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TECHNOLOGY ADOPTION AND RESOURCE UTILIZATION UNDER CACAO-BASED FARMING SYSTEM

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Technology, Resources, Organic farming, Hybrid-seed, Fertilizer, Irrigation, Productivity index.

ABSTRACT

Conducted in the Care Channels Farm at Sitio Manirob, Esperanza, S.k. the study entitled "TECHNOLOGY ADOPTION AND RESOURCE UTILIZATION UNDER CACAO-BASED FARMING SYSTEM" aimed to know the technology adopted and resources utilized by Care Channels in cacao farming system. The farm was sloppy terrain, soil type was mostly clay loam, labor workers were all hired, cacao varieties were mostly HYVs, planting distance was 4mx5m, source of irrigation was rainfed, fertilizers and pesticides applied were organically formulated such as Oriental Herbal Nutrients (OHN) and Effective Microorganisms and Activated Solutions (EMAS). Harvesting of cacao was done manually. The problems encountered were inadequate capital, some portion of the area being too shady, inadequate information on cacao technology, pests and diseases, lack of irrigation facilities, government support for the low regulation price, technical support, care and management, erratic weather condition, marketing of the product and infertile soils. To overcome the problems encountered by the respondents, they suggested having a lending agency with a minimal interest rate, the establishment of market linkages, conducting technology training in cacao farming, and government price support. Cacao Productivity Index of the respondents was low with an average of 0.191. the reason was that the respondents did not adopt the recommended package of technology in the cacao farming system.

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Introduction

Technology adoption is a process by which the user starts becoming aware of the technology and ends up fully using it. It is influenced by various factors that include the farmer's awareness, knowledge, acceptance, attitudes, skills, and effective usage of the technology. In usual instances, if the farmers accept new technology, full adoption will likely occur (Aneani *et al.,* 2012). Resource utilization, which is associated with technology adoption, is an important aspect of increasing any crop production. The utilization of resources in production varies with the management by the farmers. One way of increasing production by the small farmers is to efficiently use all the resources available in the production process. Efficiency in the use of available resources is a major pivot for a profitable farm enterprise (Iheanacho *et al.*, 2000).

Among many crops, Cacao is one of the most cultivated in the country. In Sultan Kudarat Province, Cacao production is undertaken by Care Channel Farm (CCF). CCF is designed as an integrated organic farm and it is divided into two farms - Farm A and Farm B. Farm A has 3.5 hectares, of which 0.5 hectare is planted with black pepper. Farm B has 11.3 hectares, of which 6 hectares are planted with Cacao and intercropped with forage crop, 1 hectare is planted with 0il palm, and 4.3 hectares are allotted for ecological purposes to allow the wild animals, insects, and other microorganisms to the harbor. The Cacao crop in Farm B is established along the slopes and is intercropped with forages like indigo, rensonii, flemengia, acid ipil-ipil and madre de Cacao.

Studies reflecting technology adoption and resource utilization in the Cacao-based farming systems are limited. CCF had been known in the past as productive with Cacao, however, lately, information tells that productivity is not being sustained. Thus, the technology adoption and resource utilization under the Cacao-based farming system of CCF are most relevant to the present times to be investigated. The objectives of the study were assessing the technology adoption and resource utilization in the Cacao-based farming system of Care Channel Farm (CCF) at Sitio, Manirob, Brgy. Pamantingan, Esperanza, Sultan Kudarat.

Specifically, the following were done;

1. to determine the technology adopted by CCF under the Cacao-based integrated farming system;
2. to describe the components of this technology and the different resource materials under the Cacao-based farming system;
3. to find out the problems encountered by CCF in adopting the technology and utilizing resources under this system;
4. to describe the coping mechanisms adopted by the farmers to solve the problems encountered under this system;
5. to determine the productivity indices of Cacao under this system;
6. to compare the technology adopted by CCF with the recommended package of technology for Cacao production; and,
7. to formulate a recommendation framework to improve technology adoption and resource utilization of CCF under the Cacao-based farming system.

Materials and methods

Research Design

The study used a descriptive design. A triangulation method was employed in data collection involving the use of two or more methods that can help to explain the richness and complexity of data (Silverman, 2000). Qualitative research mainly focused on the technology adopted and resource materials. Information was attained through interviews and focus group discussions by using an interview guide. Focus group discussion was unstructured, thus allowing participants to open up and discuss freely. The respondents were individually interviewed using a modified guide questionnaire based on a previous study (Buisan, 2014) and treated the multiple responses of the respondents. Quantitative research gathers data in a numerical form which can be put into categories, or in rank order, a rating scale. It was used on the problems encountered by CCF.

Methodology

Before the conduct of the study and gathering of the data, the approval of the administration of CCF was asked for. The survey questionnaires were personally administered by the researcher to the supervisor and farm in charge as well as the caretakers. There were 30 caretakers of CCF. Qualitative data were collected through interviews by asking about the technology adopted and resources materials utilized as well as the coping mechanism to address the problems encountered at the study site. Explanations were provided to clarify information on observed data, and focus group discussion and observation were put into different categorical variables. A research analysis was done using findings from both quantitative and qualitative surveys applying the triangulation method.

The next part regarding the total harvested in Cacao per tree per year was also collected for the computation of average productivity indices of Cacao production. The quantitative method was used to find out the problems encountered by CCF in form of a ranking method.

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Data Analysis

The data were arranged categorically and were analyzed using statistical techniques such as measures of central tendency like percentages/frequency counts and dispersion like SD. The data were analyzed by working out percentage, ranking method on identifying constraints encountered, and average productivity index were computed using summation relations. Further explanation was provided to clarify information from farming and a clear understanding of the result of the study. The modified questionnaires used the Likert scale and were coded to facilitate the appropriate analysis of data. The responses were carefully encoded, summarized, and analyzed using the Microsoft Excel program.

The productivity indices were computed using summation relations.

The following formula was used.

$$API=\left(\frac{\sum_{i=1}^{n} X_i - \bar{X}}{SD(X)}\right)$$

Where: API=Average Productivity Index

X= Yield of crop in kg beans per/tree/ha.

$\bar{X}$=Yields (in mean/tree)

SD=standard deviation.

$\bar{X}$=Average yield of cacao in kg/tree (PCARRD, 2009).

Results and Discussion

Technology Adopted By CCF

The package of technology adopted by CCF includes the use of seedlings, fertilizers, pesticides, and irrigation (Table 1). Most of the varieties used are high-yielding varieties (96.67%). The native varieties are the least used (3.33%). The fertilizers applied are mostly organic (83.33%). Only 13 percent of the fertilizers used are derived from farm residues. The pesticides applied are mostly of botanical origin (86.66%). The mixtures of chemical and organic fertilizers are the least used (3.33%). The mixture of chemical and botanical pesticides is the least applied. The source of irrigation is 100 % rain-fed.

In the present study, the high percentages of use of HYV seedlings (96.6 %), organic fertilizers (83.3 %), botanical pesticides (86.6 %), and rain-fed (100%) are the foundation of the productivity in CCF. These choices of technology were decided upon by the farmer-users based on their access to information. Earlier studies would support these findings as they have shown that a package of technology requires the application of fertilizer that is inevitable for the replacement of soil nutrients. Adequate use of fertilizer has been found to increase agricultural output. Fertilizer recommendation and application of pesticides, fungicides, irrigation, and herbicides as well as good agricultural practices should be part of the rehabilitation package for optimum production. It could increase food production by at least 50%. Effective use of fertilizer on Cacao would help not only to improve yield but also has the advantages of profitability, product quality, and environmental protection (Opeyemi *et al*., 2005).

Farm Resources under the Cacao-Based Farming System

The farm resources under the Cacao-based farming system of the CCF included the land, labor, source of capital and the kinds of farm implements (Table 2). The farm resources under the Cacao-based farming system of the CCF included the land, labor, source of capital, and the kinds of farm implements (Table 4). The land resource of CCF is 100% owned. Their labor sources are all hired. The source of capital is mainly charity grants from Care Channels Organization. The weed control is mostly done using bolo (90%). The use of a grass cutter is seldom done (10%). The hauling of fertilizers, seedlings, and harvesting pods is mostly done manually (73.33%). The use of a cart is seldom done (10.00%). The grub hoe is usually used in digging holes during planting (83.33%). The use of a shovel (16.67%) is seldom done. The management of CCF explained that the above-mentioned observations are primarily due to the ready availability of these materials at this time of farming. The management further explained that the productivity will be improved as soon as the materials will be upgraded, especially when capital will be available to purchase such materials, pay more hired labor, and purchase gas-operated equipment.

Farm Resources Utilized to Compose Organic Fertilizers and Bio-Pesticide Formulations

The farm resources utilized to compose organic fertilizers and bio-pesticides formulations under the Cacao-based farming system of CCF included various sources (Table 3). Goat manure is mostly utilized by 50% of the respondents as their source of organic

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fertilizer. Rice straw and corn cobs are also utilized by 16.6% of the respondents. Only 6.6% of them used rice bran. Lemon grass and garlic are mostly utilized as their sources of pesticide formulation (36.6%). Onion is used by 20% of them. Pepper or sili is the least ingredient of bio-pesticides (6.6%) utilized.

Costs in Php of Resources Utilized for Cacao Production

The costs of resources (Php) utilized for the Cacao production of CCF comprised of those corresponding to materials and human resources (Table 4). The average number of seedlings required per hectare is 571 with a total value of Php 25,698.00. The costs of fertilizers and pesticides per hectare are Php 2,851.66 and Php 4,281.66, respectively. There were 4 laborers used per day per hectare with a value of Php 1,020.00/ day.

The farmers in CCF are explained that the materials required per hectare are not fully applied due to the difficulty of hauling planting materials, fertilizers, and spraying pesticides. The main reason given by the farmers is that the topography of the area is rolling or hilly. The Cacao plants were not fertilized well, especially those found in the upper portions of the area because it was difficult for them to bring the fertilizers up to those areas. As a result, the planted Cacao is malnourished. On the other hand, the funding aspect for labor allotted for the Cacao area is not enough to sustain the farm. They further explained that if more labor should have been allotted in Cacao, the incidence of pests and diseases is mitigated, thus, making the farm more productive. Hence, adequate capital and conduction of training are very helpful.

Some studies support these findings where adequate financing encourages the farmers to purchase good quality seedlings and enables them to maximize the area planted with Cacao and could attain high yield all over the cultivated area (Narayanan, 2015). Farmers' training is very crucial for them to know the best practices regarding Cacao production. In some instances, the farmers had limited information or had inconsistent knowledge about the technologies, so they did not apply the recommended technology (Dwivedy, 2011).

Problems Encountered by the CCF in Adopting the Technology

The problems faced by the CCF (Table 5) in adopting the technology consist of Inadequate capital (100%) is the top rank problem encountered by the CCF. It is followed by too much shade (92.80%), insufficient information about the technology adoption (85.70%), pest and diseases incidence (71.40%), lack of irrigation facilities (71.40%), lack of government support price (64.20%), lack of technical guidance (57.10%), low price produce (50.00%), insufficient care and management (35.70%), lack of knowledge regarding modern practice (35.70%), weather condition (21.40%), lack of farm market produce (21.40%), infertile soil (7.10%), and lack of economic resources (7.10%). There was no problem at all encountered with Cacao plant protection measures,
As we can see in the table 6, the problems listed in descending rank reveal that inadequate capital is the top constraint in adopting the technology. The management and the farmers explained that capital is the major problem. They further explained that if capital is available, possibly the information and the adoption of technology as well as the proper practices for cacao, could be acquired and purchased based on the recommended technology to be fully used by the CCF. Hence, the availability of capital could allow farmers in attending seminars and training from the productive Cacao growers in the country.
In the previous study, financial as well as human capital is assumed to have a significant influence on farmers' decisions to adopt new technologies. Most adoption studies have attempted to measure human capital through the farmer's education, age, gender, and household size (Fernandez-Cornejo and Daberkow, 1994; Fernandez-Cornejo *et al*., 2007; Mignouna *et al*., 2011; Keelan *et al.*, 2014.

Coping Mechanism of the CCF to Address the Problems encountered

Table 6 shown the coping mechanism to address the problems encountered by the CCF is mostly through the availability of lending agencies giving low-interest rates (63.3%). The conduct of technology training on good agricultural practice is the next mechanism (30%). The establishment of market linkages and government price-support were least sought (3.3%).
The coping mechanisms given by the farmers are evidently that accessibility and availability of lending agencies with low-interest rates could help them cope with their problems and adopt the recommended technology in Cacao farming. The establishment of market linkages also helps solve their problems regarding Cacao prices. Conducting technology training for farmers is very crucial for them to become aware of the recommended technology for Cacao production and its practices.
To support these findings, the earlier studies reported that access to credit had stimulated technology adoption (Mohamed and Temu, 2008). It is believed that access to credit promotes the adoption of risky technologies through relaxation of the liquidity constraint, as well as through the boosting of a household's risk-bearing ability (Simtowe and Zeller, 2006). This is because, with the op-

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tion of borrowing, a household can do away with risk-reducing but inefficient income diversification strategies, and concentrate on more risky but efficient investments (Simtowe and Zeller, 2006).

Average Productivity Index (API).

Table 7 shown the average productivity index (API) of each area calculated showed with low productivity of 0.191. These all ranged from 12.5 and below. All areas have very low productivity indices**.**

Based on the farm in charge, the productivity of Cacao per tree per year is very low. Regarding Table 2, organic fertilizer and bio-pesticide are shown as mostly adopted, organic Cacao in CCF generally obtains very low crop yields because the fertilizers used have a slow effect and little or no synthetic fertilizers are used and pesticides control is not enough and it is associated with inadequate capital, poor farm maintenance practices, declining of soil nutrients, labor requirements, the incidence of pests and diseases that leads to low productivity of Cacao.

In a related study in Ghanaian, organic Cacao is plagued with ecological problems such as declining soil fertility, high incidence of pests and diseases, and high exposure to droughts and temperature extremes, coupled with poor agronomic practices and inadequate farm maintenance by characteristically aged farmers. Yields are estimated to be 350 kg/ha on average and are far lower than other major producing countries like Cote d'Ivoire with an average yield of 800 kg/ha and Malaysia's 1700 kg/ha (Kolavalie and Vigneri, 2011).

Conclusions

The technology adoption of Care Channels Farm is generally low, organic material resource utilization is generally high, farm yields are low and capital is inadequate. Low technology adoption is directly related to low yields, high preference for organic fertilizers, bio-pesticides, low labor, and manual operations.

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Recommendation Framework

A recommendation framework to improve ( ) technology adoption and resource utilization of CCF under Cacao-based farming system is formulated (Figure 1).

Under Cacao-Based Farming System, the intensification of labor, upgrading of capital through more accessibility to and availability of lending agency with low interest rate are recommended. The establishment of market linkages could be helpful in CCF, and conducting technology training and government price support are highly recommended to attain good prices. The packages of technology, such as use of HYVs, should remain being adopted by the farmers. The sources of bio-pesticides like fermented plant juice (FPJ), fermented fruit juice (FFJ), oriental herbal nutrient (OHN), effective microorganisms and activated solution (EMAS) must be coupled with synthetic fertilizers, pesticides, and irrigation. The use of organic materials to include forages like indigo fera, flemingia, rensonii, acid ipil-ipil and madre de cacao be done as intercrops. Vermicomposting, bokashi, goat manure, and hog manure serve as the sources of organic fertilizer to reduce cost in buying synthetic fertilizers should be sustained.

Associated problems in the adoption of Cacao-based farming system and resource utilization in CCF such as inadequate capital, technical knowhow, pests, and diseases as well as the low of adoption of technology that could result to low yield and income could be resolved by providing better adoption and resources allocation and by utilizing recommended packages of technology that support the yearning for higher yield, the expectation for high productivity and achievement of high income.

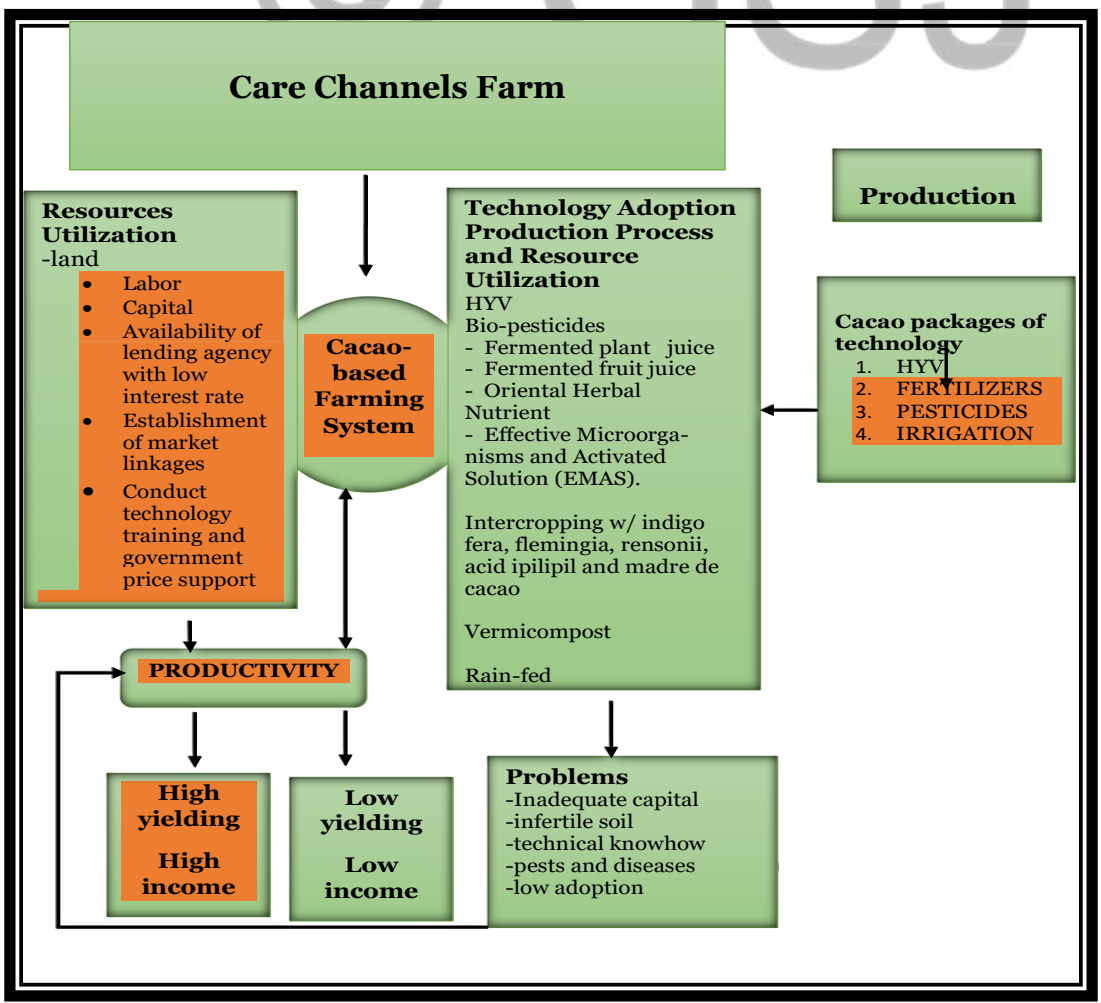

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Figure 1. Recommendation framework relating to technology adoption and resources utilization under Cacao-based farming system.

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Appendices:

Table 1. Data on the technology adopted, farm resources, problems encountered, coping mechanisms, and productivity indices.

Variables	Data gathered			
	Type of Varieties	**Fertilizers**	**Pesticides**	**Irrigation used**
1. Technology adopted	UF18 and native seeds	Organic and chemical	biopesticides and chemicals	rain-fed and irrigated
	Land	**Labor**	**Capital**	**Farm tool and Materials**
2. Farm resources	Owned, rented, and tenant	Family members, hired labor only partially hired and mostly hired.	Government, bank loans, charity, and private lenders.	Bolo, grass cutter, pruning saw grub hoe, shovel, cart, and vehicle.
3. Problems encountered	Inadequate capital, weather conditions, peace and order, insufficient care and management, lack of economic resources, lack of Government support, insufficient information about the technology adoption, pest and diseases incidence, lack of irrigation, too much shade, infertile soil, low price of produce and lack of knowledge regarding modern practices.			
4. Coping mechanism	Availability of lending agencies with low-interest rates, the establishment of market linkages, technology training, and government price support**.**			
5. Productivity indces	Weight of Cacao beans (kg) /tree/year.			

Table 2. Technology Adopted by Care Channel Farm. N=30

Technology	**Frequency**	**Percent (%)**
Seedlings used		
HYV	29	96.6
Native varieties	1	3.3
Fertilizers		
Organic fertilizer	25	83.3

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Farm residues	4	13.3
Mixture of Chemical and Organic fertilizer	1	3.3
Pesticides		
Botanical	26	86.6
Mixture of botanical and chemical	4	13.3
Irrigation		
Rain-fed	30	100.0

Table 3. Farm Resources under Cacao-based Farming System. N=30

Materials	**Frequency**	**Percentage (%)**
Land		
Owned	30	100.0
Labor		
Hired	30	100.0
Source of capital		
Charity / grants from Care Care Channels Organization	30	100.0
Farm tools used for weeds control		
Bolo	27	90.0
Grass cutter	3	10.0
Means of pruning		
Pruning saw	25	83.3
Bolo	5	16.6
Means of hauling farm materials		
Manual	22	73.3
Cart	3	10.0
Vehicle	5	16.6
Means of digging holes		
Grub hoe	25	83.3
Shovel	5	16.6

Table 4. Farm resources utilized to compose organic fertilizers and bio-pesticides formulations under cacao-based farming system. N=30

Materials	**Frequency**	**Percentage (%)**
Organic fertilizers		
Goat manure	15	50.0
Rice straw	5	16.6
Corn cobs	5	16.6
Peanut shell	3	10.0
Rice bran	2	6.6
Bio-pesticides (concoction)		
Lemon grass (tanglad)	11	36.6
Garlic	11	36.6
Onion	6	20.0
Sili	2	6.6

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Table 5. Costs (Php) of Resources Utilized for Cacao Production of CCF. N=30

Resources	No. of resources type	Costs /ha (Php)
Materials:		
Seedlings	571 (seedlings)	25,698.00
Fertilizer	11.40 (sacks)	2,851.66
Pesticides	122.33 (liter)	4,281.66
Human:		
Labors	4 (man-days)	1,020.00

Legend:

1. @45/seedling
2. @250/sack
3. @35/liter
4. @256.78/(man-days)

Table 6. Problems Encountered by the CCF in Adopting the Technology. N=30

Problems	Rank	Percent (%)
Inadequate capital	1	100.00
Too much shade	2	92.80
Insufficient information about the technology adoption	3	85.70
Pest and Diseases incidence	4	71.40
Lack of irrigation facilities	4	71.40
Lack of government support price	6	64.20
Lack of technical guidance	7	57.10
Low price produces	8	50.00
Insufficient care and management	9	35.70
Lack of knowledge regarding modern practice	9	35.70
Weather condition	11	21.40
Lack of market for farm produce	11	21.40
Infertile soil	13	7.10
Lack of economic resources	13	7.10
Lack of plant protection measures	15	0.00

Table 7. Coping Mechanism to address the Problems Encountered. N=30

Coping mechanism	Frequency	Percent (%)
Availability of lending agency with low interest rate	19	63.33%
Establishment of market linkages	1	3.33%
Conduct technology training	9	30.00%
Government price support	1	3.33%

Table 8. Average Productivity Index (API). N=30

Caretakers	kg/tree/yr.	SD (x)	API	Interpretation
1.	0.08	0.042	0.748	very low
2.	0.07	0.042	0.393	very low
3.	0.06	0.042	0.151	very low
4.	0.05	0.042	0.0227	very low
5.	0.04	0.042	0.0076	very low
6.	0.03	0.042	0.1059	very low
7.	0.03	0.042	0.1059	very low
8.	0.02	0.042	0.3177	very low

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9.	0.04	0.042	0.0077	very low
10.	0.05	0.042	0.0227	very low
11.	0.05	0.042	0.0227	very low
12.	0.06	0.042	0.1514	very low
13.	0.05	0.042	0.0228	very low
14.	0.03	0.042	0.1059	very low
15.	0.05	0.042	0.0227	very low
16.	0.02	0.042	0.3178	very low
17.	0.02	0.042	0.3178	very low
18.	0.03	0.042	0.1059	very low
19.	0.05	0.042	0.0228	very low
20.	0.04	0.042	0.0076	very low
21.	0.04	0.042	0.0076	very low
22.	0.05	0.042	0.0228	very low
23.	0.01	0.042	0.6431	very low
24.	0.06	0.042	0.1514	very low
25.	0.07	0.042	0.393	very low
26.	0.08	0.042	0.749	very low
27.	0.01	0.042	0.643	very low
28.	0.08	0.042	0.0228	very low
29.	0.03	0.042	0.106	very low
30.	0.04	0.042	0.008	very low
Total	**1.31**		**1.26**	**5.728**
Mean	**0.044**		**API=0.191**	**very low**
SD	**0.019**			

Legend:

Grading scale	**Interpretation**
87.5 and above	Very high
62.5 to 87.5	High
37.5 to 62.5	Medium
12.5 to 37.5	Low
and below 12.5	Very low

Assumption:
Assume 5th yr. average yield of 2.25 kg/tree (PCAARRD. 2009).

Table 9. Comparison between the technologies adopted by CCF with the recommended package of technology for Cacao production. N=30

Technology Adopted by CCF		**Percent Adopted by CCF**	**Recommended Technology by PCARRD, 2009**	**Interpretation**
Cultural and Management			**Cultural and Management**	
Seedlings			**Seedlings**	
HYVs		96.6%	HYVs	Highly adopted
Planting distance (Meters)			**Planting distance (Meters)**	
4mX5m	73.33%		3x3 or 4x4	Adopted
Deep of planting (Centimeters)			**Deep of planting (Centimeters)**	
	3-4		3-4	Highly adopted

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Shading		**Shading**	
Use of shade (under Coconut)	0.0%	Use of shade (under Coconut)	Not adopted
Use of shaded (Leguminous trees)	100.0%	**Use of shaded** (Leguminous trees)	Highly adopted
Pruning after harvest period	100.0%	**Pruning after harvest period**	Highly adopted
Chemical Method (Pesticides)		**Chemical Method** (Pesticides)	
OHN	86.66%	TriCFAP	Not adopted
EMAS	13.33%	Green muscardine fungus	Not adopted
		Trichogramma chilonis	Not adopted
Fertilization		**Fertilization**	
Planting time		**Planting time**	
11.40 sacks/ha (basal)	100.0%	250 grams/hole or	
Organic		5bags/ha (14-14-14)	Not adopted
Three years old		**Three years old**	
Organic	83.33%	4 bags/ha (12-24-12)	Not adopted
Farm Residues	13.33%	1 bag/ha (46-0-0) first Application	Not adopted
Mixture of Chemical and Organic	3.33%	1 bag/ha (0-0-60) second application	Not adopted
Three years and over		Three years and over	
Organic	83.33%	10 bags/ha (14-14-14)	Not adopted
Mixture of Chemical and Organic	3.33%	1 bag/ha (0-0-60) second application	Not adopted
Control Measures		Control Measures	
Mechanical	0.0%	Mechanical (Weeding, pruning, bagging or sleeping)	Not adopted
Manual weeding	100.0%	weeding	Highly adopted
Manual pruning	100.0%	pruning	
Bagging or sleeving	0.0%	Bagging or sleeving	Highly adopted

Legend:

Percentage	**Interpretation**
87.5 and above %	Highly adopted
62.5 to 87.5 %	Adopted
37.5 to 62.5 %	Pairly adopted
12.5 to 37.5%	Poor Adopted
and below 12.5	Not Adopted