ISSN-1997-2571 (Online) & ISSN-2075-1648 (Optical)
J. Innov. Dev. Strategy 4(1):12-17 (August 2010)

ECONOMIC VIABILITY OF HOT PEPPER (*Capsicum frutescens* L.) CULTIVATION IN AGROFORESTRY FARMING SYSTEM IN KAMULI DISTRICT, UGANDA

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Accepted for publication on 15 July 2010

ABSTRACT

Buyinza M, Mugagga F (2010) Economic viability of hot pepper (*Capsicum frutescens* L.) cultivation in agroforestry farming system in Kamuli district, Uganda. *J. Innov. Dev. Strategy* 4(1), 12-17.

Hot pepper (*Capsicum frutescens* L.) is cultivated widely in Uganda as an agricultural crop either in open field or in the agroforestry system. An economic assessment, using cost-benefit analysis, was carried out on hot pepper cultivation under agroforestry farming system and field observation in selected *Grevillea robusta* as a tree crop and hot pepper, *Zea mays* L. and *Phaseolus vulgaris* L. as agriculture crops intercropping in Kamuli district, Uganda between June-December 2004. The results from the Benefit-Cost Ratio (BCR) showed that hot pepper and *Grevillea robusta* agroforestry intercrop produced the highest economic returns compared to beans and maize monocultural systems. Grevillea and hot pepper intercropping also fulfilled the basic need of fuel wood from the pruning of branches and timber for furniture and house construction for the farmers. Though the price of hot pepper is variable, it can be grown as a cash crop which can contribute to the livelihood and poverty reduction in Uganda.

Key words: *economic returns, farming system, hot pepper, Uganda*

INTRODUCTION

Agroforestry technologies can make significant contribution towards addressing high levels of poverty and associated land degradation in the east and central Africa region. For this to happen we need to promote innovation that farmers can invest in and that in turn generate incomes and/or save them costs they incur. This requires to be supported by improved access to markets and stronger associations that can help facilitate economies of scale (Denning 2001).

Agroforestry is an essential component for developing sustainable agricultural systems, especially in tropical countries of the world with a multiple objectives like maximizing productivity, creating jobs and income in rural areas, and safeguarding sustainability (Siriri and Bekunda, 2001). Trees are introduced into agricultural production systems to decrease soil erosion, maintain soil moisture, and produce useful products (fuelwood, nuts, fruits, building materials) for the rural household and commercial markets (Siriri and Bekunda, 2001). ICRAF (1989) provides insights into roles of agroforestry in sustaining and increasing agricultural production. Agroforestry techniques need to be promoted among rural farmers in developing countries by demonstrating the benefits of various options (Franzel and Scherr, 2001).

Uganda is an agrarian country. Majority of the people's livelihood depends on agriculture**.** Subsistence farmers have traditionally practiced many types of agroforestry. Hot pepper locally known as "Kamulali" cultivation under agroforestry systems is extensively practiced in eastern and western highlands as well as in the central region. Hot pepper is an important crop grown for its aromatic rhizomes, which are used both as a spice and a medicine (Bosland and Votava, 2000; Abdrews 1984). It is cultivated over the greater part of the tropical parts of Eastern Africa (Swinkels *et al.* 1994).

People have been planting it under the shade of natural, planted forest as well as under shade of other trees. In this practice, hot pepper is considered as the most potential cash crop. Grevillea is a fast growing multipurpose species, which can be grown easily on the sloppy erosion prone areas as it also binds soil, gives optimum shade, increases fertility, retains soil moisture, grows fast, and used as fuelwood and timber (Franzel and Scherr, 2001). In Buzaya County, hot pepper is cultivated usually under planted trees mainly *Grevillea robusta*, *Eucalyptus* spp. (kalitunsi), *Markhamia lutea* (omusanvu), *Erythrina abyssinica* (ekikoo), *Ficus natalensis* (ekikooma), *Acacia mearnsii*. Hot pepper cultivation has been adopted by majority of people in the areas since 1980s. It has been found to grow well as an integral part of traditional farming system and is important in agriculture, forestry, and also from ecological as well as economic point of view (Abdrews 1984).

There are no standard cultivars of pepper in Uganda. The pool of all Chile cultivars comes from five species of the genus Capsium: *C. annuum*, *C. Chinese*, *C. baccatum*, *C. frutencens*, and *C. pubescens*. It is extremely difficult to maintain purity of any cultivar for a long time. The crop is mainly raised from farmer-saved seed. The two major cultivar groups of hot pepper grown in the country are bird eye hot pepper group which represents the most pungent hot pepper grown for the fresh market as well as for processing into dry hot peppers. The fruit size is rather small, 2-3.5 cm long and, Indian group characterized by a dark green type of hot pepper fruits highly adaptable to hot and

humid areas. The fruit length reaches 5-10 cm. popular name of this group is red pepper. This study dealt with the latter type, namely the red pepper.

MATERIALS AND METHODS

Description of study area

The study was confined to Buzaya County which is located in Kamuli district. The district covers an area of 4,86 km^2 of land (Figure 1). It lies on the central plateau between 1000 and 1200 m above sea level. The topography is characterized by extensive uniform undulating plains with few residual features and scattered anthills especially in the southern part. The soils are deep, well drained to poorly drained and contain high to moderate organic matter contents. They are weakly developed over sands, gravel and boulders and mainly consist of silt, sand and clay. Free draining nature of this soil has long moisture deficit period. pH of soil ranges from 5.0 to 7.0. The annual rainfall varies from 900-1200 mm with two marked dry seasons and the average temperature ranges between 22.6^0C to 24.6^0C. The study area has a population density of about 230 persons per km^2 and the growth rate is 2.3%. Subsistence agriculture is the major economic activity employing about 84% of population (UBOS, 2002). The bulk of agricultural production is from manually cultivated rain fed crops. The range of rainfed crops vary with greater potentials for maize, banana, beans, cassava and sweet potatoes. Generally, inter-cropping is a prevalent practice in Uganda (Seriri and Bekunda, 2001; Buyinza and Mukasa, 2007).

Site selection

Sites were selected in consultation with the District Agriculture Advisory Services (NAADS) Officials, local farmers and self-observation. In-depth studies were conducted from April to September 2005 in the three parishes of Bugulumbya, Kasambira and Nawandhyo of Buzaya County. The parishes are located on the Jinja-Kamuli highway. Buzaya County was selected as a study area because of the diverse social, economic, cultural, religious, rural characteristics found in the Busoga region. Buzaya County consists of predominantly peasant population. The climate allows for the cultivation of a variety of food such as beans, maize, cassava in addition community forestry is practised. Small-scale farming is a common feature and women involvement in community forestry activities is quite pronounced.

The common tree species found in the landscape include *Eucalyptus* spp. (kalitunsi), *Markhamia lutea* (omusanvu), *Erythrina abyssinica* (ekikoo), *Ficus natalensis* (ekikooma), *Acacia mearnsii* (black wattle) and *Acanthus acanthae*. These are tree used as firewood, boundary markers and are commonly mixed with crops. *Cupressus lusitanica* (kakwenda) and *Pinus* spp in farming systems are used for shade in some compounds and eventually timber. *Grevillea robusta*, *Causuarina equsetifolia* (kasarina) and *Alnus acuminata* are becoming very popular species for soil erosion control, fodder, firewood, poles and stakes for climbing beans (Bamwerinde 2004). Some large but heavily degraded plantations of Cupressus and Pinus species exist in the area. Common fruit trees include *Mangefera indica* (Omuyembe), *Persea Americana* (ovacado), *Tamarindus indica* (mukoge) and *Citrus sinensis* (omucungwa). Fodder trees like *Calliandra calothyrsus* and Leucaena trichandra are managed and conserved as farm hedges to improve animal nutrition. Fertilizer trees and woody species include *Sesbania sesban* (sesbania), *Glicidia sepium* (Mexican lilac), *Tephrosia candida* (tephrosia), *Desmondium uncinatum* (desmodium), *Cajanus cajan* (pigeon pea), *Crotalaria grahamiana* (crotalaria) (Buyinza and Mukasa, 2007).

With the decline in commodity prices of farmer's principal cash crops such as coffee, farmers are increasingly viewing timber and aromatic crops such as hot pepper as viable cash generating enterprises. Out of these potential tree species on cropland, *Grevillea robusta* + *Ficus natalensis* + hot pepper was purposively selected for the study because, *Eucalyptus* + *Markhamia lutea* + hot pepper intercropping has not equally been successful from the productivity point of view. Secondly, farmers prefer *Ficus natalensis* as it is an indigenous and multipurpose tree crop and yet farmers want trees with multiple functions. Farmers in this region call Grevillea "the friend of crops" and have therefore intensified its production. Besides, leaf is acidic in nature which may have some negative effect (increased acidity) on soil nutrient and productivity of hot pepper. Further, the propagation of Grevillea is simple and easier in comparison to Eucalyptus.

Data collection

The primary data based on the questionnaire was collected through conducting Rapid Rural Appraisal (RRA) in 2000. The key informants and particularly those farmers involved in pepper intercropping were consulted to collect information on cultivation, production, income, and marketing of hot pepper. Some of the information was obtained during field observation as well. To make a comparison, data on price of different produce, labour and transportation was obtained in 2005.

Soil sampling and analysis

Soil samples (15 cm topsoil) from five locations, four from corners and one from the centre in the selected plots were taken with the help of a soil auger. These five samples were mixed and composite samples were made. Altogether 10 composite soil samples were analyzed by standard methods in the laboratory. Hydrometer was used for soil texture analysis, Digital pH meter for determination of pH, Kjeldahl for Nitrogen, Colorimeter for Phosphorous and Spectrophotometer for other nutrients.

To maximize benefits, some farmers add organic matter before transplanting. One commercial farmers had applied fertilizers at the rates of 60-100 kgs Nitrogen, 10 kgs phosphorous, 100 kg potash and had got over 4 tons per hectare in the previous season.

RESULTS AND DISCUSSION

Result of analysis of soil samples revealed five different types of soil in the area as follows: Sands, gravel, boulders, excessively drained soil; Pale deep yellow silt clay, calcareous, moderately drained soil; Grey brown sandy loam, sandy clay over yellowish brown, silty clay loam over sand, moderately drained soil; Sandy loam, slightly calcareous soil and Sandy loam, loamy sand over sand, excessively drained, calcareous soil.

The chemical analysis of the soil samples gave following results: pH= 4.7-7.0, Phosphorus (P)=16-69.9 ppm, Nitrogen (N)=0.1-0.25%, Carbon (C)=1-1.3%, Calcium (Ca)=1.5-12 meg/100gm and Potassium (K)=1-0.5 meg/100gm.

Well drained sandy loam or loamy sand was good for the production of hot pepper in the agroforestry system. There was no significant difference among soil nutrients and their effect on pepper production. The soils in the area have very good potential for tree growth. They also favor agricultural crops but their nature of excessive drainage limits cultivation of some agricultural crops in the area.

We also discovered that bacterial spot is the most common disease in the field. Other diseases include phytophora root rot and gray leaf spots that affects the ripe fruit and reduces marketability. Proper crop management, use of disease-free seed and prevention of its spread from affected plants by spot spraying can minimize losses.

Hot pepper is subject to damage from many insects, nematodes and fungal, viral and bacteria pathogens. In Buzaya county, the major pests found were thrips, aphids, mites, and the hot pepper pod borer. Production can be further developed if good cultivars are identified and quality seed is made available to traditional areas. Hybrid pepper has been only partially successful due to the high price of seed and low pungency. The main supply of seeds are farmers themselves, however, of recent germplasm collections are maintained by the Kawanda National Agricultural Research Institute. Ongoing breeding programs are mostly for yield, earliness, pungency, flavour and colour. Some particular seed is obtained from Uganda Export Promotions Board and is suitable for harvesting for 2-3 months, therefore, with an extended harvesting period of 8 months, farmers still have to rely on old seeds.

Comparison of hot pepper cultivation with other crops under agroforestry

Agroforestry system being practiced in Buzaya County was horti-silviculture system. Major agricultural crops such as maize and beans are raised in the area as intercrops in farming systems together with trees. Most pepper production in Uganda is mainly rain fed. If natural rainfall is lacking, supplementary irrigation is required. To achieve maximum production, the plant should have sufficient moisture during fruit setting. The average yield of these commonly raised agricultural crops is given in Tables 1, 2, and 3 to compare with pepper cultivation (Table 5) and to judge in terms of yield and its viability.

Maize

Maize is one of the major food crops grown in the project area and adjoining village area. It is widely cultivated with traditional techniques of seed sowing/broadcasting during monsoon mostly using self-saved seed and labor. The average maize production in SFDP under agroforestry system was found to be 1.03 ton per ha during the first and second year of plantation of Crotalaria. The cost of production and benefit of maize cultivation (per ha) in the year 2000 and 2005 are given in Table 1.

Table 1. The cost of production and revenue (in US$) from maize cultivation (per ha)

S.N.	Particulars	Quantity	Year 2000		Year 2000	
			Rate	Cost	Rate	Cost
1	Removal of tree roots, leaves and seed using hand tool	20 man-days	0.56/man-day	1.11	0.56/man-day	1.11
2	Seed	15 kg	0.08/kg	1.25	0.13/kg	2
3	Light weeding (cutting of climbers and broad leaved re-growth)	8 man-days	0.44/man-day	3.56	0.44/man-day	3.56
4	Harvesting, plucking & removal of maize stick	20 man-days	0.56/man-day	1.11	0.67/man-day	13.33
5	Transportation-bicycles (3 km)	10 trips	4.17/trip	4.17	5.56/trip	5.56
6	Threshing (removal of scale only)	15 man-days	0.56/man-day	8.33	0.83/man-day	5.56
	Total cost			67.03		91.11
7	Average Production	2200 kg/ha	0.19/kg (local market price)	427.78	0.26/kg (local market price)	562.22
8	Benefit			360.75		471.11

Beans

The area after maize harvest was manually cultivated with mixed cropping of Beans. Further observation was made to estimate the maize and beans production and the actual costs of production in one ha in 2000 and 2005 (Table 2).

Table 2. The cost of production and revenue (in US$) from beans cultivation (per ha), Costs and rates given in US$

S.N	Particulars	Quantity	Year 2000		Year 2005	
			Rate	Cost	Rate	Cost
1	Seed	10 kg	0.25/kg	2.50	0.28/kg	2.78
2	Site prep, weeding and thinning cost	-	-	-	-	-
3	Harvesting	5 man-day	0.56/man-day	2.78	0.56/ man-day	2.78
4	Transportation by bicycle	4 trips	0.56/trip	2.22	0.83/ trip	3.33
5	Threshing by labors (cost)	4 man-days	0.56/man-days	2.22	0.67/ man-day	2.67
6	Total cost			9.72		11.56
7	Av. production (Stumpage Price)	1500 kg/ha	0.28/kg	416.67	0.36/ kg	541.67
8	Benefit			406.94		530.11

The net profit from the combination of intercropping with maize and beans per ha under agroforestry was US$. 768/= and US$. 1001/= in 2000 and 2005 respectively (presented in Table 3). Thus, there was an increase by 30 percent in net profit from the combination of intercropping in 2005 as compared to in 2000.

Table 3. Comparison of annual profit (US$) from cultivation of maize and beans per ha, 2000 and 2005

Crop production	Year 2000		Year 2005	
	Gross profit	Net profit	Gross profit	Net profit
Maize 2200 kg	427.78	360.75	562.22	471.11
Beans 3000 kg	416.67	406.94	541.67	530.11
Total	844.44	767.69	1103.89	1001.22

Hot pepper marketing opportunities

Market price of fresh chilli and dried hot pepper is very fluctuating. Therefore, the average costs for both 2000 and 2005 were taken. Estimated hot pepper production and the actual costs of production in one ha in 2000 and 2005 is presented in Table 4. The cost of production increased from US$. 66 to US$. 100 and the benefit from US$. 934 to US$. 1233 from 2000 to 2005. The hot pepper which Uganda is producing, is a product consumed mainly by the

small Asian, Carribean and other immigrant ethnic market in the UK and Holland. This is a small product whose market could easily be saturated when Ugandan production more than doubles in a season.

Table 4. The cost of production and benefit (US$) of hot pepper cultivation (per ha)

S.N.	Particulars	Quantity	Year 2000		Year 2005	
			Rate	Cost	Rate	Cost
1	Seed	100 kg	0.10/kg	10.00	0.14/kg	14.44
2	Site preparation, weeding and thinning cost	15 man-days	0.44/man-day	10.00	0.14/man-day	14.44
3	Harvesting	10 man-days	0.56/man-day	5.56	0.56/man-day	8.33
4	Transportation by bicycles	5 trips	2.78/trip	13.89	0.56/trip	27.78
5	Sowing	40 man-day	0.67/man-day	26.67	1.11/man-day	44.44
6	Total cost			65.56		100.00
7	Av. production (Stumpage price)	4000 kg/ha	0.25/kg	1000.00	0.33/kg	1333.33
8	Total			934.44		1233.33

Benefit/Cost Ratio (BCR)

The yields of all the crops vary considerably depending on a number of factors. The average expected yield is 4 to 6 tonnes per hectare. We observed that despite the lack of during the dry seasons which led to flower abortion, there was average production in the study area. Pepper cultivation provided highest net profit of US$. 934/ha in the year 2000 as compared to US$. 1,233/ha in 2005 followed by single crop of maize (US$. 361/ha in 2000 and US$. 471 in 2005) and beans (US$. 407/ha. in 2000 and US$. 530 in 2005). The total net profit from the cultivation of maize and bean in the same land was US$. 1001/ha in 2005 as compared to US$. 768/ha in 2000.

The BCR has been analysed in absolute and net ratio. BCR in both absolute and net values for maize and beans and combination of these crops and hot pepper cultivation have been presented in Table 5. The BCR of beans was found to be highest in Buzaya County in both absolute and net terms when compared with other crops for a single harvest of each and total for all crops. B/C ratio in net value of hot pepper was highest with 14.25 in 2000 as compared to 0.01 for all crops together, 5.38 for maize and 4.18 for beans. As the cost of investment increased in 2005, the net B/C ratio for hot pepper, and all crops together decreased to 12.33, 5.17 and 4.85 respectively.

Table 5. Benefit-cost ratio of different crops for single harvest and combination of maize and beans grown in the same land (in US$.)

	Cost		Benefit				B/C ratio			
Crops			Total		Net		Absolute		Net	
	Yr 2000	Yr 2005	Yr 2000	Yr 2005	Yr 2000	Yr 2005	Yr 2000	Yr 2005	Yr 2000	Yr 2005
Maize	67.03	91.11	427.78	562.22	360.75	471.11	5.38	6.17	5.38	5.17
Beans	97.22	115.56	416.67	541.67	406.94	530.11	4.25	5.57	4.18	4.85
Total	767.69	102.67	844.44	1103.89	767.69	65.56	1.09	10.75	1.01	0.63
Hot pepper	65.56	100.00	934.44	1333.33	934.44	1233.33	14.25	13.33	14.25	12.33

The marketing of fresh Chilli and dry hot pepper is done in two ways viz. trough the middlemen or sometimes traders directly collect hot pepper from farmers' fields. Also sometimes, farmers themselves carry hot pepper on bicycles to the nearby market points at Jinja, Kampala, Kamuli etc. on Jinja-Kampala Highway. From these markets, hot pepper is distributed to bigger markets like Kampala and Jinja. Small scale hot pepper producing farmers sell it in the local weekly markets called hat or bazaar. The price of hot pepper at field is lower than the market because of transportation, loading, unloading and other relevant costs associated with transportation to market areas.

The farmers sell their hot pepper mostly to assemblers, or at the local assembly markets (which are mostly held in villages along side a district road). Direct selling of pepper to consumers is only possible on small scale. Most big consumers buy only from assemblers because of the economies of scale of buying large volumes. This is because local demand for hot pepper is very limited; farmers sell their product to local assemblers, or at an assembly market. The assemblers sell hot pepper mostly to rural industries, because the profit of selling it to urban buyers is on average lower. The urban buyers may be industries, or market sellers who act both as wholesalers and retailers. Few

urban market sellers are involved directly in the transportation of their purchases from the assemblers in the production area.

CONCLUSION

Maize and Beans require full sunlight for better growth and yield. The farmers, therefore, grow these crops only for 2-3 years after plantation of Crotalaria under the agroforestry system. Hot pepper requires partial shade for better growth and yield and therefore, the agroforestry system provides an ideal condition for hot pepper cultivation. However, farmers realize that there is no difference in monoculture and intercropping of hot pepper, with respect to yield due to high manure requirement of crops for better production. Hot pepper cultivation under agroforestry system should be encouraged rather than monoculture of hot pepper in order to get maximum benefit from the unit of land and to fulfill other basic needs like fuelwood and timber.

The BCR was better for intercrops than for those planted alone. It is concluded that with appropriate crop management, optimal crop production and could be obtained. Intercropping benefits the short cycle crops, since agroforestry tree species protects them from heavy intense rains and winds, and also some management practices and some inputs are shared by both the crops, so costs are reduced.

The marketing system for hot pepper is middle man/stock holder oriented. Most producers sell their products to the middlemen. The consumers have less chance of interacting with producers for its purchase directly therefore, the maximum profit goes to the middlemen. There should be direct interactions between producers and consumers or traders. A cooperative society of hot pepper cultivators should be formed in order to provide maximum benefit to the cultivators rather than middlemen.

The BCR calculated for different crops and combination of maize and beans grown in the same land was the highest in case of hot pepper grown in Grevillea agroforestry system. Though the price of hot pepper is variable, it has gone up very high in the last 5 years in the market due to high demand. Therefore, it can be grown as a cash crop which can contribute to the livelihood and poverty reduction in Uganda.

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