Production and Input-use Efficiency in the Harvesting Activities of Medicinal Plants in Peninsular Malaysia

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ABSTRACT

The increasing awareness on herbal remedies and the demand of herbal products leads to rising requirements for local raw medicinal resources by the traditional medicine industries. Although the dependence of the industries on the amount of local medicinal plants required for the production of herbal products is still low when compared to imports, some local medicinal plants are known to be used as the main ingredients in the herbal products processing by Malay traditional medicine manufacturers. Using data from a survey on 33 medicinal plant collectors in Peninsular Malaysia, a descriptive profile of collectors of medicinal plant resources was obtained to provide an overview of the socio-economics of the industry in terms of demographic characteristics of collectors, frequency, duration and travel distance of collecting trips, cost and revenue structure, and production inputs and output. An estimation of a Cobb-Douglas production function was done to determine the relationship between major inputs and medicinal plant production. Both labour and capital inputs in harvesting activities are statistically significant in affecting the amount of medicinal plants harvested. In terms of factor input utilisation, labour input is found to be excessively used when compared to capital input. Both inputs provide positive value marginal products but only for capital was the value marginal product in excess of the cost of its acquisition suggesting that efficiency could be gained by raising capital input utilisations. In the case of labour input, it

is more efficient for collecting activities to downsize its labour force.

Keywords: *traditional medicine, labour, capital, production function, returns to scale*

Introduction

Herbal medicine has been known as the substitute remedies for modern medicine and has been widely used by people around the world. Since herbal products basically do not involve the use of chemical and synthetic drugs, more people begin to turn towards the use of natural products as remedies for treating or preventing diseases. It was reported that the sales of herbal medicine product internationally is growing at 5% to 18% a year from 1985 to 1998. The local market for herbal products in Malaysia is estimated at RM4.9 billion and the market growth rate is 15% to 20% annually (Tunku Mahmud et al. 2002).

This shows that the demand for the herbal products is very encouraging which leads to a high consumption of the raw materials by the industries. The medicinal plant resources are basically applied in both traditional (by the local practitioners) and modern preparations. Besides, creating good business opportunities to the industries, the harvesting of medicinal plant resources also provides income to rural people, as full time or part time collectors especially those living near the forest. Therefore, there is a need to have a sustainable supply of the raw material for the development of the domestic industries, as well as, uplifting the socio-economic livelihood of the rural people.

The traditional medicine industries in Malaysia obtain their raw material supply from three main sources, namely the natural forest, plantations and imports. In general, the dependence of the industries on the amount of local medicinal plants required for the production of herbal products is lesser compared to imports. The majority of the raw materials are imported from China, Indonesia and India. However, some local medicinal plants such as tongkat ali (*Eurycoma longifolia*), kacip fatimah (*Labisia pumila*), rancang besi (*Artaboltrys* spp) and hempedu bumi (*Andrographis paniculata*) are known to be used as main ingredients in the herbal product processing, especially among the Malay traditional medicine manufacturers. These local medicinal plants are important to these industries and are needed on a regular basis. Although medicinal

plants are considered as alternative crops that have commercial potential in income generation, the resources have not been fully explored to be cultivated on a large scale. The utilisation and collection of local medicinal plants (from the forest) is more related to forest encroachment and over-collection. With high demand from the industries on the one hand, and limited stocks of potential medicinal plants in the forests on the other, this situation could lead to the extinction of the highly demanded species. Therefore, the supply of medicinal plants from local sources could possibly be inconsistent and unsustainable.

Despite, the importance of collection of medicinal plants as an important economic activity in the rural economy, very little is understood on the economics of the collection activity. The relationship between factor inputs upon the collection activities is not much studied. Considering the medicinal plants supply situation, there is a need to know the efficiency of the collection activity as an information base to help come up with policies relevant in sustainable management of the medicinal plant resources.

This study tries to estimate the production function of harvesting activities by medicinal plant collectors in Peninsular Malaysia. The amount of medicinal plants harvested per trip is regressed against two major inputs namely capital (harvesting tools) and labour. The function allows us to understand the interrelationships between these two factor inputs in medicinal plant harvesting activities. The study also attempts to evaluate the efficiency with which these inputs are used in the harvesting of medicinal plants. The returns to scale underlying this harvesting activity are also estimated.

Materials and Methods

Collector's Survey

The main source of information on the list of medicinal plant collectors was from *PURBATAMA* (Malay Traditional Medicine Industries Association) while other sources of information on the industry were gained from personal communication with collectors and other related associations, and from newspaper reportings. Random sampling technique was used in selecting the respondents (collectors of medicinal plants). Only 33 medicinal plant collectors had been randomly identified and interviewed using structured questionnaire all over Peninsular Malaysia

from 1998 to 2001. The distribution of respondents (medicinal plants collectors) is as shown in Table 1.

The structured questionnaire contained information on the socio-economics of the respondents, amount of medicinal plants harvested per trip, transportation and location data, number of workers/friends involved, time taken during harvesting session, distance to harvesting areas, price of the medicinal plants sold, wages of workers and number of trips per month. However, for the purpose of estimating the production function, only three related inputs are required: amount of medicinal plants harvested per trip, number and value of harvesting tools used per trip and number of persons and their man-days involved in the harvesting activities per trip.

Table 1: Distribution of Respondents Interviewed

Zones	States	Number of respondents
North	Kedah Perlis Penang	7 0 0
	Sub-total	**7**
South	Johore N.Sembilan Malacca	2 2 3
	Sub-total	**7**
East	Pahang Terengganu Kelantan	13 1 0
	Sub-total	**14**
West	Perak Selangor Kuala Lumpur	3 1 1
	Sub-total	**5**
Peninsular Malaysia	**Total**	**33**

Specification of Production Function

A production function is a systematic way of showing the relationship between different amounts of a resource or input that can be used to produce a product and the corresponding output or yield of that product (Kay & Edwards 1994). Although there are several production functional forms, there is a limited number being used by researchers (Bettie & Taylor 1985; Doll & Orazem 1984). These are generalized as Cobb-Douglas function, quadratic function, linear function, generalized constant elasticity of substitution (CES) function and transcendental function. In this study, generalized Cobb-Douglas production function was used to determine the interrelationship between inputs used in harvesting activities of medicinal plants from the forest.

The general form of production function (Cobb-Douglas) for the harvesting activities of medicinal plants is as below:

$$Q_{mp} = \alpha L^{\beta} K^{\gamma} e^{\mu}$$

Whereby;

Q_{mp} = Amount of medicinal plants harvested by collectors per trip (kg)
L = number of labour (in mandays) involved in the harvesting activities per month (hours)
K = value of capital used during harvesting activities (measured by depreciation of capital stock values) (RM/trip)
α is a constant term
β is the coefficient for the labour input which is also the production elasticity for labour
γ is the coefficient for the labour input which is also the production elasticity for labour
$e^{\mu i}$ is the exponential of the residual term of the estimated function

In this equation, only two independent variables (labour and capital) were used with the dependent variable (quantity or medicinal plants harvested). Other social variables such as age, experiences and education levels were excluded even though they are known to influence the rate of the utilisation of capital and labour. One of the reasons for this exclusion is they are not readily quantified.

The above function was converted into its logarithmic forms and estimated using ordinary least squares technique.

Results

A descriptive analysis had been carried out on the data related to the collectors' harvesting activities. This enables an examination of the profile of these medicinal plants collectors based on their activities.

The collectors' range in age with the youngest being 21 years old and the eldest at 88 years old. Corresponding with this age distribution, similar pattern in the distribution work experience is also observed with a range of 1 to 60 years. The average age and work experience of the collectors are in the middle of this range at 50 years old and 20 years of experience respectively. The majority of the collectors have either none or mainly primary schooling educational level, with only 3% having tertiary education. This implies that this business is much dominated by the aged and relatively uneducated in rural society.

The distance travelled to make the collection activity ranges from 4 to 317 km away from home with the average being 44 km indicating that the collecting forest sites can be close by, as well as, located across districts. The number of harvesting sites visited ranges from one to six per month with an average of two sites. The number of collecting trips made, ranges from 0.2 to ten trips per month with the average being three per month. This implies that a site may receive repeated visits. Putting these facts together suggest that collectors are now having had to make across district and state travels to collection sites, and that collections involve many sites, though some of which involve multiple visits. There is certainly an indication of potential scarcity of the medicinal plant resources considering the long collecting travel distance and multiple collecting sites.

The collecting activity team involves a range from an individual to 20 members with the average being five members per team. The wage rates for each member too vary from as low RM10 to RM80/person/trip with an average of RM36. The duration of the collecting activity involves a ranges of 4 to 144 hours per trip with the average being 12 hours per trip. The number of harvesting tools utilized ranges from 1 to 12 with the average being 4 harvesting tool used. The cost of the harvesting tool varies from as low RM2/unit to a high RM163/unit depending on the kinds of tools whether a used utensil knife, axe, spade or mechanical saw. Overall, it can be summarized that not all team members bring along harvesting tools during the collection trip and that the business is not homogeneous comprising of a range of size from an individual entrepreneur to much larger enterprises of different levels of skill, and utilizing various range of tools.

The medicinal plant resources harvested ranges from as low as 10 species to 44 species/trip with the average being 20 species/trip. The range of the amount being harvested ranges from 10 kg/trip to a high two metric tonne/trip with the average being 231 kg/trip. The different in number of kinds harvested and amount harvested would depend on the channel of sales either to individual traditional medicine man who utilizes various combination of plant species in his medicinal concoction, for direct selling in local farmers' markets or to specialised industrial manufacturers. Selling to individuals who either are a medicine man or sellers in farmers' market takes up 63% of the market channel, while 15% goes to the herbal industry and the rest a combination of the two.

The expenditure incurred per collection trip varies from as low RM17/trip to a high RM1,257/trip with the average being RM245/trip. This range is related to the size of the collection team, amount of harvest, and collecting sites and distance traveled to the collection sites. On a per kg basis, the harvesting cost ranges from RM0.1 to RM5/kg with the average at RM2/kg. On the other hand, the range in the price of the medicinal plant resource varies from RM5 to RM130/kg with the average of RM19/kg. It can be seen that the collection of medicinal plant resource is a lucrative business, if all the harvests are immediately marketable with low levels of rejects. It should be mentioned too, that payments of wages are either in fixed salary or in terms of the proportion of harvests.

The above profile provides a general outlook of the collection activity for medicinal plant resources. This profile could help in describing the estimated production function obtained in this paper.

Production Function of Medicinal Plants Harvesting Activities

From the econometric analysis, the Cobb-Douglas production function for medicinal plants harvesting is as follows;

$$Q_{mp} = \underset{(0.12)^{*}}{9.49}\ L^{\underset{(0.17)^{**}}{0.21}}\ K^{0.78}$$

$$n = 33$$
$$F = 18.78$$
$$R2 = 0.75$$
$$\text{Adjusted } R2 = 0.56$$

Where;

* = significant at 10% confidence interval

** = significant at 1% confidence interval

The analysis shows that the independent variables used were able to capture and explain 75% of the variation in the dependent variable. Both coefficients for independent variables were found to be statistically significant with the labour variable significant at 10% level of significance while the capital variable is significant at 1% level of significance. Hence, labour and capital can influence the amount of medicinal plants harvested by collectors. In a Cobb-Douglas production function, the coefficients of the independent variables are also their production elasticity. Judging from the higher production elasticity with respect to capital than to labour, it can be concluded that output is more responsive to percentage changes in capital than in labour. A one percent increase in capital input, *ceteris paribus*, has the potential of raising 0.78% in output while a similar increase in labour input would potentially raise 0.21% in output.

Returns to Scale

The returns to scale for the medicinal plant harvesting activities is 1 (0.99) indicating the presence of constant returns to scale. This implies that when there is an increase of 1% in the inputs (capital and labour), there will be a proportional 1% change in output (medicinal plants). Basically in the harvesting process of medicinal plants, other than the guide and driver, each collector would use one harvesting tool (capital) to harvest the resources. Each collector can work individually or as a number of workers and capital increase, the amount of medicinal plants harvested also increased proportionally if there is no resource constraint in the forest area. However, this marginal increase in medicinal plant extraction can only occur up to a certain point before resource constraint sets in since there are already indications of resource scarcities as explained in the profile section earlier.

Efficiency of Input Utilisation

Marginal physical products (MPP) is the additional or extra total physical products (TPP) produced by using an additional unit of input (Kay & Edwards 1994). It requires measuring changes in both output and input. By differentiation of the production function with respect to each independent variable (labour and capital), marginal physical products of labour and capital (MPP_L, MPP_K) can be determined as follows:

Marginal Physical Products of Labour (MPP_L)

$$MPP_L = \frac{\delta Q_{mp}}{\delta L} = \alpha \beta L^{\beta-1} K^{\gamma}$$

$$= (9.49)(0.21)(39.65)^{-0.79} (9.30)^{0.78}$$

$$= 0.62 \text{ kg/labour (man-days/month)}$$

Marginal Physical Products of Capital (MPP_K)

$$MPP_K = \frac{\delta Q_{mp}}{\delta K} = \alpha \gamma L^{\beta} K^{\gamma-1}$$

$$= (9.49)\ (0.78)\ (39.65)^{0.21}\ (9.30)^{-0.22}$$

$$= 9.86 \text{ kg/unit tool}$$

In the equation, the values of L and K are taken from the means of the natural logarithm for L (labour) and K (capital) rather than their arithmetic means. These mean natural logarithm values of L and K are anti-logged prior to inserting them into the above equation.

The value marginal products (VMP) for labour and capital are obtained by multiplying their respective MPPs with the weighted average price of medicinal plants of RM12.28/kg. The computed VMPL of RM7.61 suggests that each additional labour (man-days) added in the collecting trip could generate a marginal increase of RM7.61 worth of medicinal plants (Table 2). This small average increase in value despite an additional labour to the crew may depict that the collecting activity is experiencing diminishing returns to scale, given that there are no changes in the quantity of collecting tools.

Table 2: Value Marginal Products of Labour and Capital and Their Ratios to the Cost of Acquisition

Input	MPP(kg/unit input)	VMP(RM/unit input)	VMP/Input acquisition cost
Labour	0.62	7.61	0.21
Capital	9.82	120.60	7.20

The VMP_K computed was RM120.60 which is higher than VMP_L. This is the incremental medicinal plant output value for each additional harvesting tool used. Ideally, the medicinal plant collecting activities would require a complete set of tools including a chopping knife, cutter, *cangkul* or penggali, and mechanical saw. Depending on the scale of the collecting activity, an individual collector may only be armed with a chopping knife while in a large crew a more complete set would be available. Even in the latter, not all crew members would bring along a mechanical saw or *cangkul*. But each crew member would bring along a chopping knife to fell small saplings and cut them to manageable sizes for carrying out of the forest. Adding another *cangkul* to the crew would enhance the productivity of the collecting activity by enabling more plants to be uprooted for the whole crew to process. Hence, it is not surprising that a VMP_K of RM120.60 was obtained.

To evaluate the economic efficiency in utilising the factor inputs of medicinal plant harvesting activities, the value marginal products (VMP) of these input factors are divided by their acquisition costs. The acquisition cost of an additional labour (P_L) is the weighted wage to be paid for the whole trip duration while that for an additional unit of capital is the weighted cost of a used capital (P_K). For labour, the value of VMP_L/P_L is 0.21 while for capital input, the value of VMP_K/P_K is 7.20 (Table 2).

The results show that labour has a ratio of marginal value product to factor cost of less than one. This indicates that labour input is providing less additional value to the production process in comparison to the wages received. This implies that this input is excessively used during the harvesting activities. It is not economical for the production manager or collecting activity entrepreneur to employ any additional workers as it will cost more in comparison to the amount of medicinal plant harvested.

However, the situation is the opposite for capital input. The ratio is greater than one suggesting that investing in additional capital input has an opportunity to raise more marginal output value. It can be more economical to add additional harvesting tools during the harvesting session since the additional capital input can provide a higher marginal output value than the cost for the additional capital used.

Discussion and Conclusion

A descriptive profile of the medicinal plant collecting activity was conducted to provide an overview of the socio-economics of the industry

in terms of characteristics of collectors, frequency, duration and travel distance of trip, cost and revenue structure, and production inputs. There is an indication of approaching scarcity of medicinal plant resources considering rising needed travelled distance. An estimation of a Cobb-Douglas production function was done to determine the relationship between major inputs and medicinal plant production. Both labour and capital inputs in harvesting activities are statistically significant in affecting the amount of medicinal plants harvested. Both inputs provide positive value marginal products but only for capital was the VMP in excess of the cost of its acquisition suggesting that capital input utilisation can be further increased. Unlike capital input, similar observation could not be made for labour input. It is more efficient for collecting activities to downsize its labour force to an appropriate right size and to find an optimal combination between labour and capital inputs. Therefore, it is suggested that the production managers or leaders of harvesting group need not expand their labour force, instead they should consider additional capital inputs to complement existing labour force.

With growing interest in traditional medicine and the rising need of traditional medicinal resource supplies, existing forest sites would be facing a declining resource base affecting the sustainability of supplies. It is recommended that the industry monitor and regulate its extraction rates. In a bid to restock the excessive degradation of the resource, plantations of traditional medicinal plants should be encouraged by providing appropriate incentives as in the case of the natural forest.

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