Comparative analysis of cost and benefit: bell pepper produced under protected agriculture and open field conditions in Sri Lanka

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Introduction

Bell pepper (*Capsicum annum* L.) is one of the well-known high valued crops, consume as a condiment for use by fast-food chains. The economically vital part of this crop is sought as a major ingredient for the manufacture of premium cuisines such as salads, stews, salsa, and pizzas. Consumers enjoy this fruit because it provides vitamin A, vitamin C, potassium, as well as a healthy dosage of fibre, folate, and iron [1]. The fresh yellowish and greenish bell peppers have export potential. As a result, it is regarded as one of the country's potential crops for boosting economic growth.

In the Sri Lankan context, bell pepper is extensively grown in wet and intermediate zones under control environmental conditions with temperature 21 ^{0}C to 25 ^{0}C, relative humidity (>70%), proper air circulation within the crop canopies and the optimal supply of nutrient solutions to the root zone [2]. Therefore, the bell pepper producers require expensive structural facilities with sophisticated set-ups known as Protected Agriculture System (PAS). However, the high initial cost for the construction of this protected system causing a high degree of uncertainty for small and middle-scale farmer efforts towards the cultivation of bell pepper. In this regard, the dry zone of Sri Lanka has enormous potential for growing various types of vegetables as it conceives large extent of arable land and cheap labour force compared to wet and intermediate zones. A pioneer study confirmed that certain varieties of bell pepper can be successfully grown under open field conditions [4] with the required conventional farming practices. Therefore, it is necessary to investigate the cost-benefit analysis of bell pepper produced in such open field conditions. Therefore, this study aims to compare the gross margin and Benefit-Cost Ratio (*BCR*) of bell pepper produced under PAS and open fields in the dry zone of Sri Lanka (OF_{DZ}).

Methodology

The open field trial data was collected from the previous study carried out by Mufeeth and Mubarak (2021) [4] at the Agrotech Park, Malwatta located in the Ampara district of Sri Lanka, where the mean monthly rainfall and temperature were ranged from 152 – 235 mm and 30 – 32.5 °C respectively. The total field extend was 16 m^2 at the spacing of 45 x 45 cm. The standard agronomic practices of conventional chili recommended by DOA were adopted, mimicking the real farmer's practices. The materials (farm inputs) and labour cost incurred for the whole cultivation practices were recorded. At harvest, total yield was collected from the experimental plots then the land productivity per 1000 m^2 was calculated. Thereafter, the produce was sold at the rate Rs. 300.00 per kg in January 2019 according to Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI).

On the contrary, the data of bell pepper produced under PAS were obtained from the report published by Kumara *et.,al* [5] in which data of 128 PAS farmers from Kandy, Matale, Nuwara Eliya and Badulla districts were analysed for the total cost of production, yield per cropping cycle and selling prices. Then the collected costs and benefits were converted to the present value using a discount rate of 10.75% [6]. The current study assumed that the present value year was 2019 since the open field trial at Agrotech Park, Malwatta was conducted in the same year.

The collected data from both studies were utilized to calculate the gross margin (GM) and discounted *BCR* using the following equations

(1) and (2) respectively where this analysis is the most efficient approach in project planning techniques [7]. The *PV*(*B*) and *PV*(*C*) terms represent value benefit and cost, respectively. *BCR* shows the overall value of money, and the project is acceptable if it is greater than one [3].

$$GM = \text{Net sales} - \text{Cost of good sold} \quad (1)$$

$$BCR = \frac{PV(B)}{PV(C)} \quad (2)$$

Results and Discussion

The cost and revenue were calculated for medium size (1000 m^2) PAS and OF_{DZ} of bell pepper is expressed in Table 1. The total cost of production under PAS was more expensive than open-field cultivation as a result of the additional cost incurred for supplying fertigation and crop supporting materials (Rs. 10,260.00). A farmer who cultivates bell pepper under PAS require to use expensive Albert hydroponic solution and modified potting media such as Coir plugs, coir dusts and peat mosses to promote vigorous crop growth in order to obtain quality fruits.

Table 1. Cost-benefit analysis for bell pepper production under protected agriculture system (PAS) and dry zone open field condition (OF_{DZ}).

	Bell Pepper Growing Systems per 1000 m^2	
Costs and Revenue	**PAS** (Rs/cropping cycle)	**Open field (OF_{DZ})** (Rs/cropping cycle)
Growing Media	19,766.17	27,450.98
Polybags	4,849.58	NA
Land Preparation	NA	15,000.00
Seeds	7,265.17	8,921.57
Crop supporting Materials	5,411.58	NA
Fertilizer	34,394.60	3,374.51
Agro Chemicals	8,955.27	9,343.14
Crates and packaging materials	2,724.18	3,459.41
Irrigation	2,400.74	2588.24
Other Materials	2,442.16	274.15
Total Material Cost	**88,209.45**	**70,412.00**
Total Labour Cost	62,118.73	67,365.00
Total Cost of production	**150,328.18**	**137,777.00**
Average Total Harvest (kg/Season)	792	745
Average Quantity Sold (kg/Season)	748	704.025
Average Selling Price	300	300
Revenue	**224,400.00**	**211,207.50**
Gross Margin	**74,071.82**	**73,430.50**
Benefit Cost Ratio (*BCR*)	1.50	**1.53**

(Source: HARTI Survey Data, 2012)

Further, the crop supporting materials are very important to support the plants to withstand upright positions and to avoid stem breakage during the fruit-bearing stage. Conversely, inexpensive inorganic fertilizer and organic fertilizer were used during the OF_{DZ} trial, while

recurrent land preparation and field maintenance is essential for a successful production. Moreover, the cost for agrochemicals is an inevitable current cost for crop maintenance particularly against potential pest. A recent study reveals that about 35 species of insects and mites have been identified as potential pests for capsicum spp [8]. Among them, thrips, whitefly, aphids, capsule borers, and yellow mites cause serious damage to the plant and its yield [9]. Though maintenance increased humidity, it can be considered as an added advantage in PAS, the cost for electricity for operating exhaust fans and fan-pad cooling systems requires additional electricity cost than $OF_{DZ.}$ The labour cost for PAS was comparatively lower (Rs. 62,118.73) than with automated watering and fertigation led to reducing the labour requirements. However, OF_{DZ} required additional cost for field maintenance particularly for the above two components apart from weed management.

The comparative analysis found that the fruit yield per 1000 m^2 of bell pepper was similar in both production systems (PAS = 792 kg; OF_{DZ} = 745 kg). As a consequence, in PAS system revenue (Rs. 224,400.00) and gross margin (74,071.00) remains higher. Therefore, the value of *BCR* indicates that both bell pepper production systems were financially feasible for a medium-scale farmer who wanted to cultivate more than 1000 m^2. Such findings are new to the dry zone farming communities, since, the *BCR* of bell pepper produced under OF_{DZ} (1.53) proves more or less similar financial gains as PAS

Conclusion

In terms of financial analysis, both bell pepper production systems compared in this study are feasible for generating profit. Interestingly, the findings of the present study provide an insight on bell pepper cultivation under OF_{DZ} is advantageous to farmers in Sri Lanka since the initial capital investment is very lower than PAS. Thus, OF_{DZ} cultivation of bell pepper is profitable as PAS in the up-country districts, which is limited to the varietal selection and the field maintenance. Though, bell pepper cultivation under protected agriculture systems breaks the seasonal barriers of production and ensures the availability of products throughout the year.

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