Analyzing Constraints for Replanting Aged Cocoa Trees with Hybrid Cocoa Varieties among Smallholder Farmers in Asamankese District of Eastern Ghana

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Acknowledgment

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List of Abbreviations

ICCO	International Cocoa Organization
LBC	Licensed Buying Company
Cocobod	Ghana Cocoa Board
CRIG	Cocoa Research Institute of Ghana
NCP	Nestlé Cocoa Plan
PPP	Private Public Partnership
SPU	Seedling Production Unit
MMYE	Ministry of Manpower, Youth and Employment

Abstract

This research studied the constraints for replanting aged cocoa trees with hybrid cocoa varieties among Nestlé supplier cocoa farmers in Asamankese district in Eastern Ghana. The confectionery industry, the government and various public private partnerships acknowledge aged cocoa farms as one of main challenges of cocoa supply chain causing low productivity and decreasing incomes for growers. Nestlé, as one of lead firms of global cocoa chain the commissioner of this research, set up its own Nestlé Cocoa Plan with new variety development and promotion objectives and is interested to understand insights into farmers' experiences and perceptions about new hybrid cocoa varieties as well as factors that influence farmers' decisions to replant or keep aged cocoa trees. Therefore this study aimed to reveal existing situation in terms of productivity and relationship between age of cocoa trees and yields, farmers' opinions about differences between hybrid and traditional cocoa varieties and what encouraged and discouraged replanting aged and low productive cocoa trees and doing so with hybrid varieties.

To obtain the insights, the research used quantitative survey method of 90 stratified but randomly selected farmers with the following selection criteria: at least 1ha and at least 25 years or older cocoa farm. According to initial consultation with cocoa buying company, Armajaro, there were total of 450 such farmers in Asamankese district and we interviewed 90 of them. Questionnaire was designed in such a way to reveal

1. farmer demographics,
2. farmer resources,
3. current farm performance,
4. comparative opinions between hybrid and traditional cocoa varieties
5. and farmers' opinions about constraints for replanting aged trees

The findings showed that economic reasons and particularly the loss or lack of income were the main constraints for replanting aged but still bearing trees among all types of farmers regardless of gender, education and resources. In the mean time we found that the farmers were replanting and doing so with hybrids only in cases of totally dead and unproductive trees. However, it was not possible to establish some clear indicator which would suggest high likelihood of replanting action. While economic reasons explain awareness and inaction, the action to change the situation is a result of more complex interaction of social, cultural, economic and other factors which cannot be clearly defined or assumed.

The survey also revealed high rate of hybrid cocoa adoption as 82% of surveyed farmers have already planted them at various scale in their farms. The interesting and possibly new finding was that farmers do not view hybrid cocoa varieties as superior to older varieties in every key characteristic particularly in disease and drought resistance.

Chapter 1: Introduction

1.1. Cocoa Supply Chain

Cocoa is the key raw material for confectionery industry and according to statistics 4.3 million tonnes of cocoa beans was produced during 2010/2011 campaign season (ICCO, 2011). 75% of this quantity was produced in West African countries and Ghana in particular produced 1.02 million tonnes or 23% of global annual cocoa production. Ghana, for decades has been second biggest cocoa producer country despite fluctuating annual crop volumes. For comparison, in 2009/2010 production season, Ghana produced 632 thousands of tons of cocoa beans which is 38% less than figures for following season. According to ICCO this difference within one year should be explained mostly by weather related factors and not so much as an effect of significantly improved cultivation practice. Another reason contributing to such difference can be large recently planted areas coming into their first or pick productive periods. One more factor could be smuggling of cocoa beans from Cote d'Ivoire due to occasionally higher cocoa bean prices paid in Ghana by government regulated cocoa marketing board.

Globally as well as in Ghana cocoa is smallholder farmers' crop. There are about 5.5 million smallholder cocoa farmers and about 14 million dependants worldwide. 98% of these farmers own less than 5ha. The growing, harvesting, fermenting and drying are all done manually and labour demand is high (Cocoa Barometer 2012). In Ghana as well as other West African countries, small holder farmers sell their cocoa beans to traders (In Ghana Licensed Buying Companies (LBC) which then supply grinders. Grinders produce semi-finished products such as cocoa liquor, butter and supply confectionery industry which makes final consumer products and retailers then sell them to consumers.

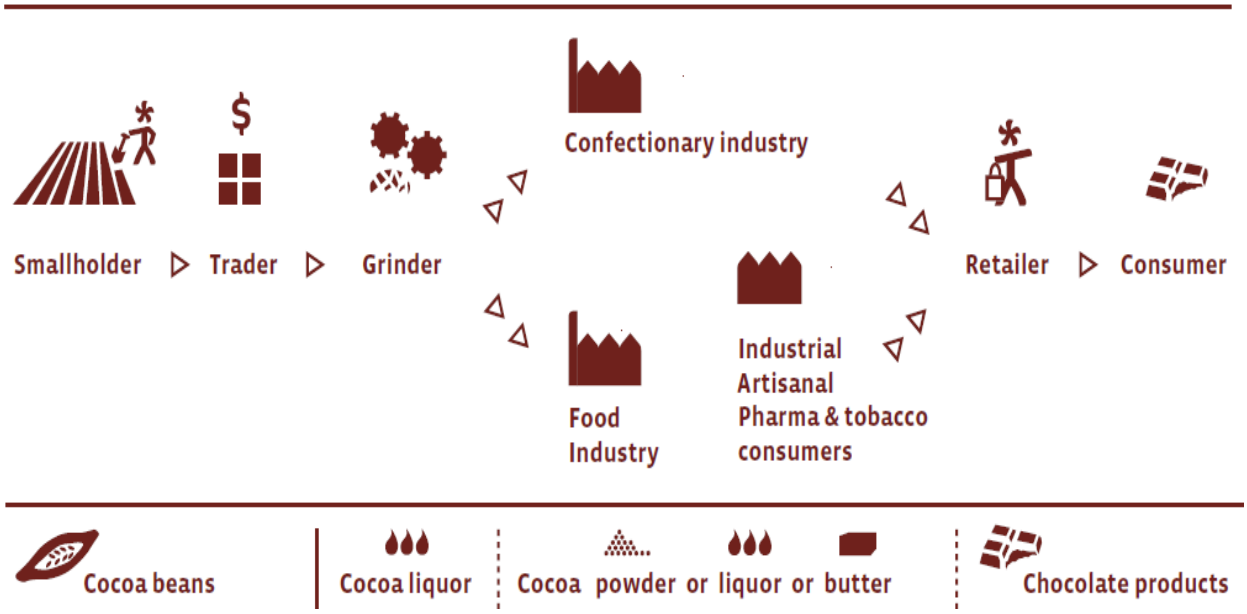


Figure 1: Cocoa Supply Chain Map (Source: The Cocoa Barometer 2012)

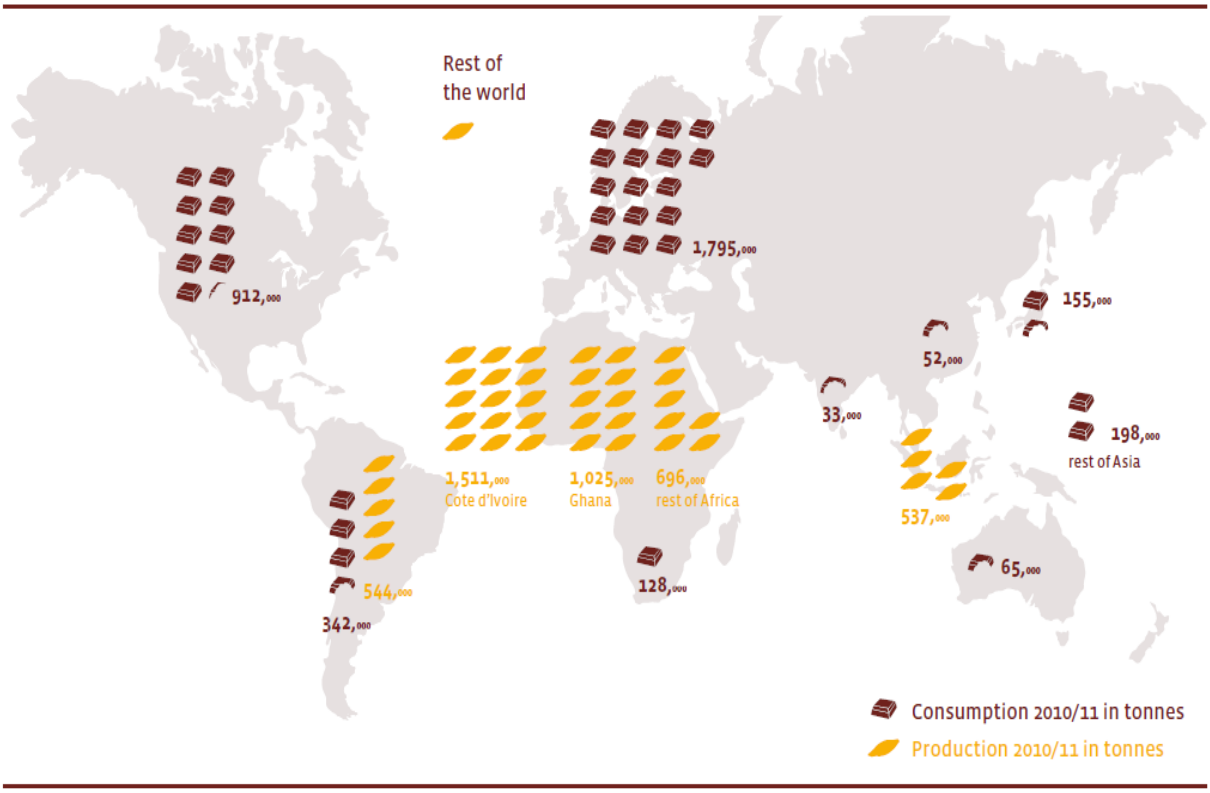
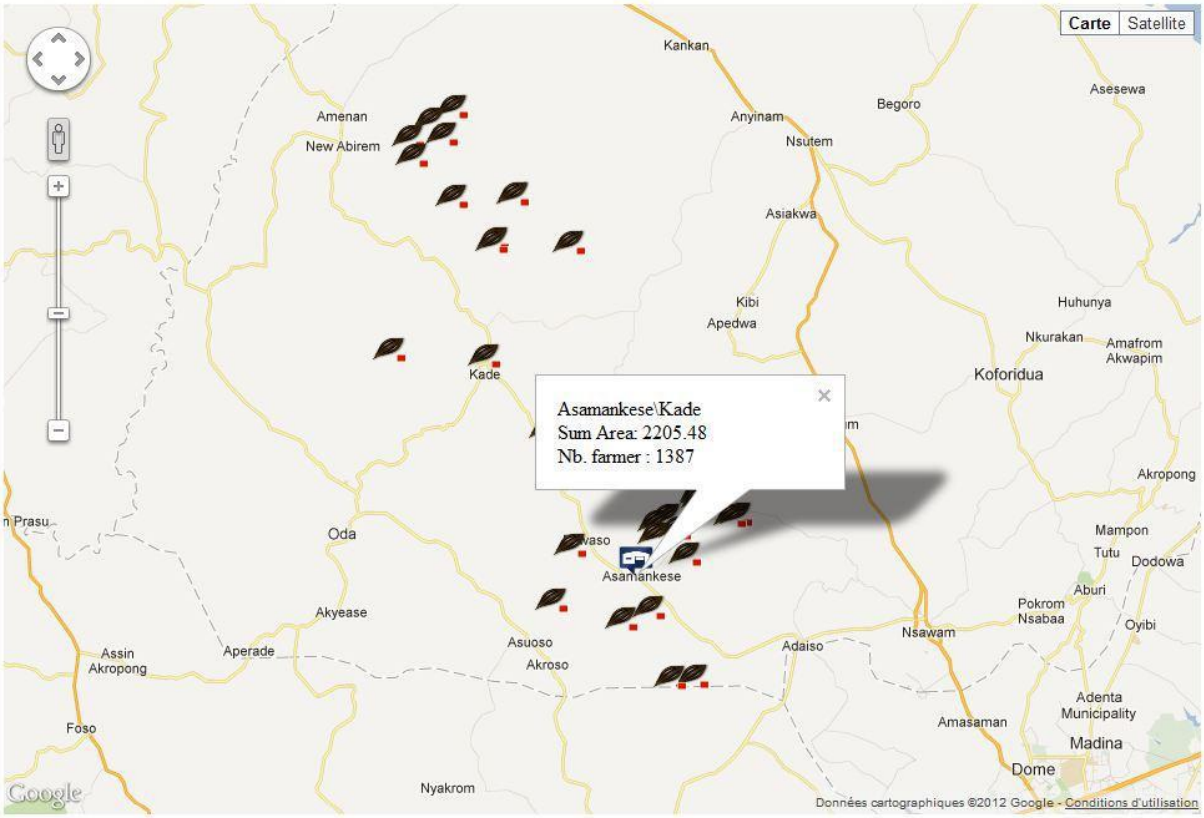


Figure 2: Production and Consumption Geography of Cocoa (Source: The Cocoa Barometer 2012)

1.2. Our Research Location

In Ghana cocoa production occurs mostly in forest agro-ecological zones and particularly in following 6 regions: Ashanti, Brong-Ahafo, Central, Eastern, Western, and Volta regions with about 800 000 smallholder farming families majority of whose farm sizes range from 0.4ha till 4ha (Anim-Kwapong and Frimpong. 2004). The cocoa growing started in the eastern part and gradually penetrated the centre and the west of the country. New cultivation areas followed suitable rain forests and also farmers found it easier to abandon old orchards and move to western parts, clear forests and set up cocoa orchards (The World Bank, 2012)

Our research will focus on Eastern region of Ghana and particularly on villages which make up Asamankese district. Almost no previous academic research on cocoa has been performed in this district but the lack of literature is partially compensated by cocoa supply chain actors' private farmer survey which was executed by Geotraceability Ltd for Armajaro ltd and Nestlé S.A. in 2012. The data set covers 29 villages which host 1387 farmers with 2295 cocoa fields on 2205ha of land. These farmers sell their cocoa to Armajaro Ltd which then supplies them to Nestlé S.A. Nestlé considers these farmers as members of one of its own cocoa supply districts and tries to understand technical, demographic, social and economic conditions of farmers to define problems in the supply chain and learn what can be done to address these problems. The database shows land size, farmer gender and farm age distribution, land tenure and previous land use patterns, cocoa varieties planted, percentage of farmers using various cultural practices, scale of various pest and disease proliferation etc.



Map 1: Cocoa Fields in Asamankese District (Source: Geotraceability ltd, 2012)

Chapter 2: Literature Review

2.1. Persistent Problems in Cocoa Supply Chain: Causes and Effects

Ghana's cocoa supply chain is a host of interdependent and aggravated problems. For decades increasing demand for cocoa was met with expansive agricultural methods of clearing forests and planting cocoa trees. During 1990s Cocoa acreage expanded by 9% annual rate, mostly at the expense of forests. From 1988 to 2010 total cocoa farm size increased from abt. 700 000ha to 1 625 00ha. (Gockowsi, 2011). This expansion was facilitated by government's policy and particularly by the Cocoa Rehabilitation Project (CRP) which was itself part of Economic Recovery Program (ERP) launched in 1983 (African Development Bank, 2002). In a period between 2001 and 2010 The upward trend in the producer price also supported by the government have further provided incentives for farmers in Ghana to expand cultivated land, leading to more losses of forestall area (Ofori-Bah and Asafu-Adjaye, 2011). These developments caused environmental problems in the sector.

While expanding and causing environmental problems, cocoa farming could not so far improve livelihood of one its key stakeholders, the farmers. According to The Cocoa Barometer 2012, average annual income of cocoa farmer in Ghana is 1070US$ which is well below absolute poverty line which it cites at 2281US$ for Ghana. A randomized survey of 3000 cocoa farmers by Hainmueller et al in 2009, covering 335 villages in Ghana, suggested even lower income levels. The median cocoa farm family had an annual income of 716 GHC (504US$) from cocoa farming, and 80 GHC (56US$) from the sale of other crops. The total annual crop income was 1020 GHC (718US$). A median annual income was 250 GHC (176US$) per household member, which meant 0.68 GHC (0.48US$) per person per day.

With this economic data things start to become more complicated and lead to other more negative effects. By itself low income is caused by lower farm productivity while low farm income theoretically does not allow farmers to overcome "inherited rigidities" and save for reinvestment into higher productivity (Teal and Zeitlin, 2006). However, the issue of "missed reinvestments" will be one of our main discussion areas and we will return to this in next stages of our research and for now we can mention one more major problem which also partially is thought to be caused by poverty of cocoa farmers: child labour.

Literature indicates to economic and cultural reasons behind the use of child labour. Dumas explains it with land and labour market imperfections (2013). Boas and Huser also point to traditions whereas children working in their own family garden are acceptable for local cultures (2006). While child labour was practiced for decades, it became the focus of attention of NGOs, activists and general public after Knight Ridder Newspapers' reporters Sudarsan Raghavan and Sumana Chatterjee published their reports on forced child labour in June 2001.

Publications and documentaries that followed played catalytic role not only in revealing worse forms of child labour but also environmental and economic problems of cocoa supply chain. Child labour issue acted as last destabilizing sign of the ''old system'' and highlighted the urgency of transition to new system. It provided last ingredient to forces within and outside cocoa chain that were already mobilizing their resources and acting to address environmental and economic challenges. Sustainability movement which started in early 1990s as environmental awareness and then acquired economic and social dimensions now had favorable environment to target each perverse link in the chain. Grin et al have published the book about transition experiences in which they emphasize the importance of such destabilizing signs of old regimes to speed transition process and innovations (2010). They define transitions as co-evolution processes that require multiple changes in socio-technical

systems and configurations. It requires development of innovations as well as their adoption in societal applications. Besides, transitions are seen as multi-actor processes with interactions between businesses, user groups, scientific centers, policymakers, social movements and interest groups.

If we apply this framework to our research problem, lead firms of cocoa supply chain, scientific circles, NGOs and governments in cocoa consumption countries do not lack resources to innovate and to implement such changes within their areas of direct influence. This was found by Dingwerth (2008) who wrote that actors from consumption countries brought most of resources and played key role in defining agendas of partnerships. However innovations to be implemented, farmers in cocoa producing countries, local chain actors and facilitators such as government and extensions services should also possess resources to participate in development of innovations and in their anchoring into applications domain. Renewal of aged orchards and adoption of improved hybrid varieties is one of such innovations in cocoa production system and we will see in next stages of this research what constraints and resources are available within farming communities of Asamankese area in Eastern Ghana. Most reserves for system transition exist on the production side of cocoa supply chain but if the scale of implementation of innovations will be insufficient, scale of application of innovations on consumption side will also be hindered. For example if a supermarket chain is willing to sell only responsible sourced cocoa based chocolate but in case only 10% of chocolate satisfy this criteria, supermarket chain will be limited in its scale of change to available volumes of chocolate.

More purely economic driver behind global food chain upgrade motivation is probably the unprecedented power of retail industry. Consolidation of global retail and their increased bargaining power as well as introduction of their own private labels in almost any food category allowed them to squeeze profits of upstream producers. (Bontemps et al, 2008) Food companies themselves, either had to pass this pressure further down on their own suppliers and lower their production costs or try to engage their suppliers in a more close cooperation to discover new reserves of efficiency. I mention this factor because besides environmental and social drivers, there were strong economic factors already motivating global food companies to intervene in weak parts of their supply chains to respond to new pressures.

2.2. Problems Solving Initiatives

To address environmental, economic and social problems, cocoa supply chain actors, interest groups such as NGOs and certification organizations and research institutes had started to cooperate to understand the causes and context of persistent problems and to develop relevant solutions. Such cooperation takes the form of private-public partnerships (PPPs) and participants themselves prefer to describe these activities as pre-competitive. By literature such partnerships are considered as innovative mechanisms to solve failure of one or several actors in certain chain or process to meet new public requirements as well as secure private interests of actors in post transition environment (Biermann et al. 2007)

However such initiatives set different demands from participants for which they may have not been well prepared due to different structural models of public and private institutions as well as different cultures of different sectors and countries. This situation created demand for new knowledge, skills and different financing models because according to Arnoldus et al (2011) not all the producing countries were ready for this shift, some lacking organization, infrastructure and trust. Also buyers have faced challenges, such as not being fully informed about local business practices and having to invest in strengthening the capacities.

According to literature, different chains had different focus areas and while in coffee it was to develop new speciality markets, most of such initiatives in cocoa chain are concerned about assured supply of raw material and child labour (Bitzer, 2012). The initiatives targeted increasing cocoa small holder farmers' incomes by enabling them to produce more cocoa per unit of land implying that more intensification of cocoa farming will reduce conversion of new forestall areas into cocoa farms, thus reducing environmental footprint. Another objective is that higher incomes will improve their livelihood and allow cocoa farmers to use paid labour, gradually removing the economic motivation to use unpaid and forced child labour. As a kind of check of these initiatives and way of accountability various third party certification schemes have been created such as UTZ Certified, Fair Trade, and Rainforest Alliance etc (SustainAbility, 2011).

If successful, effect of such initiatives on environmental and child labour issue will most likely be positive but their effect on poverty issue is not so certain. Some authors also expressed concerns about the side effects of yield improvement initiatives. Gockowski points that investments in productivity-enhancing change will cause price to decline offsetting the gains in output achieved for farmers. While early adopter farmers will be relatively better off, non adopters, with continuous low yields and with ''new'' lower prices, will earn even less than before, increasing their poverty (2007). Laven (2010) also expressed her doubts about inclusion scale of small cocoa farmers and questioned ''transformative character'' of lead firm dominated global value chain approach (GVC). She thinks that GVC framework tends to ignore local context of farmers' environment and provides insufficient evidence on heterogeneity in outcomes for different types of producers.

Nestlé, the commissioner of this research, is one of lead firms in global cocoa supply chain and buys and processes more than 370 000 tons of cocoa annually which is almost 9% of 2010 globally reported cocoa harvest. Given this share in cocoa market, it is obvious why Nestlé is participating in PPPs to make its share in addressing persistent problems in the chain. Besides engagement in multi-stakeholder programs, the company has its own permanent departments and programs working on the sustainability transitions of its supply, operational and sales processes. From 2007 it is transforming its operations according to set of economic, environmental and social indicators and is publishing Creating Shared Value reports and views itself as Nutrition, Water and Rural Development company. According to Porter and Kramer (2011) Shared Value is about expanding the total pool of social and economic values. They argue that opportunities to create shared value arise because societal problems can create economic costs in the firm's value chain and externalities actually inflict internal costs on the firm. In comparison they consider Corporate Social Responsibility concept as more reputational while that of Shared Value as more at the core of companies in the next wave of capitalism.

As part of its internal sustainability transitions initiatives, Nestlé, set up Cocoa Plan with R&D centers and nurseries in Tours, France and Abidjan, Cote d'Ívoire with the objective of using new propagation method to produce new cocoa varieties for distribution among smallholder cocoa farmers.

2.3. Productivity Problem of Cocoa Farming and Causes

Literature provides varied data on current productivity levels of cocoa beans per 1ha of land. The results can be different whether reported of measured land size is taken into consideration. Gockowski et al surveyed 171 farmers in 2011 and found average yield per

1ha to be 534kg. Hainmueller et al during their survey of 3000 farmer households in 2009 found median yield per 1ha at 377kg based on measured land size against 234kg based on reported land size. The same survey found that yields varied within the same region. For instance in Eastern region of Ghana yields per 1ha of measured land varied between 200kg and 600kg among surveyed farmers. Similar variance was observed in other 5 cocoa regions of Ghana. This difference in yields shows reserve for growth and justifies cocoa chain actors initiatives to select this subject as main ‘’tangible’’ and measurable objective. This objective is further strengthened if comparison will be drawn to Indonesia where yields per 1ha exceed 1000kg (Fairlabor, 2012) assuming that climate and soil conditions are equally favourable and the gap is caused by the difference in labor and non labor inputs.

Causes of low productivity of cocoa farms in Ghana can be divided into short-term ‘’operational’’ and more long term, ‘’capital’’. Under the short term causes we mean those that can be implemented within less than a year and whose results can be assessed by next first harvest, as soon as dried cocoa beans are weighted. These are attributed to farm practices such as negligible application of fertilisers, pesticides and fungicides, lack of pruning and weeding.

The survey of 3000 farmers across 6 major cocoa regions of Ghana, conducted by Hainmueller et al revealed that only 21% of farmers applied fertilisers. The figure was lowest in our research area, in Eastern Ghana, at 9%. Besides number of farmers who ever applied fertilizers, rate of application is also significant factor in assessing effectiveness of fertilization. Gockowski, during his randomized survey of 171 farmers in Ghana found that average real application rate was 66kg instead of recommended 370kg/ha per year (2011).

Other causes of low productivity are, according to Dormon et al (2007), black pod disease, Mirids/capsids and swollen shoots. According to the World Bank data, these diseases had significant economic impact on the income of Ghana’s cocoa sector:

1. Black pod disease - the average estimated value of annual crop losses stemming from black pod disease was more than US$300 million during the period 2008-10.

2. Mirids / capsids - continue to inflict a heavy toll on Ghana’s annual cocoa output. During the period 2008-2010, the average estimated value of annual crop losses due to mirid/capsid infestation was nearly $US172 million.

3. Swollen shoot - During the period 2007-10, outbreaks of swollen shoot affected more than 100,000 hectares across Ghana’s cocoa production belt. First-year cumulative losses resulting from the felling of affected trees cost farmers an estimated US$84.9 million.

In our own research area of Asamankese, according to Geotracability data (2012), swollen shot infestation is practically absent but blackpods infestation was reported by 76% of fields with the rate of 10% and by 6% of fields with the rate of up to 25%. Capsid Myrids infestation, according to the same data, was reported in 58% of fields with up to 10% rate and by 5% of fields with up to 25% rate. Hainmueller’s survey (2009) of 3000 cocoa farmers reveals that only abt. 20% of them applied fungicides and pesticides in their orchards while about 55% of them had insecticides used in their orchards.

Review of pests and diseases allows us to move to more long-term, ‘’capital’’ problems and solutions since besides application of pesticides and fungicides, one more option to avoid losses due to diseases is adoption of improved, disease resistant varieties of cocoa. Such varieties are also regarded as higher yielding and more suited for intensified cocoa production systems including for the reason of easier canopy management.

2.4. Aged Orchards and the Importance of Renewal

According to Gockowski (2011), one of important factor for productivity is the quality of cocoa trees which itself is a function of genetics, biophysical environment and the age of cocoa tree. Age is important due to biological lags inherent to every perennial crops including cocoa. Yield potential therefore is correlated to the state of these parameters.

According to Binem et al (2008) after four years from the time of planting, the cocoa tree becomes productive and the yield rate increases annually until approximately 18 years after planting. Then the yields begin to decline due to exhaustion of soil nutrients, erosion, and increasing occurrence of pests and plant diseases. Some 20–30 years after planting, the farmer is confronted with a major investment decision: to either renew the orchard by replanting, invest in soil improvement and future pest abatement or to migrate to a new land plot.

Mahrizal et al (2012) describe coco tree productivity in 4 stages based on varied yields:

1) an early period of no yield which normally occurs in years one to year three,
2) a period of increasing yield at an increasing rate,
3) a period of increasing yield at a decreasing rate, and
4) a period of decreasing yields.

They also point that since annual rate of decrease in yields in aged trees can be marginal, it may be difficult for the farmer to appreciate the timing of renewing of the orchard. Assare (2008) suggests using pod count per trees as another indicator or signal for renewing trees. He provides following criteria for assessing yield performance of the plant:

25 or more pods per tree ---- Good
15-24 pods per tree ----- Average
14 or less pods per tree --- Poor.

Since productivity of cocoa trees is correlated to their age, renewal of aged orchards with new plant material is recommended for increasing or at least recovering yield performance by Asare (2008), Gockowski et al (2011).

Besides aging and lowering yields, another reason for renewal, according to literature, must be death of old trees due to diseases. Black pod disease, while mostly infecting cocoa pods, can also infect the trunk and branches with canker and cause root rot. Once the trunk is infected, the tree could die. In cases when Capsid/Mirid and Black Pod simultaneously affect the tree capsids leave behind lesions which can be infected by parasitic fungi that cause dieback of twigs and cankers on the trunk (Duffey, 2009)

2.5. Plant Supply Infrastructure

Renewal of orchards occurs through two main channels: using plant material from farmers' own collections and ''unapproved'' seedling gardens and using plant material from ''official'' nurseries which also perform breeding and plant material improvement works. The same farmers might have plant materials from both sources and it is possible to find different varieties within one field (Opoku et al, 2006).

In Ghana 26 state owned cocoa nurseries are registered of which 23 are operational. They are managed by Seed Production Unit which was established by Cocobod, a government owned cocoa marketing board of Ghana. Collectively these nurseries own 2 732ha of land of

which 495ha is used for the production of seedling material while rest is used for cocoa and other crops production. Our research region of Eastern Ghana has 8 nurseries including one in Asamankese district (Asare et al, 2010). Cocoa seedling development itself evolved from Lower Amazonian basin originated Amelonado and Trinirario varieties to new hybrid varieties which are based on the Upper Amazonian materials. Amelonado and Trinitario varieties are described as low yielding and late bearing which also lack adaptation potential to environmental stresses and are described as highly susceptible to pests and diseases such as black pod, Mirids, Cocoa Swollen Shoot Virus (Thresh et al 1988). Susceptibility to diseases has motivated later interest in developing alternative varieties from 1950s when upper Amazonian originated material and crosses with Amelonado were developed. These were called Series 2 hybrids. Later improved hybrids were also developed. Table below shows development stages of breeding programs in Ghana.

Variety no.	Variety Name	Parent	Source	Extension period	Years to bearing †
		'Traditional' varieties			
1	Amelonado	Amelonado	Equatorial Guinea	Before 1887	6–8
2	Trinitario	Trinitario	Trinidad, Jamaica, and Venezuela	1900–1909	6–8
3	Mixed Amazon	Mixed Amazon	Peru via Trinidad	1950s	5–6
4	Originally Series II Hybrids	Upper Amazon × Amelonado and Local Trinitario	Peru and WACRI	1966–1970	4–6
5	Modified Series II Hybrids	Upper Amazon × Amelonado Hybrids	WACRI	1971–1985	2–3
		'New' varieties			
6	BRT collection	Inter-Amazon	British Research Team	Mid-1980s	2–3
7	Mutant hybrids (MV5)	Irradiation techniques	Current CRIG collections	1990s	4

Figure 3: Development stages of cocoa breeding works in Ghana (source: Edwine and Masters, 2005)

2.6. Effect of Hybrids on Yields and Adoption Rate

Edwine and Masters surveyed 192 fields during 2002 and found 42% increase in yields and much of this increase being consequence of genetic improvements in recently released improved hybrid varieties (2005). Wiredu et al, based on the study of 366 randomly selected cocoa farmers from Ashanti region of Ghana, found that adopters of hybrid cocoa varieties gained additional yield of 320kg per 1ha (2011).

Despite these findings, Gockowski, while surveying 167 bearing cocoa farms, found that only 17% of farms had hybrid varieties planted but share of land planted with hybrid varieties on these farms did not exceed 7% (2011). However with recently planted un-bearing young orchards he found that out of 57 surveyed farms already 30% used hybrid varieties and share of land devoted to these varieties was 31%. He also found that among varieties used for replacement of dead trees, improved hybrids accounted for 18% only while Amazon/Almelonado varieties accounted for 69%.

But as we saw from literature one of the main problems in cocoa supply chain is poverty of cocoa smallholder farmers and for the maximisation of poverty reduction, is hybrid variety adoption alone, sufficient to achieve this objective? Literature shows that it is not because further gains in productivity can be achieved with the addition of fertilizer (Wiredu et al) and

with application of pesticides and weed control. Therefore we should view hybrid cocoa adoption and renewal of orchards as one complementary or first enrolment step to a more cocoa yield improvement process.

2.7. Literature of Adoption Constrains of Hybrid Cocoa in Ghana

New orchard development or orchard renewal with hybrid cocoa varieties is part of wider cocoa technology which is promoted by Cocoa Research Institute of Ghana (CRIG). It includes hybrid plant material, fertilization, pest management, pruning, weeding, shade management and other practices. CRIG takes into account additive and interactive nature of these components and is in favour of their simultaneous adoption (Aneani et al 2012).

Aneani et al during their randomized survey of 300 cocoa farmers from all cocoa growing regions of Ghana in 2006, found the age of the farmer and the educational status as main influencers regarding adoption of hybrid varieties. The older the farmers got, the lesser became their readiness to try new varieties. The older farmers who were used to the traditional Amelonado and Amazon varieties were more resistant to change to Hybrid seeds by replanting their old cocoa farms. The researchers argued that lower level of education does not allow such farmers to receive and analyse information about description of hybrid varieties.

Wiredu et al in their analysis of 366 randomly selected cocoa farmers in Ashanti region also found relationship between age, as a proxy for the farmer's experience, and adoption of hybrid varieties concluding that older farmers were more cautious to the extent to which they allocated the resources for new varieties. The same survey also showed that households with younger heads were more likely to allocate larger share of their land holding to hybrid varieties (2011). Contrary to Aneani's findings, this research did not find education as significant factor in adoption decisions. Wiredu's study also found that large households of food crop production system were less likely to devote higher share of their land to hybrid cocoa because of cocoa's competition with food crops for land and labour resources.

A different, more multidisciplinary approach was taken by Boahene et al in 1993 when they surveyed 103 farmers for the study of the adoption of hybrid cocoa varieties in Suhum and Nkawkaw districts of Eastern Ghana, very near to our Asamnkese district. They selected 50 adopter and 53 non-adopter farmers who both had either at least 60kg of cocoa harvest per year and/or at least 0.4ha of land planted with hybrid varieties. The difference of the study was in the depth of collecting social data about surveyed farmers. The authors interviewed them about their economic as well as social situations one year prior to their adoption of hybrid cocoa. Then the researchers tried to see how these factors played a role in the farmers' decisions. Questionnaire included farmers' connections, number contacts among previous successful adopters, social status, type and amount of social support received from acquaintances such as support obtained in spraying the farm, loan obtained from informal networks, ability to discuss cocoa production issues with other cocoa growers, support obtained for the harvest, access to advice from more educated acquaintances, farm size of connections etc.

The study of Boahene et al concludes that bank loan and hired labour have significant positive impact on adoption as well as education and access to extension services. It also found impact of social factors on farmers' adoption decision. Particularly, farmers who had more possibility to obtain resources from networks, unpaid cooperative labour (local teams helping each other in shifts, ''noboa'') were more likely to adopt hybrid cocoa while those with less access to such support were less likely to adopt. Contrary to economic theory that larger farm size should increase adoption outcome, the study found that smaller land holders, if they had more access to resources from networks were more likely to adopt the hybrid

cocoa. This group of farmers overcame economic constraints of adoption through inclusion of social support.

Besides economic and social constraints to adoption, economic geographers also point to spatial differences in resource endowment. In our case it may have impact on at least two components of adoption: ease of access of information about hybrid cocoa from experts, extension services and other adopters and ease of accessing hybrid cocoa plant material nurseries. Because of high cost of passing the information on the new technology to a large heterogeneous population of farmers, it may limit awareness of farmers about the benefits of new technologies.

Regarding ease of access to hybrid variety nurseries, Assare et al (2010) point that despite relatively high number of annual seedling production figures, access for farmers is increasingly difficult due to spatial gaps between seedling production units and farmers' location is some districts of Ghana. This encourages alternative sources of seedling production including the production of lower yielding non hybrid plant material by farmers' own collections.

Another field of adoption studies focuses on the compatibility of the innovation with the norms of the society (anthropology). Particularly, cocoa farm practices may change with changes in household cycle. This was reflected by Ruf during stratified random survey of 180 migrant and autochthon farmers in four districts of Ghana in 2005 and 2008. Almost 5% of respondents explained switch from shaded cocoa to un-shaded cocoa orchard practice by change in generation in the household. Younger farmers insisted that the change to full sun farms was a ''natural development''. Ruf concluded that younger farmers who inherited old cocoa farms may aim to plant their own farm to reduce the risk of family interference in their business (2011).

2.8. Literature on Ghanaian Smallholder Cocoa Farmers

As review of literature on constraints of adoption shows, it is important to understand social and economic situation of our research audience of Ghanaian cocoa smallholder farmers.

Teal and Zeitlin, based on randomized survey of the same 443 cocoa farm households in Ashanti, Brong Ahafo and Western Regions in 2002 and 2004 found that average household size in 2004 was 5.7 and average age of household head was 53 years. 83% of families had a male head while 17% a female. 67% of family members had primary school education. Comparing to previous survey of 2002, they found that family size decreased due to migration mostly from average of 6.9 to 5.7. Main geographic destination of migrating households was urban Ghana (65%) while 21% migrated to other rural areas whereas 15% left the country. As for the reasons of migration, education and employment were almost equally the case with about 40%-40% of migrants. Cocoa income made up almost 80% of all annual income on average for 443 families and 64% reported that they also had other source of income.

One interesting finding, which may have implications for our research, is that Teal and Zeitlin revealed increase of adult labour days in the orchard by 129% between 2002 and 2004. This is remarkable because it occurred in parallel to the increase in cocoa farm gate prices and this suggests farmers are responsive to price and are willing to put more inputs when they have expectation of higher rewards. Especially increased household men labour days in the orchards by 75% and also increased labour days for paid workers by 65% while unpaid labour days of nnoboa decreased perhaps for two reasons: less time to help other for free when more work at own orchard and more incentive to use paid labour due to higher revenues because of higher cocoa prices.

The same survey also provides the data on non-labour input usage and shows that between 2002 and 2004 fertilizer usage increased and number of farmers using no fertilizers dropped from 90% to 52%. Another interesting finding was that larger the farm size lesser the amount of fertilizer applied. This indicates to limited financial resources of farmers. In line with this finding, smaller sized farms had on average higher cocoa yields per 1ha than larger farm sizes. Relevant to our research subject, the survey found that while cocoa orchard land increased, share of hybrid varieties in the total cocoa lands including old and new orchards decreased from 58% to 47% in these 3 regions between 2002 and 2004.

A more massive survey was commissioned by the government of Ghana during 2007-2008, particularly by Ministry of Manpower Youth and Employment. It interviewed more than 8000 cocoa farmers in all six cocoa regions including Eastern region where our research will take place. The survey was commissioned with the objective to respond to international concern over child labour issue but the survey also included demographic, social, technical and economic questions and I would like to refer to those parts from its findings.

Out of 8957 cocoa farmer respondents (male heads of households) vast majority 8704 lived in rural areas while only 253 (abt. 3%) of them lived in urban areas. Out of 8885 respondents to the question of religion, 86% claimed to be Christian, 9% Muslim and rest were either following traditional religion or were atheists.

47% of respondents were local and owners of the cocoa farm, while 17% were owners but migrants. Among care takers share of locals was four times less than that of migrants which is an interesting finding. It shows that migrants lack resources to purchase and operate their own lands and they choose to operate other farmers' orchards to gain some income. The average number of cocoa fields owned by farmers differed across 6 regions with highest of 2.36 in Central region and with the lowest on 1.35 in Volta region. Our Eastern region reported average of 1.78.

For our research it could be interesting to note which other crops do farmers cultivate to check possible competition between renewal of cocoa orchard and following other crop cultivation. The survey indicates that besides cocoa, 46% of cocoa farmers also grow Plantain, 36% Cassava, 20% Oil Palm, 19% Maize, 5% Oranges and less than 2% grow Yam, Cocoyam, Rice, Tomato, Pepper, Bananas and other crops. The limitation of this survey is that it does not provide comparison of other cultivated crops frequency and share in household's farm to previous years. Therefore we cannot judge if any of these crops' frequency and share is increasing and whether any of them are gaining at the expense of cocoa fields.

The government commissioned survey shows that 69% of respondents houses are roofed with galvanised metal sheets, 15% with thatch, 12% with asbestos. Material for the walls of houses is still thatch for 44% while brick and cement walls are used by almost the same share of cocoa growers. 65% have cement floors, 25% have earth floor, 9% mud and 1% wood.

Further, it shows that for 67% of cocoa households main source of water is bore hole, 22% have to use surface water source and only 11% has pipe borne water access. As for the toilet facilities 60% has none at all.

84% of farmers have radio, 27% have bicycle, 22% have sewing machine, 21% has mobile phones, 14% have TV, 8% have a fridge and 2%-2% have moto-bike and vehicle. This set of data shows how they are able to access information and communicate with their network including getting information about cocoa technologies. Among regions, Western area has

highest frequency of radio ownership at 40% while Central region has lowest at 4%. Our Eastern region has 10% reported radio ownership. 92% of farmers access their farms by means of walking while 50% said that their farm is less than 1.6km from their house. 35% have to move more than 2km to reach the farm and the rest have to pass more than 6km.

It is interesting to see that mist blower/knapsack sprayers ownership, important to protect cocoa trees from pests and diseases, a kind of proxy for adoption of advanced cocoa management technology, is low. Even in most used region of Western Ghana, only 12% of cocoa farmers own them. Lowest level is reported in Volta region at 0.3% while in Eastern regions 3% of farmers have them.

In terms of access to health care facilities, 93% reported access to clinics, 80% can access pharmacies and 17% also use traditional healers. Self-treatment is reported by 37% of cocoa farmers. To the question, who is paying for health services in the household, 32% responded that health insurance does while 29% said that head of household is paying. Spouses are paying in case of 15% of respondents and children and parents pay in case of 12% and 9% respectively.

Activities distribution through the year is shown on a figure below with peaks in November and December:

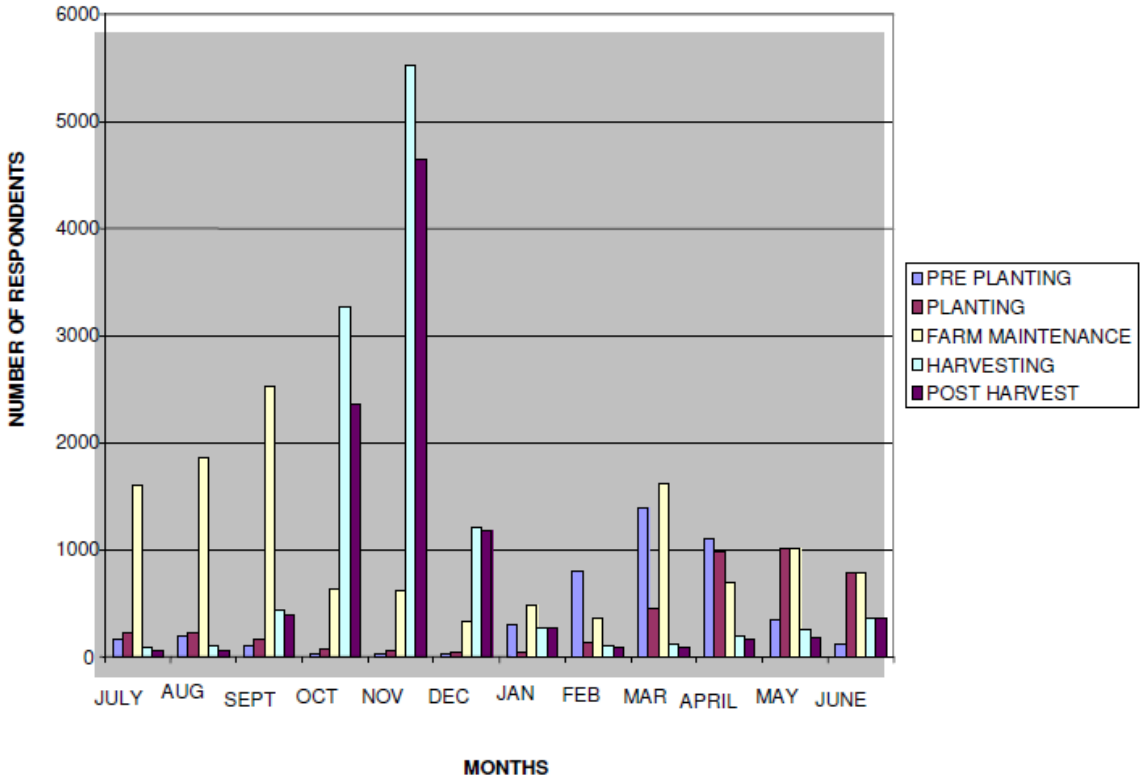


Figure 4: Distribution of farm activities per month (source: MMYE, 2008)

Another interesting data for our research is frequency of contacts with extension officers since extension services can play a role in promotion of hybrid cocoa varieties by providing information on its benefits and management. The survey findings are given below:

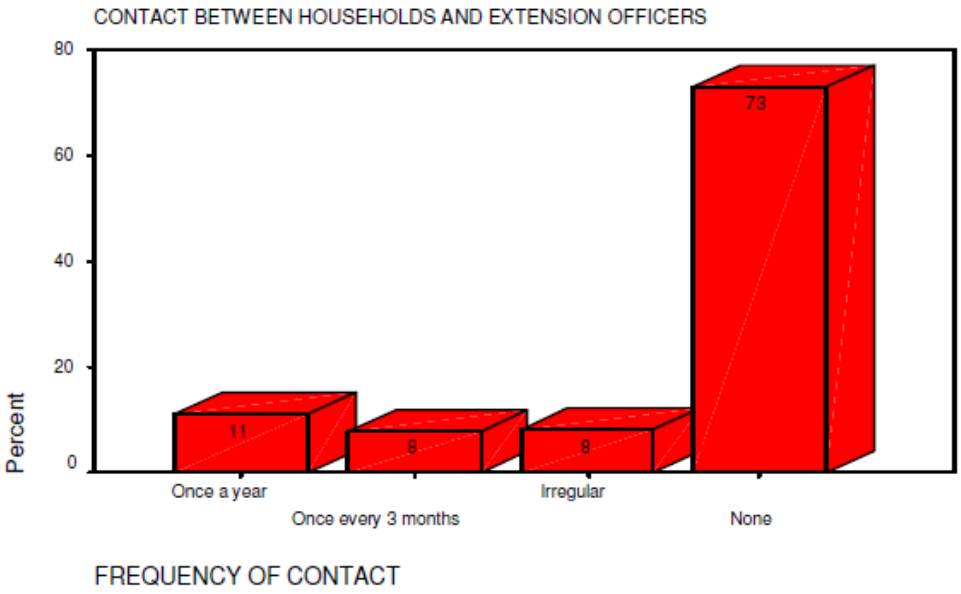


Figure 5: Frequency of contact between cocoa farmers and extension officers (MMYE, 2008)

Across regions differences may indicate to local spatial gaps as well as ineffectiveness of extension service branches.

REGION	ONCE A YEAR		ONCE EVERY THREE MONTHS		IRREGULAR		NO CONTACT	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	percent
Western	81	4.7	35	2.0	32	1.9	680	39.6
Central	6	0.3	1	0.1	2	0.1	81	4.7
Volta	5	0.3	1	0.2	10	0.6	73	4.2
Eastern	28	1.6	6	1.5	18	1.0	130	7.6
Ashanti	38	2.2	48	2.8	65	3.8	161	9.4
Brong Ahafo	33	1.9	22	1.3	13	0.8	126	7.3
TOTAL	191	11.0	113	7.9	140	8.2	1251	72.8

Figure 6: difference in frequency of contacts with extension across regions (MMYE, 2008)

According to the same survey, 57% of children attended primary school, 15% attended Junior High School and only 1% went to Senior High School or above. Between gender, share of children who ever attended school was equal at 92%. Among 22% of children who never attended school or stopped going there, explained it due to poverty. 17% said that they had to work on cocoa farm while 17% did not feel like attending the school.

One more large scale randomized survey of 3000 farmers across 6 major cocoa regions of Ghana, conducted by Hainmueller et al revealed consumption and financial patterns of cocoa farmers across all 6 cocoa growing regions. It showed that most farmers send someone from the household to the market once a week to buy food and supplies and on this activity they spend an average of 10GHC (5US$). Figure below displays annualized short term expenditures in relationship to annual income of households in those 6 regions:

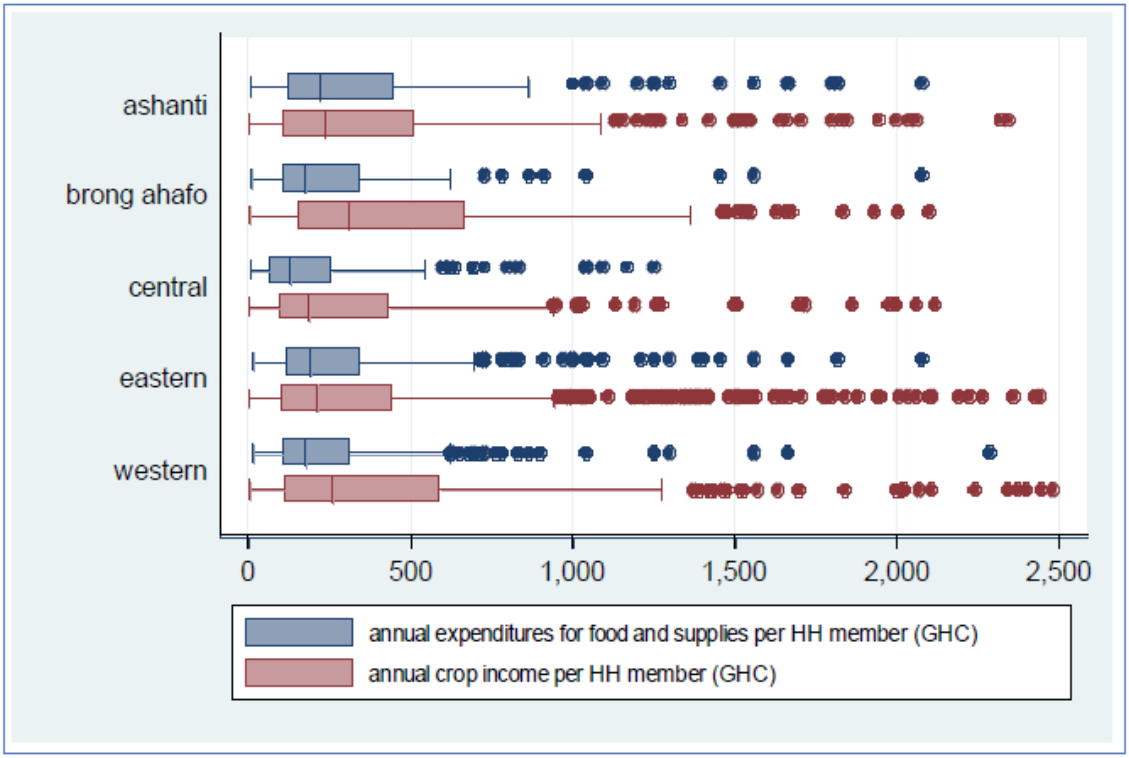


Figure 7: Annual Income and Annual Short Term Expenditures of Surveyed Cocoa Farmers (Source: Heinmueller et al, 2010)

Among more capital items, funerals related expenses are main costs for surveyed 3000 farmers. The median funeral related costs are 40GHC (20US$) per year. Median costs on medical expenses are 10GHC(5US$) per year. Thes and other cost items are displayed in the figure below:

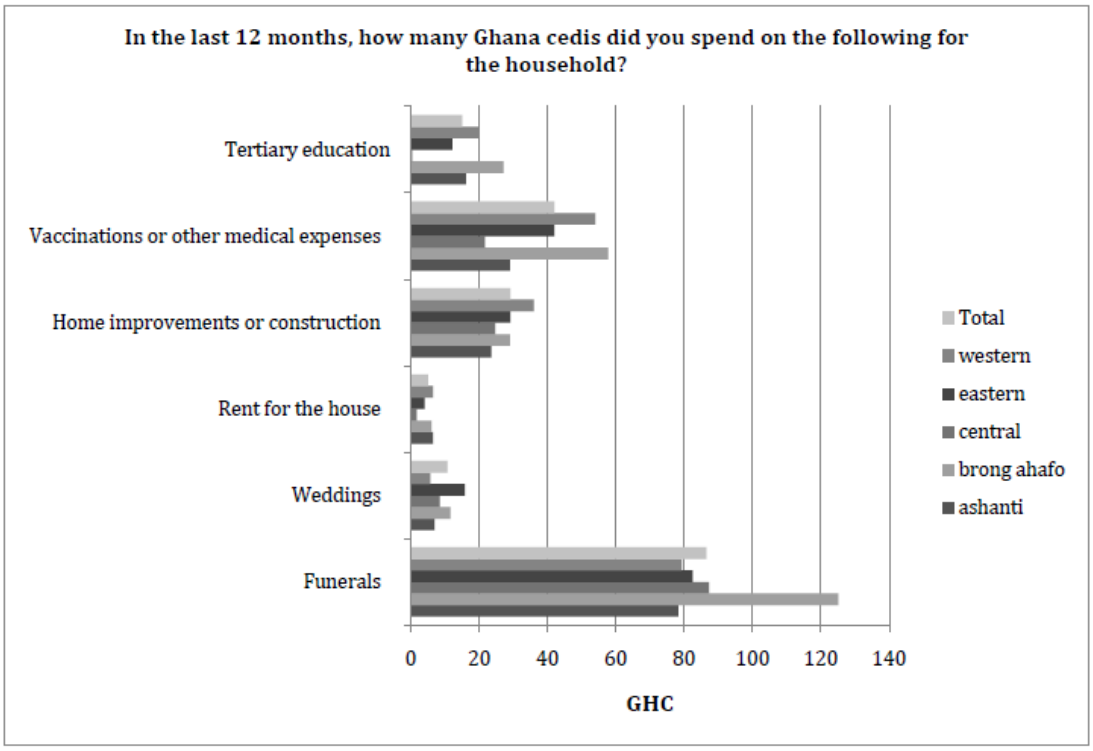


Figure 8: Annual Capital Costs among 3000 Surveyed Cocoa Farmers (Heinmueller et al, 2010)

Hainmueller et al also found that 31% of farmers had a bank account; 11 % had Susu account. Among these account holders, 19% allow their spouse access to the account. Median total savings are reported at 40GHC. Around 29 % of farmers report zero savings. Median savings are fairly similar across regions (ranging from 50 GHC in Brong Ahahfo to 20 GHC in the Western region). About 14% of farmers have received a loan within the past 12 months (ranging from 23% in Brong Ahafo to 11 % in Eastern). Of these loans, 39% were from friends or relatives, 13% were from LBCs, 11% were from a money lender, and 11% were from a rural bank. The median loan size was 200 GHC. Approximately 20% of farmers report that they tried to get a loan in the last 12 months but were unable to do so. The reported reasons are shown in figure below.

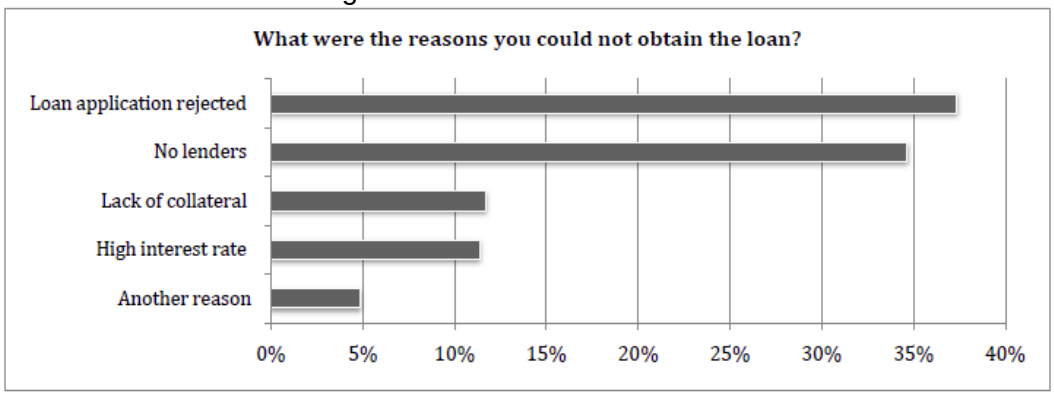


Figure 9: Reported Reasons for Inability to Obtain the Loan (Heinmueller et al, 2010)

In terms of organizational and membership activity level, which is also important for our research subject, only 6 % of surveyed farmers reported being members of farmer related groups. For those farmers who joined a farmer organization, on average the organization held meetings 6 times during the last year and most members attended only one (67%) or two (21%) meetings. In these farmer organizations decisions are made either by a vote of all members (in 54% of cases), an elected leader (35%), or by the village chief (7%). Around 68 % of farmers who are members of a farmer organization paid a membership fee; about 40% of these farmers had seen the annual budget of the organization. Membership pattern of this and other types of groups is displayed below.

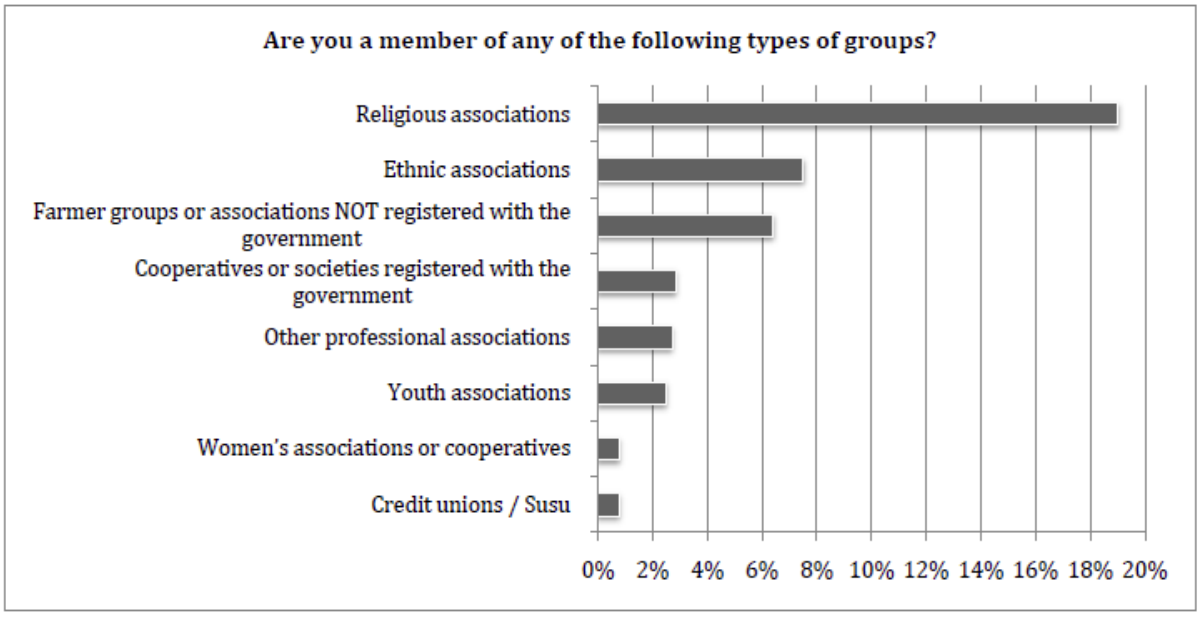


Figure 10: Memberships and Group Types (Heinmueller et al, 2010)

According to Armajaro there are total of its cocoa depots, which then delivers the beans to Nestlé. These farmers are located in 29 villages around Asamankese. Asamankese itself is a market town with abt. 32 000 population.

These 1387 farmers in total own 2205ha of cocoa farmland and average farm size per farmer is 1,59ha. Cocoa farms are not located on single consolidated land plot but rather on separate fields and average number of fields per farmer is 1.66 while average field size is 0.96ha. Figures below show distribution of farm and field sizes.

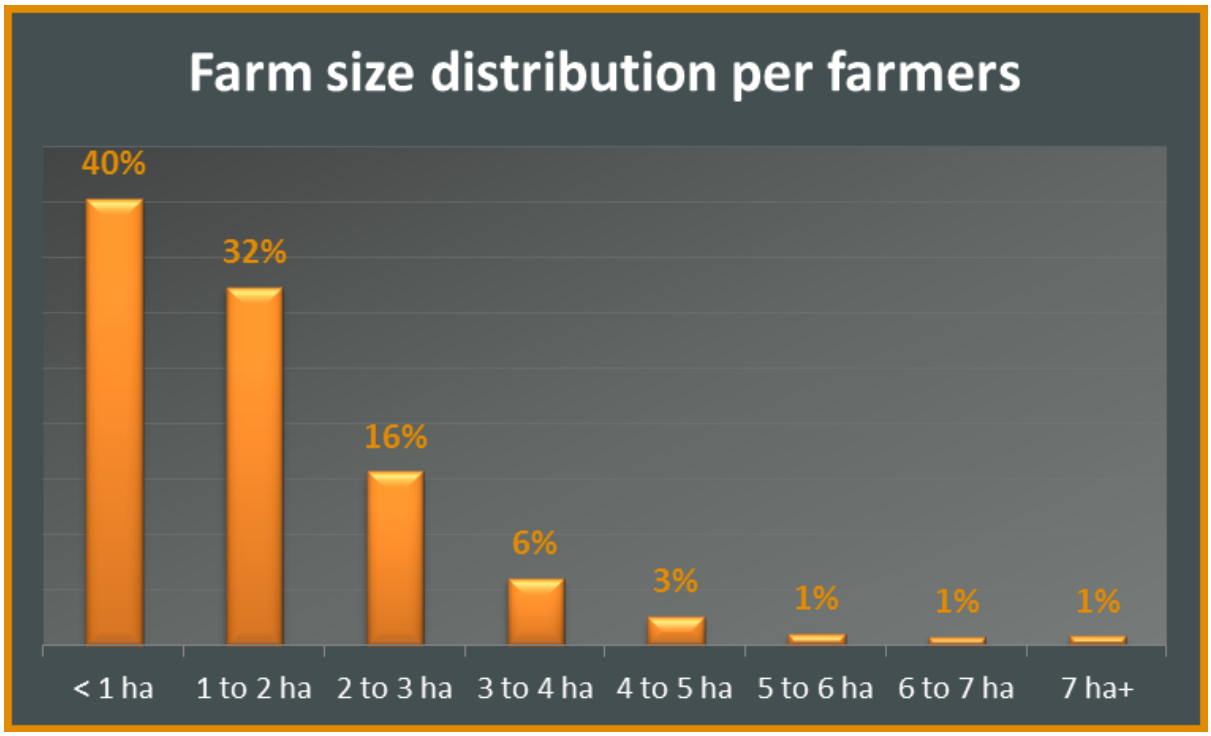


Figure11: Farm Size Distribution per Farmers (Source: Geotraceability, 2012)

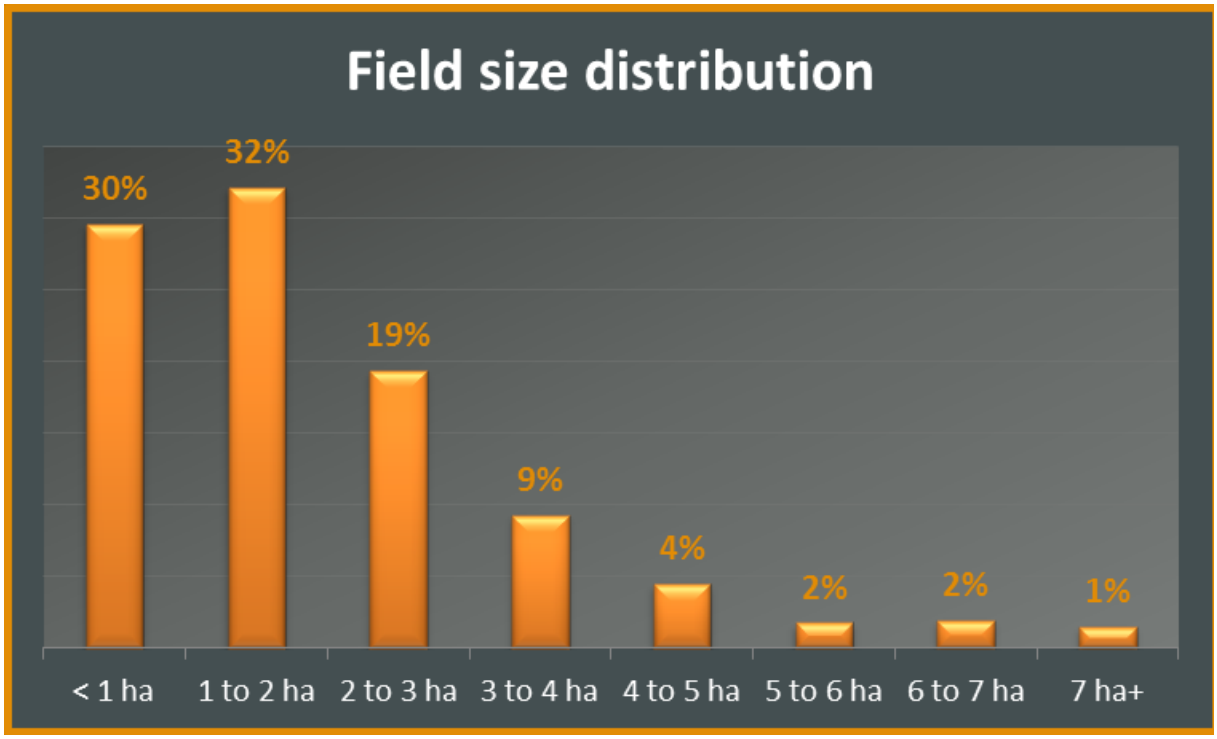


Figure 12: Field Size Distribution per Farmers (Source: Geotraceability, 2012)

In terms of gender distribution, out of 1387 cocoa farmers, 81% are male and 19% are female. 62% of fields are operated by owners while 38% are operated by sharecroppers.

It gives interesting insight into previous land use and shows that 35% of fields have been forests prior planting cocoa. 52% of current cocoa fields in 29 villages of Asamankese district previously were used for other crops. This piece of data shows that at some point farmers made a decision to switch to cocoa however the data does not provide farmers' reasons for giving preference to cocoa. 12% of current cocoa fields have been used for cocoa previously but when, how and why old cocoa fields were replanted is not known.

In terms of used cocoa varieties, the data shows that 50% of fields have improved varieties, 48% have mixed varieties but which exact varieties are used whether Hybrid Series II or Amelonado-Amazonian crossings is not elaborated and need to be check during field research. This is important since share of existing Hybrid Series II variety can indicate the presence of early adopters and as we have seen from literature review existence of adopters has positive impact on decision making of other would-be adopters through social interactions.

Geotraceability's survey includes the data on labour and non-labour inputs. It reveals more expensive non-labour inputs such as fertilizer and herbicides are not practiced by majority of Asamankese farmers. Some labour and non-labour inputs are done when needed but how often do they decide the need is not given. It also not showed how these practices differ by size of field, community or gender. Usage of fertilizer, which according to literature has positive correlation with hybrid cocoa adoption, is not done on 66% of fields and 29% of fields get fertilized once a year, However as we saw from literature review, rate of application is as important as frequency of application but the survey does not include this information.

labour inputs	systematically	when needed	never	once a year	twice a year
weeding, % of fields	2%	77%	22%		
pruning, % of fields	5%	59%	35%		
non labour inputs	**systematically**	**when needed**	**never**	**once a year**	**twice a year**
fertilization, % of fields			66%	29%	4%
insecticides, % of fields	3%	72%	26%		
fungicides, % of fields	3%	64%	33%		
herbicides, % of fields	0%	12%	88%		

Table 1: Labour and Non-labour Inputs (Source: Geotraceability, 2012)

Chapter 3: Conceptual Framework

As we saw from literature review improved crop variety is one of the components of agricultural technology. We also saw that the innovation of new cocoa varieties involves research institutes, governments, extension services, lead firms and farmers. Our research focuses on the farmers' side. We will, therefore, draw the framework which will let to analyse all the factors that affect farmers' decision process and outcome.

According to Rogers (2003), the attributes of the innovation are relative advantage to previous model and compatibility to the existing values, past experience and the future needs of potential adopters. He also refers to trial-ability and observeability – the degree to which potential applicator can experiment with the effects of the innovation. Complexity is another attribute for Roger and under this he means the degree of relative difficulty to understand and adopt the innovation. Besides these attributes other factors that determine diffusion are: type of decision making (individual or collective or by authority), media and personal communication channels, social systems with norms and network connections and the level of change agents' efforts.

If we apply this general definition to our research we will need to study how attractive hybrid cocoa varieties are perceived by farmers, how do they receive information about these varieties and what is the environment where farmers operate. This shows that the adoption process is multi-dimensional and this itself determines our choice for conceptual framework which will also impact our choice of methodology and type of questions during the survey.

In our literature review section, we have seen various works by different authors who tried to analyse constraints of adoption of new cocoa technologies from economic, social, geographic and anthropological concepts. Some of them included both, social as well as economic factors.

For the analysis of the adoption of hybrid cocoa we will use adjusted conceptual framework of constraints of adoption of agricultural technologies developed by Agricultural Technology Adoption Initiative of Jameel Poverty Action Lab (MIT) and Center for Effective Global Action (Berkeley). According to this framework, markets of well-functioning economies capture all costs and benefits and farmers will adopt a new technology but under one or more market inefficiencies, farmers will face constraints to adopt a new technology (Jack, 2011). It defines 7 groups of inefficiencies of following types:

1) Externalities
2) Input and output related
3) Land market related
4) Labour market related
5) Credit market related
6) Risk market related
7) Information related

ATAI's approach however already assumes that beneficial technology already exists and the research for revealing the constraints on their adoption will improve the rate of application. As we saw from the literature review benefit of hybrid cocoa variety on the yield of existing adopter farmers is proved through numerous randomized surveys and not only in ideal

research station conditions. However, during our research and especially during field surveys I will not make such assumption because since 34% of fields in Asamankese area are more than 54 years old there might be some reasons why farmers do not see the proven benefit of hybrid cocoa varieties beneficial for their particular aspirations.

If the benefit of technology is proven by early adopters then some inefficiencies should be acting as barriers to its further uptake. If technologies are adopted in some places by some farmers, it is likely that improving inefficiencies will increase adoption.

The market inefficiencies identified by ATAI, do not exist in isolation and in many cases one imperfection may be aggravated by another. While addressing all of them at once may be desirable, the adoption constraints could be relaxed by solving one of them or several of them. Therefore we might find that some of the imperfections may matter more and addressing them may give some progress earlier. It could also be that some of imperfections may matter more and their solution may bring higher impact but removing them might not be as easy as removing other imperfections. Therefore we need to learn relative weight of each imperfection, the level of difficulty of addressing each imperfection and possible impact of each imperfection on the adoption rate.

Among *externalities,* ATAI mentions:

Spill-over externalities – some of the benefits of the adoption that do not accrue to the individual who adopted. In the case of higher yielding variety, this can be reduction of total farmland needed for cocoa due to intensification through adoption. ‘’freed land’’ can be converted back into rainforest or be used by other farmers benefiting wider community and not only the adopter of improved variety. Therefore first farmers who adopt a new variety may generate positive externalities for others for which they are not rewarded.

Another applicable externality from ATAI’s framework is **informational externality**. Early adopters provide information for others about the benefits and correct and wrong use of the innovation at their own risk. The adopters in this case bear the cost of learning process for which they are not awarded. It could well be that first adopter farmer may plant the improved variety, weed, prune, fertilize but due to lack of funds not use the fungicide make only this one mistake and fail while his neighbour, the late adopter, can ‘’easily’’ avoid making the same mistake and win. Such informational externalities are especially ‘’costly’’ for early adopters and especially ‘’cheap’’ for late adopters in an environments where learning from other farmers is the main source of learning, with limited availability of extension services, nurseries and demonstration orchards. As we have seen from literature that is the case with an average Ghanaian cocoa farmer with 73% of farmers having made no contact with extension services.

During our field research we can check how these externalities are present among Asamankese cocoa farmers and what might work for them to relax the pressure of these constraints. Before that, literature shows some possible solutions such as, in case of spill-over externalities, to correct prices which do not reflect the costs and benefits for adoption. Zilberman et al argue that since modification of agricultural production systems in developing countries provide environmental benefits to other people, payment for environmental services should become the topic of development and poverty reduction (2008). Even if ‘’saved’’ land, due to better intensification will not be used for forestall conversion, adopters

are still creating positive externalities because ‘’extra’’ land now can be used for other cash or food crops and consumers as well as on farm hired labourers will still benefit through more food and job security. In reality, such price corrections could be done either through third party certification scheme or inside lead firm or other chain actor’s loyalty premiums.

In the case of informational externalities the solution by motivating early adopter by premiums for engaging others in their network could be more difficult since those early adopters at the early stage of adoption could be confident in their success and may not also want to bring more applicants for various reasons. After all there is also competition between farmers. They may also be discouraged to act as promoters if they themselves are not very confident in their own probability of positive outcome and may not want to be responsible for involving others in uncertain experiment. Therefore this informational externality may be better addressed collectively under cooperative and farmer group models.

Another set of inefficiencies in ATAI framework is **input-output related.** Under this, usually, annual orchard non-labour and labour inputs are meant and this would be relevant if our research subject was adoption of fertilizers or pest management practices but since we focus on the constraints of adoption of a more capital item such as perennial cocoa plant material, we will refer to the latter as an input in our case. Input related inefficiency for hybrid cocoa variety would be inability to access the plant material and information about it. While in some cases plant material is provided for free, spatial gaps and far distances between nurseries and farmers may erode feasibility due to lack of funds to travel longer distances. Moreover, farmers obtain most of their annual cocoa income during November-December while most appropriate time for planting cocoa trees is in late spring. Because cocoa farmers are extremely poor with many challenges to respond, they may not have sufficient funds by the time of planting. In case if farmers think that adoption of hybrid varieties results in tangible advantage when combined with adoption of fertilization and other inputs, high fixed cost of distribution due to poor infrastructure further negatively affects their adoption decision. If they think that all the efforts gone into replanting and waiting 3 years for first crop may be wasted if they cannot obtain fungicides to protect their precious asset, this will of course make them reluctant to take such high risks.

Since input related imperfections represent a barrier for hybrid cocoa adoption we will survey Asamankese farmers how this factor is affecting them and whether elimination of spatial gap in plant material and other inputs supply would have a positive impact on their adoption decision.

Farmer organizations could relax the adoption constraints stemming from input-output related inefficiencies by consolidating demand and decreasing transaction costs but as we have seen from randomized surveys in literature review farmers’ engagement in such organizations and number of such groups is low. Besides, even if membership rates were high, heterogeneity of member base would still present some challenges because of different resources of different farmers.

For the impact of output market on adoption of cocoa varieties, we will have to check relationship between higher cocoa price and adoption as well as higher prices of any other competing crops. Those 34% of farmers in Asamankese area, with older than 54 year cocoa orchards, might be not replanting due to these factors, among other causes.

Next constraint to adoption of agricultural technology is **land market related.** The lack of ownership security reduces incentives for investments into inputs and particularly into long-term investments (Ali et al, 2011). As cocoa in best case can only bear first income after 3 years and needs even more time for peak yields, farmers with uncertain tenure security will be most restrained in risky adoption decisions.

Sharecropping, while solving landholder's constraint to farming, may not be facilitating adoption in some cases. This is reflected by Otsuka (2007) who argues that such arrangements create disincentives to invest in improved technologies because long-term investments must be made by landholders while profits shared with sharecroppers. According to ATAI sharecropping arrangements are also part of land market inefficiency.

Since 38% of cocoa fields in our research area are under sharecropping agreements and tenure security might as well be the issue, we will study how these constraints are affecting the adoption of hybrid cocoa among Asamankese farmers.

Labour related inefficiencies are considered as fourth constraint by ATAI framework. Some agricultural innovations save labour for the adopter farmer, while others increase it. Therefore those technologies that save labour may be adopted by households who lack domestic labour force and are financially restrained to use hired labour. If this is not the case, such households will be constrained in adoption. Labour market inefficiency can be aggregated in times of high input cost and low output price periods and by credit market inefficiency.

For this research we unite education and health issues under labour market related group of variable. According to ATAI, when no major innovations occur, education is not important factor but when agricultural technologies change, more educated can adopt earlier than less educated farmers. Health is also important especially in poor countries since health problems inside household may affect labour supply as well as divert financial resources from farming to treatments.

Credit market inefficiencies, according to ATAI framework, represent one of major constraints for adoption. Farmers often refer to lack of capital as major reason for not adopting better farming practices. This could be particularly hard for capital decisions such as renewing orchards since it will mean at least a 3 year gap in income. This is why poor are more reluctant to adoption of new higher yielding varieties. Due to very long payback time for tree crops, likelihood of ''official'' bank loan is extremely low and would not be even feasible due to high interest rates.

An adoption can also be constrained by **risk related inefficiencies**, especially for those farmers who already have old and low yielding but certain level of income from existing cocoa orchard. The new variety is promising but not certain. The uncertainty can be aggregated by lack of information on whether new variety needs a different treatment. Combined with capital constraints, the two factors can have negative impact on adoption considering foregoing income from old orchard for next several years of dormancy period of new orchards.

Informational Inefficiencies relate to the lack of information about new crop or highly varied opinions about the yields of the new variety and about ease or difficulty of its orchard care. Farmers receive such information from other farmers experience and observation of their orchards and results, from own experience and from external source such as nursery staff, extension workers and in some cases from media. Each of these sources has their limitations. If potential adopter's social circle is small, then number of experienced adopters may also be small and their experience may not be representative of new variety's real performance. Therefore, such an interaction with another farmer may make adoption more likely as well as less likely (Kremer and Miguel, 2007). Extension officers would not be available for every farmer and even when available not every extension officer is fully knowledgeable about new crops and technologies. Nursery and demonstration orchard staff may present the information based on their ideal trial site conditions and may actually cause a suspicion in farmer and leave him undecided. Specific to perennial tree crops such as cocoa is that, real outcomes to be properly evaluated, several years must pass and learning is slow and so is the transmission of information to other farmers.

Chapter 4: Methodology

To understand the constraints of adoption of hybrid cocoa varieties in Asamankese district of eastern Ghana, I have chosen to focus on constraints that local farmers are confronted. This will require to obtain the feedback from farmers and to understand their environment and the resources that these farmers posses.

The research will have qualitative and quantitative approach and the data will be collected through interviews and surveys:

1. Qualitative interviews with focus group of farmers to make the initial inventory of views about aged cocoa farms and qualities of new cocoa hybrid varieties. Findings will help to compile quantitative questionnaire.
2. Quantitative survey of randomized sample of 90 farmers stratified by the following criteria: with the orchards planted before 1988 and owning at least 1ha of cocoa farm.
3. Qualitative interviews with Ghanaian cocoa experts to understand their opinion about farmers' perceptions regarding hybrid cocoa performance

My choice of qualitative interviews with resource persons was motivated by learning more about the improved varieties, available plant material supply infrastructure, experts' opinion about constraints of adoption and their experience with farmers' decision making. I plan to conduct such interviews prior to field research and also after the field research to discuss findings with the experts. The outcome from earlier interviews would be among others, discovery of some of currently unknown questions for the inclusion into the farmer questionnaires.

Randomly selected stratified sample of 90 farmers will be surveyed to reveal their demographic and socio-economic conditions and which of the constraints, described in conceptual framework of this paper, are they facing to replant aged cocoa trees

Sample size selection was determined by the fact that our field research is in its nature a micro-study. However as Harrington (1981) suggested, a relatively small sample of 40-60 farmers is sufficient for a given recommendation domain.

The expected outcome of this quantitative survey will be what is common and different among adopters in terms of their exposure to the constraints. For example, if informational inefficiency and particularly the lack of information about hybrid varieties is present with different degree among non adopters, some having least information and others having sufficient information, then we can conclude that having sufficient information does not in itself lead to adoption. On the other hand if lack of information about hybrid cocoa variety is similarly present among non-adopters, we may conclude that lack of such information is characteristic to non adopters and one of recommendation would suggest looking at how awareness can be increased. Besides this variable we will learn from informational inefficiencies related sub-questions about the sources of information for such farmers, their network size and this can show the channels which can be used for the delivery of information or feasibility of targeting those channels.

I decided to conduct quantitative survey of only non adopter farmers with old cocoa orchards for the reason that cross-sectional quantitative survey of adopter and non-adopters would not be feasible given following limitations:

1. Available time for field research, including local preparations, is limited to 41 days
2. Available budget of research does not allow hiring enumerators and transportation means to reach higher number of farmers. I assumed that since adopters represent minority, they may be scattered across different 29 villages of Asamankese district, far from each other.
3. The lack of dynamics of such micro-studies (Doss, 2003): it will be difficult to reliably record pre-adoption conditions of adopter farmers during short quantitative session and only recording their current post-adoption conditions and comparing them to the conditions of non-adopters would not allow making valid cross-sectional comparisons.

To partially offset exclusion of adopter farmers from quantitative survey, I selected ''bright spot'' approach and plan to do 4 case studies on 4 individual adopter farmers. Each of 4 cases will be organized as at least 1 full day observation, interaction and qualitative in-depth studies. To minimize the error of retrospective data recollection by such farmers, I will try to select the most recent adopters and will not seek those adopters who have cocoa bearing orchards. Since our research subject is to study adoption and non adoption causes and not the effect of adoption (possible higher revenues from bearing hybrid cocoa orchard) such an approach is both practical and valid. The case studies will aim to understand what adopters have done differently, which circumstances allowed them to re-plant their aged orchards with new hybrid cocoa varieties, how more of such farmers can be identified as next adoption targets.

The outcome of these case studies would be the identification of distinct features of adopter farmers and the recommendations for their possible targeting for the increase of the rate of adoption.

Literature review of agricultural surveys revealed that there is a separate discipline on the methodology of agricultural adoption surveys. I will use methodology developed by prominent international crop improvement non-profit organization CIMMYT. In 1991 it produced the guideline for studying agricultural adoptions which makes differentiation even within adoption study methodology: studies that focus on the degree and scope of adoption and studies that focus on adoption patterns (CIMMYT, 1991). Adoption patterns survey factors that exist prior to adoption decision and influence it positively or negatively. It reveals farm resources and farmer characteristics and factors such as the degree of compatibility, markets and information systems. CIMMYT framework provides recommendations on sampling size and frame, survey design, implementation and results analysis.

Answers will be processed through SPSS software for statistical analysis.

Chapter 5: Results

We provide results of survey in consistency with our literature review, conceptual framework and methodology and focus on 6 main and relevant data sets according to following criteria: farmers' demographics and resources, adoption patterns – existing trends, farmer's opinions about hybrids, relationship between age of farm and yield and constraints for replanting aged farms.

5.1. Farmers' Demographics

Average age of interviewed 90 farmers was 53 years, median 52 and minimum and maximum was 23 and 84 respectively. Below table shows distribution of farmers' percentage across different age groups.

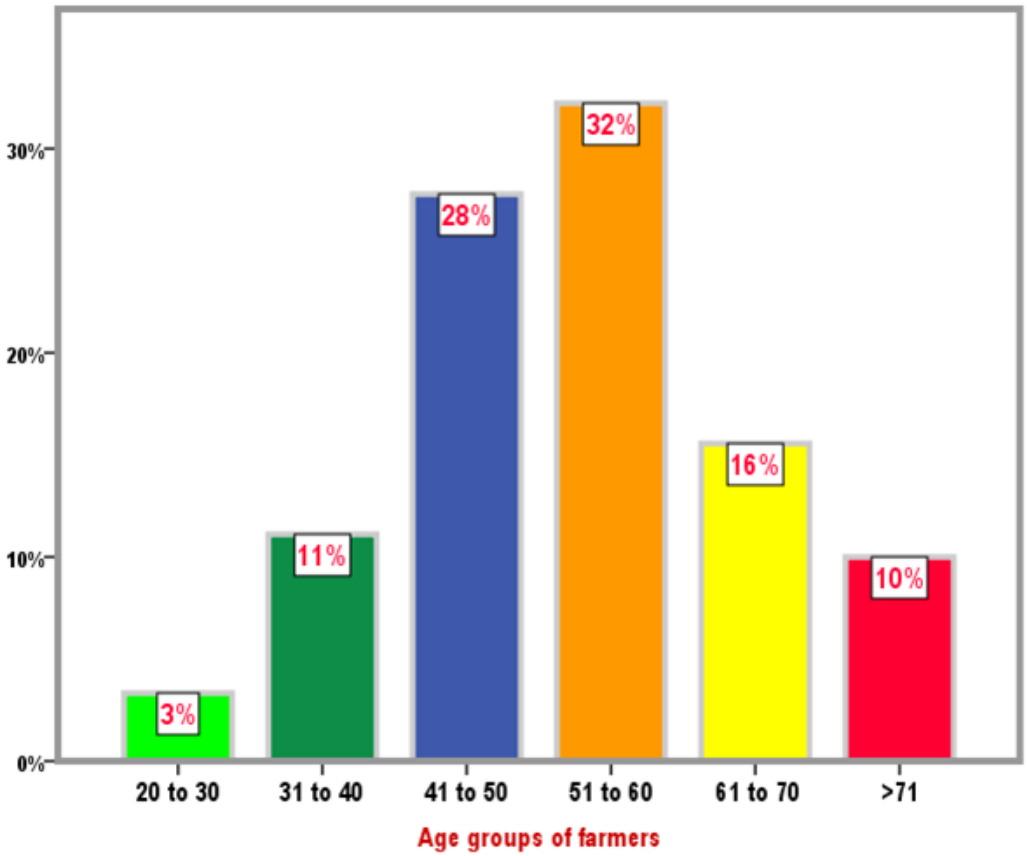


Figure 13: Age groups of interviewed 90 farmers

On demographics, we also collected data on household numbers, how many persons have migrated from HH and for what purpose. Below table shows summary of findings for these questions.

Items	Mean	Median	Minimum	Maximum
Total NN of Persons Per HH	9	9	2	25
Migrated	3	3	0	15
Migrated for Work (%)	90%			
Migrated for Study (%)	10%			
Migrants Moved to Urban Area (%)	90%			

Table 2: Some demographic indicators of surveyed farmers

Besides, we also noted ethnic affiliation and found that among 90 surveyed farmers 3 ethnic groups made main categories: Akuapeam (34 farmers), Fante (20) and Eve (17). In terms of education levels, 20% had no formal education and 22%, 46% and 12% attended primary, junior high school and senior high school respectively.

5.2. Farmers' Resources

We gathered data on total and cocoa farm land size, as well as other cash crops' cultivated land size, income sources. Below, table provides the summary of these findings.

Items	Mean	Median	Minimum	Maximum
Total Farmland (Ha)	5,84	4,65	1,21	40,46
Cocoa Farmland (Ha)	2,95	2,22	0,8	16,59
Other Cash Crops (Ha)	1,2	0,8	0	5,66
Cocoa Income (US$/Year)	2089	1590	222	11660
Other Cash Crop Income (US$/Year)	363	250	0	1250
Off-farm Income (US$/Year)	1113	720	0	10800
Total HH Income Per Year (US$)	3565	2560	222	23710

Table 3: Some indicators of surveyed farmers' resources

Survey showed that 80% of cocoa farmers grow other cash crops and 69% run off-farm, income generating activities, mostly trading and some tap palm wine, some have chain-saws and cut trees for a fee.

5.3. Hybrid Cocoa Adoption: Existing Patterns

During our stratified randomized survey of 90 farmers, we found high rate of hybrid cocoa adoption.

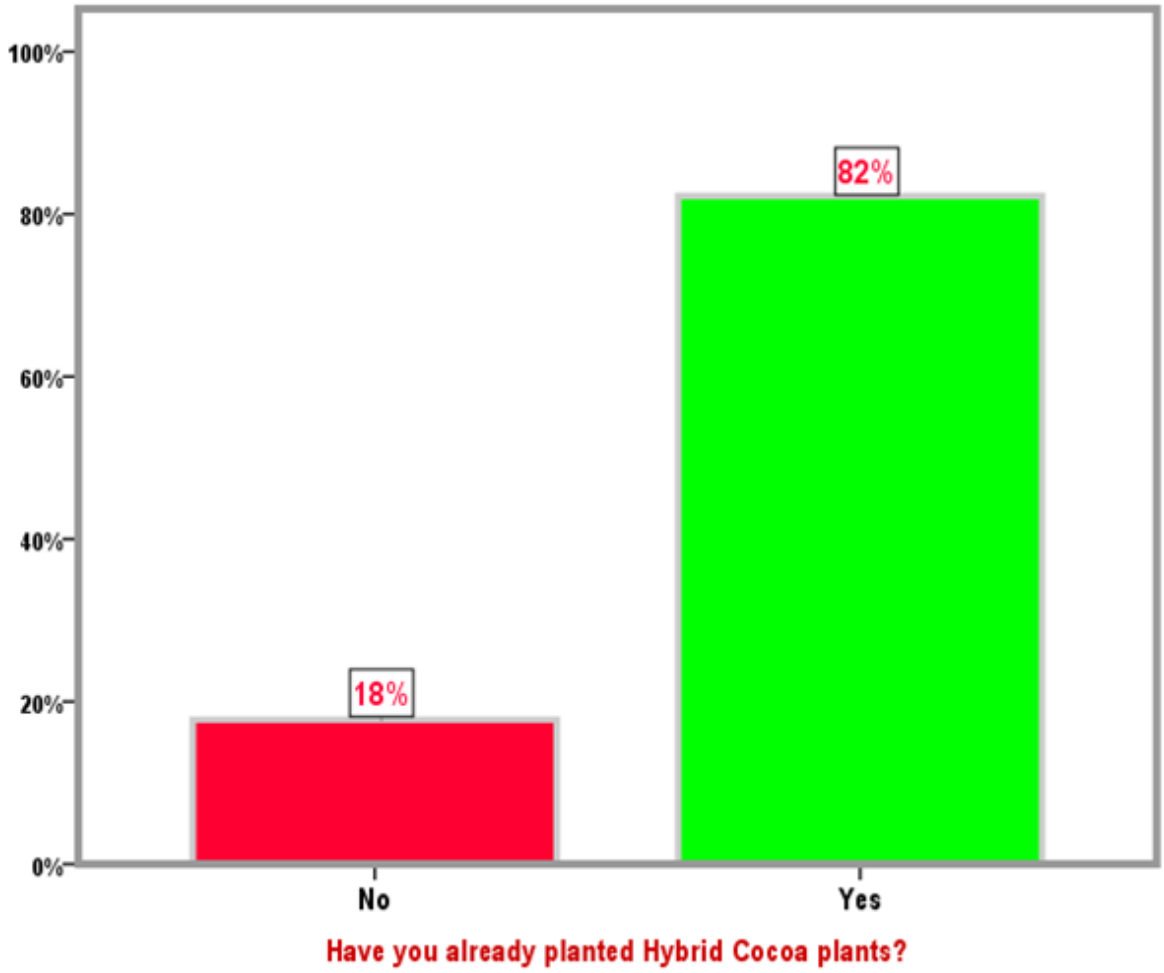


Figure 14: Rate of hybrid cocoa adoption among surveyed farmers

This was already suggested by focus group interview with 4 farmers in 2 different communities as well as interviews with local purchasing clerks and extension officer as well as field manager of Armajaro in Asamankese district. Later, survey itself confirmed high rate of hybrid adoption.

Regarding scale of adoption, 74 out of 90 surveyed farmers, who planted hybrids, had an average of 1,17ha of hybrid cocoa. Median figure was 0.80ha. Considering that total median size of cocoa farm among adopters was 2,4ha (mean: 3,2ha), median adoption scale is 33% among adopters.

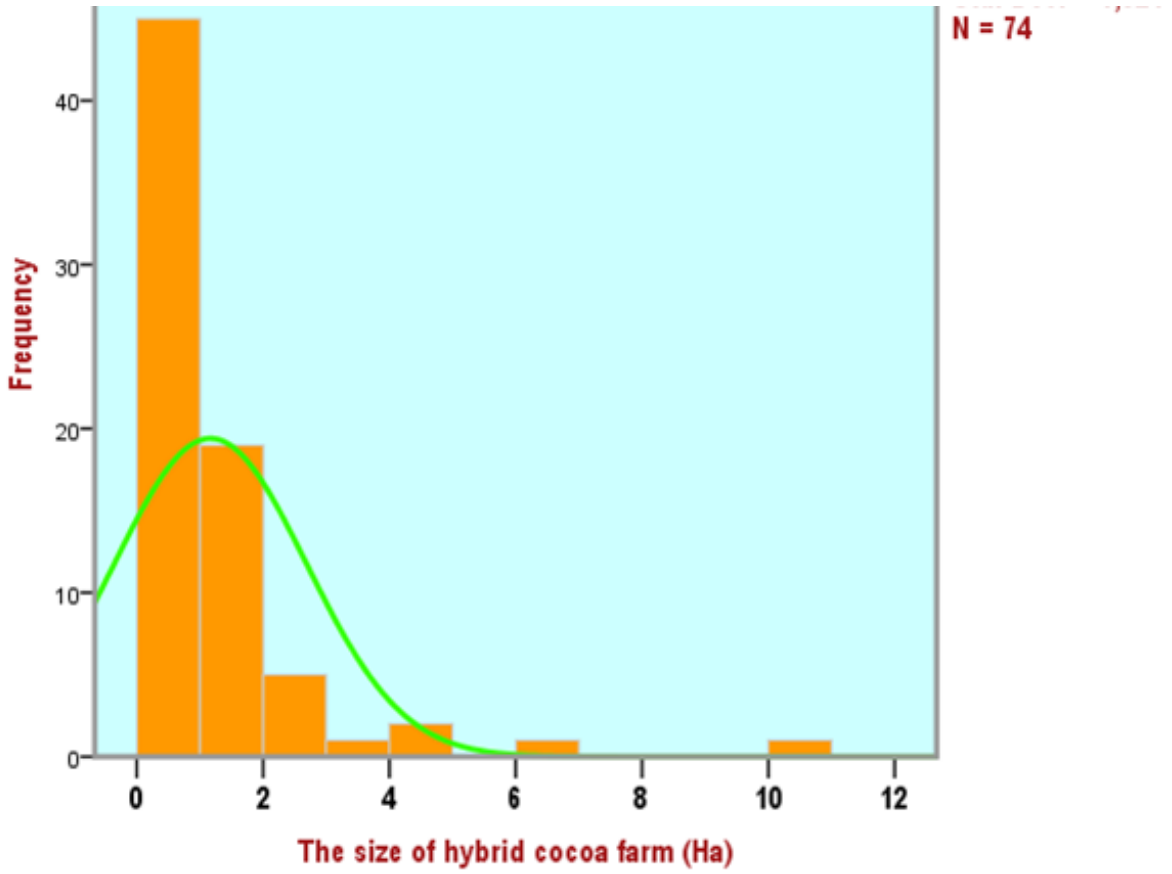


Figure 15: the size of hybrid cocoa farm

Then we looked into relationships between various factors and adoption of hybrids and found following: Mean age of cocoa farm of adopters was 32 years while that of non-adopters was 35. Among farmers themselves, adopter farmers' mean age was 53 years while non adopters' mean age was 56 years. In terms of gender, females had higher rate of adoption of hybrid cocoa varieties than males and statistically significant difference was confirmed by Independent Sample T Test. Another statistically significant difference was found between landowners and sharecroppers: landowners were more likely to adopt. In terms of difference in mean total land size, between adopters and non-adopters, adopters had significantly higher mean size of total farmland, 6,3ha vs. 3,5ha. Further, in terms of difference in mean total cocoa farm size, adopters' mean cocoa farm was 3,2ha and that of non-adopters was 2ha. Tests on the difference in adoption between different levels of education showed that primary and junior high school attendant farmers had higher adoption rate than those with no formal and senior high school education. One interesting difference in terms of adoption rate was found between farmers with and without off-farm source of income.

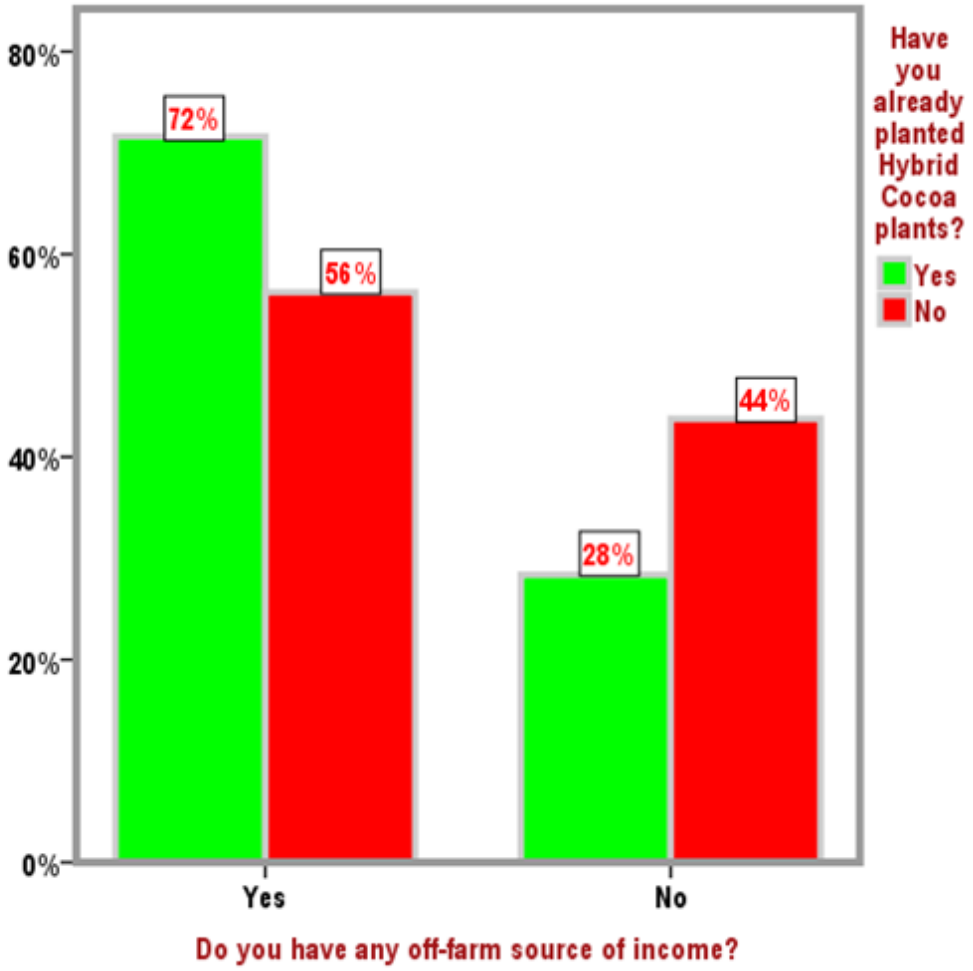


Figure 16: Difference in hybrid adoption between farmers with and without off-farm income

Within different levels of off-farm income, farmers between 1000-3000 GHC/year (500-1500US$) off-farm income, had higher adoption rate of hybrid cocoa than those with less or more off-farm income.

5.4. Farmers' opinions about hybrids

Farmers' opinions about hybrid cocoa varieties in themselves can be divided into 2 categories: 1) experiences/perceptions that encourage use of hybrids as planting material and 2) experiences/perceptions that do not encourage use of hybrids as planting material. Among positive opinions are early bearing feature of hybrids (21% think that hybrids bear 1 year earlier, 47%: 2 years earlier, 16%: 3 years earlier) compared to older varieties. Most of them also believe that Hybrids yield more than traditional varieties. See the graph below (for the ease of data representation, we united all older varieties under the name of ''Amazonian''):

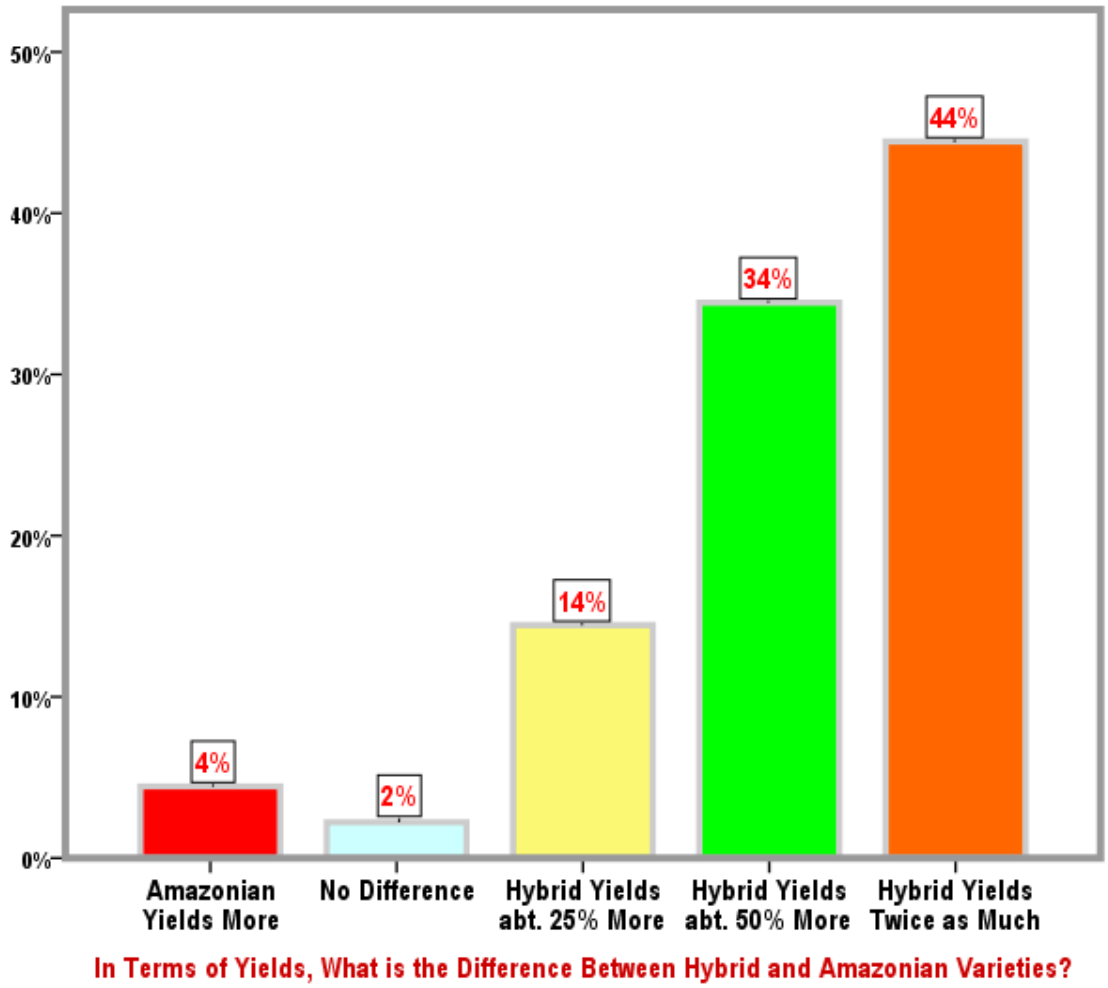


Figure 17: Farmers' opinions about yield advantage of hybrid cocoa varieties

Among negative opinions, 68% mentioned hybrids were less resistant to diseases, 73% mentioned lower drought resistance and 86% said that hybrid cocoa bean's size was smaller than that of older varieties. In terms of maintenance, 63% of farmers said that hybrid variety needs more pruning, 71% more weeding.

As during our field research, we also had the opportunity to interview Ghanaian scientists from Cocoa Research Institute and Cocobod, we asked them to provide with their comments on farmers' opinions and next figure shows their responses:

Some of the Quotes from Interviews
On Disease Resistance: ‘’Hybrids produce cocoa pods throughout the year which means they have also food for pests... Hybrids need therefore more spraying and government's spraying scheduling does not match the spraying timing of hybrids, they must be sprayed at least 4 times a year: in March, April, September and October’’ --- **Dr. Richard Adu-Acheampong**, Senior Research Scientist, Entomologist, CRIG. 06.08.2013
On Drought Resistance: ‘’Hybrids are less resistant to drought because their roots do not go deeper into the soil and cannot obtain nutrients and moisture from lower levels of soil’’ --- **Dr. Kofi Acheampong**, Plant Scientist, CRIG. 06.08.2013
On Bean Size Difference: ‘’Drought and Capsids reduce the size of beans in general... About 20% of annual harvest is not exported due to small bean size each year and are sold to grinding companies inside Ghana’’ --- **Dr. Gilbert John Anim-Kwapong,** Head of Agronomy, CRIG. 06.08.2013
On Drought and Disease Resistance: ‘’In 60ies and 70ies we had more shades and less Capsids... Environment has changed in cocoa farm as well as generally. Now we have less shades and less rain. In 1991 for example, we had rain every day in Tafo [CRIG location] but this July we had only 10 rainy days. Stress levels for plants increased... Because of this we now have shorter durations of peak cocoa seasons’’ --- **Dr. Francis Baah,** formerly Senior Scientist at CRIG, currently, deputy of CEO at Cocobod. 09.08.2013

Table 4: Ghanaian cocoa scientists comments on farmers’ concerns regarding hybrid cocoa

5.5. Relationship between Age of Cocoa and Yields

Survey findings regarding productivity of cocoa per 1ha of land suggest that the yield (kg/ha) declines as the age of trees increases: reported yields of 90 respondents show that mean yields of cocoa farmers with older orchards are declining from 512kg/ha to 337kg/ha across 5 farm age categories.

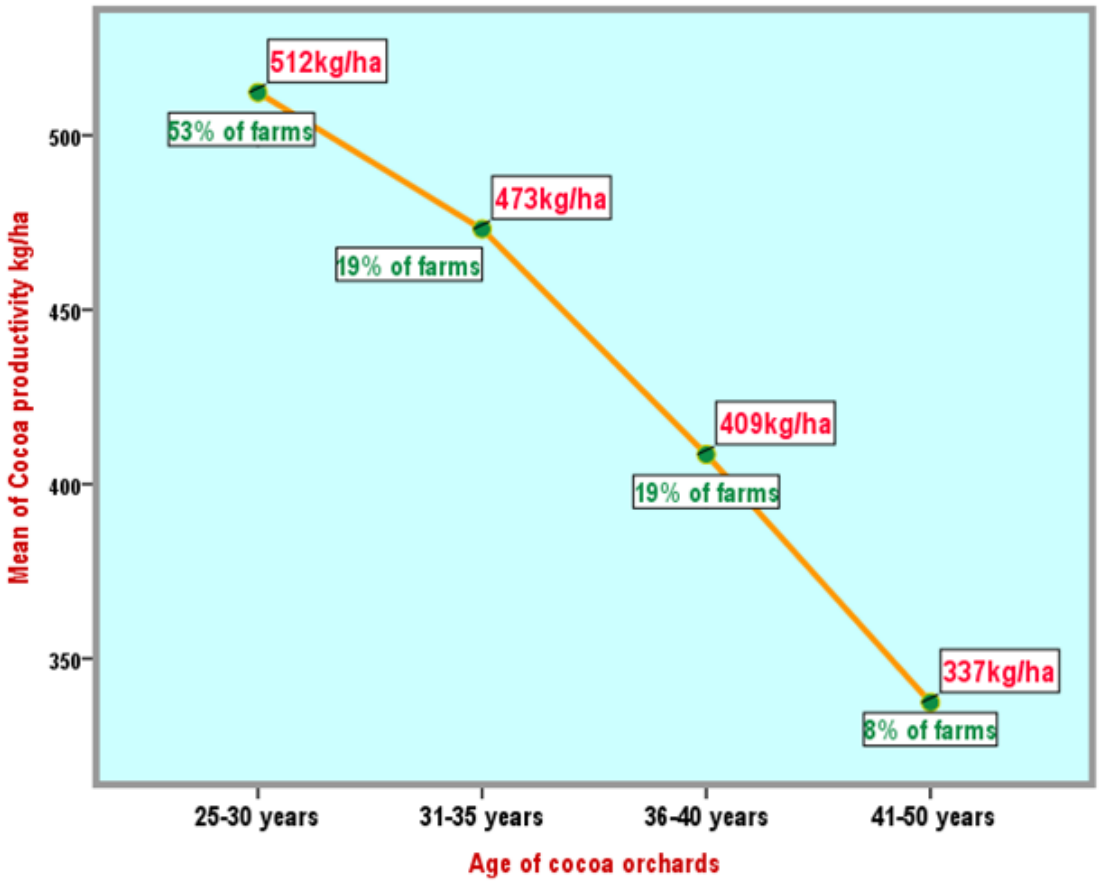


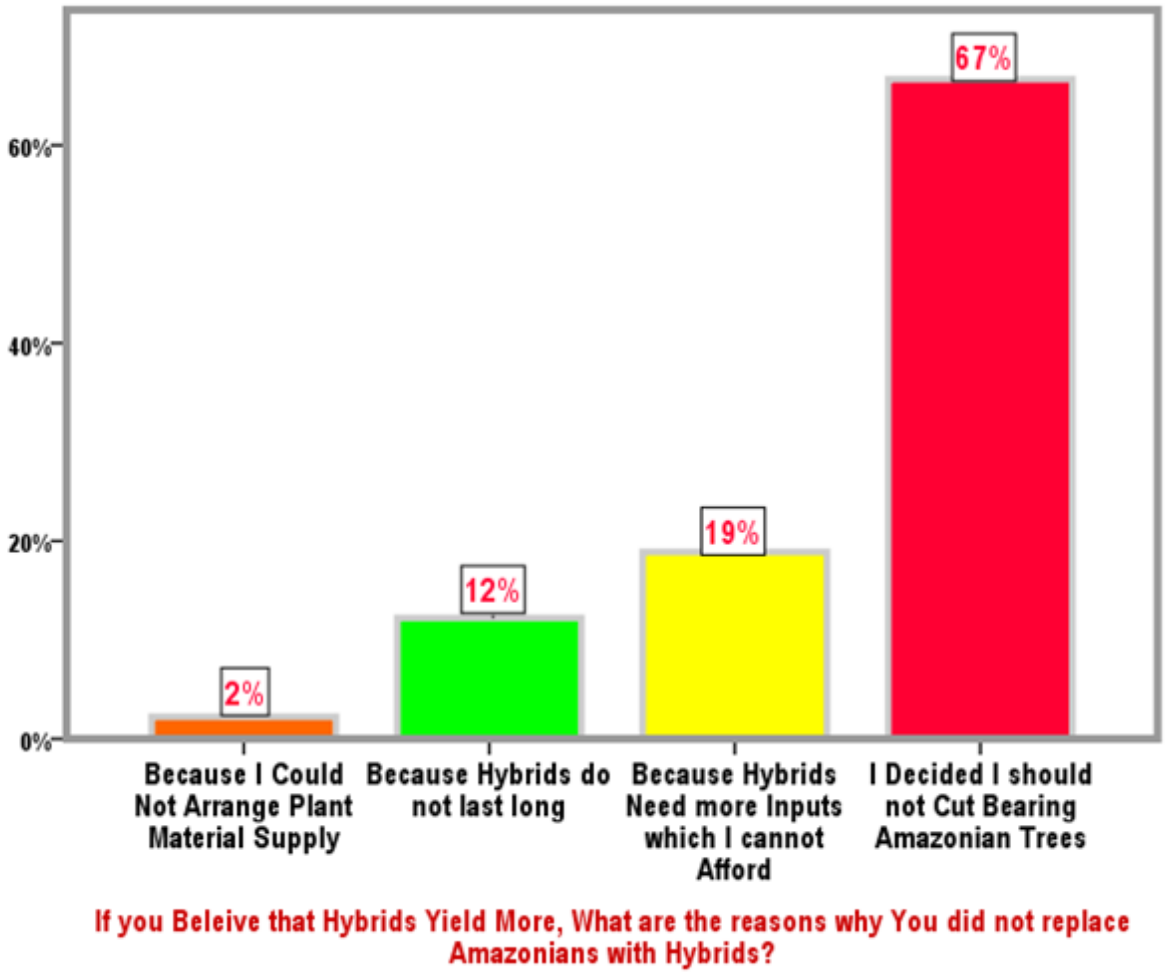
Figure 18: relation between mean yields and age of cocoa farm

We cannot suggest at what age cocoa yields exactly start to decline since our survey sample was stratified by age of farm and we interviewed only farmers who had 25 years and older farms but we can see the steady downward trend in productivity from 25-30 year old farms till 41-50 years old category. Another suggestion from our finding is that in about 5 years time yields of 53% of farms will decline by about 10% and in another 10 years time they will decline by 20% compared to current levels. Considering that confectionery industry's demand from cocoa is expected to grow, this finding is certainly a concern for the industry.

However, we cannot claim that this finding has a statistical significance as One Way Anova test could not find it. Another limitation of this data set is that every surveyed farmer had parts of their cocoa farms planted at different times while none of surveyed farmers record yields of older and younger parts of their farms separately.

5.6. Constraints for Replanting Aged Farms with Hybrid Varieties

To the question, why farmers were not able / willing to replant aged cocoa trees, we considered 4 answer options, based on reasons which focus group interviews revealed to us. During the quantitative interviews, however we let farmers to mention their open answers and then applied them to our answer options.



Graph 19: Farmers' reasons for not replanting aged cocoa trees

As we can see from Graph 2, three main reasons for not replanting aged cocoa trees are related in some ways to the income or if we may say ''cash flow''. 67% do not want to replant because replanting would mean ***loss of cash***, caused by 3-4 years of dormant period of newly planted trees. 19% does not want to replant because they think hybrid cocoa is more expensive to establish and maintain and they cannot afford it i.e. ***lack of cash*** is the reason. 12% who said practically say that even if they replant they would not do so with hybrids, suggest that they expect ''earlier termination of cash flow'' because they believe hybrids will have to be replanted again, earlier than traditional cocoa varieties.

To verify farmers responses to the most important survey question, we also asked several ''double check'' questions. One of them was, if they could compensate income gap caused by replanting, during dormant period of newly planted cocoa trees.

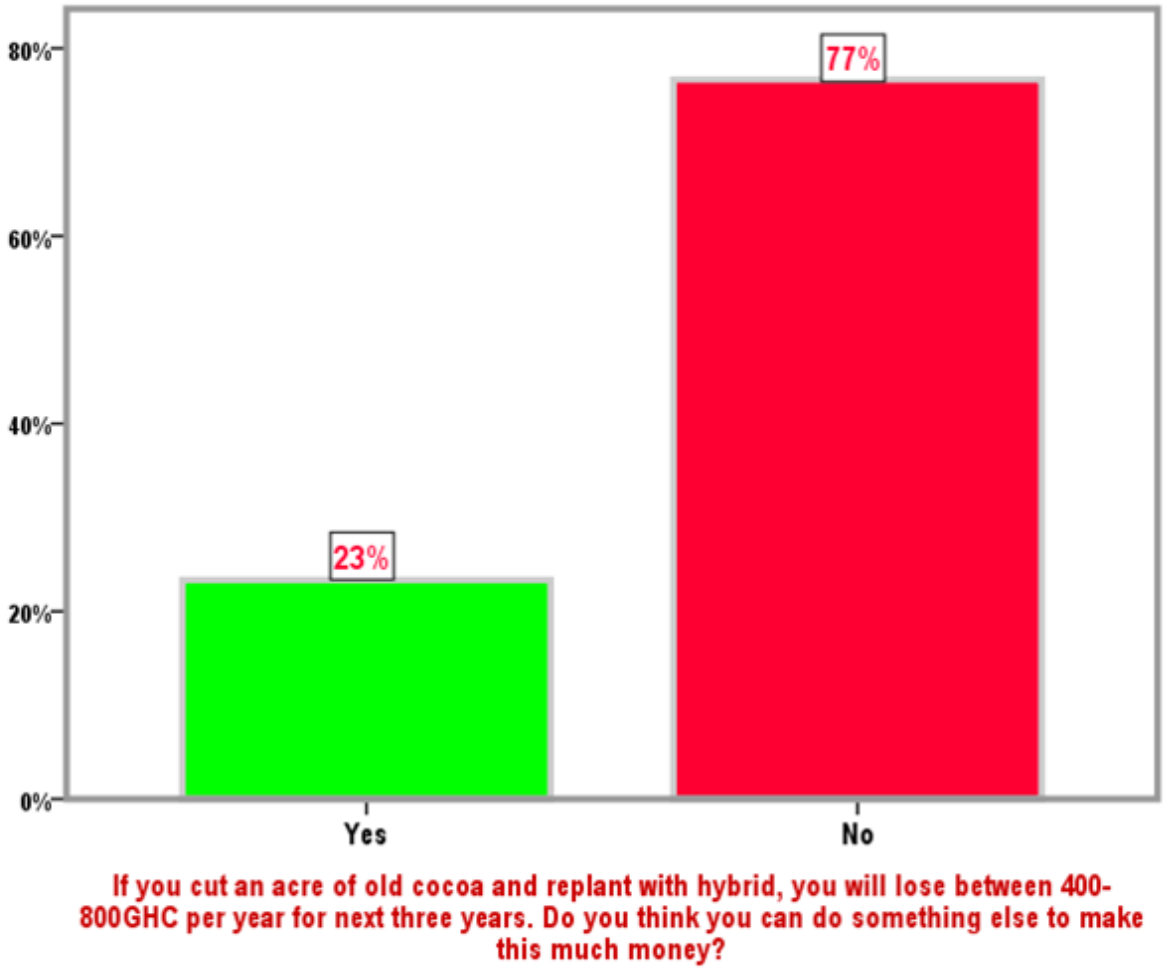


Figure 20: Farmers responses to ‘’income gap’’ question

As we can see from Graph 3, 77% of farmers said they would be unable to compensate the income gap caused by replanting. School fees, housing needs and other ‘’social’’ expenses absorb most of cocoa income and while 69% of farmers have some kind of off-farm income, most of this off-farm activity is petty trading and as trading whether petty or big requires constant ‘’reinvestment’’ into stocks, they are unable to take trading income out of trading business and use it for mentioned expenses.

However, cocoa farmers do replant or plant hybrids and to see in which cases they do so, we asked them another question to reveal planting/adoption patterns.

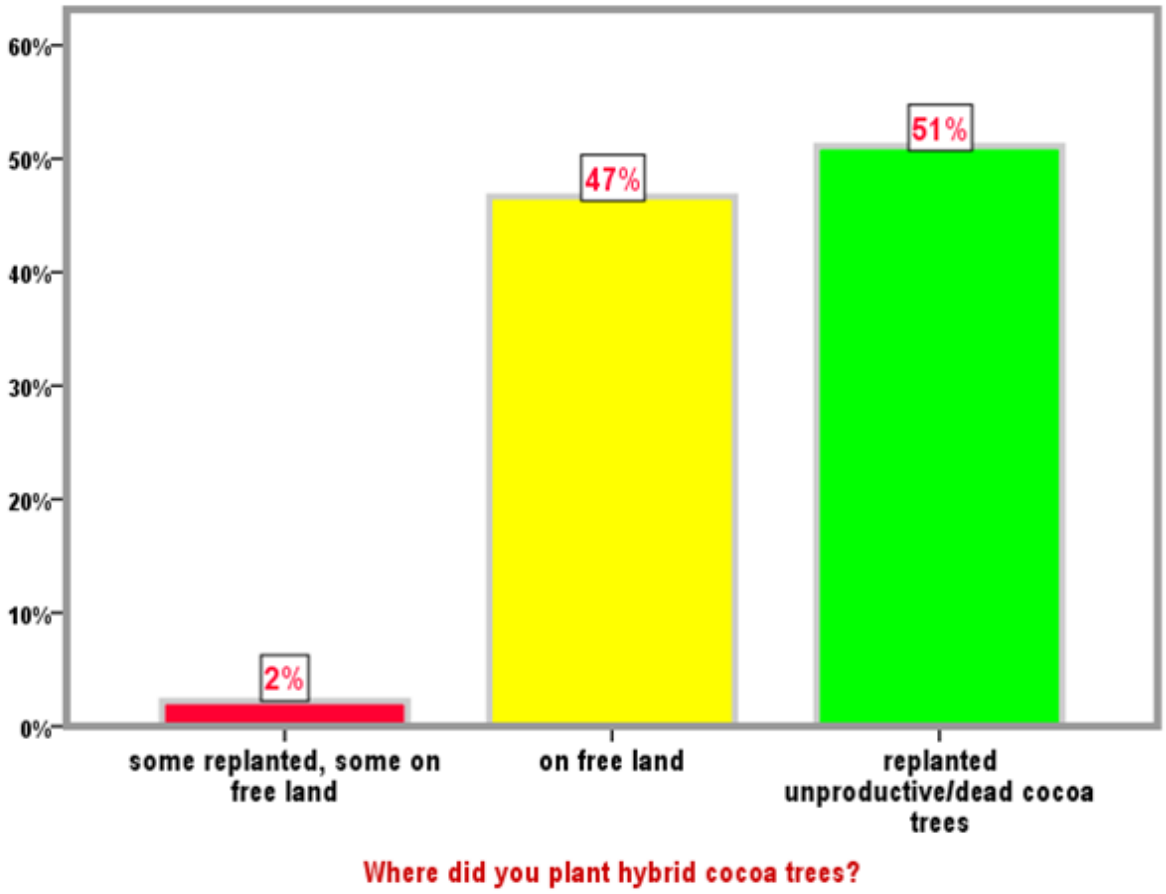


Figure 21: Replanting/planting patterns with hybrid cocoa

As we can see on Graph 4, 51% of farmers only replanted aged trees when they become dead due to diseases or become ‘’too’’ low-productive. This again supports ‘’cash flow’’ argument in a way that farmers will only take action when they see that old trees no longer bring income and by keeping them they will create ‘’income/cash gap’’. 47% of farmers who planted hybrids on ‘’free land’’ did so because the free land was idle and did not provide any income and ‘’opportunity cost’’ was near to zero.

This finding created demand to know how many dead/low-productive trees farmers have since our previous data suggest that farmers with such trees are the most realistic target group for facilitating replanting activity. We asked this separately, how many dead trees and how many low productive trees did they have and we found that on average each farmer had about 467 dead/low-productive trees while median number was 167 trees.

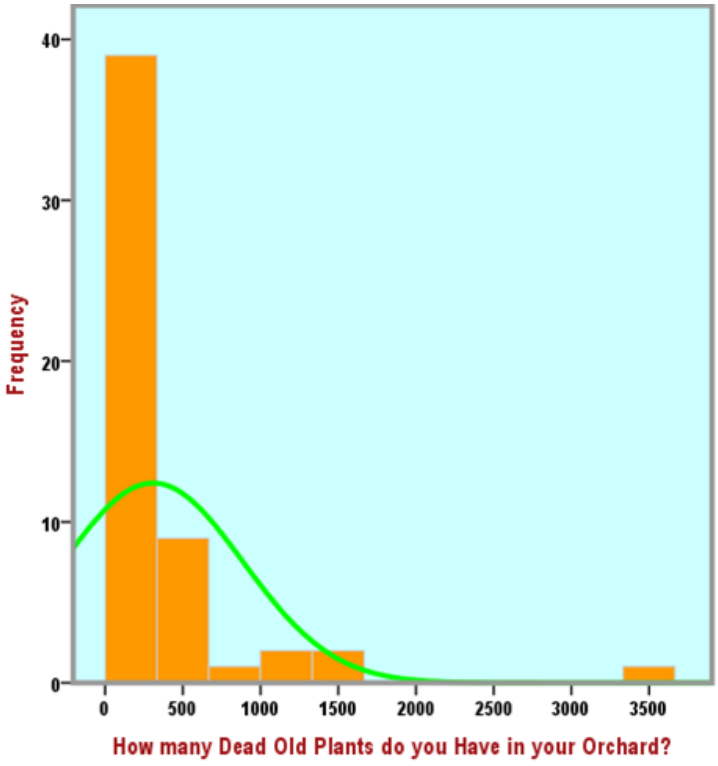


Figure 22: NN of dead trees

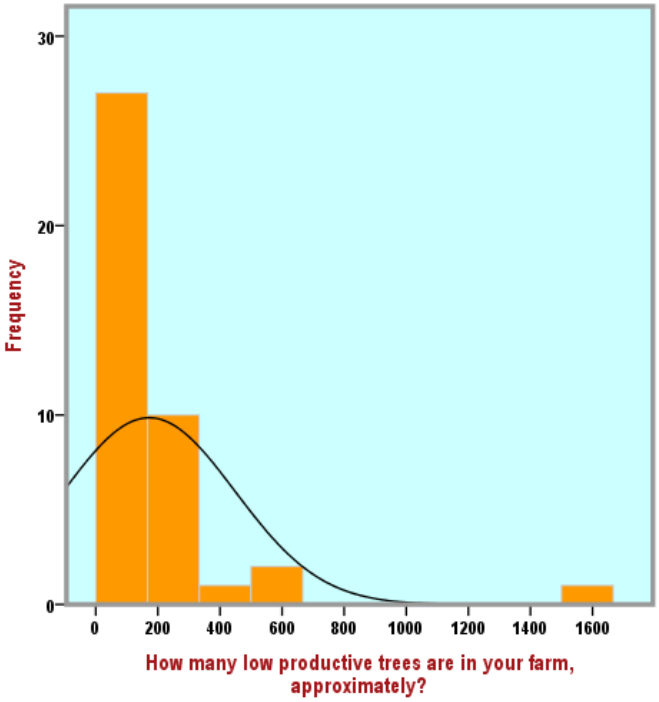


Figure 23: NN of low productive trees

Next logical question would be if farmers know that they have dead/low-productive trees in the farm why they not replanted them already? For this question we have done one case

study and we selected one of interviewed farmer Mr. Steven Achiki to witness all the steps which any typical farmer has to take from cutting dead/low-productive trees to replacing them with new plant material. The case study revealed some technical, social and political reasons. The fact is that not all of dead and low productive trees are only in one segment of cocoa farm. They are scattered throughout and when a problem is scattered or ‘’diluted’’ it probably does not create high level of urgency to act. Then, placing the order for hybrid plant material is not possible at the community level. The farmers have to go outside their community to visit CSSVD district branch (94%) and they may have to do so several times and waiting time between order placement and actual delivery is minimum 3 months (22%) and maximum 5 months (68%). Political reason is that as we have seen during case study of ‘’CSSVD replanting program and farmer’’, farmers think that if they visit CSSVD branch alone, they would not be given attention. This lack of confidence in CSSVD is caused by frequent suspension and renewals of the program. As CSSVD Asamankese branch manager informed us, in last 2 years the program was suspended twice and after it was suspended last time in March 2013, it has not yet been renewed. Frequently, farmers mentioned that CSSVD delayed monetary compensation for swollen shoot affected orchard replanting (900US$/ha). Therefore farmer who goes to register his plant material order, may then learn that program is suspended and be left unclear about the prospect of renewal. This certainly creates frustration and reduces incentives to incur costs of several visits to CSSVD units.

Chapter 6: Discussion

On farmers' demographics, our findings partially match with those of Tiel and Zeitlin. In our case, mean number of households as in their survey is 6 persons. However in terms of migration destination we find higher rates of migration to urban areas, 90% vs. 65%. Also we find that work as purpose of migration is higher among our surveyed households at 90% vs. 40%. Another difference is in percentage of farmers with primary school education, which in our case is 22% while Tiel and Zeitlin indicate 67%.

Regarding farmers' resources, we found that reported mean income from cocoa beans sales among 90 surveyed farmers was 2089US$ while median income from cocoa beans sales was 1590US$. To compare, Hainmueller et al in 2009 found the median cocoa income level at 504US$. The same study suggested median income of 56US$ from the sale of other cash crops while our surveyed farmers reported median, annual other cash crop income at 250US$. Further on farmers income sources, as Naminse et al found in 2012, we also see that about 28% of farmers total annual income is made from off-farm activities.

In terms of existing patterns/constraints of adoption of hybrid varieties, Gockowski, while surveying 167 bearing cocoa farms, found that only 17% of farms had hybrid varieties and that share of land planted with hybrid varieties on these farms did not exceed 7% (2011). When he also considered recently planted un-bearing young orchards he found that out of 57 surveyed farms already 30% used hybrid varieties and share of land devoted to these varieties was 31%. In our own survey of 90 farmers in 10 communities of Asamankese district, we find much higher rate of adoption of hybrid cocoa with 82% of farmers being hybrid variety growers and yet in terms of scale our findings match to those of Gockowski: 33% vs. 31%.
Regarding yield advantage of hybrid cocoa over traditional varieties, Edwine and Masters surveyed 192 fields during 2002 and found 42% increase in yields and much of this increase being consequence of genetic improvements in recently released improved hybrid varieties (2005). We cannot provide such exact figures because most of our surveyed farmers did not weight separately hybrid and other varieties' yields at harvesting point but we can conclude that most farmers believe that hybrids yield more than traditional varieties.

Among the factors influencing adoption of hybrids instead of traditional varieties, age of farmer is frequently referred as a factor determining adoption decision in literature. Particularly, Aneani et al (2012) and Wiredu et al (2011) found the age of the farmer influencing adoption of hybrid varieties. The older the farmers got, the lesser became their readiness to try new varieties. The older farmers who were used to the traditional Amelonado and Amazon varieties were more resistant to change to Hybrid seeds by replanting their old cocoa farms. In our own survey, while average age of hybrid cocoa adopters was 53 and that of non-adopters 56, Independent Sample T Test did not find this difference as statistically significant. Therefore we cannot, based on our survey results, argue that age is a factor.

Education level of farmers is referred as another important factor in adoption studies. Aneani et al argued that lower level of education does not allow such farmers to receive and analyse information about description of hybrid varieties. Wiredu et al, however did not find education as significant factor. In our own survey, we found that education level is statistically significant factor and moreover, there are significant differences between various education levels too. Particularly, Chi-Square test showed that primary and junior high school attendant farmers had higher adoption rate than those with senior high school education.

Like Wiredu et al (2011) we also find relationship between mean cocoa farm size and hybrid adoption. In our survey, mean cocoa farm size of adopters was 3,2ha and that of non-

adopters was 2ha. However Independent Sample T Test does not allow us to conclude statistical significance of this factor. The same test performed on total farmland size and adoption, however established statistical significance, with adopters' mean land size being markedly bigger at 6,3ha compared to mean size of non-adopters' total farmland at 3,5ha.

Our finding regarding **relationship between age of cocoa tree and yield** is in line with suggestions from literature review. Gockowski (2011) emphasized importance of age together with genetics and biophysical environment for productivity. Binem et al (2008) noted that after 23 years from planting, yields start to decline due to exhaustion of soil nutrients and increasing occurrence of pests and diseases.

Regarding constraints for replanting aged trees, partially this issue is addressed in discussing current adoption patterns and we can add one more, a more technical constraint. This is about spatial differences in resource endowment and particularly how easy is to obtain information and hybrid materials for those farmers who are considering to use hybrid material for planting or replanting purposes.

Our finding about ''technical'' barrier to replanting and particularly long waiting time of hybrid plant material order and distance between seedling production unit and farmers' community is in line with Asare et al (2010) who point that despite relatively high number of annual seedling production figures, access for farmers is increasingly difficult due to spatial gaps between seedling production units and farmers' location is some districts of Ghana.

During literature review, we could not find sufficient resources on comparative studies between traditional and hybrid varieties concerning their resistance profile to diseases and droughts. During our survey of 90 farmers, this issue came up as one of serious constraint factors for replanting aged trees with hybrid material. 68% of interviewed farmers said that hybrid cocoa variety was less resistant to diseases such as Capsids, Black Pod and Mistletoes than traditional varieties. 73% said that hybrid varieties were also less resistant to drought than older varieties.

One more interesting finding, not found in literature, was farmers' opinion about the bean size of hybrid cocoa. 94% said that hybrid cocoa's bean was smaller than that of older varieties and they had higher rejection rates for hybrids during sieving of beans. Farmers usually sieve beans before they bring them to purchasing depots in their communities.

Chapter 7: Conclusions

In line with our research problem, we would like to divide conclusions into two main parts:

1) Factors that cause and encourage replanting of aged cocoa trees with hybrid varieties
2) And factors that discourage

7.1. Encouraging Causes and Factors

1). Farmers will only replant aged cocoa farm if the trees became extremely low productive or dead due to diseases. They will not replant aged trees if they still bear some cocoa pods and provide with some cash. How low is ‘’low productive’’ for our surveyed farmers? 7 farmers out of 8 farmers whose cocoa yield is between 100-200kg/ha answered that they decided not to cut still bearing trees to the question of ‘’if you are convinced that hybrids yield more, why you did not replant your aged cocoa trees?’’. The same answer option applies to 7 out of 12 farmers whose cocoa yield per 1ha was reported at 201-300kg. From this we can conclude that at least 111kg/ha (lowest reported yield kg/ha) is still considered as not low enough to trigger replanting decision among surveyed farmers.

Number of dead trees is a stronger cause for replanting. However, we could not establish any threshold or indicator about how many dead trees should a farmer reach to warrant replanting. The range varied from few dozens to 3600 dead trees and none of them had yet replanted them although they have made the decision to do so. In the mean time, many farmers who adopted hybrid cocoa varieties became hybrid users as a result of replanting dead/low productive trees (51% of surveyed farmers who had hybrids). Mean size of replanted aged cocoa farms with hybrid plant material was 0,8ha and median was 0,4ha and minimum was as low as 0,01ha which means abt. 10 trees provided tree spacing of 3mx3m.

2). Once the farmer decides to replant aged trees do hybrids stand higher chance for being selected as plant material of choice to farmers? Our conclusion is positive because hybrids offer two most valuable advantages to farmers: they yield earlier (81% of farmers) and yield more (94%). In this case farmers’ extreme preoccupation with ‘’cash flow’’, which they refer to when justifying their decision to keep aged but still bearing trees, works for the benefit of hybrids. Once confronted with imminent reality of replanting more farmers are likely to choose hybrids because it can help them to get back replanted part of their farm to bigger and earlier cash streams.

However, while more farmers are likely to choose hybrids for replanting, there are considerable numbers of farmers who may not do so. Particularly, those who mentioned that hybrids need more input which I cannot afford (19%) and those who said that hybrids do not last long enough (12%). In first case, lack of cash and in second case expected earlier termination of cash flow (shorter life span of hybrids compared to older varieties) may deter them from choosing hybrids.

3). among encouraging factors is CSSVD monetary compensation of abt. 900US$ for each replanted 1ha and free clearance of dead trees and free provision of hybrid plant material. However, this compensation only applies to swollen shoot virus affected trees and not to all dead or aged trees. As we have found out from the interview with CSSVD Asamankese

branch officers, abt. 200ha of 298 farmers was replanted during 2012 in Asamankese district only.

4). Most of farmers (89%) trust quality of hybrid plant material produced by seedling production units. This is very important since many advantages of new varieties could be irrelevant in an environment where farmers are unsure whether what they plant is true to type or weak.

5). 98% of farmers have positive outlook at output market. They believe that cocoa bean prices will increase every year a bit over next 10 years. This means that the farmers do not expect any major risk in continuing farming cocoa and since perennial crops such as cocoa takes at least 3 years to bear first fruit, this confidence in market price removes risk factor from such long term commitment as replanting.

6). Bigger cocoa farm owners have higher likelihood of choosing hybrids for replanting. We could not establish precise reason why but it could be that bigger farms have bigger share of dead/low-productive trees and this intensifies the urgency to react on this problem for the farm owner.

Other factors encouraging replanting and doing so with hybrids, based on correlation/difference tests, are: off-farm income earners, female farmers, landowners, schooled (especially primary and junior high school levels) have higher hybrid adoption rates.

7.2. Discouraging Factors

1). While yield and time to first harvest seem to be convincing advantages of hybrids, ‘’maintenance profile’’ of them, is weak point for new cocoa varieties. 68% of farmers view hybrid varieties as less resistant to diseases and 73% view them as less resistant to drought.

How important are disease and drought resistance to farmers? To understand if benefit of higher hybrid cocoa yields might have been reduced by disease and drought we asked farmers to explain the impact of diseases and drought on their productivity and next two graphs represent their answers:

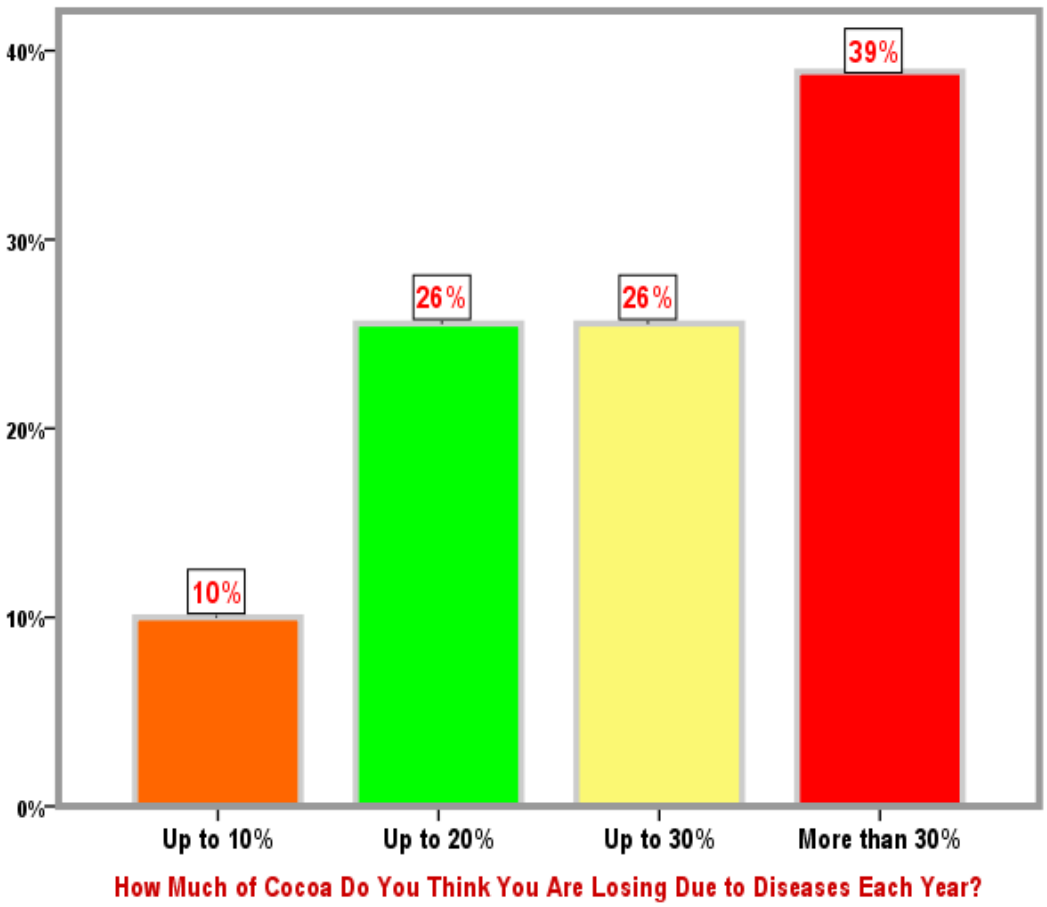


Figure 24: Farmers assessments on impact of diseases on cocoa farm yields

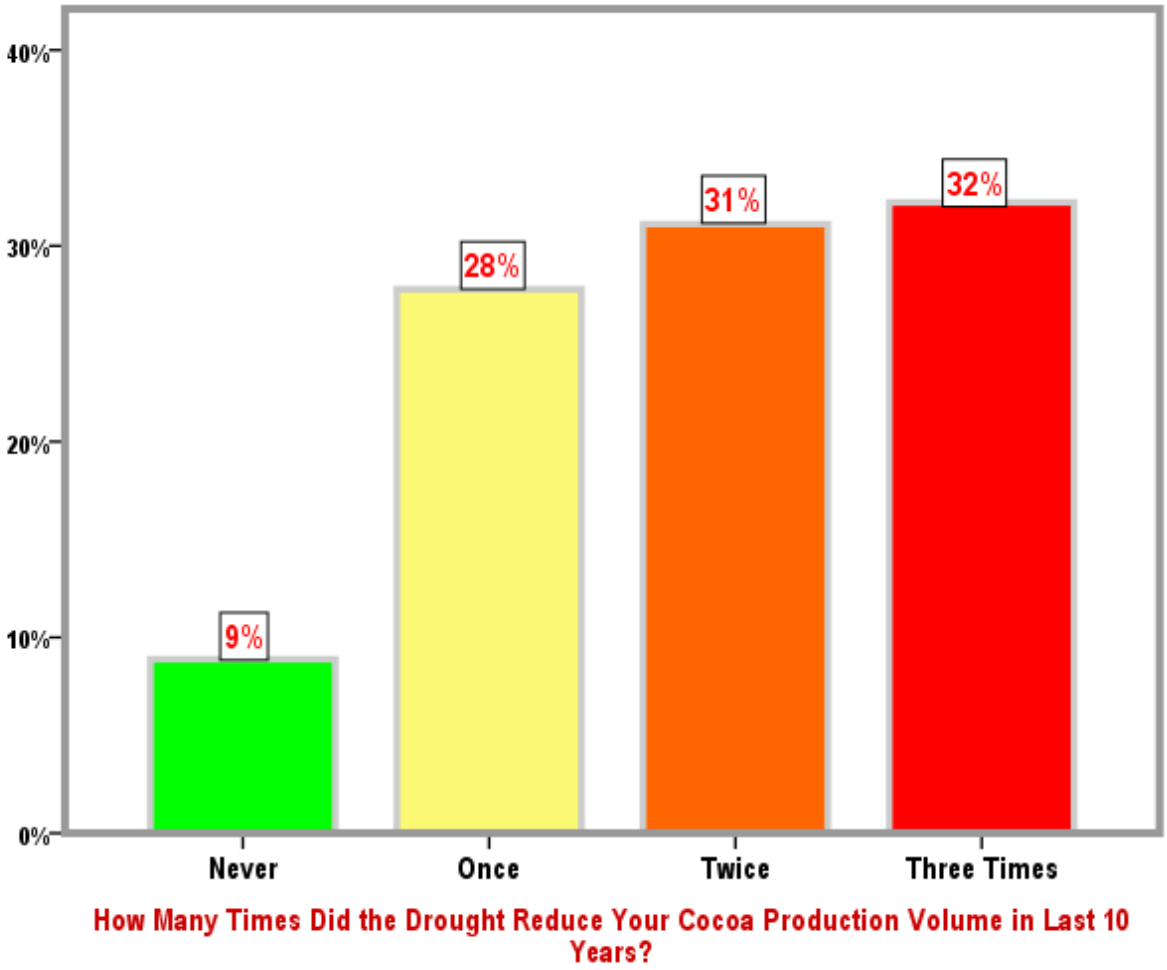


Figure 25: Farmers assessments on impact of drought on cocoa farm yields

2). Further on ‘’maintenance profile’’ of hybrid cocoa varieties, 63% of farmers think that hybrids need more pruning and 71% think that hybrids need more weeding.

Together these four factors, disease and drought resistance and more pruning and weeding make hybrids also a more expensive to manage and this well explains why 19% of farmers said that they will not choose to replant aged farms with hybrids because they ‘’need more input which I cannot afford’’.

3). Smaller beans size of hybrid cocoa is discouraging factor since farmers have to sieve beans prior to delivering to cocoa purchasing depots and when they realise (86%) that more reject beans occur in hybrids, this further reduces adoption incentive for them.

4). There are no market incentives for using hybrid cocoa as replanting/planting material. 94% of farmers said that purchasing depots do not require them to pack hybrid cocoa beans separately from older variety beans. In the mean time, 76% of farmers believe that hybrid cocoa beans make a tastier chocolate for consumers. This means that farmers realise that on the one hand they have to put more resources to maintain hybrids and that hybrids offer spill-over advantages to customers but on the other hand they are not differentiated and awarded for their extra work and adoption of hybrids by the markets.

5). one of the hardest constraints is land market related imperfection: landowners and sharecroppers do not agree to share costs of replanting and maintenance during dormant years of newly planted trees (82%). Since 35 out of 90 farmers were sharecroppers among our survey sample, the impact of this constraint on the scale of replanting is significant.

6). as we have seen from case study ‘’CSSVD and Cocoa Farmer’’, frequent suspension and renewal of CSSVD replanting program, delayed and unpaid compensations, reduce farmers’ incentive to apply for this service.

7). Majority (90%) of farmers mentioned that they have to place the order for the hybrid plant materials at least 3 months in advance and 94% of farmers have to go outside their communities to do so. This implies transportation costs and inconveniences. Sometimes they have to make this trip several times to ensure the actual delivery. We have met one farmer who was unwilling to spend abt. 20US$ to buy a tool against mistletoes although he knew that the damage from this pest was much higher than the cost of the tool. In such an environment several trips to order plant materials represent a serious constraint to farmers.

To summarize,

1). our main conclusion is that surveyed cocoa farmers are willing to replant aged cocoa trees but only after those aged trees become low productive or dead however It is not possible to define exact threshold for how low productive should cocoa trees become to cause replanting action or how many dead trees per 1ha should there be to make farmer to renew orchard.

2). another important conclusion is that when it comes to choice of plant material, more farmers will choose hybrids due to ‘’cash flow’’ advantages such as higher yielding and early bearing. We believe that disadvantages of hybrids such as less resistance to diseases and drought will be given less weight during plant material choosing process in farmers’ minds because

3). Those farmers who mentioned that hybrids need more input which they cannot afford (19%) and who said hybrids last less(12%) are most unlikely to choose hybrid cocoa plants as material for replanting aged cocoa trees. For these 2 categories of farmers, hybrids, in themselves, represent the threat to their present and future income streams and since we have shows income (cash flow) to be main criteria, they will likely reject to use hybrid plant materials.

4). Farmers are not considering aged trees, as long as they bear, as one of their major problems and do not view replanting in general as one of their priorities. Besides asking ‘’relevant’’ questions about various moments of replanting and hybrid cocoa, we also asked some extra questions to see where farmers’ minds were about their cocoa farming. In our opinion, what we see on the below graph is again supporting our income stream / cash flow argument. Farmers prefer to choose the type of intervention which will bring benefits in shortest possible time and therefore more farmers (73%) prefer to start fertilizing old cocoa trees rather than replacing old trees with new and higher yielding plant material.

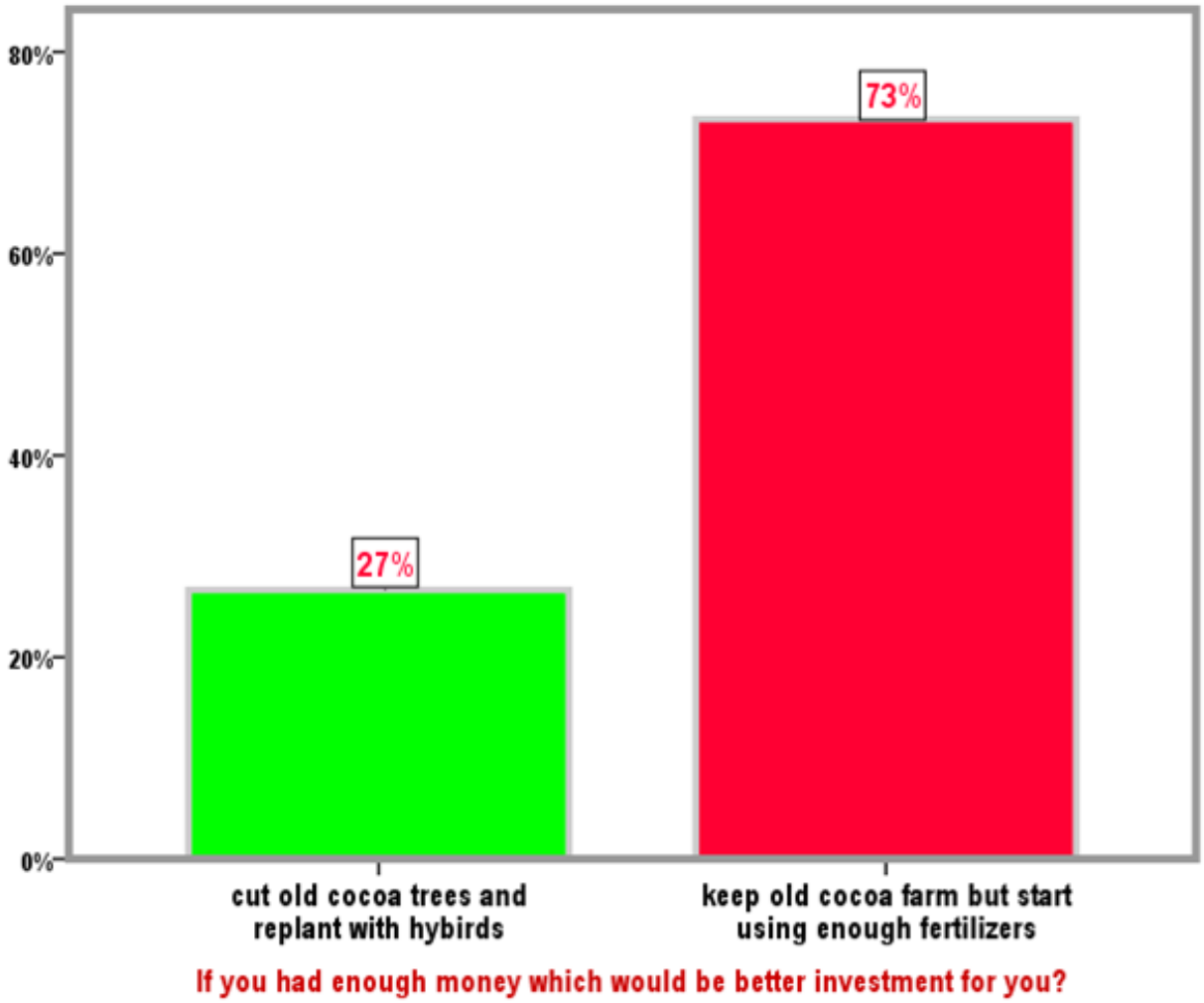


Figure 26: Farmers Own Choices

In the above question farmers still had to choose among two answer options of which one was about hybrids. In another question we did not offer them any answer options but instead applied their responses to certain categories and as we can see below, when farmers were given total freedom to name main concerns, the issue of aged cocoa trees did not appear among their answers at all.

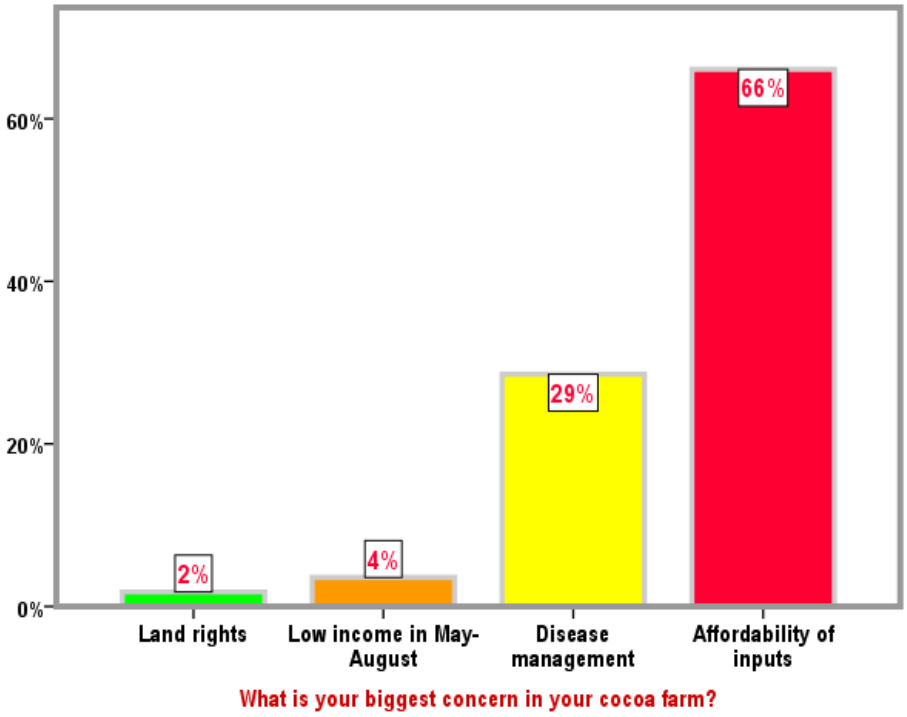


Figure 27: Farmers opinions about main problems of their cocoa farms

Chapter 8: Recommendations

Based on our conclusions and before we describe the recommendations, we would like to define the profile of small holder cocoa farmer from Asamankese district. Most of them are not active, solution-seeking individuals and as some graphs have showed they do not feel that, the issue of replanting, is among their top priorities. Our recommendations take this into account and we tried to offer recommendations which have, in our opinion, have highest probability of activating farmers' towards replanting aged cocoa trees with hybrids.

Our recommendations are divided into two parts: competitive (company specific) and pre-competitive. The first unites recommendations for the implementation among Nestlé's own supplier base (farmers and cocoa purchasing company) and own plant breeding program. The pre-competitive recommendations include suggestions to target problems which go beyond the scale of any single company and require multi-stakeholder approach.

Competitive recommendations:

1). Introduce LBC (Licensed Buying Company) operated plant material supply program

The reason why we recommend this is that LBCs are already engaged with farmers, have required human resources and have representatives such as purchasing clerks in every community in Asamankese district. In recent years LBSc act as main conductors of knowledge between cocoa chain supporters and farmers through LBC employed and hired extension officers, run trainings on good agricultural practices, bookkeeping and on certification. For framers LBCs and most particularly LBC contracted purchasing clerks and extension officers are most important cocoa supply chain stakeholders. Besides selling cocoa to LBCs, farmers also get some financial supports such as credits for fertilizer.

Under LBC operated plant material supply program, we unite 4 key components such as registry of dead and low productive trees among farmers, handling of plant material order and delivery procedures, establishment of LBC owned hybrid cocoa nursery and facilitation of relations between farmers and CSSVD.

In our opinion, this will increase number of farmers willing to replant dead and low productive trees since in such a case farmers can register their inquiry and place the order inside their communities at purchasing clerk level. As we have seen from survey results, currently 94% of farmers have to go to district centre and frequently, several times, to place the order for plants and then monitor whether the order will actually be delivered. Going several times outside community is, in our opinion significant constraint and relaxing this constraint will see much higher numbers of applications for replanting inside communities. In our survey, 97% of farmers already expressed that they prefer hybrid plant material ordering to move to the community level i.e. decentralize. Inside communities most suitable structure to handle this activity would be purchasing clerks who are in contractual relationships with LBCs and who can pass farmers' applications further to LBC's extension officers who themselves are visiting communities regularly under pre defined monthly itineraries.

As an outcome of this program, we expect useful stats and qualitative insights for LBCs and Nestlé into farmers replanting trends, useful stats to plan productivity of LBC's own nursery

of hybrid cocoa material and higher share of younger cocoa trees among Nestlé's own growers base.

Another company specific recommendation is to investigate disease and drought resistance among different hybrid cocoa varieties promoted by CRIG, Nestle Cocoa Plan (NCP) and other parties with the objective to identify the most resistant variety and update spraying instructions and breeding programs.

This recommendation includes pre-survey of cocoa farmers' field experience with hybrids' disease resistance and besides reported opinions of farmers should also include measured scientific field tests.

As an outcome we expect a even shorter short-list of most prospective and resistant varieties, exchange of information between NCP and CRIG and more adequate spraying instructions for hybrids.

Among pre-competitive recommendations, we provide encouragement of CRIG to administer national survey among cocoa farmers regarding performance of hybrid varieties. The reason why we offer this recommendation is that CRIG is the main authority in Ghana who issues cocoa maintenance manuals and decides what information and recommendation is given to farmers through extension officers. Outcomes of the survey would be more awareness of farmers' maintenance limits, updating extension officers' manuals and policy implicated findings for Cocobod.

As Dr. Francis Aneani, the head of social sciences and statistics at CRIG informed us during the interview, CRIG did not conduct specific hybrid adoption or hybrid field performance measuring farmers' surveys yet and we think that doing this now will bring many refreshing revelations.

Second pre-competitive recommendation is to initiate and enter into dialogue between industry stakeholders and CSSVD to understand the causes and impact of shortcomings in CSSVD replanting program and to learn at what terms the program will be renewed. In case it will not be renewed, assess what impact it will have on aged trees renewal process.

Competitive programs	Components	Outcomes/Objectives
LBC Operated Plant Material Supply Program	1. Register NN Dead/Low Productive Trees Among Farmers 2. Let Farmers Place Plant Material Order at LBC's Purchasing Clerk Level 3. Setting Up LBC Owned Nursery (1 per district) 4. Mediating between farmer and CSSVD	Stats for Nursery, Assured Order & Supply of Hybrids / More Younger Trees Among ''Our Farmers"
Comparative Study of Disease/Drought Resistance Among CRIG, NCP and Other Promoted Hybrid Varieties	1. Pre-Survey of Farmers' Field Experiences About Hybrids' Disease/Drought Resistance 2. Compare Performances of Main Promoted Varieties	Hybrids' Results Under Farmers' Maintenance Capacities / Adjustments to Spraying Recommendations and Breeding
Pre-competitive Initiatives	**Objectives**	**Outcomes**
Encourage CRIG/Cocobod to Administer Hybrid Cocoa Field Performance Survey	Local Insights On Constraints, Collaboration on Hybrids Theme	Updating Extension Officers' Manuals, Breeding Programs, Findings for Cocobod Policy
Dialogue with CSSVD/Cocobod	Will CSSVD Program Renew and What Terms Will It Offer to Farmers	Assessing How Renewal or Closure Will Affect Replanting Program

Table 5: Summary of recommendations

Appendixes

Appendix 1: Questionnaire for farmers interviews

Question NN	Questions	Answer Options	Effects
1	What is your age?		Experience
2	When did you plant your cocoa orchard?		Experience
3	What is cocoa farm size		resources
4	Gender	f/m	capacity
5	which of the following did you attend?	1) primary school 2) junior high school 3) senior high school 4) university	more empowered or more distracted from farming
6	Are you local or migrant?	yes/no	capacity
7	How many persons are in the family now?		labour/savings
8	How many persons moved to other area?		labour/savings
9	Why did they migrate?	education, labour, other	diversification
10	Urban?	yes/no	
11	Rural?	yes/no	
12	Will your kids continue cocoa farming?	yes/no	
13	If not why?	1) migration 2) plan other crop	
14	If your kids will not continue cocoa farming what will happen to your cocoa farm?	1) my kids will grow other cash crops 2) my kids will grow other food crops 3) it will be bought or used by other farmer for cocoa farming	expected dynamism
15	What is your total land size?		resources
16	What is your lands size for other cash crop?		diversification
17	How many bags of cocoa did you have last year?		efficiency
18	How much did you earn from other cash crop last year?		diversification
19	If any, how much did your household earn from off-farm employment?		diversification
20	In terms of yields, what is the difference between hybrid and amazonian cocoa varieties?	1) no difference 2) hybrid yields abt. 25% more 3) hybrid yields abt. 50% more 4) hybrid yields twice as much	perception of relative beneits
21	In terms of first harvest, what is the differenece between hybrid and amazonian cocoa varieties?	1) no difference 2) hybrid yields 1 year earlier 3) hybrid yields 2 years earlier 4) hybrid yields 3 years earlier	

22	In terms of bean size, what is the differenece between hybrid and amazonian cocoa varieties?	1) no difference 2) hybrid's bean is bigger 3) amazonian's bean is bigger	
23	In terms of resistance to diseases, what is the differenece between hybrid and amazonian cocoa varieties?	1) no difference 2) hybrid is more resistant 3) amazonian is more resistant	
24	how much cocoa crop do you think you are losing every year due to diseases	1) up to 10% 2) up to 20% 3) up to 30% 4) more than 30%	
25	In terms of resistance to draught, what is the differenece between hybrid and amazonian cocoa varieties?	1) no difference 2) hybrid is more resistant 3) amazonian is more resistant	
26	how many times did the draught reduce your cocoa production volume in last 10 years?	1) once 2) twice 3) three times 4)never	
27	In terms of life time, how long do you think hybrid cocoa tree lasts?	1) up to 10 years 2) up to 15 years 3) up to 20 years 4) up to 25 years 5) up to 30 years	
28	the answers you have just given us about the differences between hybrid and amazonian cocoa, are based:	1) mostly on what I heard from other hybrid cocoa farmers 2) mostly on what I heard from extension services 3) mostly on my own hybrid cocoa experience	
29	in terms of pruning, what is the difference between hybrid and amazonian cocoa varieties?	1) no difference 2) amazonian needs more pruning 3) hybrid needs more pruning	perception of complexity
30	in terms of weeding and spraying, what is the difference between hybrid and amazonian cocoa varieties?	1) no difference 2) amazonian needs more weeding ad spraying 3) hybrid needs more weeding and spraying	
31	Do you know any hybrid cocoa farmer whom you can visit and observe his results?	yes/no	perception of observability
32	Did you ever plant one or two hybrid plants to see how it works?	yes/no	trialability
33	if yes (to Q35) what can you say about yields?	1) yield is much higher, 2) yield is higher but not very much,	
34	If yield was much higher why you did not plant more?	1) I could not get more plants 2) I decided that I should not cut bearing trees 3) because hybrid trees do not last long enough	

		4) because it needs more inputs and I cannot afford them	
35	In last one year, how many times did you discuss suitability of hybrid cocoa with other farmers?	1) never , 2) once, 3) several times, 4) frequently	readiness to learn more
36	Besides farmers, who else will benefit if you and other farmers will produce more cocoa?	1) traders, 2)governement, 3)foreign companies who buy cocoa 4) people who eat chocolate	awareness about external beneficiaries
37	Do you agree that if yield per acre of cocoa increases, less land will be needed to produce as much cocoa as traders want?	yes/no	awareness of spillover effects
38	From which source you can learn more useful information about hybrid cocoa performance?	1) hybrid cocoa farmer 2) extension officer	who is bearing the cost of learning
39	If you plant hybrid cocoa, what will your neighbours do?	1) my neighbours will plant immediately 2) my neighbours will plant after one year 3) my neighbours will plant after they see my first harvest 4) my neighbours will not plant just because I did it. They have their own problems	response to adoption
40	Where you have to go to place the order for hybrid plants?	1) SPU 2) local Cocobod office 3) local farmer group	physical access to plant material
41	To be sure that you get plants, how much in advance you should place the order?	1) just few days in advance 2) at least one month in advance 3) at least two months in advance 4) at least three months in advance 5) more than 3 months in advance	
42	Where would you wish to be able to place the order for hybrid plants?	1) SPU 2) local Cocobod office 3) inside my own community	possible impact of new distribution approach
43	Do you think that if you plant hybrid cocoa, then you should also use more fertilizers and chemicals?	yes/no	farmers opinion about role of inputs in success of hybrid variety
44	Do you think you have enough money to buy enough fertilizers and chemicals?	yes/no	capacity to sustain non-labour inputs for adoption
45	do you think that foreign companies (or people who eat chocolate) can make a more tasty chocolate from hybrid beans than from amazonian beans?	yes/no	perception of market's quality preference

46	do traders like hybrid cocoa beans to be packed in separate bags from amazonian cocoa beans?	yes/no	awareness of market signals
47	Do you use sharecroppers?	yes/no	farming model
48	(if yes to Q44) if you decide to replant the old orchard, will the sharecropper share the costs?	yes/no	sharing risks and incentives
49	Do you think that if you offer your land as collateral, you can get loan from bank?	yes/no	access to resources
Question NN	Questions	Answer Options	Effects
50	How many hours do you work in cocoa farm per week?		utilization of own labour
51	Do you currently use paid labour?	yes/no	access to resources
52	If you had hybrid cocoa will you need more paid labour?	yes/no	economic disincentive
53	Can you borrow money for fertilizers and chemicals?	yes/no	credit and adoption
54	If you replant your entire orchard, can you find other money to live until cocoa bears first fruit?	yes/no	additional income
55	Do you think many farmers would renew orchards if they had access to zero interest special loans?	yes/no	credit and adoption
56	Are you concerned that some hybrid plants that come from SPU/Cocobod might be mistaken hybrids?	1) i heard that some farmers got mistaken hybrids 2) i am sure that all plants from SPU/Cocobod are true hybrids	risk of loss
57	Do you think that cocoa beans price in next 10 years will:	1) remain almost the same as now 2) increase every year a bit 3) decrease every year a bit 4) increase and decrease in different years	market expectations and non adoption
58	Among annual cash crops which one can give you enough money during non bearing years to compensate loss of cocoa income?	1) pepper 2) tomatoe 3) maize 4) other:	compensating opportunities for loss of income during dormant years
59	Among these micro-livestock activities which one has most potential to compensate loss of replanted cocoa income during dormant years?	1) buying little chicks, raising and selling eggs and chincken 2) raising a cow and selling milk 3) raising sheep and selling output 4) other:	
60	if you had enough money what would you do to have more cocoa production?	1) i would replant with hybrids 2) i would buy fertilizers to increase production of my amazonian cocoa	risk managment

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