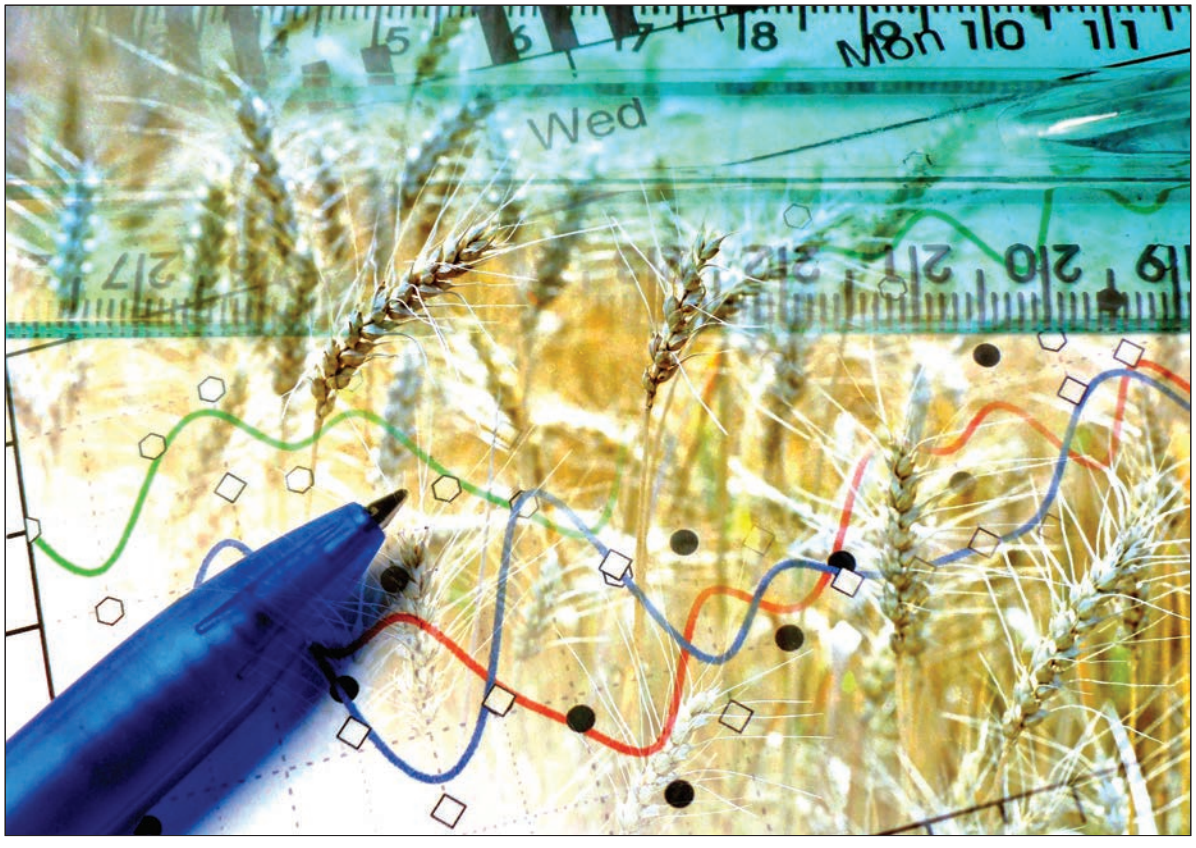


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# An Economic Analysis of Stevia (*Stevia rebaudiana* Bert.) Cultivation through Stem Cutting and Tissue Culture Propagule in India

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**Abstract:** The present study has been formulated to study the cost of cultivation of stevia to encourage the farmer regarding cultivation of this plant and also provide information regarding profitability of cultivation. Stevia become a potential and renewable raw material in the food market because the increase in the number of diabetic and health conscious individual boost up the international market of high quality stevia leaves which is a non-caloric natural sugar. Lack of information regarding the cost of cultivation of stevia specially in Indian context generate plenty of confusion with regard to cultivation of this plant and also about selection of the profitable propagating material. The present study thus concerned with calculating the cost of cultivation, return and cost benefit ratio to identify economic viability and technical feasibility of stevia cultivation through cutting and tissue culture propagated planting material. For this an experimental plot size of 100×100 m each was used for cultivation for 3 years with cutting and tissue cultured plantlets as propagating material. The cost of cultivation refers to the total expenses incurred in cultivating stevia, expressed on a per hectare basis and worked out using operation wise approach in both the cases for three years. Lastly benefit cost ratio was incurred which is the ratio of the present worth of gross costs and represents the economic viability of the two projects. From the two project it was revealed that fixed as well as variable cost was more in tissue culture plantlets propagated field but tissue cultured plants favour disease free clean cultivation with high foliage production as compared with cutting where disease and pest infection was severe. For this during three years of economic life total sales of dry stevia leaves was generate more income in tissue cultured propagule established fields than cutting propagated field. From the cost benefit ratio of the two projects it was clear that profit of the two projects was comparable with each other and was technically feasible and economically viable.

**Key words:** Cultivation, benefit cost ratio, fixed cost, variable cost, return

## INTRODUCTION

Stevia (*Stevia rebaudiana* Bertoni, Asteraceae) a 'wonder' herb of Paraguay, is a gift of nature and use as a non-caloric sweetener due to sweetening property of its leaf. Stevia leaf is 30 times sweeter than sugar on dry weight basis and sweetness is due to steviol

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glycoside. The sweet compounds pass through the digestive process without chemically breaking down, making stevia safe for diabetic and obese people (Kinghorn, 1992). Stevia is poised for major growth in the Indian cash crop market as domestic and export demand is estimated (in 2008) to leap by 300% over the next three years. Worldwide, 32,000 ha are covered under stevia cultivation, of which China has a major chunk of 75%. The Indian farmers have also started taking up stevia cultivation following the large demand for diabetic market here. The country's total annual production is currently nearly 600 t (Agriculture and Industry Survey, 2005).

Stevia cultivation can be successful venture provided if any one is able to produce high quality leaves and at the same time produce optimum quality of marketable leaves (NABARD, 2003). It is a cash crop with low risk and can yield very high returns for three years as compared to traditional crops with careful selection of planting material. Due to increased awareness towards use of herbal and traditionally accepted medicinal plants, a very good domestic and international is coming up for the medicinal plants and herbals (http://www.agricare.org/stevia.htm). But information on the economics of production of stevia is lacking in India because the plant is relatively new to Indian market. Hence there is plenty of confusion with regard to cultivation of this plant (Kumar and Kaul, 2005) and also about selection of the propagating material. Generally stevia is propagated through cutting because seed production is problematic in this plant. However tissue culture plantlets with high production cost offer excellent quality of foliage production in disease free condition. The data on cost of production and return are of special interest to farmers since they reveal the input output relationship of their enterprises and bring out the differences in unit cost between the less efficient and more efficient farm enterprises (Roy, 2007). This would enable the farmer to choose the right combination of resources or enterprises. Adoption of technical innovation by farmers also demands precise and detailed information on cost and return. In view of the above the present study has been formulated to work out cost of cultivation and return from stevia cultivation and estimate cost benefit ratio for sensitizing the farmers of India regarding selection of planting material and economic viability and technical feasibility of stevia cultivation through cutting and tissue culture propagated planting material .

## MATERIALS AND METHODS

### Design of the Study

The study was conducted at Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India during September, 2005 to October, 2008 in the Medicinal and Aromatic Plant's Garden. Planting materials used in the study was stevia cuttings and tissue cultured propagule obtained from Sun Fruits Company, Pune, India and Hitech Agricultural Products, Bangalore, India respectively. An experimental plot size of 100×100 m each was used for cultivation for 3 years with cutting and tissue cultured plantlets as propagating material. Data collected form the experimental fields were converted to 1 ha for uniformity in both the cases.

### Analysis of Cost and Returns Operation Wise

The cost of cultivation refers to the total expenses incurred in cultivating stevia, expressed on a per hectare basis and worked out using operation wise approach. Average economic life of stevia plant is 5 years, but data was collected only during the tenure of study, i.e., 3 years. A rental value of owned land as one fifth of the total value of gross production was considered. In this study the tax on land under stevia cultivation was considered nominal. The cost of hired labour was computed on the basis of the wages actually paid and the wage levels prevailing in India during 2005-06 were used as proxy to

evaluate the cost of farm labour. Land preparation and planting were necessary only once due to ratooning nature of this plant. For 1 ha stevia cultivation about 45,000 planting materials was required. In subsequent times about 4500 cuttings of stevia were necessary for gap filling but for tissue cultured propagating material the number of plants required for gap filling was only 250. As a source of plant nutrition about 30 tons of Farm Yard Manures (FYM), 750 kg of DAP and a good source of micronutrient were used for excellent vegetative growth. Within one year for 1 ha cultivation about 4 kg of fungicides were required for protecting against fungal diseases, which generally occurred during the rainy seasons. The annual rate of depreciation was worked out on each item using the straight-line method and then cumulated to get the annual depreciation allowance. Interest on fixed capital was worked out at the rate of 12.25% on the book value of temporary stock, implements and machinery used in stevia cultivation with proper apportioning wherever necessary. This rate has been used since it appears to be a realistic measure of the opportunity cost of capital on short-term investment. As regards the valuation of returns, the average of actual price received by the farmers in different channels of marketing was used as the unit values which was Rs. 200 $kg^{-1}$ during 2005-06 in Indian market.

**Benefit-Cost Ratio (BCR)**

This is a discounted measure of capital productivity. It is the ratio of the present worth of gross costs. Ideally the ratio should exceed one. Multiplying the resultant number with 100 produce the Present Value Index.

## RESULTS AND DISCUSSION

**Fixed Cost**

It is the initial cost or one time investment for the establishment of the crop during the first year. Cost of stevia planting was highest in the first year as land preparation and planting were only required during first year (Grow More Biotech Ltd., 2004). Tractor was employed for thorough tillage of soil and incorporation of FYM. Stevia plants can't tolerate prolong waterlogged condition hence ridge and furrow method of planting was considered to be the best land and land was prepared with mould board plough in both the cases. Irrigation water was supplied from existing shallow pump and total cost of pump set and accessories were Rs. 25,000.00. Good quality planting materials produced by cutting were of costing Rs. 5.00 $piece^{-1}$, whereas price of tissue cultured planting materials were calculated as Rs. 8.00 $piece^{-1}$. For planting about forty labours were utilized to dig pits and to plant the propagating materials in the field of both the propagating material. So the total fixed cost for establishing one ha stevia crop from cutting was Rs. 2,58,600.00 (Table 1) and that of tissue cultured planting material was Rs. 3,93,600.00 (Table 2).

Table 1: Fixed cost of stevia cultivation (cutting: planting material)

| Sl. No. | Fixed investment | Amount (Rs.) |
|---|---|---|
| 1 | Land preparation:<br>Tractor @ Rs. 300 $h^{-1}$ @ 10 h $ha^{-1}$<br>Labour for raised bed preparation @ Rs. 80 $manday^{-1}$<br>@ 30 mandays $ha^{-1}$<br>5,400.00 | |
| 2. | Irrigation (Charges of pump + main pipe lines and lateral for drip irrigation) | 25,000.00 |
| 3. | Planting material:<br>@ Rs. 5.00 $plant^{-1}$ @ 45000 plants $ha^{-1}$ | 2,25,000.00 |
| 4. | Planting:<br>Labour @ Rs. 80 $manday^{-1}$ @ 40 mandays $ha^{-1}$ | 3,200.00 |
| Total | | 2,58,600.00 |

Table 2: Fixed cost of stevia cultivation (tissue cultured plantlets: planting material)

| Sl. No. | Fixed Investment | Amount (Rs.) |
|---|---|---|
| 1 | Land preparation:<br>Ploughing @ Rs. 300 $h^{-1}$ @ 10 h $ha^{-1}$<br>Labour @ Rs. 80 $manday^{-1}$ @ 30 mandays $ha^{-1}$ | 5,400.00 |
| 2 | Irrigation (Charges of pump + main pipe lines and lateral for drip irrigation) | 25,000.00 |
| 3 | Planting material:<br>@ Rs. 8.00 $plant^{-1}$ @ 45,000 plants $ha^{-1}$ | 3,60,000.00 |
| 4 | Planting:<br>Labour @ Rs. 80 $manday^{-1}$ @ 40 mandays $ha^{-1}$ | 3,200.00 |
| Total | | 3,93,600.00 |

Table 3: Working expenses of stevia cultivation (cutting: planting material)

| Sl. No. | Fixed Investment | Amount (Rs.) |
|---|---|---|
| 1. | Manures:<br>@ Rs. 1000 $ton^{-1}$ @ 15 ton $ha^{-1}$ | 15,000.00 |
| 2. | Labour charges:<br>Weeding @ Rs.80 $mandays^{-1}$ @ 65 $mandays^{-1}$ $ha^{-1}$<br>Hoeing @ Rs.80 $mandays^{-1}$ @ 30 $mandays^{-1}$ $ha^{-1}$<br>Gap filling @ Rs.80 $mandays^{-1}$ @ 15 $mandays^{-1}$ $ha^{\times 1}$<br>Application of fertilizer and pesticide @ Rs.80 $mandays^{-1}$@ 6 $mandays^{-1}$ $ha^{-1}$<br>Harvesting @ Rs. 80 $mandays^{-1}$ @ 60 $mandays^{-1}$ $ha^{-1}$ | 14,080.00 |
| 3. | Chemical fertilizer including micronutrients | 4,000.00 |
| 4. | Insecticide/pesticide | 4,000.00 |
| 5. | Fuel charges @ Rs. 38.00×400 l | 15,200.00 |
| 6. | Watchman @ Rs. 2000 $month^{-1}$ | 24,000.00 |
| 7. | Yearly installment | 1,33,829.10 |
| 8. | Depreciation @ 20% (Drip irrigation) | 5,000.00 |
| 9. | Others @ 15% annum | 11,442.00 |
| 10. | Land Revenue | 15,000.00 |
| Total | | 2,41,551.00 |

Table 4: Working expenses of stevia cultivation (tissue cultured plantlets: planting material)

| Sl. No. | Fixed Investment | Amount (Rs.) |
|---|---|---|
| 1. | Manures:<br>@ Rs. 1000 $ton^{-1}$ @ 15 ton $ha^{-1}$ | 15,000.00 |
| 2. | Labour charges:<br>Weeding @ Rs.80 $mandays^{-1}$ @ 65 $mandays^{-1}$ $ha^{-1}$<br>Hoeing @ Rs.80 $mandays^{-1}$ @. 30 $mandays^{-1}$ $ha^{-1}$<br>Application of fertilizer and pesticide @ Rs. 80 $mandays^{-1}$<br>@ 4 $mandays^{-1}$<br>Harvesting @ Rs. 80 $mandays^{-1}$ @ 60 $mandays^{-1}$ $ha^{-1}$ | 12,720.00 |
| 3. | Chemical fertilizer including micronutrients | 4,000.00 |
| 4. | Plant protection chemical | 1,000.00 |
| 5. | Fuel charges @ Rs. 38.00×400 l | 15,200.00 |
| 6. | Watchman @ Rs. 2000 $month^{-1}$ | 24,000.00 |
| 7. | Yearly installment | 1,83,294.00 |
| 8. | Depreciation @ 20% (Drip irrigation) | 5,000.00 |
| 9. | Others @ 15% annum | 11538.00 |
| 10. | Land Revenue | 15,000.00 |
| Total | | 2,86,752.00 |

**Variable Cost**

Every year working expense was required for maintenance of the crop which was depicted in Table 3 and 4. FYM @ Rs. 1000.00 $ton^{-1}$ with a total worth of Rs. 15,000.00 were required for applying in both the field. Though chemical fertilizers were generally not suitable for stevia being a medicinal plant yet to maintain sustainable economic yield DAP and micronutrients were applied after every harvesting. Tissue cultured plants undergo sanitary treatment along with careful upbringing during *in vitro* nourishment, ensuring sound protection against any kind of infection. Hence in case where planting materials were tissue

cultured plantlets there were initially good plant stand due to no incidence of disease and pest but at the later stage little pest and disease infection was found. In contrary severe incidence of diseases and pests were seen in fields where cutting were used as planting materials. There were reports of incidence of leaf spot (*Sclerotinia* sp.) (Chang *et al*., 1997) and black spot (*Alternaria* sp.) infection (Skaria *et al*., 2004) in cutting propagated fields. So carbendazime were sprayed as a precautionary measure twice a year costing up to Rs. 4,000.00 year$^{-1}$ in case of cutting and Rs. 1000.00 year$^{-1}$ in case of tissue cultured propagated field. Labour were required for weeding, gap filling, application of fertilizer and pesticide, irrigation purpose and hoeing in case of field propagated with cutting. So in this case for all these operations about 176 mandays were required with total labour charges of Rs.14,080.00 during a single year. In general, in case of tissue cultured plants in *ex vitro* condition 0.5% mortality rate was recorded so only 250 plants were needed in comparison with cutting propagated field where around 10% mortality rate was observed. Plants for gap filling purpose would be managed from plants present in the field. So labour for gap filling was not at all required in case of tissue cultured propagated field. The sanitary measures registered a sound premium against any kind of infection in tissue-cultured plants so there was less requirement of labour for pesticide application. These indicated that in tissue cultured propagated field about 21 mandays were required less than the cutting propagated field with a total labour cost of Rs. 12,400.00. Other than hired labour a permanent watchman @ Rs. 2,000.00 month$^{-1}$ was employed throughout the entire crop season in both the cases. For running the pump set 400 L diesel were required every year. Farmer has to pay land revenue of Rs. 15,000 annum$^{-1}$ for 1 ha land and this value was supported by Megeji *et al*. (2005) as he also incurred the variable cost of stevia cultivation by fixing same amount of land revenue for 1 ha land. In five years the Book value of pump set and pipeline would be zero. So Rs. 5,000.00 year$^{-1}$ was calculated as depreciation value of pump set and hence added to each years working expense. In case of cost benefit analysis, expenses incurred were calculated taking into account a particular year assuming that every year price of inputs would increase by 15%. Yearly installment was calculated on the basis of 12.75% simple interest.

**Factor Cost, Product Price and Profitability**

Stevia crop gave the highest foliage yield in the 3rd year after planting. Leaves were harvested thrice a year with a gap of 4 months each (Mishra *et al*., 2010). Total foliage yield varied in both the fields; for first year production was low and total dry leaf weight produced was 1750 kg (Table 5) and 2230 kg (Table 6) for cutting and tissue cultured planting materials respectively. Dry foliage yield in the second and third year were 2400 and 2650 kg respectively where cuttings were used as propagules. On contrary tissue cultured plantlets yielded better due to fewer incidences of pest and disease and showed good stand. After third year the foliage yield gradually decreased and response to interculture operation show a declining trend (Saxena and Miang, 1988). There is a good demand of dry stevia leaf in

Table 5: Year wise sales of dried stevia leaves from cutting propagated field @ Rs. 200 kg$^{-1}$

| Item | Year I | Year II | Year III | Total |
|---|---|---|---|---|
| Production (kg) | 1750.00 | 2400.00 | 2650.00 | 6,800.00 |
| Sales (Rs.) | 3,50,000.00 | 4,80,000.00 | 5,30,000.00 | 13,60,000.00 |

Table 6: Year wise sales of dried stevia leaves from tissue culture plantlets propagated field @ Rs. 200 kg$^{-1}$

| Item | Year I | Year II | Year III | Total |
|---|---|---|---|---|
| Production (kg) | 2,230.00 | 2,850.00 | 3,050.00 | 8,130.00 |
| Sales (Rs.) | 4,46,000.00 | 5,70,000.00 | 6,10,000.00 | 16,26,000.00 |

Table 7: Cost-benefit analysis of stevia cultivation (cutting: planting material)

| Item | Year I | Year II | Year III | Total |
|---|---|---|---|---|
| Expenditure (Rs.) | | | | |
| Fixed (Rs.) | 2,58,600.00 | - | - | 2,58,600.00 |
| Working (Rs.) | 2,25,109.00 | 2,41,551.00 | 2,41,551.00 | 7,08,211.00 |
| Total (Rs.) | 4,83,909.00 | 2,41,551.00 | 2,41,551.00 | 9,67,011.00 |
| Sales (Rs.) | 3,50,000.00 | 4,80,000.00 | 5,30,000.00 | 13,60,000.00 |
| Profit (Rs.) | -1,33,909.00 | 2,38,449.00 | 2,88,449.00 | 3,92,989.00 |

Benefit cost ratio = 1.406

Table 8: Cost -benefit analysis of stevia cultivation (tissue culture plantlets: planting material)

| Item | Year I | Year II | Year III | Total |
|---|---|---|---|---|
| Expenditure (Rs.) | | | | |
| Fixed (Rs.) | 3,93,600.00 | - | - | 3,93,600.00 |
| Working (Rs.) | 2,75,214.00 | 2,86,752.00 | 2,86,752.00 | 8,48,718.00 |
| Total (Rs.) | 6,68,814.00 | 2,86,752.00 | 2,86,752.00 | 12,42,318.00 |
| Sales (Rs.) | 4,46,000.00 | 5,70,000.00 | 6,10,000.00 | 16,26,000.00 |
| Profit (Rs.) | -2,22,814.00 | 2,83,248.00 | 3,23,248.00 | 3,83,682.00 |

Benefit cost ratio = 1.308

India as well as in International market. Dry leaves are purchased directly from the farm by individuals. The average market price for the last two years was Rs.200 $kg^{-1}$ (Megeji *et al.* (2005) and in this study also this rate was considered for calculating the total sale price. As the highest production of green leaf was in the third year the value for sale reached its highest and there after gradually decreased. During three years of economic life total sales of dry stevia leaves was Rs. 13,060,000.00 and Rs. 16,26,000.00 for cutting and tissue cultured propagule established fields, respectively.

**Benefit-Cost Ratio**

Following efficient management practices through timely application of nutrients, irrigation and proper maintenance both the project display prominent and attractive commercial advantage, which guarantees significantly high economic return. The success of such venture primarily depends on its commercial acceptance. The issue has been addressed through cost benefit outcome analysis. Being a long-term crop benefit cost ratio is an important financial indicator for economic sustainability of the project. Ideally benefit cost ratio value should be greater than 1 (Science Tech Enterpreneur., 2004). Here the values calculated for the project where cuttings were used, as planting material was 1.406 (Table 7). This value was less than the value calculated by Megeji *et al.* (2005) where benefit cost ratio was 1.89. The major cause for this discrepancy of result may be the cost of planting material in the present study because Megeji used seeds as propagule. In the second project where tissue cultured plants were utilized, as planting material the benefit cost ratio value was 1.320 (Table 8). Profut from (NABARD, 2003) stevia cultivation is highest that can be obtained from any crop currently being cultivated in India and being a medicinal plant coming under horticultural crop, Stevia cultivation entitles one to tax-free returns. Though profit was Rs. 1549 more in the project where tissue cultured plants were used as propagule than the cutting propagated field but less benefit cost ratio value in case of tissue cultured propagated field was due to high cost of planting material. Though cost of tissue cultured propagule were more than the cutting but survival percentage was more in case of tissue-cultured propagule. Tissue cultured plants favour disease free clean cultivation, which profit conscious farmers, would always welcome because cost for plant protection chemicals as well as labour for gap filling and application of pesticide was nil as compared with cutting where disease and pest infection was severe. Lastly tissue cultured propagule produced more harvestable foliage as compared with the cutting with excellent quality of leaves.

## CONCLUSION

So from the cost benefit ratio of the two projects it was clear that profit of the two projects was comparable with each other and was technically feasible and economically viable but tissue cultured plants ensure certain advantages over cutting. The approach outlined by and large demonstrates the unique opportunity for the enterprising entrepreneurs to take up protocol for large scale tissue culture of stevia like banana, gerbera etc. as a small scale endeavor for the supply of large amount of tissue cultured propagule. In that case it will be possible to reduce the cost of tissue cultured planting material that ultimately generates more profit for the farmer in India.

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