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The economics of commercial mulberry saplings production using mini clonal technology over conventional method

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Abstract
A nursery is an area under supervision and designed to provide suitable conditions for juvenile cuttings until they are ready for main field transplantation. The main objective of all nurseries is to generate high quality saplings in sufficient numbers to satisfy the user needs. The present study was conducted to examine the economic viability of the nursery adopting both traditional and modern techniques like Mini clonal Technology of mulberry saplings generation. Analysis of various economic tools have shown that mulberry nurseries using mini clonal technology have an edge over traditional method of propagation. Economic tools used during study include net income and benefit cost ratio. The study showed that initial capital investment for mini clonal nurseries is high compared to traditional nurseries which can be recovered. The economic analysis revealed that entrepreneur involved in nursery business have obtained gross income of Rs.2,56,000/- using traditional technology and gross income of Rs.4,60,800/- using mini clonal technology. The net income of traditional nurseries and clonal nurseries are Rs.1,50,890/- and Rs.2,62,750/- (for first harvest) & Rs.3,18,270/- (from second harvest) respectively. The capital investment on clonal mulberry nurseries is highly viable due to high B:C ratio of 1:2.32 (for first harvest) & 1:3.23 (from second harvest) followed by traditional nurseries having B:C ratio of 1:2.43 is also considerably viable.

Keywords: Mulberry, economics, stem cuttings, apical cuttings, mini clones

Introduction
Sericulture involves rearing of domesticated mulberry silkworm *Bombyx mori* L. feeds primarily on Mulberry (*Morus*. sp). Genus *Morus* comprises of more than 70 species and majority of them confined to Asian continent. Most of the mulberry varieties in India belong to *M.indica* (Datta, 2000) [5]. Mulberry is said to be originated in Indochina border and widespread along subhimalayan region upto range of 3300m (Tikader and Vijayan, 2010) [25]. Most of the mulberry varieties evolved by selection, selection from open pollination, mutation breeding and controlled hybridization techniques (Manuel, 2000). Mulberry is a deciduous, woody, deep rooted perennial, capable of growing fast and usually dioecious plant. Leaves are alternate, simple, stipulate, petiolated, lobed or entire (Hawramee *et al.*, 2019) [7]. Mulberry inflorescence is catkin type and fruit is sorosis. Mulberry (*Morus.* sp) can be reproduced by both sexual and vegetative means. In sexual method of propagation, mulberry plants are reproduced using seeds collected from ripen fruits. Seedling propagation is not commercially viable due to constraints like fruit availability, drudgery in fruit collection, poor germination percentage, less storage period and time consuming for mulberry saplings production. Mulberry seeds have high heterozygosity and poor viability (Sudhakar *et al.*, 2018) [22].
Layering, grafting and cutting are the techniques commonly employed in vegetative method of propagation. In layering method, inducing the roots from the part of a stem, still it is attached to the mother plant, Then the rooted plant part is excised to grow into a separate plant. Disadvantages of layering include time consuming, cost expense, unsuitable for rapid scale multiplication of saplings and not viable in varieties having poor rooting ability. In grafting and layering, plants have low survival rates (Tikader and Karthiga, 2006) [24].
Propagation by stem cuttings is commonly used method in mulberry. Lateral buds on stem cuttings will give rise to shoot formation in absence of apical bud by increasing the rate of cell division at the site. Disadvantages of cutting method includes uniformity in growth, more

gestation period in nursery, limited availability of 10-12 mm diameter shoots and the requirement of more nursery area. Lack of seed material, more drudgery in preparation, maintenance, uprooting and transportation are constraints in stem cutting method of propagation (Sudhakar *et al.,* 2018) [18]. The success of semi hardwood cuttings of mulberry depends on growing medium and environmental conditions (Singh *et al.,* 2018) [20].

In order to achieve a rapid scale of mulberry saplings production, an advanced vegetative propagation technique known as "Mini clonal Technology" is used. In this method, Apical shoots with active terminal bud is excised from mother plant and rooting is artificially induced by exogenously synthesized auxin treatment. The main objective of mini clonal technology is to generate quality mulberry saplings rapidly at low cost with effective utilization of space and time compared to other methods of propagation (Kiruthika *et al*., 2020) [9]. Advantages of Mini clonal Technology includes well developed root system, good rooting potential, uniformity among saplings in nursery and almost half gestation period compared to conventional methods (Parthiban *et al.,* 2021) [15].

Materials and Methods

The research was conducted during 2021- 22 at Department of Sericulture and Clonal complex at Forest college and Research Institute, Tamil Nadu Agricultural University, Mettupalayam. The stem and apical cuttings of V1 and MR2 commercial varieties of mulberry were collected from main field of Department of Sericulture, FC& RI, TNAU, Mettupalayam.

Stem cutting propagation

In this method, well grown 8-10 months old plants having 8 – 10 mm shoot diameter with atleast 4 to 5 active lateral buds of 15 – 20 cm length was given a cut at the ends without splitting the shoots. The base of the cuttings were dipped in Azospirillum solution for 20 minutes (one kg in 40 litres of water) for early root inducement. The base portion was given a slant cut and planted at 15 cm × 7 cm spacing at tilted angle of 45° in raised nursery bed of size 4 × 1.5 m size. Irrigate the nursery 4 - 5 days once. Farm Yard Manure (FYM) was applied at 1600 kg for 800 sq. m nursery area. VAM was applied at 100 grams per sq. m area. Hand weeding was done at 50- 55th day after planting and 100 g of urea per sq m is applied after weeding. The 90- 120 days old saplings were ready to transplant in main field. The economics of stem cutting propagation is worked out with 80% survival rate.

Apical cutting propagation

Stem cuttings were used for raising the clonal mother garden. Plants were planted at 20 × 20 cm spacing in mother bed. Pruning of mother plants was done on 60th day. After 18 – 20 days, collection of apical tips was done. Apical cuttings were excised from mother plants in clonal garden at early hours of the day using sterile secateurs or scissors. Mini-cuttings with active terminal bud having two to three terminal juvenile leaves was taken and rooting is artificially induced by auxin treatment. Auxins like Indole-3 Butyric Acid (IBA) was synthesized exogenously applied to the basal cambium portion of mini cuttings to stimulate root growth. Base of apical cuttings were dipped in rooting hormone with concentration 3000 ppm and 5000 ppm for V1 and MR2 variety respectively. The root trainers containing 40 cells with volume 90 cc are filled with Soil: Coir pith: FYM (1:1:1). The cell cavity was intactly filled with rooting medium for proper rooting. Before planting, the rooting medium was wetted with systemic fungicide treatment (2g/lit) then apical cuttings were planted in the rooting medium. Root trainers were kept under low-cost poly tunnel structure. Irrigation is done 5- 6 days once. Temperature inside the poly-tunnel was maintained at 30 °C ± 2° C and 85 – 90 % relative humidity. After 45 days, the root trainers with mini cuttings were transplanted to green shade house condition for hardening of mini cuttings. The saplings are ready to sale at 60th day. The saplings are mass multiplied using this technique and economics of this technology is calculated.

The economic measures used in the study to evaluate the nursery is given below

Net income

Net income indicates all profit that business makes after deducting all the expenses.

Net profit margin

Net profit margin is one of the most important indicator of business financial health.

B:C ratio

Benefit cost ratio is used to evaluate the investment in a project for their profitability or viability.

B:C ratio = | PV (Benefit) | / | PV (Cost) |.

BCR < 1, Investment in loss

BCR = 1, Investment neither loss not profitable

BCR > 1, Investment is profitable

Payback period

The payback period is used to determine period required for a business to recover an investment made in a project.

Payback period = Initial investment/Cash flow per year.

Results and Discussion

Economics of nursery using traditional technology

The expected cost and returns of mulberry nursery producing saplings using conventional technology is presented in the table1. Mulberry cuttings are raised in nursery throughout the year with utmost care and providing suitable environment conditions. Fixed costs comprise of land rental cost and expenses for buying equipment. Variable costs include expense for stem cuttings procurement, land preparation, bed preparation, irrigation, weeding followed by uprooting and shifting to polybags (Krishnan *et al.,* 2014) [10] Total cost comprises of fixed cost and variable cost. In conventional method of propagation by stem cuttings, total fixed and variable costs incurred was Rs.12,000/- and Rs.93,110/- respectively per harvest for one acre nursery area. The total cost for conventional technology is Rs.1,05,110/- harvest/acre. With the sale of 1,28,000 no's (@ 80% survival of 1,60,000 no's) of sapling at price of Rs.2 per sapling, the gross income of Rs.2,56,000/- is obtained. Net income was calculated by deducting total cost incurred to the gross income. Net income is found to be Rs.1,50,890/- per harvest per acre. From the data, the benefit cost ratio was found to be 1:2.43. For investment of every Rs.1/-, you can generate Rs.2.43/- in conventional nurseries. The B:C ratio of more than one indicates that the project is profitable (Raju and Sannappa, 2018) [18].

Table 1: Expected cost and returns of conventional technology [using stem cuttings]

S. No	Particulars / Work	Quantity	Rate (Rs)/Unit	Total cost (Rs.)
A.	**Fixed cost**			
1.	Land rental cost (@30,000Rs/acre/yr)	1 acre	10,000 (for 4 months)	10,000
2.	Nursery tools		2000	2000
			Total fixed cost (A)	**12,000**
B.	**Variable cost**			
1.	Land preparation cost	3 hours	800	2,400
2.	Bed preparation cost	10 MD	400	4,000
3.	Stem cutting cost	1,60,000nos	0.20	32,000
4.	Transportation cost	-	1000	1000
5.	Azospirillum	5 Kg	40	200
6.	FYM @ 20T/ha	8 T	2000/T	16,000
7.	VAM @ 100g/sq. m	400 Kg	30	12,000
8.	Planting cost	10 MD*	300	3000
9.	Insecticide (250ml)	1	300	300
10.	Fungicide	1 Kg	1150	1150
11.	Weeding	15 MD*	300	4500
12.	Fertilizer @ 100gm urea / sq. m	400 Kg	6.4	2560
13.	Irrigation cost	15 MD	400	6000
14.	Uprooting cost	20 MD	400	8000
			Total variable cost (B)	**93,110**
Total expense (A+B)				**105,110**
C.	**Returns**			
a.	**Sale of saplings @ Rs.2/unit**			
1.	Sale of saplings	1,28,000 no's @ 80% Survival	2	2,56,000
2.	Gross income (C)			**2,56,000**
3.	Net income		C-(A+B)	**1,50,890**
4.	B:C ratio (@ Rs.2 per sapling)			**1:2.43**
5.	Profit margin per sapling (Rs./unit)			**1.43**
b.	**Sale of saplings @ Rs.1/unit**			
1.	Sale of saplings	1,28,000 no's @ 80% Survival	2	1,28,000
2.	Gross income (C)			**1,28,000**
3.	Net income		C-(A+B)	**22,890**
4.	B:C ratio (@ Rs.2 per sapling)			**1:1.21**
5.	Profit margin per sapling (Rs./unit)			**0.21**

Note: MD – Man; MD* - Women

Economics of nursery using Mini clonal technology

The expected cost and returns of mulberry nursery producing saplings using Mini clonal technology is presented in the table 2. Establishment of clonal mother garden is the first step in Mini clonal Technology. In one acre nursery area, 1800 sq. m was used to propagate mini cuttings in root trainers under low-cost poly-tunnel structures and 1500 sq. m area was used for the establishment of mother garden to procure mini cuttings which acts as a source. Each poly-tunnel structure occupies an area of 9 meters (6 × 1.5m) can hold 40 root trainers with 40 cells to produce 1600 saplings per unit. From 180 units, 2,88,000 no's of saplings is generated. In, mini clonal method of propagation high initial investment was required (Packialakshmi *et al.*, 2019) [12]. The total cost incurred for establishment of clonal mother garden per acre was Rs.62,160/-. The costs include land rental cost, land and bed preparation cost followed by expense on maintenance like fertilizer application, weeding and irrigation etc. The total expenses incurred for mini clonal propagation per acre was found to be Rs.1,34,360/- by adding fixed costs and variable costs incurred for mini clonal propagation was Rs.93,600/- and Rs.40,760/- respectively per acre. The total expenditure (TE) was calculated by adding total cost incurred for mother garden establishment and total cost incurred for mini clonal propagation is Rs.1,98,050/-. The gross income generated by sale of saplings (2,30,400 no's) is Rs.4,60,800/- Net income was derived by deducting total expenses from the gross income. Net income for the nurseries following mini clonal technology is Rs.2,62,750/-. The B:C ratio for mini clonal nursery is 1.2.32 for first harvest. The results are in line with Sabarish *et al.* (2017) [19]. From second harvest, the cost incurred for mother garden establishment is zero only maintenance cost gets added which is approximately Rs.8,170/-. The total cost incurred for mini clonal propagation per acre is Rs.1,42,530/-. The gross income and net income is calculated and found to be Rs.4,60,800/- and Rs.3,18,270/- respectively. The B:C ratio for mini clonal nursery is 1.3.23 from second harvest. The expected cost and returns of mulberry nursery producing saplings using Mini clonal technology is presented in the table 3. The payback period is 10 months (four harvest). The benefit cost ratio clearly indicates the project is highly profitable from second harvest. Due to high B:C ratio, the price per saplings is reduced significantly without compromising in quality.

Table 2: Expected cost and returns of mini clonal technology [using apical cuttings] for first harvest

S. No	Particulars / Work	Quantity	Rate (Rs)/Unit	Cost
A.	**Cost incurred for clonal mother garden establishment/acre:**			
1.	Land rental cost	1 acre	30,000	30,000
2.	Land preparation cost	1.5 hours	800/hour	1200
3.	Bed preparation cost	6 MD	400	2400
4.	Stem cutting cost	30,000nos	0.20	6000
5.	Azospirillum	3 Kg	40	120
6.	FYM	4 T	2000/T	8000
7.	VAM	200 Kg	30	6000
8.	Planting cost	6 MD*	300	1800
9.	Insecticide (250ml)	1	300	300
10.	Fungicide	1	1150	1150
11.	Weeding	6 MD*	300	1800
12.	Fertilizer cost (N:P:K)	50:50:50	6.4:8.4:19.6/Kg	1720
13.	Irrigation	8 MD	400	3200
	Total cost:			**63,690**

S. No	Particulars / Work	Quantity	Rate (Rs)/Unit	Total cost (Rs)
B.	**Initial investment required for mini clonal propagation/acre:**			
1.	Root trainers	8000nos	50	4,00,000
2.	UV poly sheet	7200 m	50	3,60,000
3.	Angle	600	150	90,000
4.	Green shade net	1800 sq. m	30/sq. m	54,000
5.	Bamboo poles	500	50	25,000
6.	Rope	100 Kg	50/Kg	5000
7.	Nursery tools		2000	2000
	Total			**9,36,000**
C.	**Cost incurred for mini clonal propagation/acre:**			
a.	**Fixed cost:**			
1.	Depreciation @10% (on buildings and equipment)			93,600
	Total fixed cost:			**93,600**
b.	**Variable cost**			
1.	Cocopeat	1000 Kg	8	8000
2.	Rooting hormone	2 Kg	2680/kg	5,360
3.	For mini cutting harvesting at 60th day	20 MD*	300	6000
4.	For preparation of mini cuttings	25 MD*	300	7500
5.	For filling rooting medium in root trainers	20 MD*	300	6000
6.	Planting cost	15 MD *	300	4500
7.	Irrigation cost	6 MD*	300	1800
8.	Foliar spray	2 l	500	1000
9.	Spraying cost	2 MD*	300	600
	Total variable cost:			**40,760**
	Total cost (Total fixed cost + Total variable cost):			**1,34,360**
	Total expense (TE) = Cost incurred for mother garden establishment + Cost incurred for mini clonal propagation			**1,98,050**
D.	**Returns:**			
a.	**Sale of saplings @ Rs.2/unit**			
1.	Sale of saplings	2,30,400 no's @ 80% Survival	2	4,60,800
2.	Gross income (C)			4,60,800
3.	Net income		C-(A+B)	**2,62,750**
4.	B:C ratio (@ Rs.2 per sapling)			**1:2.32**
5.	Profit margin per sapling (Rs./unit)			**1.32**
b.	**Sale of saplings @ Rs.1/unit**			
1.	Sale of saplings	2,30,400 no's @ 80% Survival	1	2,30,400
2.	Gross income (C)			2,30,400
3.	Net income		C-(A+B)	**32,350**
4.	B:C ratio (@ Rs.2 per sapling)			**1:1.16**
5.	Profit margin per sapling (Rs./unit)			**0.16**

Note: MD – Man; MD* - Women

Table 3: Expected cost and returns of mini clonal propagation from second harvest

S. No	Particulars / Work	Quantity	Rate (Rs)/Unit	Total cost (Rs)
A.	**Cost incurred for mini clonal propagation/acre:**			
a.	**Fixed cost:**			
	Depreciation @10%			93,600
	Total fixed cost:			**93,600**
b.	**Variable cost**			
1.	Cocopeat	1000 Kg	8	8000
2.	Rooting hormone	2 Kg	2680/kg	5360
3.	For mini cutting harvesting at 60th day	20 MD*	300	6000
4.	For preparation of mini cuttings	25 MD*	300	7500
5.	For filling rooting medium in root trainers	20 MD*	300	6000

6.	Planting	15 MD*	300	4500
7.	Irrigation	6 MD*	300	1800
8.	Foliar spray	2 l	500/l	1000
9.	Spraying cost	2 MD*	300	600
			Total variable cost:	**40,760**
	Total cost (Total fixed cost + Total variable cost):			**1,34,360**
B.	**Cost incurred for maintenance of clonal mother garden /acre:**			
1.	Insecticide	1l	300/l	300
2.	Fungicide	1Kg	1150/Kg	1150
3.	Weeding	6 MD*	300	1800
4.	Fertilizer (N:P:K)	50:50:50	6.4/Kg:8.4/Kg:19.6/Kg	1720
5.	Irrigation	8 MD	400	3200
			Total cost:	**8170**
	Total expense (TE) = Cost incurred for mother garden maintenance + Cost incurred for mini clonal propagation			**1,42,530**
C.	**Returns:**			
a.	**Sale of saplings @ Rs.2/unit**			
1.	Sale of saplings	2,30,400 no's @ 80% Survival	2	4,60,800
2.	Gross income (C)			4,60,800
3.	Net income		C-(A+B)	**3,18,270**
4.	B:C ratio (@ Rs.2 per sapling)			**1:3.23**
5.	Profit margin per sapling (Rs./unit)			**2.23**
b.	**Sale of saplings @ Rs.1/unit**			
1.	Sale of saplings	2,30,400 no's @ 80% Survival	1	2,30,400
2.	Gross income (C)			2,30,400
3.	Net income		C-(A+B)	**87,870**
4.	B:C ratio (@ Rs.2 per sapling)			**1:1.61**
5.	Profit margin per sapling (Rs./unit)			**0.61**

Note: MD – Man; MD* - Women

Economic viability of the nursery

Economic viability and financial feasibility of mulberry nursery is examined by calculating Benefit-cost ratio and Net income of the business. Net income and B:C ratio of traditional technology is Rs.1,50,890/- and 1:2.43 respectively. Net income and B:C ratio of mini clonal technology is Rs.2,62,750/- (for first harvest) & Rs.3,18,270/- (from second harvest) and 1:2.32 (for first harvest) & 1:3.23 (from second harvest) respectively. Benefit-cost ratio for first harvest is less than second harvest due to cost incurred for mother garden establishment. These economic measures clearly indicate commercial nurseries adopted mini clonal technology is highly profitable from second harvest compared to nurseries following conventional technology.

Conclusion

Sericulture, a rural based cottage industry capable of giving returns every month for the silkworm rearers. Realizing the potential of sericulture, Central silk board (CSB), Ministry of textiles, Government of India has proposed Catalytic Development Programme (CDP) to encourage sericulture clusters in rural and tribal areas. With increase in area, there is a need for quality mulberry saplings at lower cost. Nursery business are mean of self-employment opportunity for the entrepreneurs and unemployed youths. The study examines the viability of the mulberry nursery using two important factors net income from the business and benefit cost ratio of the nurseries following both traditional and advanced method of saplings production. Nurseries adopted traditional technology can generate totally three harvests per year (90-120 days/harvest) whereas in commercial nurseries following mini clonal technology can generate totally six harvests per year (60 days/harvest) with effective utilization of space and time. Cost of production per sapling for mini clonal nurseries was found to be Rs.0.85/sapling (for first harvest) and Rs.0.61/sapling (from second harvest) and for conventional nurseries Rs. 0.82/sapling. Based on the study, mulberry nursery enterprise is a viable means of income for the individual involved in the project.

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