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Logistics cost estimation and analysis for exporting green bean from Indonesia to Singapore

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ABSTRACT

This article involved a supply chain for exporting green bean from Indonesia to Singapore. The objectives were to identify the cost structure and estimate the cost of the activities in the supply chain. Survey data were collected from three major stakeholders, which were 100 farmers, three collectors, and one exporter in the Central Java Province, the main source of exported green bean. The cost structure consisted of the costs of various activities for each stakeholder. It was found that activity with the highest cost were harvesting cost for the farmers, material handling cost for the collectors, and administration cost for the exporter. Statistical data analysis was performed to identify significant factors affecting the farming cost and logistics cost so as to recommend the cost-effective practices. Analysis results showed that (1) not performing three activities, including making soil beds, setting mulches, and using the 2nd seeding, could reduce the farming cost without losing the yield of green bean; and (2) using motorcycle could lower the delivery cost from farms to pack house for the collectors.

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INTRODUCTION

Indonesia and Singapore formed an agreement called ISAWG (Indonesia-Singapore Agribusiness Working Group) in 2010. The purposes of the agreements were to improve the performance of Indonesian exports in horticultural products, enhance the quality and the quantity of fruits and vegetables, and strengthen the cooperation between Indonesian exporters and Singaporean importers. To implement the programs, the government of Indonesia was assigned many provinces to grow the plants that could be exported to Singapore. One of the provinces was Central Java Province. Indonesia Statistics (2013) recorded that Central Java Province had an export revenue of USD 411.18 million in January 2013, a drop of USD 24.61 million (5.65 %) from the revenue in December 2012 of USD 435.79 million. Yet, exporting to Singapore increased to USD 23.09 million, which was higher than that of December 2012. The increase in export values to Singapore was related to demand for agricultural products such as eggplant, salak (snake fruits), red and green peppers, papaya, peppers, and green bean.

In this study, the product of interest was green bean. Rukmana (1998) stated that green bean (*Phaseolus vulgaris L.*) was a leguminous type. The fruit, seed, and leaf were used as a vegetable and these were rich in protein content. Moreover, from the economics value perspective, FAO (Food and Agriculture Organization, 2007) stated that beans account for 5% of the total vegetable consumption of population. All kinds of beans could be planted in small areas to meet family's demands and part of the beans harvested was supplied to local markets. For agriculture practice, Taber (2008) discussed two management practices of successful green bean production, which were scheduled planting to maintain continuous supply through harvest period and timely harvesting when green bean was of peak quality.

An important gap in the exporting of green bean is the lack of study on its cost structure and cost components. This knowledge could help the stakeholders to identify room for improvement in term of appropriate practices that could lower the cost without jeopardizing the yield. This article aims at deriving the cost structure from activities that occur through flow of green bean in the supply chain, as well as estimating the corresponding cost components. Data were collected from supplying of agricultural inputs (seed and fertilizer) at the farmer level to delivering the green bean to Singapore by flight at the exporter level. The cost and yield data were analysed using statistical methods to find out the practices (farming and logistics) that had significant effect on the cost and yield.

Chopra and Meindl (2004) defined two principles of logistics costing. The first principle involved identifying the costs of providing service to the customers. The second principle concerned with separating the cost and performing revenue analyses with respect to customer type, market segment, and distribution channel. Zhao and Tang (2009) mentioned that there were three factors influencing the logistics cost: macro, industry, and micro. The macro level mainly referred to a country or a region's overall level of logistics development and industrial structure. The industry level is mainly referred to characteristics of products for a particular industry or a certain category of goods. The last was micro level, which is the management level of enterprises that would directly influence the cost of logistics. Ciesielski (1999) specified the criteria for categorizing the logistics costs: type of costs, cost flow phases and cost centres, logistics processes, the variability of costs versus the amount of the material flow. Fredriksen et al. (2005) studied the logistics cost in biomass supply chain. The logistics cost came from three conditions: production (the size of the biomass or solid biofuel being treated), size of the task (moving the biomass from one place to another), and system (component employed to solve the task).

In pharmaceutical case, Utang (2010) defined logistics cost in immunization systems consisting of vaccines supply cost, waste management cost, distribution cost (transportation cost and cool storage cost), and surveillance and monitoring cost. Engblom et al. (2012) stated that logistics costs included six components: transport, warehousing, inventory carrying, administration, packaging, and indirect costs of logistics. In addition, Ongkunaruk and Piyakarn (2011) stated that agricultural logistics had five activities to track the logistical cost. They were procurement, material handling, transportation, inventory, and customer communication. According to Pettersson and Segerstedt (2013), logistics cost was normally referred to as cost components related to distribution or transportation, and costs for warehouses as reflected by the definition of logistics. Moreover, supply chain cost could be defined as all relevant costs in the supply chain of a company or organization under consideration, e.g. production cost, transportation cost, warehousing cost, inventory carrying cost and internal material handling cost. Ioannou (2005) investigated the performance of an activity-based costing in the distribution and operating expenses of Hellenic Sugar Industry (HSI) in Greek. It was reported that the highest proportion was transportation cost, followed by packaging cost, loading/unloading cost, warehousing cost, advertising cost, and stacking cost. Moreover, Guasch (2011) studied logistics cost for moving goods, particularly for exporting purpose, from factory to the point where the goods left the country (port, airport, border crossing). The logistics cost included transport cost, customs cost (licences, permits, and customs processing), inventory cost, insurance cost, border processes cost (port, airport, and border), financing costs, and administrative costs.

MATERIALS AND METHODS

Supply chain mapping

The supply chain activity started from seed and fertilizer suppliers. These supplies were distributed to farmer through farmer groups. Farmer group was an organization that facilitated farmers in their farming activities in order to improve harvest quality and increase yield, as well as fulfil their farming needs. Furthermore, farmers groups had link to exporter regarding selling green bean and being supplied seeds.

Farmer groups also graded the green bean for different customers. Green bean with lower quality was sold to domestic market through collectors, wholesalers, and retailers. The green bean with good quality was sent to the exporter. Moreover, there was a consolidation of farmer groups that communicated with the government to help farmers improving and sustaining green bean farming. The high demand of green bean made Central Java Provincial government increased the assistance to farmers at farmer group level to improve the quantity and maintain the quality of the product. Government also had connection with exporter to monitor the farmer performances in terms of green bean quality. Besides, the exporter in this supply chain came from a single company, named Bina Sari Lestari (BSL) Limited.

The map of green bean supply chain was shown in Figure 1.

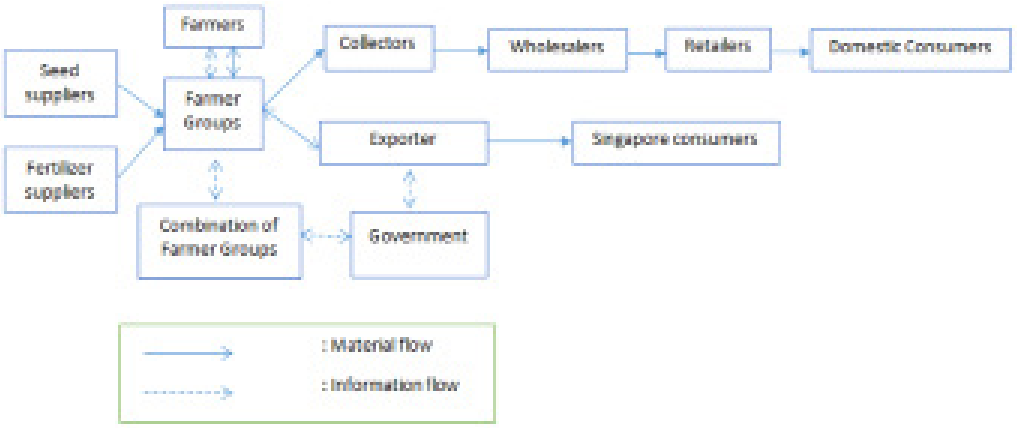

Figure 1 Supply chain map of green bean

The company was a private company but many of the staffs come from Ministry of Agriculture in Central Java Province. Every day, the exporter sent around 1.5-2.0 tons of green bean to Singapore by flight from Adisutjipto International Airport in Yogyakarta. In addition, exporter needed to perform an additional role as coordinator so that a fair price and benefit sharing can be properly arranged among farmers and the exporter.

Conducting survey

Survey data were collected from samples of key stakeholders in Magelang, Central Java Province, because this was the major province that exported green bean to Singapore. The research instruments were in-depth interviews and questionnaires. The samples included 100 farmers from four sub-districts (Kaliangkrik, Dukun, Pakis, and Sawangan), three collectors (i.e. representatives of groups of farmers), and one exporter. These sub-districts were chosen because most farmers at these locations had been growing green bean for export purpose. The sample data were employed using purposive sampling method.

Rantasila (2010) mentioned that was three main approaches to measure macro logistics costs: statistics based, survey based, and case study. In this research, we conducted to use survey based. The survey was performed to collect cost information of every logistics activity and information related to green bean farming from farmer level to the exporter level. Specifically, the collected cost data were procurement cost, transportation cost, material handling costs, harvesting cost and labour cost, inventory cost, and administration cost.

Demographics of key stakeholders

Demographics data were as shown in Table 1. Respondents' genders were reasonably balance, as well as the numbers of farmers in the three farmer groups. Note that all farmers in Kaliangkrik sub-district were in Melati Sari group, farmers in Dukun and Sawangan sub-districts were in Merapi Asri group, and farmers in Pakis sub-district were in Ngudi Roso group. There were two types of farming, mono culture (growing one type of plant on a piece of land) and intercropping (growing at least two types of plants, mostly three types). For intercropping, the farmers grew green bean with chili, cabbage, scallion, cucumber, or onion. Sometimes the farmers used the same fertilizers and pesticide for whole varieties of plants.

Data analysis

The data were analysed using Minitab 16. The result showed differences in the total cost (USD/ton) and yield (ton/ha) among different practices of green bean farming. The activities that had differences practices consist of transportation mode (motorcycle or on-foot (for the farmers who had no access to motorcycle)) and cultivation activities (with or without using soil beds; with or without setting mulches; and with or without using 2nd seeding). Sub-district and farming types (monoculture vs. intercropping) were treated as factors as well.

Table 1 Demographics data of the 100 respondents

Gender	Freq.	Farming type	Freq.	Sub-district	Freq.	Farmer group	Freq.
Female	51	Monoculture	22	Kaliangkrik	33	Melati Sari	33
Male	49	Intercropping	78	Dukun	21	Merapi Asri	32
				Sawangan	11	Ngudi Roso	35
				Pakis	35		

RESULTS AND DISCUSSION

Logistics cost structures

In this supply chain, the cost structure consisted of transportation cost, production cost, harvesting cost, material handling cost, inventory cost, and administration cost. The cost components were relatively consistent with the studies reported in the literature, as discussed in the Introduction section. At the farmer level, the costs consisted of transportation cost (using motorcycle or on-foot), production costs consisted of land cultivation cost (land cultivating, making beds, fertilizer, mulches, and labour), plant treatment cost (seed, fertilizer, pesticide, and labour), and harvesting cost (labour). At the collector level, the major logistics activity concerned with material handling. The cost of material handling consisted of the costs of labour, packing, and transportation. Furthermore, at the exporter level, the cost included transportation, inventory, material handling, and administration.

The cost structure for exporting green bean to Singapore and the cost for each activity was estimated directly from the collected data as shown in Table 2. From the result, it was found that the exporter's administration cost was the highest cost component, followed by farmers' harvesting cost, and exporter's material handling cost. In addition, the last column of table contained the 95% confidence intervals (C.I.) for each cost component. For example, the average land cultivation cost was estimated to be 31.84 USD/ton. We were 95% confident that the average land cultivation cost was between 25.99 USD/ton and 37.69 USD/ton.

The administration cost consisted of customs cost and KIR (permission cost) and material handling cost had labour cost and package cost. These costs that incurred at the exporter were fixed costs. Moreover, the green bean was packed according to Singapore wholesaler requirements to prevent damage during shipping.

Table 2 Cost structure for exporting green bean

Level	Logistics activities	USD/ton	USD/ton	95% C.I.
Farmer	**Transportation cost**			
	On-foot	15.80		Fixed cost
	Motorcycle			
	Administration cost		1.65	(1.11, 2.22)
	Fuel cost		0.15	(0.08, 0.21)
	Maintenance cost		2.25	(1.23, 3.28)
	Production cost			
	Land cultivating cost and the agricultural inputs			
	Land cultivation	31.84		(25.99, 37.69)
	Making soil beds	17.15		(13.62, 20.68)
	Fertilizing 1 and fertilizer 1 cost	69.98		(53.81, 86.14)
	Setting mulches and mulches cost	65.74		(57.30, 76.13)
	Plant treatment cost and the agricultural inputs			
	Planting cost and seed 1 cost	62.60		(54.30, 70.91)
	2nd seeding cost and seed 2 cost	19.46		(14.12, 24.80)
	Fertilizing 2 and fertilizer 2 cost	14.41		(30.28, 47.45)
	Spraying pesticide and pesticides cost	13.57		(10.56, 24.37)
	Harvesting cost	543.30		(464.05, 6,231.55)
Collector	**Material handling cost**			
	Labour cost	33.71		(0, 58.14)
	Packing cost	1.47		(0, 3.45)
	Transportation cost per trip	15.52		(3.61, 27.43)
Exporter	**Transportation cost to airport (pick-up truck)**			
	Driver cost	7.90		Fixed cost
	Fuel cost	4.01		Fixed cost
	Maintenance cost	0.70		Fixed cost
	Vehicle administration cost	0.23		Fixed cost
	Transportation cost to collector (pick-up truck)			
	Driver cost	87.78		(0, 196.80)
	Fuel cost	33.84		(0, 93.74)
	Maintenance cost	11.70		(0, 26.24)
	Vehicle administration cost	3.90		(0, 8.75)
	Material handling			
	Labour cost	63.20		Fixed cost
	Package cost	237.00		Fixed cost
	Inventory cost			
	Cold storage	26.33		Fixed cost
	Administration cost			
	KIR	0.10		Fixed cost
	Customs (freight/tons)	529.30		Fixed cost
Total cost		1,935.00	1,923.41	

Harvesting cost was the highest cost at the farmer level. Farmers had to pay for labour cost of at least two people for harvesting activity that occurred every two days. The process of harvesting was tedious and labour intensive, because the workers must pick good quality green bean one by one to meet the level of quality that the exporter specifies. This was because the exporter set the buying price according to the quality. In other words, if the quality of green bean was below the specification, the farmer would receive lower price.

Statistical data analysis

Total cost

Analysis results of the total cost per ton were shown in Table 3 and Table 4. From Table 3, there was strong evidence of 2-way interaction effects on the total cost, which included (1) interaction between farmer groups and 2nd seeding, p-value = 0.030; and (2) interaction between 2nd seeding and making beds, p-value = 0.019. In addition, farmer groups which represented different farming areas and farming types (monoculture or intercropping) were not significant to the total cost. A further analysis using Tukey's multiple comparisons with respect to the two significant interaction terms were shown in Table 4.

To interpret the results in Table 4, the levels (or rows) with the same letters in the statistical grouping column indicated that those levels were not statistically different. For the farmer group×2nd seeding interaction, not using the 2nd seeding significantly decreased the total cost for Merapi Asri group, i.e. the 1st row had letter A, while the 4th row had letter B, indicating that the two levels were in different groups. The effect of the 2nd seeding was not significant for the other two farmer groups. Overall, not using the 2nd seeding should lower the total cost for all three farmer groups. Similarly, for the 2nd seeding×making beds interaction, not using the 2nd seeding significantly decreased the total cost when making soil beds were not used (see the 1st row vs. the 3rd row), but the 2nd seeding effect was not significant when making soil beds were used (see the 2nd and 4th rows).

Table 3 ANOVA table for the total cost

Source	DF	Adj. SS	Adj. MS	F-Value	P-Value
Farmer groups	2	1.64E+08	81918922	1.84	0.166
Farming type	1	16940123	16940123	0.38	0.540
Mulches	1	29801834	29801834	0.67	0.416
2nd seeding	1	2.2E+08	2.2E+08	4.93	0.029
Making beds	1	55366583	55366583	1.24	0.269
Farmer groups×Farming type	2	3202330	1601165	0.04	0.965
Farmer groups×Mulches	2	1853108	926554	0.02	0.979
Farmer groups×2nd seeding	**2**	**3.27E+08**	**1.63E+08**	**3.66**	**0.030**
Farmer groups×Making beds	2	62682814	31341407	0.7	0.498
Farming type×2nd seeding	1	9061306	9061306	0.2	0.653
Farming type×Making beds	1	20634394	20634394	0.46	0.498
Mulches×2nd seeding	1	1.11E+08	1.11E+08	2.48	0.119
2nd seeding×Making beds	**1**	**2.55E+08**	**2.55E+08**	**5.72**	**0.019**
Farmer group×Farming type×2nd seeding	2	54341100	27170550	0.61	0.546
Error	79	3.52E+09	44611707		
Lack-of-Fit	1	8072499	8072499	0.18	0.673
Pure Error	78	3.52E+09	45080159		
Total	78	3.52E+09	45080159		

Table 4 Multiple comparisons of the total cost vs. significant interaction terms

Interaction term		N	Mean	Statistical Grouping	
Farmer groups	2nd seeding				
Merapi Asri	Use	15	1,930.85	A	
Melati Sari	Use	20	1,332.01	A	B
Melati Sari	No use	13	1,080.67	A	B
Merapi Asri	No use	17	952.82		B
Ngudi Roso	Use	16	910.56	A	B
Ngudi Roso	No use	19	765.34		B
2nd seeding	Making beds				
Use	No use	15	2,128.05	A	
No use	Use	37	1,147.62	A	B
No use	No use	12	718.27		B
Use	Use	36	654.22	A	B

Transportation cost

Another analysis was performed specifically to investigate the transportation rate (USD/ton) with respect to transportation modes (on-foot or motorcycle) using the t-test, i.e. the cost of on-foot was fixed cost, therefore, the comparison was made as a one-sample analysis of motorcycle cost. The result indicated strong evidence that the average transportation rate using motorcycle was significantly lower than the transportation rate of on-foot, p-value < 0.001, as shown in Table 5.

Table 5 Comparisons of transportation rate vs. transportation mode

Transportation mode	N	Average (USD/ton)	95% C.I.
On-foot	56	15.80	Fixed cost
Motorcycle	32	4.05	(2.53, 5.57)

Yield

Analysis results of yield were shown in Table 6 and Table 7. From the ANOVA, there was strong evidence of a 2-way interaction between farmer groups and 2nd seeding on yield, p-value = 0.004. A further analysis using Tukey's multiple comparisons (see Table 7) revealed that using the 2nd seeding could not significantly increase the yield. Notice that for each farmer group, use and no use of the 2nd seeding shared the same letter in statistical grouping column. The purpose of doing the 2nd seeding was to cover the seed that could not be grown. However, the new seeds that had been put to the soil could not increase the yield as expected because of some diseases or lack of nutrition from the fertilizer that was used in the 1st seeding. Based on this result of the total cost, using 2nd seeding was therefore not recommended. Furthermore, others activities such as setting mulches and making soil beds were not significant to both the total cost and yield. This implied that it would be better for farmers not to perform these two activities as well.

Implication for development

At the farmer level, harvesting cost might be reduced by improving labour skills and farming pattern, i.e. plantation and harvesting scheduling. In addition, loss during harvesting should be reduced to obtain the required quantity of green bean. Moreover, farmers could increase the yield by using appropriate fertilizer and pesticide, while reduced the cost by not performing the 2nd seeding, setting mulches, and making soil beds that had no evidence that it could improve the yield. Collectors or farming group should manage the timing when the farmer should begin green bean plantation. This could prevent excessive amount of green bean during harvest time. Even though the exporter had cold storage for preserving, but they still had to concern with green bean shelf life to keep the green bean fresh to satisfy the importer requirement.

Table 6 ANOVA table for yields

Source	DF	Adj. SS	Adj. MS	F-Value	P-Value
Farmer group	2	0.12706	0.063531	18.88	0.000
Farming type	1	0.00001	0.000009	0.000	0.959
Mulches	1	0.00359	0.003593	1.07	0.305
2nd seeding	1	0.00583	0.00583	1.73	0.192
Making beds	1	0.00026	0.000262	0.08	0.781
Farmer group×Farming Type	2	0.01279	0.006395	1.90	0.156
Farmer group×Mulches	2	0.00509	0.002545	0.76	0.473
Farmer group×2nd seeding	**2**	**0.04071**	**0.020355**	**6.05**	**0.004**
Farmer group×Making beds	2	0.00576	0.002882	0.86	0.428
Farming type×2nd seeding	1	0.00271	0.002707	0.8	0.372
Farming type×Making beds	1	0.00001	0.000009	0.00	0.958
Mulches×2nd seeding	1	0.0079	0.0079	2.35	0.129
2nd seeding×Making beds	1	0.01016	0.010161	3.02	0.086
Farmer group×Farming type×2nd seeding	2	0.01414	0.007068	2.1	0.129
Error	79	0.26577	0.003364		
Lack-of-Fit	1	0.00439	0.004392	1.31	0.256
Pure Error	78	0.26138	0.003351		
Total	99	1.25556			

Table 7 Multiple comparisons of yield vs. significant interaction term

Interaction term		N	Mean	Statistical Grouping		
Farmer groups 2nd seeding						
Ngudi Roso	Use	16	4.43457	A		
Ngudi Roso	No use	19	3.99593	A		
Merapi Asri	No use	17	2.67464		B	
Melati Sari	No use	13	2.24809		B	C
Merapi Asri	Use	15	2.03016		B	C
Melati Sari	Use	20	1.55851			C

CONCLUSION

This article investigated the activities that occurred in the green bean supply chain for exporting from Indonesia to Singapore. The supply chain had many stakeholders including farmers, groups of farmers, government, exporter, wholesaler, local consumers and foreign customer. The cost structure was derived and cost components were estimated from survey data. It was found that harvesting cost was the highest cost at farmer level, material handling cost at collector level, and administration cost at exporter level. From the statistical analysis, not making soil beds, not using setting mulches, and not using the 2nd seeding could reduce the cost, without losing the yield of green bean. For transportation, farmers should use motorcycle to obtain lower delivery cost from farm to pack house (collector level).

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