J. Bamboo and Rattan, Vol. 3, No. 2, pp. 99–106 (2004)

Also available online - www.vsppub.com

Benefit–cost analysis of bamboo in comparison with other crops in mixed cropping home gardens in Kerala State, India

C. N. KRISHNANKUTTY*

Statistics Division, Kerala Forest Research Institute, Peechi, 680 653 Kerala, India

Abstract—Bamboo (*Bambusa bambos*) is one among the crops in mixed cropping home gardens in Kerala State, India. A statistically designed survey was carried out in home gardens in two different agro-climatic zones in Kerala to analyse profitability of bamboo in comparison with seasonal-annual crops, perennial crops and tree crops. Benefit–cost analysis shows that bamboo has at least a second position in terms of profitability among the crop groups in home gardens in the two zones. The high benefit–cost ratio of bamboo was due to negligible inputs and high farm price of bamboo. Advantages due to the existence of an organised wholesale market near the study area and the efficiency of the bamboo depots there make bamboo growing in home gardens profitable. The high ratio reported for bamboo does not recommend for increasing the cultivation of bamboo at the cost of other crops. It shows that bamboo is profitable in home gardens in villages with market advantages.

Key words: Bamboo; *Bambusa bambos*; benefit–cost analysis; mixed cropping; home gardens.

INTRODUCTION

Mixed cropping is the characteristic feature of land use in home garden agroforestry systems in Kerala State, India. It integrates agricultural crops with several trees of different species, bamboo and miscellaneous crops. Bamboo is found in home gardens either on boundaries or mixed with trees or in pure small patches, depending upon the socio-economic status of households. The most common species of bamboo found in home gardens is *Bambusa bambos* [1]. Generally not much inputs or expenditures are required for growing bamboo in home gardens, whereas seasonal, annual and perennial crops require high labour and inputs. Most of the demand for bamboo in Kerala is met from the bamboo extracted from home gardens. Of the total bamboo supply during 1993–1994, home gardens contributed the major

*E-mail: cnkkutty@kfri.org

share [2]. The bamboo market in Kerala is dominated by a few private wholesale bamboo depots in Palakkad District which collect bamboo from home gardens mainly in Palakkad, Thrissur and Malappuram Districts and sell to different places, mainly in Southern India [3]. The depots have a crucial role in the development of bamboo resources in home gardens. In this context, a financial benefit–cost analysis of bamboo in relation to other crop groups in mixed cropping home garden system assumes special significance.

Different crop groups in mixed cropping home gardens are seasonal-annual crops, perennial crops, tree crops, bamboo and miscellaneous crops such as fodder grass, *Gliricidia sepium,* etc. [4]. Seasonal-annual crops include all vegetables, pulses, tubers, betel vines (*Piper betle*), pineapple (*Ananas comosus*), banana (*Musa paradisiaca*), plantain, etc. Perennial crops include coconut (*Cocos nucifera*), arecanut (*Areca catechu*), palmyra (*Borassus flabellifer*), pepper (*Piper longum*), cocoa (*Theobroma cacao*), nutmeg (*Myristica fragrans*), etc. Tree crops consist of all trees except those considered as perennial crops. Jack (*Artocarpus heterophyllus*), mango (*Mangifera indica*), cashew (*Anacardium occidentale*), tamarind (*Tamarindus indica*), *kudapuly* (*Garcinia gummi-gutta*), teak (*Tectona grandis*), *anjily* (*Artocarpus hirsutus*), *matty* (*Ailanthus triphisa*), etc., are the most commonly found trees in home gardens of Kerala [5]. Bamboo and other crop groups, except miscellaneous crops, were considered for the financial benefit–cost analysis in this study.

Estimation of the benefit–cost ratio for different crop groups in mixed cropping home gardens has not been attempted so far. Available methodology for estimating the benefit–cost ratio is applicable only for either single crop or hedgerow intercropping or plantations of same age. Complications that arise in the computation of benefit and cost per ha per annum in a mixed cropping home garden are (i) there is no uniformity among crops with regard to age and pattern of growth, (ii) type of mixing of different crops and intensity of cultivation vary from home garden to home garden, (iii) there are numerous trees of different species and ages and (iv) home garden size varies among households. Among other complexities, estimation of area under each crop, growing stock of trees and stream of costs and benefits over time are the major ones. Adopting an innovative method, these complexities were simplified and benefit–cost ratios for different crop groups within mixed cropping home gardens with bamboo as one of the crops were estimated. Profitability of bamboo crop in relation to other crop groups using benefit–cost ratios is discussed in this paper.

MATERIALS AND METHODS

Study area and data base

This study was confined to two different agro-climatic zones, one in central midland zone and the other in low rainfall dry zone in Kerala. For selecting the study area, Wadakkanchery Block in Thrissur District (normal annual rainfall of 3300 mm) and Kuzhalmandam Block in Palakkad District (normal annual rainfall

of 2400 mm) were selected from the above zones. Villages, where bamboo is grown in home gardens, were identified after visiting all the villages in the selected blocks. One such village was randomly selected from each block. The villages selected were Peringandur (411 ha) in Wadakkanchery Block and Kuthannur (2451 ha) in Kuzhalmandam Block. In both villages, bamboo clumps were found in most home gardens. Peringandur Village has better water availability and perennial crops, such as arecanut, are intensively cultivated. Kuthannur Village, on the other hand, is relatively drier and intensity of perennial crops cultivation is relatively low. Coconut is the main crop. Trees and seasonal/annual crops are relatively more in Kuthannur Village.

Data were collected through sample surveys during August 1996. All households in the selected villages were visited and bamboo growing home gardens was listed. At the time of listing, information on number of bamboo clumps and home garden size were gathered. Bamboo growing home gardens in each village were stratified on the basis of home garden size and number of clumps within home garden. Three size classes were 0.04 to 0.20 ha, 0.20 to 0.40 ha and above 0.40 ha. Home gardens of size below 0.04 ha were excluded in the survey. Home gardens were further classified into two groups as those with one or two clumps and those with three or more clumps. From each of the six categories, ten households each were chosen at random in each village. Data on costs and benefits with respect to different crop groups in home gardens of selected households were collected using a questionnaire and crop details were recorded in a proforma for the crop year 1995–1996. Data on costs of seed or seedling, labour, cultural operations, manuring, irrigation and harvesting and data on different benefits in respect of individual crop were gathered from head of the household by holding personal interview. Data on crop details were recorded by a team of field assistants. For each seasonal and annual crop, either the area or number of plants was recorded in the proforma. Similarly for each perennial crop, number of plants or palms was taken depending upon the nature of the crop. For estimating growing stock of palms, height of each palm by species was also assessed. For each tree, girth at breast height (1.37 m from the ground) was measured for estimating volume of standing tree and crown diameter for calculating area occupied by the tree. For estimating growing stock of bamboo, number of culms in different diameter classes (below 5.0 cm, 5.0 to 7.5 cm, 7.5 to 10.0 cm, above 10.0 cm at the middle of second internode from bottom of the culm) in each clump was recorded in the proforma. Ground space occupied by crown of each clump was also assessed. Age of each plant of perennial crops, tree and bamboo clump was also assessed in consultation with household members to arrive at the mean annual value. Data pertaining to the sample households in selected villages were used for the benefit–cost analysis.

Valuation of annual benefit in a home garden

Annual benefit from a particular crop was defined as the gross value of all food and non-food materials available from that crop during the year 1995–1996, irrespective

of whether the produces were sold for cash or used for home consumption. Gross value of the produces from each seasonal or annual crop was estimated as the sum of the values of all outputs from each crop. For each perennial crop, quantity of annual yield of each item was multiplied by the weighted mean price of each item to arrive at the gross value. To obtain mean annual value of woody biomass, current value of the standing palm or plant was divided by its age. Benefit per annum from each perennial crop was the sum of the value of mean annual yield and mean annual value of the woody biomass of all palms or plants. Volume of a standing tree was calculated using its girth at breast height based on the volume tables of Nair [6] for forest trees of Kerala, as volume tables for trees in home gardens were not so far developed. Stumpage price of a standing tree was arrived at by multiplying volume of commercial timber and that of fuelwood (in m^3) with the respective stumpage prices of commercial timber and fuelwood per m^3. Benefit from wood component per annum from a tree was calculated by dividing stumpage value of the tree with its age. Mean annual benefits from wood component of all the trees of different species and annual returns in terms of fruits wherever available were added together to arrive at the mean annual benefit of tree crops. For estimating mean annual benefit from bamboo, number of standing culms in each clump were counted and classified into different culm diameter classes. Stumpage price of the clump was found out by multiplying the number of culms in each diameter class with the respective stumpage prices of culms in the locality. Mean annual benefit from each clump was obtained by dividing current stumpage value with age of the clump. Annual benefit obtained by harvesting thorn from a clump was quantified by multiplying number of bundles of thorn harvested during 1995–1996 with the price per bundle in the locality. Mean annual benefit from bamboo was obtained as the sum of mean annual benefits from all clumps.

Assessment of annual cost in a home garden

As in the valuation of annual benefits, annual costs during 1995–1996 were also assessed. Costs include cost of crop cultivation and cost on capital. Cost of crop cultivation includes costs incurred on fertilisers and organic manure, pesticides, hired labour, fuel and lubricants for operating farm machinery, hiring plough animals and implements, irrigation, imputed cost of family labour used for crop cultivation, etc. Actual cost incurred for seed or seedling of seasonal/annual crops was included. Mean annual cost of seedling of all other crops was accounted by taking price of seedling of each crop during 1995–1996 divided with age of each plant or palm or tree or bamboo clump. Cost on capital includes costs incurred for land development, interest on agricultural loans, annual land rent and depreciation to capital. Among costs on capital, imputed value of land rent alone was considered in this study, as it was difficult to arrive at an annual figure on other costs for each crop. Land rent was imputed for each crop on the basis of area occupied by each crop. Crown area (in the case of seasonal or annual crops and climbers) and canopy area (in the case of palms, trees and bamboo) were taken as area occupied by crops.

When area under each crop was assessed using area occupied by crown or canopy, area under all crop groups together in a home garden sometimes exceeded actual area of home garden. So land rent was first of all computed for the area of home garden and then distributed proportionately on the basis of gross area under each crop. Annual land rent was taken as a percentage of land price prevailed during 1996 in the villages. Instead of using a single rate as land rent, three rates (9, 12 and 18% of land price) were used for calculating annual land rent.

Calculation of annual benefit and cost per ha in a home garden

For calculating benefits from a crop and costs incurred per unit area, the area under that crop is required. There is no definite method by which actual area under each crop can be measured in mixed cropping system, because it varies from home garden to home garden depending upon the farmer's practice. A large number of crops ranging from seasonal to perennial crops and trees of different species in various age classes are often grown in intimate mixture in a home garden. Therefore, area of home garden was taken for calculating annual benefit and cost per ha for each crop group in a home garden.

Estimation of mean annual benefit, mean annual cost and benefit–cost ratio

Annual benefit and cost per ha pertaining to different crop groups were calculated for each household in the villages in the two agro-climatic zones. Mean annual benefit and mean annual cost per ha for each crop group per household in each village were estimated using the annual benefit and annual cost per ha of each crop group in the sample households in each village. Benefit–cost ratio of each crop group in a village was computed as a ratio estimate by dividing mean annual benefit per ha per household with mean annual cost per ha per household of each crop group in that village.

RESULTS AND DISCUSSION

Estimated mean annual benefit from different crop groups in home gardens per ha in villages representing two agro-climatic zones is presented in Table 1. Mean annual benefit from all crops in home gardens per ha was around US$ 903 (1 US$ = Indian Rs 33.48) per household in Peringandur Village and that in Kuthannur Village was US$ 606 per household. Contribution of perennial crops was nearly half in the former village whereas in the latter, highest benefit was from tree crops. Estimated mean annual cost (without and with land rent at various rates of 9, 12 and 18% of land price) of different crop groups in home gardens per ha are shown in Table 2. Mean annual cost without land rent was US$ 166 per ha per household in the former and that in the latter was US$ 59 per ha per household. Mean annual cost was much lower in Kuthannur Village as the cost incurred for the perennial

Table 1.
Mean annual benefit from different crop groups in home gardens per ha in villages representing two agro-climatic zones (US$ per ha per annum)

Crop group	Peringandur Village	Kuthannur Village
Seasonal and annual crops	131.1	106.6
Perennial crops	415.8	163.6
Tree crops	223.7	233.3
Bamboo	132.2	102.6
All crops	902.8	606.1

Table 2.
Mean annual cost of different crop groups in home gardens per ha including land rent at various rates (percentage of land price) in villages representing two agro-climatic zones (US $ per ha per annum)

Crop group	Peringandur Village				Kuthannur Village			
	0%	9%	12%	18%	0%	9%	12%	18%
Seasonal and annual crops	46.6	59.8	64.2	73.0	36.4	53.4	59.1	70.4
Perennial crops	119.4	141.9	149.4	164.4	22.4	35.8	40.3	49.2
Tree crops	0.2	161.3	215.1	322.6	0.2	155.8	207.7	311.6
Bamboo	0.1	22.3	29.7	44.6	0.1	23.7	31.6	47.4
All crops	166.3	385.3	458.4	604.6	59.1	268.7	338.7	478.6

crops was only US$ 22. Mean annual costs in respect of tree crops and bamboo were negligible. Although annual costs incurred for tree crops and bamboo were negligible in Peringandur Village, the potential benefit which would be the mean annual value of the growing stock was substantial. In Kuthannur Village, returns from bamboo were almost equal to that from seasonal and annual crops for which a high annual cost compared to bamboo was incurred.

The estimated benefit–cost ratios for different crop groups in home gardens, at various rates of land rent (9, 12 and 18% of land price), in the selected villages are shown in Table 3. Bamboo had the highest benefit–cost ratio at the three rates of land rent in Peringandur Village whereas it had only a second place in Kuthannur Village. Price received by farmers for standing bamboo clump was 40% of its wholesale price indicating fair returns for bamboo crop for which no inputs or expenditures were incurred [2]. Partly because of negligible annual cost and partly because of the fact that the benefit was calculated on the basis of growing stock and its farm price, bamboo was found to have at least a second place among different crop groups in terms of profitability. Nearness to the market, accessibility of traders to bamboo clump and ability of farmer in negotiating with the bamboo traders were found to determine whether the potential value was realised by the farmer. In Peringandur Village, even perennial crops had a lower benefit–cost ratio even at 18% land rent. Even with a high benefit–cost ratio for bamboo, other type of

Table 3.
Benefit–cost ratios at various rates of land rent (percentage of land price) for different crop groups in home gardens in villages representing two agro-climatic zones

Crop group	Peringandur Village			Kuthannur Village		
	9%	12%	18%	9%	12%	18%
Seasonal and annual crops	2.2	2.0	1.8	2.0	1.8	1.5
Perennial crops	2.9	2.8	2.5	4.6	4.1	3.3
Tree crops	1.4	1.0	0.7	1.5	1.1	0.7
Bamboo	5.9	4.4	3.0	4.3	3.2	2.2
All crops	2.3	2.0	1.5	2.3	1.8	1.3

crops continue to be grown in the village as the potential benefit from bamboo was not realised by all farmers. Intensity of cultivation and use of inputs as well as labour for perennial crops in Kuthannur Village were low and therefore the benefit–cost ratio was found to be quite high. In both villages, benefit–cost ratios for seasonal, annual crops and tree crops were almost identical at the three rates of land rent. The higher benefit–cost ratio for bamboo in Peringandur Village in comparison with that in Kuthannur Village needs some explanation. Although *Bambusa bambos* was grown in both villages, bamboo culms in home gardens in the former had better growth and larger size than those in the latter. Apart from agro-climatic differences, intensive cultivation of perennial crops with inorganic fertilisers and irrigation in Peringandur Village had their effect on bamboo crop which was grown on margins. Higher price of the standing culms in Peringandur Village gave a higher benefit–cost ratio.

Profitability of a product depends on the net returns that can be realised in market. As the agricultural economy in Kerala is highly commercialised, there are thriving markets for most of the agricultural produces. Nearness of organised markets is an added advantage for producers. For home garden bamboo, there is a well-established wholesale market in Palakkad District. The market consists of about 35 wholesale depots which are highly efficient to attract bulk purchasers from other States in Southern India [2]. The existence of the bamboo market and efficiency of the wholesale depots make bamboo growing profitable in both villages. When there is no organised market, bamboo can have only the status of a miscellaneous crop and no economic returns can be expected. Therefore, it has to be born in mind that the apparent profitability of bamboo in both villages may not be replicable in villages without market advantages.

CONCLUSIONS

Benefit–cost analysis of bamboo in comparison with seasonal-annual crops, perennial crops and trees in home gardens, shows the relative economic position of bamboo among different crop groups. But various criteria and priorities exist for the

farmers in choosing or retaining a particular crop-mix in home gardens. In a mixed cropping home garden system, different types of crops and bamboo are complementary to each other and integrated as an ecological and economic system. Comparison of bamboo with other crop groups is not intended to promote one type of crop against another, as all crops have their place and role. The home garden system with bamboo, as seen in the two agro-climatic zones, has evolved over several decades and is now in more or less optimum balance. The high benefit–cost ratio reported for bamboo does not recommend for increasing cultivation of bamboo at the cost of other crops. It only shows that bamboo is profitable in home gardens in villages with market advantages.

Acknowledgements

The author is thankful to Dr. K. S. S. Nair, former Director, Dr. J. K, Sharma, Director, Kerala Forest Research Institute and Dr. K. Jayaraman, Scientist-in-Charge, Statistics Division, for their encouragement and guidance, Dr. Eric R. Boa and Mr. Mick Blowfield of the Natural Resources Institute, UK, for facilitating the financial support from the Overseas Development Administration, UK.

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