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Potential and Viability Analysis for Ginger Cultivation using Fertigation Technology in Malaysia

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ABSTRACT: Ginger, or *Zingiber officinale Roscoe* in Latin, is a plant with high medicinal and commercial values. Most of high quality gingers are conventionally grown in mountain slopes such as in Janda Baik and Bukit Tinggi, Bentong, Pahang. Second phase planting on the same land can only be done after the land has been left (without any commercial crop) for at least 6 years. Thus, nomadic cultivation is still practised due to the soil-borne diseases such as bacterial wilt and fusarium wilt that attack ginger rhizomes, which results in yield decline. This study was conducted to evaluate the costs and benefits of ginger cultivation using fertigation with conventional methods for the production of mature and young ginger. Data were obtained from pilot project plot under MARDI and Department of Agriculture. Cost-benefit analysis showed that the costs of production for mature and young ginger using fertigation system were RM0.90/kg and RM1.41/kg, respectively, compared to RM1.36/kg and RM1.24/kg using conventional method, respectively. Annual net income for mature (RM174,680/ ha) and young (RM32,500/ ha) ginger production using fertigation system was higher than the conventional method (mature ginger: RM49,200 and young ginger: RM21,100). The higher net income was due to the high yield of ginger, two to threefold per hectare than the conventional method. Partial budget analysis also showed a higher benefit value than implication value in the event of farmers switching from using conventional methods to ginger cultivation using fertigation system. Overall, ginger cultivation using fertigation technology is proven to improve ginger yield and has a high viability. The high cost or initial capital will be offset by high production yield. This technology is also more environmentally friendly than the conventional methods and in accordance with the practice of sustainable agriculture development, besides conforms to present agriculture agenda.

KEYWORDS: Cost of Production, Ginger Cultivation using Fertigation Technology, Viability, Ginger, Fertigation system.

1 INTRODUCTION

Ginger, or *Zingiber officinale Roscoe* in Latin, is a plant with high medicinal and commercial values [1]. This plant produces greenish yellow flowers like orchids, which make ginger also good as an ornamental plant [2]. High quality gingers are usually grown in the highland areas at 1200–1500 meters above sea level [3]. In Malaysia, gingers are commercially grown in Bentong (Pahang), Keningau and Tambunan (Sabah), and Bakun (Sarawak). The main varieties preferred by the entrepreneurs are Bentong, Bara, Chinese, and Indonesian gingers. Malaysian ginger demands for domestic and international markets are very high especially for Bentong ginger. Bentong ginger has a better quality compared to gingers from Indonesia, Thailand, China (Hong Kong), Taiwan, and the United States of America. Therefore, Bentong gingers have high demands in Hong Kong and Britain's markets.

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Most of high quality gingers are conventionally grown in mountain slopes such as in Janda Baik and Bukit Tinggi, Bentong, Pahang. Nomadic cultivation is still practised. Second phase planting on the same land can only be done after the land has been left (without any commercial crop) for at least 6 years. The shrinking of the cultivation area is causing low production thereby limiting the amount of export capacity. The low production is due to the lack of suitable land for cultivating high-quality ginger. The soil-borne diseases that easily attack ginger crops are also causing the lack of interest among farmers to cultivate gingers [4]. The fertigation method using coco peat in black plastic bags is an alternative technique in ginger cultivation to overcome the problems in ginger cultivation.

The role of agriculture sector in the economic growth of developing countries is important [5], [6], [7]. The use of technology is crucial in increasing tha yield and income of farmers. Thus, the adoption and utilization of new technology is critical in agricultural growth. Fertigation technology is proved to be effective and efficient in the cultivation of leaf vegetables and fruits. The production yields of chillies, rockmelons, cucumbers, eggplants, and tomatoes have increased by three to fivefold per unit area compared to the conventional cultivation method [8], [9]. Ginger cultivation in lowland areas using fertigation method is also capable of increasing the average yield of ginger rhizomes (5.4 kg per clump) up to two or threefold compared to the conventional method (900 gm/clump). The use of fertigation system could also enable gingers to be cultivated in the same area repeatedly for years [10].

2 METHODOLOGY

This study focuses on the comparison in terms of benefits, costs, and revenues between conventional ginger cultivation and fertigation system methods. The evaluation of ginger cultivation using fertigation technology will also be done to observe the viability of this technology and the potential and appropriateness of this technology to be adopted by agricultural entrepreneurs and farmers to increase their production of ginger. Secondary data collection for ginger production using fertigation technique was done in three project areas namely (1) Fertigation Crops Complex at MARDI Kluang Station, Johor, (2) Serdang MARDI Station, Selangor, and (3) commercial-scale pilot production project in Kampung Sungai Assap, Bakun, Sarawak. Data collection was done for two years starting from 2009 until 2012. For conventional method, the same data were obtained from the Department of Agriculture. The analyses performed were the cost and revenue analysis, viability analysis, and partial budget analysis. The obtained data were used to prepare cash flow and subsequently financial analysis was done to compare these two cultivation systems.

Cost and revenue analysis was conducted to compare the revenues and costs of production per hectare of ginger production using fertigation system and conventional methods. The purpose of this cost and revenue analysis was to identify variable costs and fixed costs involved in ginger cultivation for both methods as well as estimating the incomes earned by ginger growers based on the secondary data obtained from the MARDI Plot and Department of Agriculture. The parameters involved were gross and net incomes, gross and net margins, production costs per kilogram, and profit margins per kilogram. Variable cost is the value and quantity of inputs that change according to scale of production. Variable costs for both cultivation systems were fertilisers, labours, insecticides, pesticides, and herbicides, while the fixed costs or capital costs included construction of infrastructures such as irrigation systems, farm machineries, farm roads, and farm stores.

Viability analysis is a tool used to assess the viability of a project for a certain period. Normally, viability analysis is used to estimate the feasibility and the time needed by an enterprise to prop up the total amount of investments in the specified period of time [11]. Viability analysis of a project is made by constructing cash flow charts within 10-15 years. In this study, cash flow charts for the last 15 years were prepared. In the cash flow charts, financial analyses such as net present value (NPV), internal rate of return (IRR), capital return period, and sensitivity test were performed.

3 RESULTS AND DISCUSSION

3.1 COST OF PRODUCTION

The cost of production of the project is divided into two, fixed or capital cost and variable cost. Fixed cost is the cost of development that is used as the capital to develop the farm. Among fixed costs involved in the development of farm are infrastructures for irrigation systems, roads, stores, farm machineries, and rain protective structure for ginger cultivation using fertigation system in lowland areas. On the other hand, the variable costs involve expenses that vary according to the scale of production such as the cost of labours, planting materials, fertilisers, pesticides and utilities. Two major infrastructures are required in ginger cultivation using fertigation system, which are fertigation irrigation system and rain protective structure. The development cost of fertigation ginger farm per hectare was RM355,400 of the overall costs, compared to the development cost of the conventional method farm, which was RM56,400 per hectare for the production of

mature gingers and twice the amount for young gingers. The development cost of the conventional method was repeated for every planting season due to the nomadic cultivation system (Table 1).

The development cost for fertigation system was nine times higher than conventional cultivation method for one-hectare area. The input costs, labours, and other costs for the production of young gingers were higher than mature gingers for both cultivation systems because the cultivation of young gingers can be done for two to three seasons per year compared to one year for mature gingers. Ginger cultivation using fertigation system that can be automated will be able to reduce the reliance on manual labours compared to the conventional cultivation method.

Table 1. Comparison of the costs of production of ginger cultivation system using fertigation system and conventional method

Parameter	Average cost for fertigation system				Average cost for conventional method			
	(RM / ha / year)		%		(RM / ha / year)		%	
	Mature ginger	Young ginger	Mature ginger	Young ginger	Mature ginger	Young ginger	Mature ginger	Young ginger
Development cost	355,400	355,400	85	80	56,400	112,800	66	72
Input cost	42,500	58,200	10	13	11,500	22,800	13	14
Labour cost	7,200	15,100	3	4	14,400	16,000	16	10
Other costs	8,900	12,800	2	3	4,100	5,900	5	4
Total	414,000	441,500	100	100	86,400	157,500	100	100

3.2 YIELD AND INCOME

Table 2 shows a comparison of ginger yield per hectare between fertigation system and conventional method for one season of ginger crops. The average yields of mature and young gingers cultivation using fertigation system were 64.8 and 20.4 tons, respectively. The development cost of fertigation system for mature gingers was RM58, 600 and RM28, 700 for young gingers. Meanwhile, the average farm price for mature gingers was RM3.60 and RM3.00 for young ginger. Entrepreneurs who used this fertigation system were able to earn average net incomes of RM174, 680 for mature gingers and RM32, 500 for young gingers. The average yields for the conventional method were 22 tons for mature gingers and 12 tons for young gingers. Data also showed that the cost of production for mature gingers using fertigation system was lower than the conventional method. However, the cost of production per kilogram for young gingers was lower for conventional method than the cost of production per kilogram for fertigation system. By considering the same average farm price, it was found that the average net income for the cultivation of mature and young gingers using fertigation system was higher than the conventional method. The average net income is affected by the level of production and its market price.

Table 2. Comparison of ginger yield per hectare between fertigation system and conventional method for one season of ginger crop

Parameter	Fertigation system		Conventional method	
	Mature ginger	Young ginger	Mature ginger	Young ginger
Average yield (kg/ha)	64,800	20,400	22,000	12000
Average gross income (RM) @ RM3.60/ kg for mature ginger @RM3.00/kg for young ginger	233,280	61,200	79,200	36,000
Production cost (RM/kg)	0.90	1.41	1.36	1.24
Average production cost (RM/ha)	58,600	28,700	30,000	14,900
Average net income (RM/ha)	174,680	32,500	49,200	21,100

3.3 VIABILITY ANALYSIS

A viability analysis was performed to assess the usability of both technologies based on the financial flows (Table 3). Despite the high development cost, mature ginger cultivation using fertigation system had a short-term capital return, which was three years. If the benefit-cost ratios are compared, entrepreneurs who used fertigation technology were able to earn RM0.78 for each RM1.00 invested in the production of mature gingers and RM0.68 for young gingers, which was much more profitable than the conventional method (mature gingers = RM0.17 and young gingers = RM0.16). However, planting system with BCR greater than 1 has greater benefit than liability to make. Results of the viability analysis showed that the use of fertigation technology in ginger production was more viable in long run. Comparison of the viability indicators in the productions of both mature and young gingers showed higher values for indicators of ginger cultivation using fertigation technology than using conventional methods.

Table 3. Viability Analysis of Ginger Production using Fertigation System and Conventional Method

Viability indicators	Fertigation system		Conventional method	
	Mature ginger	Young ginger	Mature ginger	Young ginger
Net present value (NPV) @ 10%	493,420	36,674	3,027	17,728
Internal rate of return (IRR)	34.57	12.31	12.15	19.64
Capital return period (year)	3	6	5	5
Benefit-cost ratio (BCR) @ 10%	1.78	1.68	1.17	1.16

3.4 PARTIAL BUDGET ANALYSIS

Partial budget analysis showed that the benefit value earned was higher than the amount of the implications for mature ginger cultivation (+RM28,580) and young ginger cultivation (+RM41,500) using fertigation system (Table 4). Therefore, it is recommended to shift the conventional method of ginger cultivation to the fertigation technology.

Table 4. Partial budget of ginger cultivation using fertigation technology compared to conventional cultivation method

Changes from conventional method to fertigation system					
	Mature ginger	**Young ginger**		**Mature ginger**	**Young ginger**
Benefits			Implications		
Yield increase	64.8 tons @ 10% = 6.48 tons 6.48 tons * RM3.60/kg * 1000 = RM233,280	61.2 tons @ 10% = 6.12 tons 6.12 tons * RM3.00 * 1000 = RM183,600	*Cost increase*	Rain protective structures (RPS) = RM270,000	Rain protective structures (RPS) = RM270,000
Cost reduction	Average labour cost/year =RM8,900 Average cost of repeated annual land preparation and development due to nomadic cultivation system = RM56,400	Average labour cost/year = RM15,100 Average cost of repeated annual land preparation and development due to nomadic cultivation system = RM112,800			
Total Benefits	RM298,580	RM311, 500	Total Implications	RM270,000	RM270,000
	+RM28,580	+RM41,500			

4 DESCRIPTION OF TECHNOLOGY

Commercial ginger cultivation method is carried out nomadically on highland slopes. This system has become the main reason of illegal invading activities in highland forests. Besides, this nomadic cultivation system has also caused harm to the environment and often caused landslides. The burning of the invaded forests has also become the major cause of environmental pollution. This nomadic cultivation system is applied because gingers cannot be grown continuously in the same area as the area has been infected with soil-borne diseases such as bacterial wilt and fusarium wilt that cause declination of ginger yield up to 80% in the second phase [12]. The former ginger crop area should be left idle for 6 years before the new phase of ginger cultivation can be carried out. Therefore, by using fertigation technology, ginger cultivation can be done in the same area continuously.

Fertigation technology is a cultivation system without soil. In the fertigation system, the crops media such as coco peat, perlite, and burnt paddy husk are used as a replacement of soil. The crops media are filled into polybags according to appropriate sizes. Besides, in this fertigation system, irrigation and fertilisation are done simultaneously and directly to the crops' roots [13]. This fertigation system is able to increase crop yields and reduce the use of fertiliser by supplying fertiliser solution based on each crop's formulation while distributing the solution to the crops based on their growth levels and needs. Fertigation technology is able to save the cost of production as it does not involve the cost of land preparation, weeding, and fertiliser spreading, unlike the conventional method. The technology can be automated using a timer, therefore it can reduce the labour force.

Ginger cultivation using fertigation technology can be used for the production of young and mature gingers. This fertigation technology does not only enable the cultivation of ginger to be carried out in the same area repeatedly, it also increases the yield of ginger by two or threefold compared to the conventional cultivation method. This high yield is used to offset the high development or initial cost. High yield do not depend only on vast area put under cultivation but on yield potentials which may be as a result of use of improved planting system which include planting materials and good management practices [14]. The average yield of mature gingers is up to 5.4 kg for each polybag, which takes about 9 months, while the yield of young gingers is 1.7 kg for a polybag of 4–6 months [15]. This technology also uses a low amount

of ginger seeds than conventional method. Ginger seeds used are 1–2 inches long and weigh around 30 g with 2–3 buds. The percentage survival of the seeds after being transferred to polybags also increases up to 97%. Besides, the cost of embroidery works, which are the main task of the conventional method, is also reduced. However, this ginger cultivation using fertigation technology is less popular among farmers because of its high cost compared to the conventional method. Therefore, farmers are still reluctant to switch from conventional method to fertigation technology. No technology regardless of its ecological and economical soundness will have any impact on productivity and income unless it is adopted by significant proportion of farmers [16]. Furthermore, adoption of technical innovation by farmers also demands precise and detailed information on cost and return [17].

In addition, this ginger cultivation using fertigation technology can also be used for seed production of ginger. Ginger seeds produced using fertigation system are not contaminated with bacteria and fungi. Ginger seeds free from bacteria and fungi are difficult to find in the market. The price of ginger seeds especially Bentong gingers can reach up to RM12 and this price provides a lucrative business opportunity for entrepreneurs. Hence, a new business opportunity is created by them.

The cultivation of high-quality gingers such as Bentong ginger can provide a quick return. Bentong ginger definitely has high demands from countries like Dubai, China, Korea, and Hong Kong. Bentong ginger export value in 2012 was RM65.4 million and all of them were grown in Bukit Tinggi, Bentong [18]. Therefore, the use of fertigation technology can ensure continuous production of Bentong ginger for export purposes. In fact, Bentong ginger can be grown in lowland areas with high yield and similar quality to the Bentong ginger grown in highland areas [15]. This opportunity could provide a lucrative return to the capital that has been issued because of extremely high export price for Bentong ginger.

5 CONCLUSION

In short, ginger cultivation using fertigation method has been proven to increase the yield and income of farmers and entrepreneurs compared to conventional method. The high cost or initial capital will be offset by higher production. Significant increase in yield of up to two or threefold than the conventional method is able to provide high net income for entrepreneurs. However, the high initial investment for the construction of rain protective structures has impeded the use of this technology among farmers. Nevertheless, the viability analysis showed that this technology has a strong competitive edge and is suitable to be adopted by farmers as it can provide higher return than conventional method. If it is viewed from environmental sustainability perspective, this technology is more environmentally friendly than the conventional method and it is in accordance with the agenda of current agricultural practices namely sustainable agricultural development practices.

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