takes about twice as long, with 29.5 mandays of labour for watering seedlings saved under the hiko tray technique.

Overall Nursery Cost for Hiko Tray and Polybag Systems

Table 4 summarises the labour costs for the two nursery production systems, taking into account the above labour input requirements. Overall, the hiko tray system results in a saving of PhP6900 for sufficient seedlings to plant one hectare of tree farm.

Table 4. Nursery activities and cost of labour using hiko tray and polybag techniques

Activity	Polybag	Hiko tray
Constructing transplant shed and haulage of potting mix ingredients, mandays	23	23
Bagging, hiko tray/polybags, mandays	4.4	0.8
Potting of seedlings, hiko tray/polybag, mandays	2.32	0.92
Watering, hiko tray/polybag, mandays	58.5	29
Total labour, mandays	.22	53.72
Total cost, PhP[a]	17644	10744

a. Based on a wage of PhP200 per manday.

COMPARISON AT TREE FARM ESTABLISHMENT PHASE

The field trial involved major operations which include site preparation, hauling of seedlings from the nursery, field planting, fertilizer application and maintenance. Specifically, site preparation activities involved brushing and cleaning of the tree farming site, and staking and hole-digging. Maintenance activities on the other hand involved ring-weeding and liberation cutting or removal of vines. For the economic analysis of this phase of the study, particular attention was given to efficiency and cost of labour in hauling and field planting using hiko tray and polybag seedlings.

Relative Labour Efficiency

Table 5 reports that, on a per hectare basis, labour requirements for hauling hiko tray seedlings are greater than for those in polybags. More than three times as much labour is required for hauling polybag seedlings to planting sites compared to those in hiko trays. Also, the planting-out labour requirement is almost twice as high for polybags.

Table 5. Labour requirement for hauling and field planting of hiko tray and polybag seedlings (mandays/ha)

Activity	Polybag	Hiko tray
Hauling of seedlings		
No. of seedlings/person/haul	25	80
No. of hauls, 1111 seedlings	44.44	13.88
Labour to haul 1111 seedlings – (4 haul/person/day (mandays)	11.11	3.35
Labour for field planting (mandays)	1.4	0.74

Comparison of Cost Efficiency

A comparison of labour cost incurred in the field trial reveals that the hiko tray seedling system is more cost-efficient than using polybag seedlings (Table 6). Overall, a tree farmer is able to reduce labour cost by 8.42 mandays/ha or a peso equivalent of PhP1684.00/ha when using hiko tray seedlings. This advantage is due to higher labour efficiency when using the hiko tray technique in the hauling of seedlings as well as field planting.

Table 6. Cost of labour in field planting and maintenance using hiko tray and polybag techniques

Container type	Polybag	Hiko tray
Brushing/clearing, mandays	59.11	59.11
Staking and hole-digging	24.91	24.91
Hauling of seedlings, hiko tray/polybag	11.11	3.35
Field planting, hiko tray/polybag	1.4	0.74
Ring weeding, 4 times/yr (Yr 1)	152	152
Fertilizer application (Yr 1)	6	6
Weeding of vines, 2x/yr (Yr 2)	66	66
Weeding of vines, 2x/yr (Yr 3)	66	66
Total labour requirement, mandays	378.11	378.11
Total cost, PhP/ha[a]	77306	75622

a. Labour is priced at 200 PhP/manday.

CONCLUSION

Assessment of the comparative advantage of using hiko trays as opposed to polybags in seedling production can be expanded to consider the quality and realizable volume of timber product produced per hectare over a given time, and the level of assurance and amount of cash-equivalent benefits that can be realized when the timber crop reaches maturity.

The use of the introduced hiko tray technique in seedling production is more cost-effective than the polybag technique. It provides higher labour efficiency in the conduct of seedling production activities, particularly bagging of potting mix, potting of seedlings and watering. Stand establishment activities including hauling of seedlings and field planting are also made more efficient. This higher efficiency arises from a reduced labour requirement and also quicker accomplishment, and therefore reduced cost in producing seedlings as well as establishment of tree farms – a scenario that is favourable to smallholder farmers who are usually constrained by the availability of time, labour and cash to engage in tree farming. The high quality of seedlings produced in the hiko tray technique may eventually provide smallholders with a higher level of assurance of timber harvest and cash income from forestry. While the initial outlay on hiko trays is high, they are expected to have a useful life of not less than 10 years; polybags can only be used once. How to make this type of seedling container readily available and adoptable for smallholder use is an issue that needs immediate attention.

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