Farmer perspectives on the use of indigenous fruit tree species in cocoa growing systems in Suhum-Kraboa-Coaltar District of Ghana

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ABSTRACT

Indigenous fruit trees are known to provide nutrition and income for rural households. *Chrysophyllum albidum*, which is used as a shade tree in cocoa farms in some parts of Ghana, is one of those multi-purpose trees. The objective of the survey was to explore farmers' knowledge and perceptions on the interactions between *C. albidum* and cocoa trees, its management and challenges faced. The study was undertaken in the Eastern Region of Ghana in which a structured questionnaire was used and 70 farmers participated. The study demonstrated that the use of *C. albidum* as a shade tree for cocoa is widespread in the area and that farm-owners were more likely to plant it than farm caretakers. The *C. albidum* trees provide economic gain to the farmer through the sale of fruits and so enable income diversification when cocoa yield is low. The study revealed farmers' perceptions on above- and below-ground interactions between cocoa and *C. albidum* trees. Most farmers in the study had technical problems and needed assistance in their agroforestry practice, particularly in seed and vegetative propagation. The results of the survey show the importance of a baseline study prior to drawing up a research programme to address the concerns of farmers.

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Introduction

Cocoa is a key source of income for a number of West African countries including Côte d'Ivoire and Ghana. It is typically grown under shade, and shade trees continue to be used as the upper canopy in cocoa cultivation in most countries (Asare, 2006, ICCO, 2010). Some cocoa farmers cultivate exotic or indigenous fruit trees as shade or companion trees to diversify their sources of income. Some exotic tree species could be invasive and, therefore, displace some local flora (Sala *et al.*, 2000) thereby undermining profitable environmental and ecosystem services (Rice & Greenberg, 2000; Klein *et al*., 2002; Wishnie *et al*., 2007). In the Suhum-Kraboa-Coaltar District of the Eastern Region of Ghana, farmers use an indigenous fruit tree, *Chrysophyllum albidum*, as a shade tree in cocoa farms. *C. albidum* G. Don (Family: Sapotaceae) grows to a height of 30 m or more and has buttresses (Taylor, 1960, Irvine, 1961). It typically has a straight stem and a compact crown which is evergreen. It bears auxilliary clusters of flowers in May to June. The fruits, which are globose in shape, change from green to yellow-orange when ripe in November to March. The fruit, which contains five seeds in a pulp, is edible and is sold in the local markets (Taylor, 1960; Irvine, 1961). The tree is found in the forest regions of Ghana

and is distributed from Sierra Leone to Kenya (Taylor, 1960; Irvine, 1961). Germination is epigeal. The wood can also be used for furniture and household items (Irvine, 1961).

The use of indigenous fruit trees in cocoa farms can help farmers obtain a more regular income particularly as the income obtained from cocoa is, to some extent, seasonal in West Africa (Degrande *et al*., 2006; Leakey, Schreckenberg & Technology, 2003). In some cases, the shade or companion crops generate more income per unit area than a mono crop (Gold, Godsey & Josiah, 2004, Snelder, Klein & Schuren, 2008). The use of indigenous fruit trees as shade trees has its uncertainties and risks as it often lacks established markets for its products (Gold, Godsey & Tosiah, 2004). The importance of a particular shade tree species may be site specific due to the prevailing local conditions (Alavalapati & Nair, 2001). Some tree species could be multi-purpose. For example, trees in cocoa plantations can provide the right level of shade as well as fulfilling household sale or consumption needs (Degrande *et al.*, 2006). The importance of an agroforestry tree can change with time (Puri & Nair, 2004). A tree grown for shade and its fruits sold to generate income may later provide timber when its shade spreads wider and become detrimental to the crop.

In addition to providing income, indigenous fruit trees are seen as low risk ventures as they do not require much capital input (Schreckenberg *et al*., 2002). The opportunity to market a particular fruit can push farmers to plant more trees (Degrande *et al*., 2006). Consequently, planting indigenous trees becomes more beneficial and sustainable if there is a local market for its produce, than trying to target distant/overseas markets which may be difficult due to trade barriers and other issues (Russell & Franzel, 2004).

A recent study has been carried out to assess farmers' knowledge, growth and competiveness of some timber tree species with cocoa trees in Ghana (Anglaaere, 2005). However, the use of indigenous fruit trees as shade trees in cocoa farms has not received attention. Hence, there is little information on the knowledge used in the management of such systems, or the benefits and the challenges to the farmer of growing indigenous fruit trees as shade trees in cocoa farms. Such knowledge is important so that appropriate research can be planned to solve problems, and to address the specific needs of farmers wishing to grow indigenous fruit trees.

The objective of the study was to analyse the knowledge of farmers on growing the indigenous fruit tree, *C. albidum* and how they apply this knowledge when using this species as a shade tree on cocoa farms. The study also tested the association of some questions used in the survey and the significance of these relationships.

Materials and methods

Study site

A survey on the socio-economic use of *C. albidum* as a shade tree in cocoa farms was conducted in villages and towns of the Suhum-Kraboa-Coaltar District of the Eastern Region of Ghana. Suhum-Kraboa-Coaltar District is 10 km west of Koforidua, the Regional capital. The district lies in latitude 5º 50' N to 6º 07' N and longitude 0º 18' W to 0º 39' W. The land area of the district covers 1018 km^2 (Assembly, 2006) and lies 60 km north-west of Accra and is in the

southern part of the Eastern Region of Ghana. Most of the farmers who took part in the survey were farm owners running family farms with few as caretakers who run the farms for ageing or deceased farm owners.

The study was carried out in the northern part of the district where *C. albidum* is one of the main trees used for shade in cocoa farms and for income generation. Although in some areas the tree is found planted near villages, the study focussed on trees found in cocoa farms.

Preparation and questionnaire administration

Initial visits were paid to the study area to establish contacts and build confidence with the chiefs, District Assembly representatives, farmers and traders involved in cultivating and trading in *C. albidum* fruits, and to explain the objectives and scheduled dates for subsequent meetings.

In the selection of farmers to participate in the survey, two farmers were selected at random in small villages (not more than 10 houses). In larger villages, a maximum of 10 farmers were selected at random. Farms belonging to participating farmers were visited to evaluate farm practices, and to determine the dominant shade tree species before pre-testing questionnaire. During each questionnaire session, the questions together with multiple answers were read to respondents in 'Twi' (local language). All questionnaires were administered in person. In some instances, answering of the questionnaire was in the form of a group discussion, where the respondents were accompanied by relations who contributed to the answering of the questionnaire.

The questionnaire comprised mainly of closed ended questions. There were also open ended questions which respondents gave varied answers. The questions provided socio-demographic data on the respondents such as age, level of education, marital status and size of cocoa farm. Background information was also obtained on acquisition of farm land, varieties of cocoa grown and source of labour. The types of shade trees grown were recorded and the farmers' perceptions of their importance were explored. Respondents were also asked about challenges they faced on their farms when growing *C. albidum*, if they needed technical support, the kind of support they needed and preferences on tree characteristics. Seventy farmers participated in the study which was carried out between October 2008 and January 2009.

Data analysis

Responses given by the farmers were entered into an Excel spreadsheet. The data were analysed using Genstat, 10th edition. Firstly, percentage frequencies of responses were calculated. Subsequently, contingency tables were calculated to determine associations between questions, and a chi-square test was performed to evaluate the significance of these relationships.

Results

Demographic characteristics of respondents

Majority of the respondents (72%) were more than 40 years old and most of them were married (81%). Eighty-four per cent of them had formal education (13% – Primary School education; 50% – Middle School education; 14% – JSS education; 1% – SSS education; 6% Tertiary education) (Table 1). A relatively small number of the respondents

(16%) had had no formal formal education. The cocoa farms were tended to mostly by farm owners (76%) with caretakers accounting for 24% (Table 1).

Land acquisition, age and size of cocoa farms

The majority of the farmers (81%) indicated that they were using family land, whilst 15 per cent were sharecropping and 6 per cent had bought the land (Table 2). A large proportion of the cocoa farms (57%) were more than 50 years old (Table 2), whilst 17 per cent of farms were established 20 years ago. The majority of the farms (61%) were between 1.2 and 4 ha in size, whilst 24 per cent were greater than 4 ha and 16 per cent were between 0.4 and 0.8 ha (Table 2).

Cocoa variety, source of labour and shade trees used

The majority of the farms (40%) were planted with traditional Amelonado cocoa whilst 37 per cent were planted with Upper Amazon hybrids, and 23 per cent were planted with newer Cocoa Research Institute of Ghana (CRIG) hybrids (Table 3). Half of the farmers combined use of family and hired labour, whilst 41 per cent used family labour alone and a small number (9%) used solely hired labour (Table 3).

Reasons for use of shade trees

The majority of farmers (46%) used mainly indigenous fruit trees as shade species (Table 3). Timber tree species were used by 27 per cent of farmers, whilst a further 27 per cent used mainly exotic fruit trees such as *Citrus* spp., *Mangifera indica* and *Persea americana*. Most farmers (60%) indicated that they used shade trees to protect cocoa trees from the direct rays of the sun, whilst 36 per cent used shade tree as a

Table 1

Demographic Characteristics of Respondents in a Survey in the Suhum-Kraboa-Coaltar District of Ghana

Age	*%*	*Marital status*	*%*	*Education*	*%*	*Ownership status*	*%*
21-30	14	Married	81	Never attended school	16	Farm owner	76
31-40	14	Unmarried	10	Primary School	13	Caretaker	24
41-50	20	Widow	6	Middle School	50		
51-60	16	Widower	3	Junior Secondary	14		
61-70	13			Senior Secondary	1		
71-80	17			Tertiary Institute	6		

n = 70

Table 2

Characteristics of Cocoa Farms

Mean of land acquisition	*%*	*Age of cocoa farms (years)*	*%*	*Size of cocoa farm (Ha; n = 63)*	*%*
Family land	81	1 - 10	7	0.4 - 0.8	16
1:2 share cropping	9	11 - 20	10	1.2 - 1.6	32
1:1 share cropping	6	21 - 30	17	2.0 - 4.0	29
Outright purchase	4	31 - 40	6	>4.0	24
		41 - 50	3		
		>50	57		

Values refer to percentage of respondents (n = 70, except where stated)

TABLE 3

Variety of Cocoa Grown, Source of Labour and Characteristics of Shade Trees.

Variety of cocoa grown	*%*	*Source of labour*	*%*	*Type of shade tree used*	*%*	*Reasons for use of shade trees*	*%*
Amelonado	40	Family and hired	50	Indigenous fruit trees	46	Protection from direct sun rays	60
Upper Amazon hybrids	37	Family	41	Exotic fruit trees	27	Income generation	36
CRIG hybrids	23	Hired	9	Timber and non-timber trees	27	Nutrition	1
						Timber	1
						Other	1

Values refer to percentage of respondents (n = 70)

source of income generation to support income from cocoa beans (Table 3).

Pest and disease transmission and protection

Majority of farmers (57%) considered that *C. albidum* trees did not transfer pests and diseases to cocoa trees and 37 per cent were unsure (Fig. 1). However, a small number of the farmers had noted red ants (*Oecophylla* spp.) on *C. albidum* trees that could transfer to cocoa trees although the insects are thought to be harmless to the trees.

Yield and root competition

The majority of farmers (51%) had not noticed any effect of *C. albidum* on yield of cocoa, whilst 36 per cent believed that

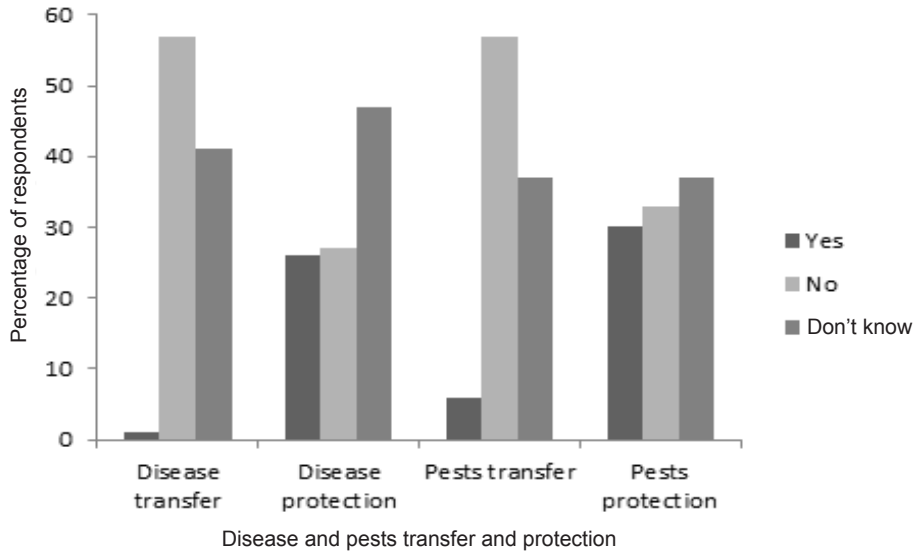

Fig. 1. Farmers' perceptions as to whether pests and diseases are transferred from *C. albidum* to cocoa or whether *C. albidum* provides protection from pests and diseases

C. albidum fruit trees did have effect on the yield of cocoa trees (Fig. 2). Most farmers (81%) considered there was no competition between *C. albidum* tree roots and roots of cocoa trees for soil water and nutrients, or did not know whether there was competition or not (Fig. 2), whilst 19 per cent thought that there was competition between the roots of the two tree species.

Background to the planting of C. albidum *trees*

Most farmers (46%) cultivated *C. albidum* trees in their cocoa farms to generate and diversify income to support what they get from the sale of cocoa beans. A further 15 per cent of farmers included the provision of shade to cocoa in addition to income generation, whilst 13 per cent included nutrition in addition to income generation. A small number (8%) gave reasons ranging from being planted by their forefathers to being a volunteer tree on their farms.

Challenges, support and preferences

Eighty per cent of the farmers found it difficult to germinate seeds of *C. albidum* (Fig. 3) and 94 per cent indicated that they needed support in cultivating this species (Fig. 3). On the type of support needed, 62 per cent preferred technical support, 36 per cent needed financial support and one per cent required support in other areas. Whilst 71 per cent of the farmers felt that they were comfortable with the use of *C. albidum* fruit trees as a shade tree in their cocoa farms, 29 per cent believed they encountered a number of challenges, including difficulty in raising planting materials and pruning of the trees as the trees can get quite high. Most of the farmers (88%) did not want to fell *C. albidum* trees, whilst 12 per cent indicated that they will fell *C. albidum* trees when they become big. Sixty-three per cent of the farmers prefer short *C. albidum* trees, 31 per cent wanted intermediate height, whilst 4 per cent preferred tall trees.

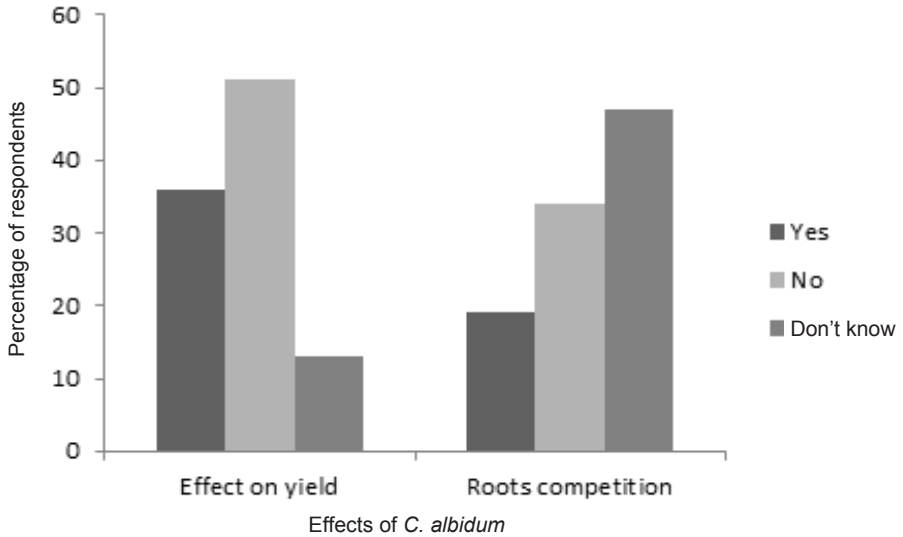

Fig. 2. Farmers' perceptions of the effect of *C. albidum* on yield of cocoa and competition with roots of cocoa in the Suhum-Kraboa-Coaltar District of Ghana (n = 70)

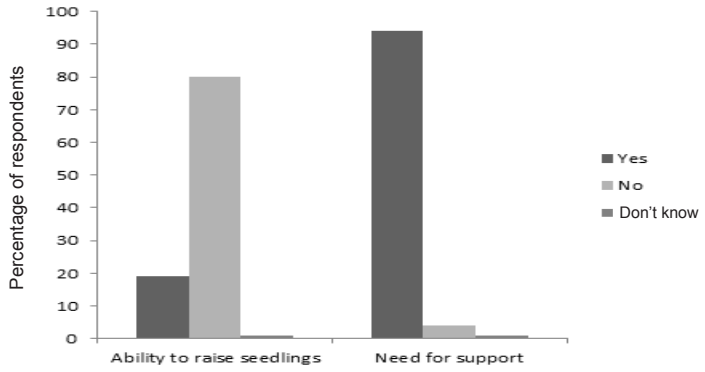

Fig. 3. The ability of farmers to raise seedlings of *C. albidum* and the requirement of farmers for support (n = 70)

Association of some characters using contingency tables

Some characters or questions were paired in a contingency table. These were later subjected to chi-square test to determine the significance of the association. Chi-square tests on the following pairings were significant:

- Ownership status of the farm and the person who planted the *C. albidum* trees ($P = 0.046$).
- The age of the cocoa farm and variety of cocoa grown ($P = 0.004$).

The relationship between the person who planted the *C. albidum* trees and the ownership status of the farm indicated that it was farm owners who tended to plant the fruit trees (Table 4). The results also indicated that farms that were established 21-30 years ago or older were mainly planted with the old cocoa varieties of Amelonado and Upper Amazon hybrids (Table 5). The younger farms mainly used recently introduced CRIG hybrids. In contrast, some old cocoa farms had been re-planted either partially or wholly with CRIG cocoa hybrids (Table 5).

TABLE 4

A contingency Table of Association of Ownership Status of the Cocoa Farm and the Person who Planted the Fruit Trees

Ownership status	*Person who planted fruit trees*			
	Farmer	*Inherited*	*Not known*	*Other*
Caretaker	8	7	2	0
Farm owner	33	17	0	3

TABLE 5

The Frequency of an Association Between Age of Cocoa Farm and Variety of Cocoa Grown

Age of cocoa farm	*Variety of cocoa*		
	Amelonado	*Upper Amazon hybrids*	*CRIG hybrids*
1-10	0	3	2
11-20	1	0	6
21-30	6	3	3
31-40	1	3	0
41-50	1	1	0
>50	9	16	5

Discussion

In most cases, indigenous tree species have been neglected in agroforestry practices (Wishnie *et al*., 2007). However, the study has shown that local communities can practise traditional agroforestry using indigenous species.

Results of the survey showed that most farmers had some level of education and 6 per cent of the farmers had tertiary education (Table 1). Those with tertiary education were retired public and civil servants who had taken up farming. During the survey,

it was observed that the higher the level of education the better the farming practices adopted, i.e. regular clearing of weeds and application of right agrochemicals leading to a more productive farm.

Given the small size of cocoa farms as noted in the survey (Table 2), cocoa alone may not be able to give the farmers sufficient income for the year. To compensate for this, farmers in the area tend to plant *C. albidum* trees in their cocoa farms. Results provided by 10 farmers in the survey (most of the farmers were not willing to divulge how much they earned from the sale of cocoa beans and *C. albidum* fruits) indicated that fruits on a medium sized *C. albidum* tree (30-45 cm diameter at breast height, dbh) was sold for GH¢ 50.00 (US$33.00) in January 2010. However, fruits on a big tree (> 45 cm dbh) could sell for GH¢ 100.00 (US$67.00). A hectare of cocoa farm could contain about five medium and three large trees of *C. albidum.* In the District where the study was conducted, a farmer harvests an average of seven bags of cocoa per hectare (Bosompem *et al*., 2007) and a bag of dried beans of cocoa was sold for GH¢ 150.00 (US$100.00) in 2009. Based on this data a farmer could generate about 50 per cent additional income from the sale of fruits.

Most farmers plant *C. albidum* trees in their cocoa farms for income generation through the sale of its fruits. In addition, 27 per cent of the respondents used mainly exotic fruit trees like *Citrus* spp., *Mangifera indica* and *Persea americana* as shade trees instead of the traditional timber tree species to diversify their crops. Income diversification is important to generate a sustainable income from the farm at all times of the year when the sale of cocoa beans had subsided. Most farmers were comfortable with growing cocoa and *C. albidum* trees together and did not think, or were not aware, that *C. albidum* fruit trees either transferred diseases or pests to cocoa trees or protected cocoa trees from disease attack. Some farmers did note that red ants (*Oecophylla* sp.) could be found on *C. albidum* trees, and that such ants could transfer to nearby cocoa trees where they prevented cocoa mirids (*Distantiella theobroma* (Dist.)) and (*Sahlbergella singularis* (Hagl.)) from attacking the cocoa trees. This observation agrees with that reported in ICCO, 2010.

Although the majority of farmers considered that there was no effect of *C. albidum* trees on the yield of cocoa trees, 36 per cent believed there was effect on the yield of cocoa. According to these farmers, extensive and dense canopies could reduce the yield of cocoa trees underneath. This observation supports an earlier model prediction (Zuidema *et al*., 2005) that excessive shade leads to a decline in yield. Other farmers believed that lateral shade provided by the fruit trees improved the yield of the cocoa trees.

Most farmers found it difficult to tell whether there was below ground competition between the roots of cocoa and *C. albidum* trees. However, some farmers thought that there was probably competition judging from the poor yield of some of the cocoa trees under dense canopies of some of the shade trees. However, this could equally be due to inadequate light for photosynthesis.

Most farmers would not fell their *C. albidum* trees for use as timber. This could be due to economic gains derived from bigger trees which would command higher price. However, a small number of respondents (12%) were of the view that it was difficult

to harvest fruits from tall trees, and their wide canopies reduced cocoa yield and so, in such cases, they would fell the trees and get them sawn into lumber for local use, and then plant new seedlings in place of the felled trees. This would allow the cocoa trees under the felled fruit trees to flourish and also give the farmer additional income from the sale of the lumber.

The majority of farmers said that they had difficulty raising substantial seedlings of *C. albidum* for cultivation, and that they needed technical support in their agroforestry practice. The seed has a hard seed coat which makes it difficult for it to imbibe water for germination. It is, therefore, not surprising that most farmers found it difficult to germinate seeds of *C. albidum* and, therefore, the need to provide them with seedlings. Although most farmers opted for short or intermediate *C. albidum* trees for ease of harvesting, these would not serve as good shade trees (Asare, 2006). A few farmers did opt for tall trees that rose well above the cocoa trees to serve as good shade trees. These trees would have more branches as they grow and bear more fruits, giving the farmer more income per tree if fruits could be harvested.

The results showed that more farm owners planted fruit trees than caretakers. This is an investment decision on the land, and the farmer has to weigh up the cost and benefits of the *C. albidum* against other crops, fruit trees or timber trees. Caretakers could be told by their farm owners to plant *C. albidum* trees, or they could consult their farm owners on the planting of *C. albidum* trees in the farm especially when the economic benefits are high.

The survey of farmers involved in the cultivation of *C. albidum* in the northern part of Suhum-Kraboa-Coaltar District in Ghana revealed an aging farmer population. The survey also showed that farmers could gain more income with cocoa intercrop than depending solely on cocoa. Therefore, educating the next generation of farmers into the potential benefits of intercropping may help to make cocoa farming more attractive, particularly if combined with financial help for start-ups and better availability of equipment. Furthermore, the use of hybrid cocoa, as seen in the study on younger farms will also contribute to a higher household income.

Conclusion

The survey has shown that the use of indigenous fruit trees in cocoa farming systems is acceptable and also financially rewarding. The study has also shown that although the farmers were doing their best to diversify and generate additional income to support their earnings from the sale of cocoa from their small holder farms, they face challenges such as seed germination which need to be addressed.

Most farmers did not have the ability to raise seedlings and most indicated that they needed technical support. These needs were not met by agricultural extension officers and researchers because of a lack of availability of biophysical data on *C. albidum* and its interactions with cocoa. Such data would enable agricultural extension officers to give managerial advice to farmers. These challenges and preferences need to be addressed in order to help the farmers in their agroforestry practice.

The Ministry of Food and Agriculture (MoFA) should capture into the national

economy the contribution of indigenous fruit trees, and provide the necessary help and incentives to the farmers who cultivate these species. Further studies should be carried out on the different products of the fruits so that farmers get maximum benefits for cultivating the fruit trees.

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