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The financial feasibility of hazelnut husk and sewage sludge based vermicompost production

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Abstract

Recycling the waste such as hazelnut husk, sewage sludge etc. has been one of the issues into the agenda of many countries. Therefore the purpose of the study was to examine the economic feasibility of the vermicompost production. Technical data about composting hazelnut husk and sewage sludge were gathered from past research. The time series data such as production, export, import and price of vermicompost collected from TURKSTAT, FAO and related institutions. Autoregressive integrating moving average model (ARIMA) and smoothing methods such as double exponential model and winter model were used in forecasting process. We followed net present value and internal rate of return procedures when evaluating the financial feasibility of the facility having one ton vermicompost production capacity per day. Research results showed that the profitability of vermicompost production facility was high, while the likelihood of loss was less. Vermicompost production facility with approximately 130 thousands of US dollars initial investment provided net present value of 1.28 million of US dollars during the economic life. The internal rate of vermicompost production facility was 23%. Research results also revealed that production cost of vermicompost was $0.2 per kilogram. Since vermicompost production facility investment with high profitability and low level of risk was good investment alternatives facing with low level of competitive in market, the study suggest to investors who has good back grounding about sector that they should pay attention to marketing system and market observation about organic input market.

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Introduction

The management of food and agricultural waste, solid and liquid waste sourced by food processing and sewage sludge is the center of the social issues for many societies. Therefore many previous researchers have focused on the possibilities utilization of the several organic waste materials (Demirbaş, 2008; Balat and Balat, 2009; Jensen et al., 2010). On the other hand, many countries have suffered from poor organic matter content in agricultural land and organic waste materials are important since they are the main organic matter source. Baghel et al. (2005) suggested that composting is one of the common mature technologies for waste disposal. Disposing and decomposing the agricultural waste and sewage sludge has been proven to technically feasible. It has been clear based on the results of the previous researches that hazelnut husk and sewage sludge as an organic material were both soil regulator and fertilizer material. However, in practical life, hazelnut husk and sewage sludge usage are not common due to the C/N ratio of hazelnut husk and content of toxic heavy metal compound in sewage sludge are high. Composting of sewage

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sludge is therefore recommended as a method not only to avoid plant growth inhibition but also to facilitate the handling of the dewatered sewage sludge cake where it is mixed with soil. In addition, composting offers a minimum risk for the environment or public health, especially in relation to epidemiological aspects and odors (Katayama et al. 1987). It is well established that a large number of organic wastes can be ingested by earthworms and egested as a stabilized humus-like product termed as vermicompost. It is much more fragmented, porous, and microbially active than parent material due to humification and increased decomposition (Edwards 1988; Garg and Kaushik 2005; Kızılkaya 2008; Kızılkaya et al. 2011; Kızılkaya and Turkay, 2014). Use of earthworms in waste management, organic matter stabilization, soil detoxification, and vermicompost production has been reported by several researchers (Bansal and Kapoor 2000; Kaushik and Garg 2003; Garg and Kaushik 2005; Gupta and Garg 2008; Turgay et al. 2011). The epigeic forms of earthworms can hasten the composting process to a significant extent with production of a better quality of compost as compared with those prepared through traditional composting methods (Ndegwa and Thompson, 2001). Kızılkaya (2008) and Kızılkaya and Türkay (2014) suggested that vermicompost produced from suitable mixture of hazelnut husk and sewage sludge by using earthworm (*Eisenia foetida*) could be used in agricultural production.

In spite of the existence of clear technical evidence for vermicompost production by using hazelnut husk and sewage sludge, there has been very limited study on economic feasibility of the vermicompost production by using hazelnut husk and sewage sludge all over the world, as well as Turkey (Shivakumar et al., 2009). Therefore the purpose of the study was to examine the economic feasibility of the vermicompost production. Profitability and risk level of pilot scale vermicompost production facility were explored in the study.

Material and Methods

When exploring the economic feasibility of vermicompost production facility, which has 1 ton production capacity, technical feasibility was examined at first stage. The bulk of the data about technical feasibility of the vermicompost production were based on the findings of Kızılkaya et al. (2008). Then cash flow of the vermicompost production facility during the economic life of the facility based on the results of the questionnaire administered main actors, the findings of previous research and the documents of related institutions. Projection of demand, input requirements and price were performed by using Box-Jenkins approach and double exponential smoothing throughout the economic life of the facility based on the time series data covering last 15 years collected from TURKSTAT. When performing time series analysis, purchasing power of the farmers, situation of the competitive firms and price fluctuation was considered. After determining the cash inflow and outflow of the vermicompost production facility, the economic feasibility was evaluated by using the methods of net present value and internal rate of return. During the feasibility analysis, all monetary values were transformed to reel values and the reel interest rate was used as decision criteria. The risk reflecting the difference between real situation and the expected situation was considered by using risk adapted discount rate and normal probability distribution approach. In addition, sensitivity analysis was performed in order to reveal the effects of basic variable such as discount rate, cash flow of the facility etc. Production cost of vermicompost was calculated based on the opportunity cost approach. Not only initial cost of items vermicompost production facility but also working capital was considered when calculating the production cost.

Results and Discussion

The technical feasibility of sample vermicompost production facility

Vermicompost production process starts with providing the raw materials. Quality of the vermicompost is highly associated with the good condition of providing sewage sludge, manure, hazelnut husk and earthworm to the plant. Following, these raw materials' are stored under suitable condition. Technical characteristic of the store should be arranged carefully. The third stage of the vermicompost production is preparing the raw materials. In this process, arranging of the particles size, drying and grinding of the raw materials are performed. After completing the third stage, second storage process is started following the measurement and packing. Earthworms are included into the process in this stage. Then, the vermicomposting period that covers 1 month at the optimum temperature and relative humidity conditions starts. In the fifth stage, vermicomposting is ended and earthworms are removed from the packages. After that the cycle is again started from the first step. The last stage of the vermicompost production is preparing the vermicompost for marketing by measuring and packing (Figure 1).

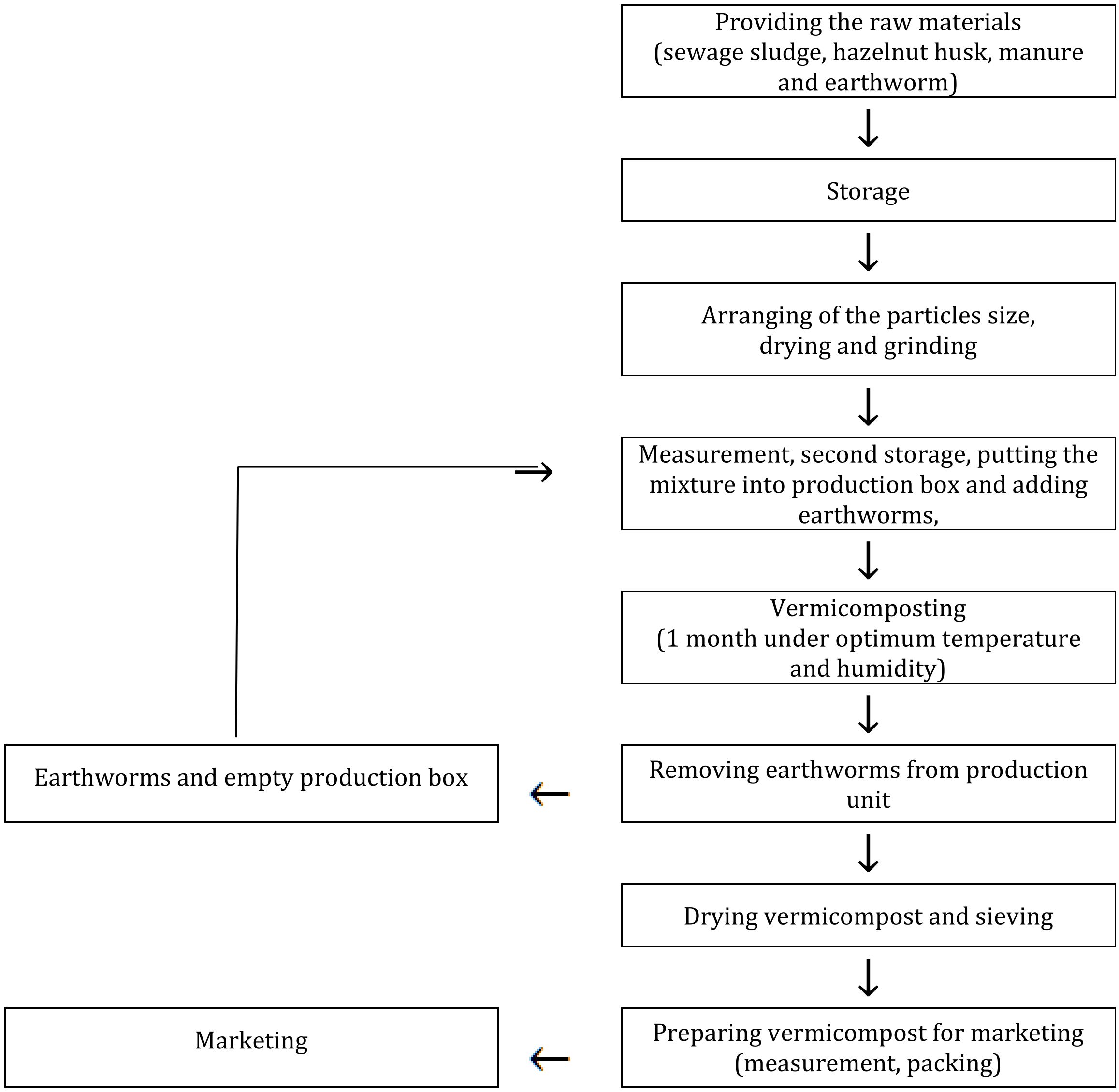

Figure 1. Workflow for vermicompost production

Technical back grounding for vermicompost production facility

The demand of the organic fertilizer has increased in Turkey. Vermicompost is such kind of organic fertilizer and their nutritional content is richer than lots of organic fertilizer. Therefore, the demand of the vermicompost has been raised all over the world, as well as Turkey. Since there has been very limited firm produced vermicompost in Turkey, all vermicompost needs has been met by importing. The minimum order size of the vermicompost is 1000 kilograms in the market. The quantity of imported organic fertilizer has getting increased and increased year by year. Last decade, the quantity of imported organic fertilizer has reached approximately $2.5 million. Nowadays, Turkey has been imported 905 tons of organic fertilizer per year. In Turkey, the minimum potential market size for vermicompost production has been approximately 1567 tons per year. This figure was determined based on the quantity of the annually imported organic fertilizer in Turkey. It is estimated that the market size will be greater than this figure. Based on the results of the double exponential smoothing model, the demand of organic fertilizer in Turkey will be 1600 tons per year in 2020 (Table 1). In this study, it is assumed that the imported quantity of organic fertilizer would be meeting in domestic production when estimating the potential market size. The share of sample vermicompost facility having 365 tons production per year is 23%. Regarding the loss, it was assumed that loss in providing raw material, vermicomposting period and packing were 5%, 10% and 5%, respectively. The labor requirement for vermicompost production per kilogram in the phases of sieving, measurement and packing was 3.1 minutes (Table 2). Regarding the cost of the farmers, the price of the vermicompost associated with contents varied from $1 to $2 per kilogram, while that of composted manure is $0.5 in Turkey.

Table 1. The vermicompost demand in Turkey (TURKSTAT, 2014)

Year	Quantity (ton)	Value ($1000)
1993-2011 (average)	447	1311
2012	1012	2743
2013	1074	2910
2014	1135	3077
2015	1197	3244
2016	1259	3411
2017	1321	3579
2018	1382	3745
2019	1444	3912
2020	1567	4247

*The values between 2014 and 2020 were the forecasted value by using double exponential model.

One good capable of managers who has soil science back grounding and 2 unskilled workers are required for vermicompost facility. On the other hand, the vermicompost facility that has 1 ton production capacity requires temperature and humidity censors, moisturizing system, power supply, harrow, data logger, grinding machine that have 1 ton capacity, dryer, scale for measurement, air conditioner for stabilizing the environment and sieve having one ton capacity.

Table 2. Basic information about technical feasibility of vermicompost production

Characteristics	Value
Potential market size (ton/ year)	1567
Market share of sample production facility (%)	23
Planned vermicompost production of facility (ton/year)	365
Production capacity (ton/day)	1
Production loss (%)	
The stage of providing raw material	5
The stage of vermicomposting	10
The stage of packing	5
Equipment and labor requirement (minutes / kg)	
Sieving	0.02
Measurement	0.05
Packing	3
Personal requirement (person)	
White collar workers	1
Blue collar workers	2

The economic feasibility of sample vermicompost production facility

Initial investment for vermicompost production facility

The vermicompost production facility required initial investment covering initial capital and working capital. Initial capital included the cost of land, construction and necessary machine and equipment, while working capital included the cost of raw material, packing material, taking production permission and quality documents, personal education, sales development etc. The initial investment requirement was presented in Table 3. The sample vermicompost production facility required approximately $130000 of initial investment. The cost of construction was %63 of the initial investment, while that of land was 20%. The share of the machine and equipment cost was 13%.

Table 3. Initial cost for the vermicompost production

Initial cost	$
Land (0.55 ha)	25000
Building (637 m^2)	77598
Equipment	15545
Permission cost for production	682
Quality documents cost	909
Raw material cost per month	678
Packing material cost	455
Promotion cost for marketing	455
Personal cost	2275
Total initial cost	123597

Production cost of vermicompost

The total vermicompost production cost was $58845. %72 of it was fixed cost such as labor, renting car, cost of equity etc., while the rest was variable cost such as raw material, marketing cost etc. Production permission cost and energy cost had the lower share in total production cost (Table 4). Considering the annual share of initial investment, which was $12359, the cost of vermicompost was calculated as $0.2 per kg. The fixed cost for per kg vermicompost was $0.12, while that of variable cost was $0.08. If the vermicompost production facility sell the vermicompost more than $0.2 per kg, it will be profitable. If the price of the vermicompost decreases lesser than $0.08, the facility should be closed. Based on the results of the break even analysis, sample vermicompost production facility covers the all production cost when it produces 100528 kg per year, indicating that the facility gains good profit when it reaches the capacity use ratio more than 28%.

The cash flow belonging vermicompost production was presented in Table 5. The vermicompost production facility reached the positive cash flow after third year. The maximum positive cash flow was observed in fifth year. After fifth year, net cash flow decreased.

Table 4. Production cost of the vermicompost production

Cost item	**Value**
Total fixed cost ($/year)	42125.45
Total variable cost ($/year)	16720.00
Total production cost ($/year)	58845.45
Annual amortization value ($/year)	12359.55
Total cost ($/year)	71205.00
Vermicompost production (kg/year)	365000.00
The cost of vermicompost ($/kg)	0.20
Price of vermicompost ($/kg)	0.45

The results of the economic feasibility analysis showed that net present value of vermicompost production investment was $1217210 (Table 5). Internal rate of return for sample vermicompost production facility was calculated as 23.28%. Since the internal rate of return of the facility was higher than opportunity cost of the capital (5.75%), the vermicompost production facility investment was clearly profitable. Our finding belong to internal rate of return corroborated with the results of the study conducted by Shivakumar et al. (2009), in which they calculated the internal rate of return for vermicompost units in Dharward district. Risk analysis showed that the expected net present value of the vermicompost production facility investment was $1217210 with the standard deviation of $290000. The probability of loss was only 0.1% (Table 6).

Table 5. Annual net cash flow and net present value of the vermicompost production facility investment

Year	Income ($1000)	Cost ($1000)	Net cash flow ($1000)	Discounting factor	Net present value ($1000)
0	-	123.64	-123.64	1.0000	-123.64
1	40.91	59.09	-18.18	1.0575	-17.19
2	50.00	63.64	-13.64	1.1183	-12.20
3	122.72	77.27	45.45	1.1826	38.43
4	250.00	81.81	168.19	1.2506	134.49
5	413.64	86.36	327.28	1.3225	247.47
6	413.64	95.45	318.19	1.3986	227.51
7	413.64	100.00	313.64	1.4790	212.06
8	413.64	113.64	300.00	1.5640	191.82
9	413.64	136.36	277.28	1.6540	167.64
10	413.64	150.00	263.64	1.7480	150.82
				Net present value	1217.21

Our finding belong to economic feasibility corroborated with the results of the study conducted by Shivakumar et al. (2009), in which they reported that the internal rate of return for vermicompost units in Dharward district was 38% and the payback period was only 1.71 years.

Based on the sensitivity analysis, the most sensitive variable on sample investment was cash flow. When the annual income of sample investment decreases lesser than $112227, vermicompost production facility investment becomes unfeasible. Discount rate was the following sensitive variable. The facility investment becomes unfeasible when the discount rate exceeds the rate of 10%. The third sensitive variable was production cost. If the production cost exceeds the value of $288637, the facility investment becomes unfeasible. The less sensitive variable of the vermicompost investment was initial investment (Table 7).

Table 6. Annual cash flow under different market conditions and expected net present value of the vermicompost production facility investment

Years	Market conditions		
	Bad	Normal	Good
0	-123640	-123640	-123640
1	-27273	-18182	-4545
2	-18182	-13636	-4545
3	-22273	45455	59091
4	81818	168182	227273
5	159091	327273	427273
6	154545	318182	431819
7	131818	313636	422727
8	118182	300000	404545
9	109091	277273	372727
10	100000	263634	350000
Net present value ($)	724046	1217210	1451682
Probability	0.17	0.66	0.17
Expected net present value ($)	123087	803359	246786

Table 7. Sensitivity analysis of the vermicompost production facility investment

Variables	Value ($)(1)	Min. and max. limits (2)	Difference ($) (3=2-1)	Variation (%)(3/1)
Initial investment	123597	Max 2940692	22817095	2278
Income	313636	Min 112227	201409	64
Cost	95554	Max 288637	193083	211
Discounting rate	5.75	Max 10	4.25	74

Conclusion

The study examines the economic feasibility of the vermicompost production facility having one ton production capacity per day. It was clear that under the light of the findings the vermicompost production facility was less demanding initial investment, highly profitable and less risky investment. Since vermicompost production facility investment with high profitability and low level of risk was good investment alternatives facing with low level of competitive in market, the study suggest to investors who has good back grounding about sector that they should pay attention to marketing system and market observation about organic input market. Organizing the education program focusing on technical and economical details of the vermicompost production to investors may increase the likelihood of the success and sustainability of the investment. On the other hand, agricultural extension services should design the awareness activities focusing on advantages of vermicompost use in agriculture for increase the knowledge of farmers as a users of the vermicompost. Establishing the supply chain of vermicompost may also enhance the dissemination of vermicompost use in agricultural activities.

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