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Use of vermicompost and vermiwash to produce bagged rubber plants in nurseries: A profitable technique in Côte d'Ivoire

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Abstract

The profitability of using vermicompost and vermiwash made from poultry droppings in rubber tree nurseries was evaluated in Côte d'Ivoire as part of the project '' Organic waste recycling in rubber tree nurseries by vermitechnology ''. The experimental design used for the demonstration test comprises three treatments (vermicompost-VC, vermiwash-VW and farmer practice-Control T) carried out at the Research Station (CNRA/Bimbresso) and at rubber tree nurseries in Abengourou, Alépé and Daoukro. The Cost-Benefit analysis revealed that the use of VW treatment is more profitable. For every 100 F CFA invested, the gain varied from 42 to 70 F CFA. The benefits of VW ranged from 7,525,556 to 7,977,667 F CFA/ha/year. Profits from VW ranged from 7,525,556 to 7,977,667 F CFA/ha/year. The VC was profitable only in the Station (4,984,484 F CFA/ha/year), which may reflect the nurserymen's lack of knowledge of this technology. Training in the production of vermiwash and vermicompost from poultry droppings should be reinforced for rubber tree nursery producers in Côte d'Ivoire.

Keywords : Profitability; Vermicompost; Vermiwash; *Hevea brasiliensis*; Nurserie; Côte d'Ivoire

1. Introduction

The rubber tree (*Hevea brasiliensis* Muell Arg.) is a latex plant of the Euphorbiaceae family, from the Amazon basin in Brazil (Bouychou, 1963; Compagnon, 1986). Hevea cultivation was introduced in Côte d'Ivoire in the 1950s as part of a policy of crop diversification (Canh, 1999). Since 1997, Côte d'Ivoire has become Africa's leading latex producer. With a production of 1,332,636 tons of latex in 2022, i.e. 80% of the continent's production, the country ranks 4th in the world with one of the best yields in the world, i.e. 1,650 kg/ha/year (Kéli et al., 1997). The creation of a rubber plantation involves the important step of installing a nursery to guarantee the quality of the planting material and the sustainability and profitability of the operation. However, rubber tree nurserymen are being confronted with a reduction in the availability of topsoil, the humus-bearing surface horizon used to fill nursery bags (Essehi et al., 2021). This situation has encouraged rubber tree nurserymen to make increasing use of various types of chemical fertilizers to accelerate the vegetative growth of seedlings and promote plant growth once they have been transferred to the field. While fertilizers increase crop yields, they are also responsible for soil degradation and pollution of the surrounding water table (Bado, 2002). Chemical fertilizers could affect the biological balance of soils by affecting the diversity and activity of beneficial micro-organisms such as bacteria and fungi. Given the disadvantages associated with the use of mineral fertilizers, the

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use of organic waste as biofertilizers (vermicompost and vermiwash) through the action of earthworms appears to be a sustainable alternative to produce rubber plants in nurseries. Therefore, any fertilizer product offered to rubber nurserymen should meet the standards of induced yield and profitability that are essential for vulgarization. This research note sets out the technical and economic bases for the profitable production of rubber plants in bagged nurseries in Côte d'Ivoire.

2. Materials and methods

2.1. Biological material

The GT1 clone of *Hevea Brasiliensis* was used as rootstock. This clone was selected for its high rate of success in grafting plants (Penot, 2001). The plant material used to graft the plants (scion) varies from one nurseryman to another. These grafts come from the five clones popularized in rural areas in Cote d'Ivoire.

2.2. Study site and Experimental design

The study was conducted at Bimbresso (CNRA research station) and in the farming areas of Alépé, Abengourou and Daoukro. Demonstration units were constructed to produce vermicompost and vermiwash (Figure 1). The experimental design includes three (3) treatments (vermicompost-VC, vermiwash-VW and control-T) tested on the vegetative growth of rubber plants in bag nurseries. Treatment Control (T) was fertilized using the chemical fertilizer NPK 10 18 18. For each treatment, 640 plants were considered, with 80 plants per 8 lines.

Figure 1 (A) Platform for compost production (pre-decomposition of organic waste) and (B) vermicompost and vermiwash production sub-unit installed at the rubber nurserymen

2.3. Data collection and analysis

Agroeconomic data were collected at the four (4) sites to evaluate the profitability of using vermicompost and vermiwash made from poultry droppings compared with the Control (T) fertilized with the chemical fertilizer NPK 10 18 18. At the agronomic level, the parameter measured was the number of transferable plants at field, i.e. the number of grafted plants with a diameter greater than 20 mm after checking the success of the plants that had been successfully grafted. Collar diameter (D) was measured 60 days after grafting.

The Transferable Plant Rate (TxT) is obtained using equation 1 below:

$$TxT = (NbPt/ NbPtT) \times 100 \ldots\ldots (1)$$

With :
TxT (%) = Rate of plants transferable to the field after grafting
NbPt = Number of grafted plants with a diameter greater than or equal to 20 mm
NbPtT = Total number of successfully grafted plants

The TxT (%) obtained from 640 plants per treatment was extrapolated to the hectare based on 90,000 plants per hectare for a bagged rubber plant in nursery.

Figure 2 Measurement of collar diameter of rubber plants (A) and grafting of rubber plants (B)

The profitability analysis was based on the determination of the Cost-Benefit Ratio (Ri) (Gittinger, 1985). The Ri ratio is obtained by dividing Profit (Bi) by Production Cost (CTPi). Profit (Bi) is the difference between Income (Rei) and Production Cost (CTPi). The production cost considers fixed costs (CF) (depreciation of equipment) and variable costs (CV) (labour, intrants, etc.) to produce compost based on poultry droppings, vermicompost and vermiwash. Fertilization costs for nursery plants were estimated based on inputs of 0.5 kg/plant, 0.4 liter/plant and 0.9 kg/plant for the VC, VW and T (NPK) treatments respectively. The study considered a cost of 360 F CFA/kg for the purchase of NPK 10 18 18 fertilizer and 2,000 F CFA/man-day for farm labour. The economic analysis was carried out under the Ceteris Paribus hypothesis, assuming that all other things are equal for the cost elements (shed construction, purchase of nursery bags, filling of bags, watering of plants, grafting, etc.) common to the treatments. The economic parameters (Rei, Bi and Ri) are obtained from equations 2, 3 and 4 below:

$$Rei = TxPT \times 90{,}000 \times PVPt \quad (2)$$

$$Bi = Rei - CTPi \quad (3)$$

$$Ri = [Bi / CTPi] \quad (4)$$

With:
Rei = Revenue (in F CFA/ha/year)
CTPi = Total Production Costs (in F CFA/ha/year)
Bi = Profit (in F CFA/ha/year)
TxPT = Rate of plants transferable to the field after grafting (in %)
PVPt = Price of transferable plants in the field (450 F CFA/plant) (unsubsidized price)
i = Treatment (VC and VW)

3. Results and discussion

3.1. Production costs, income and benefits of Vermicompost and Vermiwash

The production costs, income and profits evaluated according to the treatments (VC, VW and T) are presented by site/locality (tables 1 to 4 in the appendix).

Analysis of Table 1 shows that the production costs for VC and VW were 353 F CFA/kg and 413 F CFA/kg respectively at the CNRA Bimbresso station. The production costs of rubber plants in the nursery were lower with VW (14,883,721 F CFA/ha/year) and VC (15,873,016 F CFA/ha/year) than with NPK (29,160,000 F CFA/ha/year). The rate of plants transferable to the field was, however, higher with NPK (52,200 plants/ha) than with VW (48,600 plants/ha) and VC (46,350 plants/ha). Income from NPK was high, but in terms of production costs, organic fertilizers (VW and VC) were more profitable (6,986,279 F CFA/ha/year and 4,984,484 F CFA/ha/year). Table 2 shows the analysis for Abengourou site. The production costs of VC and VW in this locality were respectively 658 F CFA/kg and 461 F CFA/kg. The production costs of rubber plants in the nursery were 29,631,746 F CFA/ha/year for VC, 16,593,778 F CFA/ha/year for VW and 29,160,000 F CFA/ha/ha/year for NPK. The rates of plants transferable to the field were 63,720 plants/ha with VC, 62,820 plants/ha with VW and 62,460 plants/ha with NPK. The use of fertilizer products (VC and VW) was beneficial with VW (11,675,222 F CFA/ha/year). At Alépé, the production costs for VC and VW were 634 F CFA/kg and 443 F CFA/kg respectively (Table 3). The production costs of rubber plants in the nursery were 28,507,937 F CFA/ha/year

for VC, 15,964,444 F CFA/ha/year for VW and 29,160,000 F CFA/ha/year for NPK. The rates of plants transferable to the field were 63,720 plants/ha with VC, 62,820 plants/ha with VW and 62,460 plants/ha with NPK. Fertilizer use was profitable with VW (7,525,556 F CFA/ha/year). At Daoukro, VC and VW production costs were 760 F CFA/kg and 532 F CFA/kg respectively (Table 4). The production costs of rubber plants in the nursery were 34,209,524 F CFA/ha/year for VC, 19,157,33 F CFA/ha/year for VW and 29,160,000 F CFA/ha/year for NPK. The rates of plants transferable to the field were 38,250 plants/ha with VC, 60,300 plants/ha with VW and 49,950 plants/ha with NPK. The use of vermitechnology products was beneficial with VW (7,977,667 F CFA/ ha/year). Overall, it was found that VW and VC were profitable on the station and that the use of VW was beneficial in all the localities in the study. The survey of nurserymen revealed a better appreciation of VW compared with VC and chemical fertilizers (NPK, urea).

3.2. Cost-benefit ratios for vermicompost and vermiwash

Figure 3 shows the cost-benefit ratios of VC and VW compared with mineral T fertilization (NPK 10 18 18) in the rubber plant nursery. The graph shows that the cost-benefit ratios were positive for the VW in all the study sites (0.7 at Abengourou, 0.47 at Alépé and Bimbresso and 0.42 at Daoukro). These ratios indicate that for every 100 CFA francs invested, the use of VW offers a profit of 70 CFA francs at Abengourou, 47 CFA francs at Alépé and Bimbresso and 42 CFA francs at Daoukro. On the CNRA Bimbresso site, the ratio obtained with the VC is 0.31, i.e. a profit of 31 CFA francs per 100 CFA francs invested. The analysis also revealed that the use of VC was not profitable for nurserymen, nor was the use of NPK fertilizers (900 g/plant, i.e. 300 g/plant in 3 applications) in rubber plant nurseries. The advantage of VW is that the production cost per plant (0.4 liter/plant) is lower for nurserymen than for other fertilizers (VC and NPK).

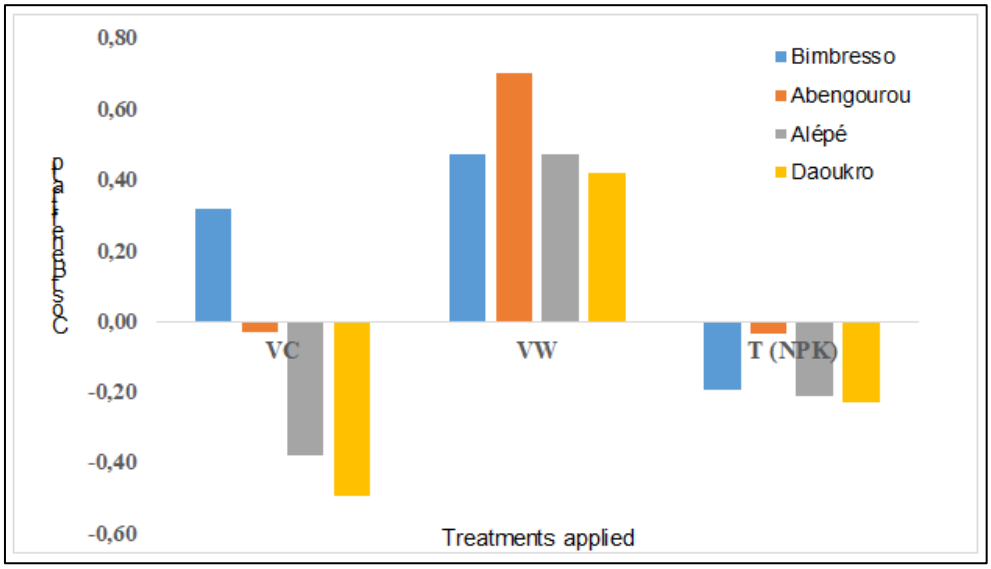

Figure 3 Cost-benefit ratio for the use of vermicompost and vermiwash in rubber plant nurseries

4. Conclusion

The profitability of using biofertilizers (vermicompost and vermiwash) based on poultry droppings was evaluated in comparison with chemical fertilizer T (NPK 10 18 18) to produce rubber plant in nursery at Côte d'Ivoire. The analysis reveals that the use of VW brings a gain ranging from 42 F CFA to 70 F CFA per 100 F CFA invested. The use of VC was profitable only on research stations (4,984,484 F CFA/ha/year), which could reflect the nurserymen's poor mastery of Vermitechnology. Training in the production of vermicompost and vermiwash needs to be stepped up for nurserymen.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared no conflict of interest

Statement of informed consent

All contributing authors read and approved the final manuscript for publication.

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Appendixes

Table 1 Production costs, revenue and benefits from the use of vermicompost in rubber tree nurseries at site of CNRA Bimbresso / Côte d'Ivoire

FIXED CHARGES	**Unit**	**Quantity**	**Unit cost (F CFA)**	**Total cost**	**Depreciation (years)**	**Annual cost**
Composting						
Shovel	-	2	2 500	5 000	1	5 000
Bucket	-	2	2 500	5 000	1	5 000
Subtotal Composting equipment						10 000
Vermicomposting						
Table for 6 tanks with taps	table	4	25 000	100 000	5	20 000
Tanks with taps	tank	21	11 200	235 200	3	78 400
Drainer	box	21	200	4 200	2	2 100
Box of 25 L	box	42	500	21 000	2	10 500
Sand (Ø ≥ 2 cm)	wheelbarrow	4	3 000	12 000	3	4 000
Sea sand	sand	1	25 000	25 000	3	8 333
Subtotal vermicomposting material						123 333
VARIABLES COST	Unit	Quantity/Cycle	Unit cost (F CFA)	Total cost /Cycle	Number of Cycle/years	Annual cost
Composting (4-month cycle)						
Inputs						
Plastic	meter	20	500	10 000	3	30 000
Poultry manure	sac	24	500	12 000	3	36 000
Manpower						
Device assembly (Spreading manure on plastic)	HJ	2	2 000	4 000	3	12 000
Turning and watering	HJ	16	2 000	32 000	3	96 000

Subtotal Composting						174 000
Vermicomposting (2-month cycle)						
Inputs						
Earthworms		4 200	0	0	1	0
Manpower						
Collecting earthworms	HJ	5	2 000	10 000	1	10 000
Device assembly	HJ	4	2 000	8 000	1	8 000
Water supply and collection vermiwash and vermicompost ver	HJ	16	2 000	32 000	6	192 000
Subtotal Vermicomposting						210 000
TOTAL PRODUCTION COST	Unit					Annual Cost
Compost (C)	F CFA					184 000
Vermicompost and vermiwash (VC and VW)	F CFA					333 333
PRODUCTION OF ORGANIC FERTILIZERS	Unit	Quantity/Cycle			Number of Cycle/years	Annual total
Quantity of Compost (C)	Kg	840			3	2 520
Quantity of Vermicompost (VC)	Kg	158			6	945
Quantity of Vermiwash (VW)	Liter	134			6	806
UNIT COST PER PRODUCTION						
Compost	F CFA/Kg					73
Vermicompost	F CFA/Kg					353
Vermiwash	F CFA/Liter					413
PRODUCTION OF HEVEA PLANTS						
COST OF PRODUCTION OF HEVEA PLANTS		Quantity of Fertilizer/plant	Cost of Fertilizer (F CFA/Kg-L)	Number Plants/ha	Unit Cost (F CFA/plant)	Annual total

VC	F CFA/ha/an	0,500	353	90 000	176	15 873 016
VW	F CFA/ha/an	0,400	413	90 000	165	14 883 721
NPK 10 18 18 (Control Treatment)	F CFA/ha/an	0,900	360	90 000	324	29 160 000
REVENUE		Number of Plants	Rate of transferable to the field	Number of Plants /ha	Unit Price (F CFA/plant)	Annual total
VC	F CFA/ha/an	160	0,515	46 350	450	20 857 500
VW	F CFA/ha/an	160	0,540	48 600	450	21 870 000
NPK 10 18 18 (Control Treatment)	F CFA/ha/an	160	0,580	52 200	450	23 490 000
PROFIT (B)						Total Annuel
VC	F CFA/ha/an					4 984 484
VW	F CFA/ha/an					6 986 279
NPK 10 18 18 (Control Treatment)	F CFA/ha/an					-5 670 000

Source : Survey data, 2021

Tableau 1 Production costs, revenue and benefits from the use of vermicompost in rubber tree nurseries at site of Abengourou /Côte d'Ivoire

FIXED CHARGES	**Unit**	**Quantity**	**Unit cost (F CFA)**	**Total cost**	**Depreciation (years)**	**Annual cost**
Composting						
Shovel		2	2 500	5 000	1	5 000
Bucket		2	2 500	5 000	1	5 000
Subtotal Composting equipment						10 000
Vermicomposting						
Table for 6 tanks with taps	table	3	30 000	90 000	5	18 000
Tanks with taps	tank	18	10 000	180 000	3	60 000
Drainer	box	18	200	3 600	2	1 800
Box of 25 L	box	36	500	18 000	2	9 000
Sand (Ø ≥ 2 cm)	wheelbarrow	4	3 000	12 000	3	4 000

Sea sand	sand	1	25 000	25 000	3	8 333
Subtotal vermicomposting material						101 133
VARIABLES COST	Unit	Quantity/Cycle	Unit cost (F CFA)	Total cost /cycle	Number of cycle/years	Annual cost
Composting (4-month cycle)						
Inputs						
Plastic	meter	20	500	10 000	3	30 000
Poultry manure	sac	21	500	10 286	3	30 857
Manpower						
Device assembly (Spreading manure on plastic)	HJ	2	2 000	4 000	3	12 000
Turning and watering)	HJ	16	2 000	32 000	3	96 000
Subtotal Composting						168 857
Vermicomposting (2-month cycle)						
Inputs						
Earthworms		3 600	0	0	1	0
Manpower						
Collecting earthworms	HJ	5	2 000	10 000	1	10 000
Device assembly	HJ	4	2 000	8 000	1	8 000
Water supply and collection vermiwash and vermicompost	HJ	16	2 000	32 000	6	192 000
Subtotal Vermicomposting						210 000
TOTAL PRODUCTION COST	Unit					
Compost (C)	F CFA					178 857
Vermicompost and vermiwash (VC and VW)	F CFA					311 133

PRODUCTION OF ORGANIC FERTILIZERS	Unit	Quantity/Cycle			Number of cycle/years	Total Annuel
Quantity of Compost (C)	Kg	720			3	2 160
Quantity of Vermicompost (VC)	Kg	79			6	473
Quantity of Vermiwash (VW)	Litre	113			6	675
UNIT COST PER PRODUCTION						
Compost	F CFA/Kg					83
Vermicompost	F CFA/Kg					658
Vermiwash	F CFA/Liter					461
PRODUCTION OF HEVEA PLANTS						
COST OF PRODUCTION OF HEVEA PLANTS		Quantity of Fertilizer/plant	Cost of Fertilizer (F CFA/Kg-L)	Number Plants/ha	Unit Cost (F CFA/plant)	Annual total
VC	F CFA/ha/an	0,500	658	90 000	329	29 631 746
VW	F CFA/ha/an	0,400	461	90 000	184	16 593 778
NPK 10 18 18 (Control Treatment)	F CFA/ha/an	0,900	360	90 000	324	29 160 000
REVENUE		Number of Plants	Rate of transferable to the field	Number of Plants /ha	Unit Price (F CFA/plant)	Annual total
VC	F CFA/ha/an	160	0,708	63 720	450	28 674 000
VW	F CFA/ha/an	160	0,698	62 820	450	28 269 000
NPK 10 18 18 (Control Treatment)	F CFA/ha/an	160	0,694	62 460	450	28 107 000
PROFIT (B)						Total Annuel
VC	F CFA/ha/an					-957 746
VW	F CFA/ha/an					11 675 222
NPK 10 18 18 (Control Treatment)	F CFA/ha/an					-1 053 000

Source : Survey data, 2021

Tableau 2 Production costs, revenue and benefits from the use of vermicompost in rubber tree nurseries at site of Alépé / Côte d'Ivoire

FIXED CHARGES	**Unit**	**Quantity**	**Unit cost (F CFA)**	**Total cost**	**Depreciation (years)**	**Annual cost**
Composting						
Shovel						
Bucket						
Subtotal Composting equipment						
Vermicomposting						
Table for 6 tanks with taps	table	3	30 000	90 000	5	18 000
Tanks with taps	tank	15	10 000	150 000	3	50 000
Drainer	box	15	200	3 000	2	1 500
Box of 25 L	box	30	500	15 000	2	7 500
Sand (Ø ≥ 2 cm)	wheelbarrow	4	3 000	12 000	3	4 000
Sea sand	sand	1	25 000	25 000	3	8 333
Subtotal vermicomposting material						89 333
VARIABLES COST	Unit	Quantity/Cycle	Unit cost (F CFA)	Total cost /cycle	Number of cycle/years	Annual cost
Composting (4-month cycle)						
Inputs						
Plastic						
Poultry manure	meter					
Manpower	bag					
Device assembly (Spreading manure on plastic)						
Turning and watering	HJ					
Subtotal Composting						
Vermicomposting (2-month cycle)						

Inputs						
Earthworms		3 000	0	0	1	0
Manpower	HJ	5	2 000	10 000	1	10 000
Collecting earthworms	HJ	4	2 000	8 000	1	8 000
Device assembly						
Water supply and collection vermiwash and vermicompost	HJ	16	2 000	32 000	6	192 000
Subtotal Vermicomposting						210 000
TOTAL PRODUCTION COST	Unit					
Compost (C)	F CFA					
Vermicompost and vermiwash (VC and VW)	F CFA					299 333
PRODUCTION OF ORGANIC FERTILIZERS	Unit	Quantity/Cycle			Number of cycle/years	Total Annuel
Quantity of Compost (C)	Kg					
Quantity of Vermicompost (VC)	Kg	79			6	473
Quantity of Vermiwash (VW)	Liter	113			6	675
UNIT COST PER PRODUCTION						
Compost	F CFA/Kg					
Vermicompost	F CFA/Kg					634
Vermiwash	F CFA/Liter					443
PRODUCTION OF HEVEA PLANTS						
COST OF PRODUCTION OF HEVEA PLANTS		Quantity of Fertilizer/plant	Cost of Fertilizer (F CFA/Kg-L)	Number Plants/ha	Unit Cost (F CFA/plant)	Annual total
VC	F CFA/ha/year	0,500	634	90 000	317	28 507 937
VW	F CFA/ha/year	0,400	443	90 000	177	15 964 444
NPK 10 18 18 (Control Treatment)	F CFA/ha/year	0,900	360	90 000	324	29 160 000

REVENUE		Number of Plants	Rate of transferable to the field	Number of Plants /ha	Unit Price (F CFA/plant)	Annual total
VC	F CFA/ha/year	160	0,435	39 150	450	17 617 500
VW	F CFA/ha/year	160	0,580	52 200	450	23 490 000
NPK 10 18 18 (Control Treatment)	F CFA/ha/year	160	0,565	50 850	450	22 882 500
PROFIT (B)						Total Annuel
VC	F CFA/ha/year					-10 890 437
VW	F CFA/ha/year					7 525 556
NPK 10 18 18 (Control Treatment)	F CFA/ha/year					-6 277 500

Source : Survey data, 2021

Tableau 3 Production costs, revenue and benefits from the use of vermicompost in rubber tree nurseries at site of Daoukro / Côte d'Ivoire

FIXED CHARGES	**Unit**	**Quantity**	**Unit cost (F CFA)**	**Total cost**	**Depreciation (years)**	**Annual cost**
Composting						
Shovel						
Bucket						
Subtotal Composting equipment						
Vermicomposting						
Table for 6 tanks with taps	table	3	30 000	90 000	5	18 000
Tanks with taps	tank	15	10 000	150 000	3	50 000
Drainer	box	15	200	3 000	2	1 500
Box of 25 L	box	30	500	15 000	2	7 500
Sand (Ø ≥ 2 cm)	wheelbarrow	4	3 000	12 000	3	4 000
Sea sand	sand	1	25 000	25 000	3	8 333
Subtotal vermicomposting material						89 333

VARIABLES COST	Unit	Quantity/Cycle	Unit cost (F CFA)	Total cost /cycle	Number of cycle/years	Annual cost
Composting (4-month cycle)						
Inputs						
Plastic	meter					
Poultry manure	bag					
Manpower						
Device assembly (Spreading manure on plastic)	HJ					
Turning and watering	HJ					
Subtotal Composting						
Vermicomposting (2-month cycle)						
Inputs						
Earthworms	ver de terre	3 000	0	0	1	0
Manpower						
Collecting earthworms	HJ	5	2 000	10 000	1	10 000
Device assembly	HJ	4	2 000	8 000	1	8 000
Water supply and collection vermiwash and vermicompost	HJ	16	2 000	32 000	6	192 000
Subtotal Vermicomposting						210 000
TOTAL PRODUCTION COST	Unit					
Compost (C)	F CFA					
Vermicompost and vermiwash (VC and VW)	F CFA					299 333
COST OF PRODUCTION OF HEVEA PLANTS		Quantity of Fertilizer/plant	Cost of Fertilizer (F CFA/Kg-L)	Number Plants/ha	Unit Cost (F CFA/plant)	Total Annual
Quantity of Compost (C)	Kg					
Quantity of Vermicompost (VC)	Kg	66			6	394

Quantity of Vermiwash (VW)	Liter	94			6	563
UNIT COST PER PRODUCTION						
Compost	F CFA/Kg					
Vermicompost	F CFA/Kg					760
Vermiwash	F CFA/Liter					532
PRODUCTION OF HEVEA PLANTS						
COST OF PRODUCTION OF HEVEA PLANTS		Quantity of Fertilizer/plant	Cost of Fertilizer (F CFA/Kg-L)	Number Plants/ha	Unit Cost (F CFA/plant)	Annual total
VC	F CFA/ha/year	0,500	760	90 000	380	34 209 524
VW	F CFA/ha/year	0,400	532	90 000	213	19 157 333
T (NPK)	F CFA/ha/year	0,900	360	90 000	324	29 160 000
REVENUE		Number of Plants	Rate of transferable to the field	Number of Plants /ha	Unit Price (F CFA/plant)	Total Annual
VC	F CFA/ha/year	160	0,425	38 250	450	17 212 500
VW	F CFA/ha/year	160	0,670	60 300	450	27 135 000
NPK 10 18 18 (Control Treatment)	F CFA/ha/year	160	0,555	49 950	450	22 477 500
PROFIT (B)						Total Annual
VC	F CFA/ha/year					-16 997 024
VW	F CFA/ha/year					7 977 667
NPK 10 18 18 (Control Treatment)	F CFA/ha/year					-6 682 500

Source : Survey data, 2021