Journal of Root Crops, 2013, Vol. 39 No. 2, pp. 221-229
Indian Society for Root Crops
ISSN 0378-2409

Economic Analysis of Seed Yam Production Systems in Nigeria

D. B. Mignouna[1], T. Abdoulaye[1], A. Alene[2], B. Aighewi[1], O. Pelemo[1], V. M. Manyong[3], R. Asiedu[1] and M. Akoroda[4]

[1]International Institute of Tropical Agriculture, Ibadan, Nigeria
[2]International Institute of Tropical Agriculture, Lilongwe, Malawi
[3]International Institute of Tropical Agriculture, Dar es Salaam, Tanzania
[4]Department of Agronomy, University of Ibadan, Ibadan, Nigeria
Corresponding author: D. B. Mignouna, e-mail: D.Mignouna@cgiar.org
Received: 13 May 2013: Accepted: 17 December 2013

Abstract

New seed yam systems from minisetts, minitubers and vine cuttings have been developed for yam production to supplant the traditional systems, which have proven inefficient and costly. The new techniques provide producers in tropical countries with the opportunity to minimize production costs, reduce seed yam price and promote greater seed availability. A discounted cash flow budget with a whole farm perspective was used to analyse the economic performance and risk implications of a hectare investment in the new seed yam system over time for a representative farm. Data based on realistic process costs and review of past reported studies were employed to reflect the relative economic worthiness and opportunity cost of investment and operating capital of seed yam systems in Nigeria. From the net present value (NPV) and benefit:cost ratio (BCR) analyses, the new seed yam production systems were more viable than current traditional seed yam production systems through milking of live immature plants. This raises the need to identify which among the new production techniques could be the most profitable and recommendable. Therefore, understanding the economics of seed yam production systems would not only help a significant proportion of local, regional and national stakeholders but also assist the policymakers, funding agencies and other organizations involved in yam projects and programmes.

Key Words: NPV, BCR, viability, seed yam production, Nigeria

Introduction

Yam (*Dioscorea* spp.), a vegetatively propagated crop, which is cultivated for its underground edible tubers, is a very important food and income source for millions of producers, processors and consumers in West Africa. About 48 m t of yams are produced annually in this sub region on 4 m ha of land. Nigeria is the largest producer of yams in the world contributing to two-thirds of the global yam production each year (NBS, 2013). About 32% of the population depends on yams for food and income security. Yam is the first most valuable food and agricultural commodity in Nigeria for the year 2012 (FAOSTAT, 2014); it is also integral to the socio-cultural life in this sub region.

Despite its importance in the economy and lives of the people, yam faces a number of constraints that significantly reduce its potential to support rural development and meet consumers' needs as an affordable nutritional product. Among the major challenges of the yam sector, the unavailability and high cost of good quality disease free seed yam emerged as the most important constraint followed by the high levels of on farm losses of yam tubers during harvesting and storage, low soil fertility, high labour costs associated with land preparation and staking, and diseases due to viruses, nematodes and fungi. Expansion and increasing intensification of yam cultivation have raised the need for ensuring a sustainable availability of high quality seed yam on a commercially viable basis in yam growing areas.

Various seed yam production systems exist in Nigeria. The traditional system is to set aside 25 to 30% of the harvested tubers as seeds for the next planting season. This makes the crop not only expensive to produce but also inefficient.The multiplication rate in the field using the traditional system is also very low (1:5 to 1:10) compared, for instance, with some cereals (1:300). Low quality seed yam containing pests and pathogens also result in a poor yield of ware yam tubers (IITA, 2010). To address these constraints, there is a need for developing an innovative yam propagation technique using other methods like minisetts, vine cuttings etc.

Minisett propagation method consists of using yam tubers of 20-25 g pieces to produce planting material for ware tuber production.Compared to whole tubers, minisetts enable faster multiplication and lesser amount of planting material. The use of vine cuttings further improves the pace of multiplication and reduces the amount of planting material. In this method, cuttings, usually one to two nodes with leaves are taken from the lateral branches of immature healthy-looking vines before tuber enlargement and planted into soil. Once the cuttings formed roots and shoots, they are transplanted to nursery beds, where they are nurtured for about 4-5 months. During this time they will produce minitubers, which are then used as the planting material for the next crop. By reducing the use of ware tubers as seeds, more yams are made available to farmers for food or sale. The technique also promotes faster multiplication and better and more uniform crop quality by introducing a break in the cycle of disease infestation often associated with regular use of field-grown tubers as planting material. The technology could address the need for faster and wider distribution of disease-free improved varieties to meet the ever increasing demand.

The use of new propagation systems for yam, which are quick, cost-effective and result in clean planting material and thereby scaling out seed yam production is subject to the availability of reliable information on the viability of these production systems.

The overall objective of this study was to economically evaluate seed yam production systems for sustained yam production in Nigeria. The hypothesis held in this study was that there is a profitability difference among the seed yam production systems in the yam belt area. This implies that farmers need to consider profitability of different systems before deciding on which system to use.

Methodology

The project and data used

The Yam Improvement for Income and Food Security in West Africa (YIIFSWA) is a 5-year project, granted by the Bill & Melinda Gates Foundation (BMGF) for the International Institute of Tropical Agriculture (IITA) to work with other stakeholders in West Africa to identify the opportunities of interventions that could potentially help to increase yam production and productivity in the region.

In order to establish sustainable availability of high quality seed yam on a commercially viable basis in Nigeria, in response to the increasing seed yam demand, data collection exercise was done between February and March 2013 and the source of data used in this analysis comprises of:

(i) Baseline study conducted in eight selected yam growing states (Niger, Nasarawa, Benue, Ebonyi, Enugu, Kogi, Edo, and Oyo) based on strata including high yam production potential area and representing different production systems.

(ii) Secondary data from previous studies on yam to complete the existing information.

Analytical framework on net present value and benefit:cost ratio

The viability of a project can be evaluated using several financial ratios including break-even analysis, payback period analysis, benefit:cost ratio (BCR), net present value (NPV), internal rate of return (IRR) and its modifications, etc. All of these methods have their strengths and weaknesses. The BCR, NPV and IRR analyses have been chosen for this work based on their simplicity and wide appeal among both financial experts and the uninitiated. Data were collected on the cost factors for the production of seed yams and on the profits from their sales.

This data was entered into a MS Excel-sheet to sum up the discounted costs and benefits for every single year up to the fifth year. This data then formed the foundation for the calculation of the most commonly used discounted cash flow performance criteria including:

- The NPV describing the present worth of the income stream from an investment. It presents today's value of the whole investment summing up discounted future earnings and losses based on a given discount rate. Usually the opportunity cost of capital is used as the discount rate. This is the rate that results after the utilization of all capital in the economy if all possible investments undertaken in the economy generate that much or more return. In other words the opportunity cost of capital is the return on the last or marginal investment made that exhausts the last available capital.
- The BCR and;
- The IRR, indicator of the efficiency of an investment. It is the annualized effective compounded rate of return which can be earned on the invested capital.

For the calculation of NPV and IRR, there exists a problem in the practical application of the opportunity cost of capital. The exact value is unknown.The choice of a discount rate depends on the type of investors. An investor with a preference for the certainty of the present to the uncertainty of the future would use a high rate for discounting his/her investments and another may be more willing to take a chance on forecasts holding true by applying a low discount rate which makes future cash flows nearly as valuable as today's. There is no single correct discount rate for a set of future cash flows and no precise way to choose one and farmers have the short-term horizon in view. Using a discount rate that is too high cannot compensate for risk and will calculate a NPV that would be unrealistically low. Conversely, using a discount rate that is too low will produce a value that is unrealistically high. The choice of a discount rate needs to be just right. A realistic discount rate of 3.4% was used in this study. This retained rate is based on the latest available lending rate (12%, March 2013) for loans of 3 to 5 years (WEBR, 2013) minus an inflation rate of 8.6% (March 2013). Thus the discount rate applied does not include a risk premium, which reflects the various uncertainties involved in yam production. The rate used in this study is close to the recommended rate of 3.5%, for all projects not exceeding 30 year period (Her Majesty's Treasury, 2011).

The following assumptions for the NPV calculation for the different seed yam production systems have been adopted as follows in this study.

(i) The time horizon of five years is used as the life cycle of a seed tuber system because by the end of the fifth year most capital equipment such as bowls, baskets, nylon and bags will reach their useful life span and will have to be replaced.

(ii) Seed yam generated is the same every year.

(iii) Production costs vary at a given proportion in a certain period.

(iv) Fixed costs were not considered because the components of what could have been part of such cost structure are either provided by nature or were done once forever.

(v) The study considered Ibadan, Nigeria, as price estimate background for the development of seed yam production.

(vi) The monetary unit used in this study is the US $ at an exchange rate of Naira157 for US $1.

The financial streams of revenues and costs were discounted to determine the NPV and BCR. The criterion for the acceptance of a project is that the NPV must be positive and BCR must be greater than one (Gittinger, 1982; Stutely, 2002; Mullins et al., 2002; Madhani, 2008). Mathematical Equations underlying the computation of NPV and BCR are given in Equations (1) and (2) below.

The NPV i.e the present value of the benefits minus the present value of costs where cash flows are summed up for 5 years: hence,

$$NPV_s = \sum_{t=1}^{n} R_t\left(\frac{1}{(1+r)^t}\right) - \sum_{t=1}^{n} C_t\left(\frac{1}{(1+r)t}\right) \quad (1)$$

$$BCR_s = \sum_{t=1}^{n} \frac{R_t\left(\frac{1}{(1+r)^t}\right)}{\sum_{t=r}^{n} C_t\left(\frac{1}{(1+r)^t}\right)} \quad (2)$$

The IRR is the capital budgeting technique which equates the NPV to zero. The IRR was calculated from the following Equation to determine the unknown r^* (3).

$$\sum_{t=1}^{n} R_t\left(\frac{1}{(1+r^*)^t}\right)-\sum_{t=1}^{n} C_t\left(\frac{1}{(1+r^*)^t}\right)=0 \qquad (3)$$

Where,

NPV_s = Net Present Value of the scheme (US \$), BCR_s = Discounted BCR of the scheme, R_t = revenue in year t (US \$), C_t = costs in year t (US \$), r = discount rate, r^* = IRR, $t \ldots n$ = year t to n^{th} of the project time horizon, $\sum$ = the sum of each of the years' discounted net benefit stream.

The IRR is the interest that can be earned or the yield on the investment. Both IRR and NPV are widely used to decide which investments to undertake and which investments not to make. The major difference is that while NPV is expressed in monetary units, the IRR is the true interest yield expected from an investment expressed as a percentage. Despite a strong academic preference for NPV, surveys indicate that executives prefer IRR over NPV. Apparently, managers find it intuitively more appealing to evaluate investments in terms of percentage rates of return than dollars of NPV. However, NPV remains the "more accurate" reflection of value to the business. Assuming all other factors are equal among the various projects, the project with the highest IRR would probably be considered the best and undertaken first.

These economic indicators were estimated for the three different scenarios of seed yam production, scenario 1 (minisett to seed yam), scenario 2 (minisett to seed yam via vine cuttings) and scenario 3 (ware yam to seed yam via vine cuttings).

Results and Discussion

Economic evaluation of different options of seed yam multiplication

The NPV estimates of the scenario 1 (minisett to seed yam), scenario 2 (minisett to seed yam via vine cuttings) and scenario 3 (ware yam to seed yam via vine cuttings) are \$44,459, \$138,886 and \$23,310, respectively (Table 1).The BCRs are 2.29, 10.52 and 1.90 for these three scenarios respectively (Table 1). Since all the NPVs are positive and the BCRs are greater than 1, the conclusion is that all the seed tuber production systems used is economically viable. The NPV is positive and reflects the economic worthiness and opportunity cost of investment and operating capital. This means that those willing to produce seed yam tubers via these three systems will gain. The minisett to seed yam via vine cuttings method is the most viable followed by the minisett to seed yam and the ware yam to seed yam via vine cuttings methods respectively. The minisett technique is usually considered to be economically better as it uses relatively low labour and capital expenditure. However this study reveals minisett to seed yam via vine cuttings technique better than simple minisett technique based on all the economic indicative parameters including its highest IRR which makes it the most desirable seed yam production system to undertake. This may be partly attributed to the double output this technique yields: seed tubers from vine cuttings and seed tubers from minisetts unlike in the ware yam to seed yam via vine cuttings method, where the double output has less gross benefits.Thus, at a discount rate of 3.4% both the NPV and the BCR indicate the viability of the various seed yam production systems though at varying degrees. Detailed information on different economic estimates in Annexures are summarized in Table 1 below.

Table 1. Economic indicative parameters of seed yam production systems

Variable (\$US)	Scenario 1 Minisett to seed yam	Scenario 2 Minisett to seed yam via vine cuttings	Scenario 3 Ware yam to seed yam via vine cuttings
Discounted revenue	*(2)* 55216	*(1)* 149543	*(3)* 32353
Discounted costs	*(1)* 10757	*(2)* 10658	*(3)* 9044
Benefit:cost ratio	*(2)* 2.29	*(1)* 10.52	*(3)* 1.90
NPV	*(2)* 44459	*(1)* 138886	*(3)* 23310
IRR (%)	*(3)* 39	*(1)* 65	*(2)* 64

Note: The figures in parentheses reflect the ranking of the different seed yam production systems according to the economic indicative parameters

Conclusion and Recommendations

This paper analysed the viability of seed yam production systems in Nigeria using baseline and secondary data on three different seed yam multiplication methods. Using NPV and BCR analyses, seed yam multiplication generally was found to be a profitable enterprise. However, while the estimates (NPV and BCR) of the minisett to seed yam via vine cuttings method are higher than those of the minisett to seed yam method, the estimates of the minisett to seed yam method are higher than those of the ware yam to seed yam via vine cuttings method.

Nonavailability and high cost of good quality, disease free seed yam were the major constraints in yam production in the region that significantly reduced the potential of the crop to support rural development and meet consumers' needs as an affordable nutritional product. Based on the results of the study, minisett to seed yam via vine cuttings is recommended to farmers and all entrepreneurs involved in yam production as a viable enterprise that offers an opportunity to increase yam productivity and profitability in the region.

Promotion of the above technology can improve food production in the study area and it is also recommended that economic analysis of similar agricultural technologies should be made and information passed on to farmers to help them in their decisions.

Acknowledgement

This paper is an output from YIIFSWA Project, funded by the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria through a research grant received from Bill and Melinda Gates Foundation. The authors gratefully acknowledge the support from both the organizations.

References

FAOSTAT. 2014. Food and Agricultural Organization of the United Nations. www.fao.org/statistics/en/FAO, Rome.

Gittinger, P. 1982. *Economic Analyses of Agricultural Projects*. Johns Hopkins University, Baltimore.World Bank publications.

HM (Her Majesty's) Treasury. 2011. The *Green Book: Appraisal and Evaluation in Central Government*, Treasury Guidance, London: TSO, UK, 26 p.

IITA. 2010. International Institute of Tropical Agriculture. A novel way to propagate yams. *annualreport.iita.org*

Madhani, R.M. 2008. Ro-based capital budgeting: a dynamic approach in new economy. *Icfai J. Applied Finance*, **14**(11): 48-67.

Mullins, D., Gehrig, G., Mokaila, G.E., Mosaka, D., Mulder, L. and van Dijk, E. 2002. *A Manual for Cost Benefit Analysis in South Africa with Specific Reference to Water Resource Development*.WRC., Pretoria, 144 p.

NBS. 2013. National Bureau of Statistics. GHS Panel 2010/11. *Yam Consumption and Production in Nigeria*. LSMS-ISA Project. www.nigerianstat.gov.ng.

Stutely, R. 2002. The Definitive Business Plan. Pearson Education Limited, U.K. 312 p.

WEBR. 2013. Nigerian Weekly Economic and Business Review, Volume **3**(13), April 2013.

Annexure 1

Minisett technique	Year 0	Year 1	Year 2	Year 3	Year 4
OUTPUT & BENEFITS					
Seed yams to be generated in number[1]	38400.00	38400.00	38400.00	38400.00	38400.00
Average price in $US [2]	0.32	0.32	0.32	0.32	0.32
Gross benefits in $US[3=1x2]	12229.30	12229.30	12229.30	12229.30	12229.30
OVERHEAD & PRODUCTION COSTS ($US)					
Land Preparation					
Remove under growth/bushes [4]	57.32	63.06	69.36	76.30	83.93
Mowing [5]	63.69	66.88	70.22	73.73	77.42
Level & plough [6]	63.69	66.88	70.22	73.73	77.42
Ridging [7]	63.69	66.88	70.22	73.73	77.42
Seed preparation					
Purchase of mother seed [8]	1783.44	0.00	0.00	0.00	0.00
Bag for loading [9]	2.55	0.00	0.00	0.00	0.00

Loading [10]	1.27	1.40	1.54	1.69	1.87
Transport [11]	6.37	6.69	7.36	8.10	8.90
Off-loading [12]	1.27	1.40	1.54	1.69	1.87
Cutting of seed into setts (man days) [13]	84.08	84.08	84.08	84.08	84.08
Treatment of setts [14]	38.22	38.22	38.22	38.22	38.22
Planting [15]	191.08	200.64	210.67	221.20	232.26
Farm management					
Spraying of herbicide [16]	25.48	25.48	26.75	26.75	28.09
Buying of stakes [17]	7.64	0.00	8.03	0.00	8.43
Loading [18]	3.06	3.21	3.37	3.54	3.71
Transport [19]	7.64	8.03	8.43	8.85	9.29
Off-loading [20]	3.06	3.21	3.37	3.54	3.71
Rope of big size [21]	33.12	0.00	0.00	0.00	0.00
Rope of small size [22]	63.69	0.00	0.00	0.00	0.00
Labour for staking [23]	114.65	120.38	126.40	132.72	139.36
Trailing of the vines [24]	191.08	200.64	210.67	221.20	232.26
First weeding [25]	95.54	95.54	100.32	100.32	105.34
Second weeding [26]	95.54	95.54	100.32	100.32	105.34
Harvesting [27]	382.17	382.17	401.27	401.27	421.34
Parking & loading [28]	38.22	42.04	46.24	50.87	55.96
Transport [29]	254.78	267.52	280.89	294.94	309.68
Off-loading [30]	25.48	28.03	30.83	33.91	37.30
Sorting [31]	19.11	19.11	20.06	20.06	21.07
Investment costs					
[32 = 4 + 5 + 6 + 7+ … + 31]	3716.94	1886.99	1990.38	2050.76	2164.25
Net benefit [33 = 3 - 32]	8512.36	10342.31	10238.92	10178.54	10065.05
Discounted revenue [34]	55215.93				
Discounted costs [35]	10757.34				
Benefits/costs ratio [36 = 33/ 32]	2.29				
NPV ($US) [37]	44458.58				
IRR [38]	39				

Annexure 2

Minisett to seed yam via vine cuttings	Year 0	Year 1	Year 2	Year 3	Year 4
OUTPUT & BENEFITS					
Seed tubers from vine cuttings using					
3 cuttings/plant [1]	120000.00	120000.00	120000.00	120000.00	120000.00
Vine cuttings success rate in % [2]	60.00	60.00	60.00	60.00	60.00
Net seed tubers from vine cuttings [3=1x2]	72000.00	72000.00	72000.00	72000.00	72000.00
Seed tubers from minisett [4]	40000.00	40000.00	40000.00	40000.00	40000.00
Minisett success rate in % [5]	80.00	80.00	80.00	80.00	80.00
Net seed tubers from minisett [6=4x5]	32000.00	32000.00	32000.00	32000.00	32000.00
Total seed tubers in number [7=3+6]	104000.00	104000.0	104000.0	104000.0	104000.00
Average price in $US [8]	0.32	0.32	0.32	0.32	0.32
Total gross benefits [9=7x8]	33121.02	33121.02	33121.02	33121.02	33121.02

OVERHEAD & PRODUCTION COSTS ($US)					
Preparation					
Remove under growth/bushes [10]	57.32	63.06	69.36	76.30	83.93
Mowing [11]	63.69	66.88	70.22	73.73	77.42
Level & plough [12]	63.69	66.88	70.22	73.73	77.42
Ridging [13]	63.69	66.88	70.22	73.73	77.42
Knapsack sprayers, face guard, spraying apron [14]	63.69	0.00	0.00	0.00	0.00
Watering can [15]	2.93	0.00	3.08	0.00	3.23
Purchase of top soil load [16]	445.86	0.00	0.00	0.00	0.00
Half a bundle of corrugated sheet					
(for soil sterilization) [17]	38.22	0.00	0.00	0.00	0.00
Black nylon [18]	31.85	0.00	0.00	0.00	0.00
Planting material					
Nylon bags [19]	168.15	16.82	17.66	17.66	18.54
Scissors [20]	7.64	7.64	8.03	8.03	8.43
Bowls [21]	2.04	0.00	2.14	0.00	2.25
Baskets[22]	6.37	0.00	0.00	0.00	0.00
Stakes [23]	5.10	0.00	0.00	0.00	0.00
Management					
Watering (2 months) [24]	91.72	91.72	96.31	96.31	101.12
Staking [25]	15.29	15.29	16.05	16.05	16.85
Herbicide [26]	7.64	7.64	8.03	8.03	8.43
Rope of big size [27]	33.12	0.00	0.00	0.00	0.00
Rope of small size [28]	63.69	0.00	0.00	0.00	0.00
Labour for staking [29]	114.65	120.38	126.40	132.72	139.36
Trailing of the vines [30]	191.08	200.64	210.67	221.20	232.26
Labour for spraying herbicide [31]	6.37	6.37	6.69	6.69	7.03
Labour for first weeding [32]	95.54	95.54	100.32	100.32	105.34
Labour for second weeding [33]	95.54	95.54	100.32	100.32	105.34
Harvesting [34]	382.17	382.17	401.27	401.27	421.34
Parking & loading [35]	38.22	42.04	46.24	50.87	55.96
Transport [36]	254.78	267.52	280.89	294.94	309.68
Off-loading [37]	25.48	28.03	30.83	33.91	37.30
Vine cutting					
Labour for soil bagging [38]	95.54	95.54	100.32	100.32	105.34
Labour for planting & cutting (40000 pieces) [39]	191.08	191.08	200.64	200.64	210.67
Watering (2 months) [40]	91.72	91.72	96.31	96.31	101.12
Sorting [41]	19.11	19.11	20.06	20.06	21.07
Treatment [42]	38.22	38.22	40.13	40.13	42.13
Storage [43]	3.82	3.82	4.01	4.01	4.22
Investment costs					
[44 = 10+11+12+13 + … + 43]	2875.03	2080.51	2196.41	2247.26	2373.18
Net benefit [45 = 9- 44]	30245.99	31040.51	30924.61	30873.76	30747.84
Discounted revenue [46]	149543.14				
Discounted costs [47]	10687.53				
Benefits/costs ratio [48 = 45 / 44]	10.52				
NPV ($US) [49]	138885.61				
IRR [50]	65				

Annexure 3

Ware yam to seed yam via vine cuttings	Year 0	Year 1	Year 2	Year 3	Year 4
OUTPUT & BENEFITS					
Seed tubers from vine cuttings using					
5 cuttings/plant [1]	15000.00	15000.00	15000.00	15000.00	15000.00
Vine cuttings success rate in % [2]	60.00	60.00	60.00	60.00	60.00
Net seed tubers from vine cuttings [3=1x2]	9000.00	9000.00	9000.00	9000.00	9000.00
Average unit price in $US [4]	0.32	0.32	0.32	0.32	0.32
Gross benefits from seed tubers					
from vine cutting [5=3x4]	2866.24	2866.24	2866.24	2866.24	2866.24
Seed tubers attached to ware yam					
(1/3 of production) [6]	1000.00	1000.00	1000.00	1000.00	1000.00
Average unit price in $US [7]	0.48	0.48	0.48	0.48	0.48
Gross benefits from seed tubers					
attached to ware yam [8=6x7]	477.71	477.71	477.71	477.71	477.71
Ware yam [9]	3000.00	3000.00	3000.00	3000.00	3000.00
Average price in $US [10]	1.27	1.27	1.27	1.27	1.27
Gross benefits from ware					
yam in $US [11=9x10]	3821.66	3821.66	3821.66	3821.66	3821.66
Total gross benefits in $US [12=5+8+11]	7165.61	7165.61	7165.61	7165.61	7165.61
OVERHEAD & PRODUCTION COSTS ($US)					
Preparation					
Remove under growth/bushes [13]	57.32	63.06	69.36	76.30	83.93
Mowing [14]	63.69	66.88	70.22	73.73	77.42
Levelling & ploughing [15]	63.69	66.88	70.22	73.73	77.42
Ridging [16]	63.69	66.88	70.22	73.73	77.42
Knapsack sprayers, face guard,					
spraying apron [17]	63.69	0.00	0.00	0.00	0.00
Watering can [18]	2.93	0.00	3.08	0.00	3.23
Purchase of top soil load [19]	445.86	0.00	0.00	0.00	0.00
Half a bundle of corrugated sheet					
(for soil sterilization) [20]	38.22	0.00	0.00	0.00	0.00
Black nylon [21]	31.85	0.00	0.00	0.00	0.00
Planting material					
Nylon bags [22]	168.15	16.82	17.66	17.66	18.54
Scissors [23]	7.64	7.64	8.03	8.03	8.43
Bowls [24]	2.04	0.00	2.14	0.00	2.25
Baskets [25]	6.37	0.00	0.00	0.00	0.00
Stakes [26]	5.10	0.00	0.00	0.00	0.00
Management					
Watering (2 months)[27]	91.72	91.72	96.31	96.31	101.12
Staking [28]	15.29	15.29	16.05	16.05	16.85
Herbicide [29]	7.64	7.64	8.03	8.03	8.43
Labour for spraying herbicide [30]	6.37	6.37	6.69	6.69	7.03
Labour for first weeding [31]	95.54	95.54	100.32	100.32	105.34
Labour for second weeding [32]	95.54	95.54	100.32	100.32	105.34
Harvesting [33]	382.17	382.17	401.27	401.27	421.34

Parking & loading [34]	38.22	42.04	46.24	50.87	55.96
Transport [35]	254.78	267.52	280.89	294.94	309.68
Off-loading [36]	25.48	28.03	30.83	33.91	37.30
Vine cutting					
Labour for soil bagging [37]	95.54	95.54	100.32	100.32	105.34
Labour for planting & cutting (40000 pieces) [38]	191.08	191.08	200.64	200.64	210.67
Watering (2 months) [39]	91.72	91.72	96.31	96.31	101.12
Sorting [40]	19.11	19.11	20.06	20.06	21.07
Treatment [41]	38.22	38.22	40.13	40.13	42.13
Storage [42]	3.82	3.82	4.01	4.01	4.22
Investment costs					
[43 = 13+14+15+16 + 17 + ... + 42]	2472.48	1759.49	1859.34	1893.34	2001.56
Net benefit [44 = 12- 43]	4693.12	5406.11	5306.27	5272.27	5164.05
Discounted revenue [45]	32353.08				
Discounted costs [46]	9043.58				
Benefits/costs ratio [47 = 44 / 43]	1.90				
NPV ($US)[48]	23309.50				
IRR [49]	64				