AMERICAN JOURNAL OF AGRICULTURAL SCIENCE, ENGINEERING, AND TECHNOLOGY (AJASET)

ISSN: 2158-8104 (ONLINE), 2164-0920 (PRINT)

VOLUME 6 ISSUE 1, (2022)

Indexed in

doi | Crossref | CiteFactor | Google Scholar | OCLC WorldCat | DRJI Directory of Research Journals Indexing | OpenAIRE

PUBLISHED BY: E-PALLI, DELAWARE, USA

The American Journal of Agricultural Science, Engineering, and Technology (AJASET) is a blind peer-reviewed international journal publishing articles that emphasize on research, development and application within the fields of agricultural science, engineering and technology. The AJASET covers all areas of Agricultural Science, Engineering, and Technology, publishing original research articles. The AJASET reviews article within approximately two weeks of submission and publishes accepted articles online immediately upon receiving the final version.

Frequency: Three issues per year
Area of publication: Agricultural science, engineering, and technology including crops, livestock, fisheries, and other evolving areas.

Contact:
American Journal of Agricultural Science, Engineering, and Technology (AJASET)
E-Palli LLC
Address: 2055 Limestone Rd Ste 200C, Zip Code: 19808
Wilmington, Delaware, USA
Email: ajaset@e-palli.com
Phone: +1 3024070506
URL: https://journals.e-palli.com/home/index.php/ajaset

American Journal of Agricultural Science, Engineering, and Technology (AJASET)

Volume 6 Issue 1, Year 2022
ISSN: 2158-8104 (Online), 2164-0920 (Print)
DOI: https://doi.org/10.54536/ajaset.v6i1.135
https://journals.e-palli.com/home/index.php/ajaset

Carbon Sequestration Potential of Fruit Farms in Selected Sites of National Greening Program in Batangas Province, Philippines

Judylin T. Enoc[1] & Bondee L. Peñaflor[2*]

Article Information

Received: January 14, 2022

Accepted: February 24, 2022

Published: March 14, 2022

Keywords

Fruit Farming, Carbon Sequestration, National Greening Program

ABSTRACT

The study assessed the carbon sequestration potential of existing fruit farms in Batangas province. A structured questionnaire was used coupled with KII, FGD, desk review of secondary data, farm and community visits, and gathering of geo-referenced points were done to gather the needed data. Data were analyzed in Microsoft Excel. Results show that there are 13 species of fruit trees being grown and the top three most grown are Coconut, Avocado and Langka.. In 2015, a decrease in the areas of Perennial and Annual Crops were observed while there was an increase in the areas covered with brush/shrubs. In Sucol, Balayan, Batangas, majority of the areas in 2010 are covered with perennial crops, shrubs and annual crops. In 2015, no recorded areas covered with perennial crops while areas covered with shrubs have increased. Meanwhile, the respondents are highly affected on climate change impacts but fruit farmers have coping strategies to address such impacts. As to carbon sequestration, Mangifera indica has the highest average above ground biomass (AGB) and carbon sequestration in Cahil with 18,854.95kg and 8,484.73kg, respectively. This is followed by Persia amaricana with average AGB and carbon sequestration of 14,165.83kg and 6,374.62kg, respectively. Coffea Arabica has the least recorded AGB with 2,669.24kg and the carbon sequestration is 1,201.16kg. In Sucol, M. indica has the highest average AGB with 55,170.89kg and carbon sequestration of 24,826.90kg. Citrofortunella microcarpa has the least recorded AGB and carbon sequestration with 184.32kg and 82.94kg, respectively. The study necessitates the need to prepare necessary documentations highlighting several success stories in the study sites which could serve as benchmark document for other greening efforts in the country and abroadtration with 184.32kg and 82.94kg, respectively. The study necessitates the need to prepare necessary documentations highlighting several success stories in the study sites which could serve as benchmark document for other greening efforts in the country and abroad.

INTRODUCTION

Philippine forest resources have long been denuded and enormous efforts such as an integrated approach to im-prove the resilience of the landscapes itself and the livelihoods of communities that the forests support have been initiated for several years. In fact, the country has been into a resource-constrained experience due to unprecedent-ed rate of deforestation for the past years. In the midst of climate change, the threat intensified, hence, restoration of the degraded state of the country's forest ecosystems is vital. Efforts are needed to be in place so as to ensure that our natural capital will be able to help people and communities through food security, poverty alleviation, and by means of helping in the adaptation and mitigation to the threats brought about by the changing climate condi-tion.

Executive Order No. 26 series of 2011 was issued by former President Benigno C. Aquino III which declares the initiative on the conduct of National Greening Program (NGP). It became a priority program of the Philippine gov-ernment which aimed to reduce poverty; promoting food security, environmental stability, and biodiversity conser-vation; and enhancing climate change mitigation and adaptation. With these, not only it aimed to work for refor-estation efforts but also geared towards a larger program which intends to attain other important national goals as well. The NGP clearly specified the planting of about 1.5 billion seedlings in 1.5 million hectares of land nationwide within the period of 2011 to 2016. The National Economic and Development Authority (NEDA, 2011) reported that this target (i.e. in hectare) to be reforested is more than double the target in the Philippine Development Plan 2011–2016 which is about 600,000 hectares of

increased forest cover by 2016. According to NEDA report, the NGP has an estimated total budget of about 30 bil-lion pesos.

Community forestry, employed in many countries in Asia, like the Philippines, involves people in communities working together to establish tree plantations or manage existing stands while simultaneously planting fruit trees and agricultural crops to satisfy food requirements and enhance livelihoods (Kumar, et. al, 2015). It is also an ap-proach employed in the NGP where involvement of people in the communities is encouraged to ensure sustainabil-ity of the program.

Under the jurisdiction of CENRO Calaca, a total of 73.15 hectares were developed under this category broken down as follows: 1.15 hectares FMS Regular; 52.0 DA converted which were planted with assorted fruit trees and the remaining 20.0 hectares were planted with narra seedlings targeted under NPS-ENRMP through

[1] Community Environment and Natural Resources Office (CENRO), Calaca, Batangas, Philippines
[2] College of Forestry and Environmental Management, Isabela State University, Garita, Cabagan, Isabela. Philippines
[*] Corresponding author's e-mail: bondee.l.penaflor@isu.edu.ph

World Bank fund located in Barangay Sucol, Balayan, Batangas. The species that were planted include: 10,000 Narra, 10, 230 Calamansi, 9,800 Cofee, 200 Guyabano, 1,355 Suha and 1,870 Cacao seedlings. The plantation area is a devolved Integrated Social Forestry Project (ISFP) site. The beneficiaries of the above- mentioned project are also the identi-fied beneficiaries of NGP and in the above-mentioned developments, they were engaged in fruit farming/growing. This is attributed to the fact that it creates livelihoods to the communities. With these plantations, there is a need to assess the carbon sequestration potential in order to determine its contribution to climate change mitigation.

Objectives of The Study

This study aimed to assess the existing Fruit Production in the selected localities in the District 1 of the Province of Batangas, and identify its significant contribution to climate change mitigation through the assessment of its carbon sequestration potential. Specifically, the study sought to: (1) ascertain the fruit-based production system in the study areas; (2) generate GIS-based map of the species distribution in the study areas and the recorded changes in land cover (2010 and 2015); (3) evaluate the impacts of climate change to the beneficiaries and how do they cope to address such impacts; and (4) assess the carbon sequestration potential of the fruit bearing plants in the study areas

LITERATURE REVIEW

Community Forestry

Forest resources provide the basis for many cultures, particularly of indigenous groups whose lives are closely inter-woven with forest resources. Belief systems are governed by spirits found in mountains, trees, lakes and other facets of nature; and rituals are performed as part of traditional natural resource management activities. In the Philip-pines, approximately 30 percent of the population, including some twelve to fifteen million indigenous peoples, de-pend on forests for their survival, and their cultures revolve around their interactions with their natural environment (DENR 2009).

Global climate change can have a variety of negative impacts particularly when carried out without management standards that are designed to protect natural assets. Climate change can have significant negative impacts on the natural environments including the loss of biodiversity and changes in the landscape features and the ecosystems. However, for the past years, strategies have evolved considerably due to frequent exposures to climate change ef-fects, demonstrating significant positive actions for climate change scenarios, while also delivering social and eco-nomic benefits to the host communities.

In response to the substantial deforestation in the past decades, large-scale reforestation and rehabilitation pro-grams and activities were implemented in the country. Activities ranged from traditional large scale government reforestation projects and industrial tree plantations to contract reforestation, community based initiatives, inte-grated development and livelihood projects, agroforestry, and private tree farming (Center for International Forest-ry Research, 2003) as cited by Senate Economic Policy Office (SEPO), 2015.

In the Philippines, community forestry has been a major government strategy to promote sustainable development in the uplands for nearly four decades. A particular case study demonstrates that the key to successful forest resto-ration programs lies in addressing the socioeconomic and food security issues of the communities and smallholder farmers. The ecological reason for reforestation of denuded uplands is widely understood. However, when a refor-estation program does not provide short- and long-term financial benefits and is in conflict with smallholders' sub-sistence farming activities in terms of time, labour and use of the land, the program is unlikely to succeed. The case study identifies and provides examples of financial return and food security as the prime motivators for communi-ties to engage in watershed rehabilitation projects, conserve biodiversity and sustainably manage their forests. Community-based forestry is widely perceived as the most appropriate strategy for effective forest restoration and sustainable development of forest resources. However, most of the community-based reforestation and watershed management programs in the Philippines have failed to address food shortage and improve the socioeconomic sta-tus of upland communities (Guiang, et al., 2001; Eslava, 2004).

Again, the key to the success for people-based forest landscape restoration programs is addressing socioeconomic and food security issues of smallholder farmers. When a reforestation program does not provide short- and long-term financial benefits and is in conflict with smallholders' subsistence farming activities in terms of time, labour and use of the land, the program is unlikely to succeed.

Community forestry, employed in many countries in Asia, like the Philippines, involves people in communities working together to establish tree plantations or manage existing stands while simultaneously planting fruit trees and agricultural crops to satisfy food requirements and enhance livelihoods (Kumar, et. al, 2015). It is also an ap-proach employed in the NGP where involvement of people in the communities is encouraged to ensure sustainabil-ity of the program.

The National Greening Program

The National Greening Program (NGP) is a massive forest rehabilitation program of the government established by virtue of Executive Order No. 26 issued on February 24, 2011 by President Benigno S. Aquino III. It seeks to grow 1.5 billion trees in 1.5 million hectares nationwide within a period of six years, from 2011 to 2016. From 2010 on-wards, a huge increase in reforestation was observed with the implementation of the National Greening Program (NGP). As of March 2015, 1.01 million hectares or 85 percent of target forest area have been planted with around 602.7 million seedlings. However, the number of seedlings planted is way below the target level. The program aims to plant 1.5 billion trees or about 1,000 trees per hectare. At present, only around 593 trees per hectare have been planted (SEPO, 2015). The Senate Economic Policy Office (SEPO) further noted that the survival rate of the seed-lings planted has been below target. The NGP expected an 85 percent survival rate, but in the 2013 Audit Report of the Commission on Audit (COA), it was noted that the survival rate for seedlings planted based on the sample area surveyed was only 68 percent.

There is still an estimated 7.1 million hectares of unproductive, denuded and degraded forestlands which contribute to environment-related risks such as soil erosion, landslides, and flooding. In order to accelerate the rehabilitation and reforestation of these unproductive, denuded and degraded forestlands, the Government shall involve the par-ticipation and investment of the private sector with a view towards enabling private companies to achieve carbon neutrality. Consistent with the updated Master Plan of Forestry Development (2016-2028), there is a need to har-monize all forest development activities that will encourage and enhance development of forest plantations includ-ing forest parks, with greater participation from the private sector, local government units, and organized upland communities. With these, Executive Order No. 193, series of 2015 expanded the coverage of the NGP to cover all the remaining unproductive, denuded and degraded forestlands and its period of implementation is likewise extend-ed from 2016 to 2028 (DENR, 2015).

Development of CBFM (ISF devolved) Areas

Under the jurisdiction of CENRO Calaca, a total of 73.15 hectares were developed under this category broken down as follows: 1.15 hectares FMS Regular; 52.0 DA converted both were planted with assorted fruit trees and the remaining 20.0 hectares were planted with narra seedlings targeted under NPS-ENRMP through World Bank fund located in Barangay Sucol, Balayan, Batangas. The species that were planted include: 10,000 Narra, 10, 230 Cal-amansi, 9,800 Cofee, 200 Guyabano, 1,355 Suha and 1,870 Cacao seedlings. The plantation area is a devolved Integrated Social Forestry Project (ISFP) site. The beneficiaries of the above-mentioned project are also the identi-fied beneficiaries of NGP and in the above-mentioned developments, they were engaged in fruit farming/growing (CENRO Calaca, 2012). Another funding support was under ERDS, with a total of 100.0 hectares were planted with assorted Fruit seedlings such as Calamansi, Atis, Guyabano, Kasoy and Mangga. The plantation is within the ISF devolved area in Barangay San Jose, Tuy, Batangas.

Coffee Plantation

To showcase the best practices involving the implementation of NGP for CY 2013 was the establishment of 50.0 hectares Coffee plantation in Sitio Matala, Barangay Cahil, Calaca, Batangas. A total of 25,000 coffee seedlings were planted using 4 m x 5 m spacing. The area is the portion of Forestland in the said Barangay. This commodity was the first area that was established in all the NGP sites for CY 2013. The identification of the area resulted from the meeting conducted with the Association of Barangay Captains in the Municipality of Calaca on January 23, 2013. During the meeting, the Barangay Captain signifies his intention to participate in the National Greening Pro-gram. As an initial step, a consultation and reconnaissance survey was conducted in the area. During this event, CENRO Calaca never encountered negative reaction or issues from the stakeholders/community members. A series of follow-up meeting were also conducted for them to really understand the benefits of the project and to clear un-certainties such as fears and worries that the government or the DENR will not get the land they are occupying once project is introduced with these parcels of land. One thing also that convinced them to plant coffee is the MOA forged between the DAR-DA-DENR and Nestle Philippines, Inc. signed sometime in September 2011 for the market of the product in the future (CENRO Calaca, 2013).

The best experiences harnessing the implementation of the NGP in the said barangay were the full support and posi-tive acceptance of the recipient barangay and the active involvement/participation of the residents and the mem-bers of the Pantawid Pamilya Pilipino Program (4Ps) led by the different barangay cluster Parent Leaders especially during the conduct of the tree planting activities. This resulted to early completion of target in coffee plantation establishment in 2013. These endeavor attributed by the continuous conduct of IEC and of course commitment by the stakeholders and the DENR through CENRO Calaca for the successful implementation of the project (CENRO Calaca, 2013).

Also, a total of 26.0 hectares coffee plantation was established in Barangay Latag, Nasugbu, Batangas. The said areas were planted with 13,000 coffee seedlings. The area was developed through the Sub Allotment Advise (SAA) Fund (CENRO Calaca, 2017).

Coffee and Fruit Trees

A total of 83.0 hectares upland was established under Regular NGP. The areas were located in the following Baran-gays as follows: Tumalim, Nasugbu, Humayingan and Lian. The areas were planted with 41,500 assorted Fruit and indigenous forest tree seedlings such as Guyabano, Langka, Calamansi, Rambutan, Cacao, Coffee, Atis and Narra (CENRO Calaca, 2018).

Food Security and Economic Development

According to the Food and Agriculture Organization (2008), there are four criteria with respect to the concept of food security. First is Availability, where food availability addresses the ‘supply side’ of food security and is deter-mined by the level of food production, stock levels and net trade. Second is Access, where an adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives. The third is Utilization, where utilization is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals are the result of good care and feeding practices, food preparation, diversity of diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individ-uals. And lastly, Stability, where adverse weather conditions, political instability, or economic factors (unemploy-ment, rising food prices) may have an impact on your food security status (FAO, 2008).

Economic development entails growth of per capita income (Briones, 2008). He further added that accompanying this quantitative increment is a qualitative change in the economic structure, namely the diversification of sector composition of output from agriculture to industry and services. This is one of the best-established patterns of eco-nomic development. Explanations of this pattern cover both demand and supply factors. On the demand side, there is the Engel effect combined with non-tradability of most of agriculture. On the supply side is the shift in re-sources, such as labor, from low productivity (traditional) to high productivity (modern) sectors.

Fruit Production in the Philippines

According to the Bureau of Agricultural Statistics (BAS), Lansones has the biggest area planted with 20,505 hectares in 2010, followed by Durian and Jackfruit while Mangosteen, Tamarind and Orange were the low-est. In terms of the volume of production in Metric Ton (MT), Watermelon ranked first followed by Durian and Lansones. The Philippine mango industry has been consistently expanding, judging by trends in area harvested. From below 80,000 ha in 1990, area has been increasing, approaching 200,000 ha by 2009. Initially, yield was also increasing, from 6 t/ha in 1990 to 8 t/ha in 1997, before plummeting to current levels of only 4 t/ha. Aggregate pro-duction reached 1 million tonnes in the late 1990s (Figure 2), and again in 2007, before dropping to below 800,000 tonnes in 2011. Climate and pests remain major drivers of production. For instance, in 2008 the drop in production was traced to typhoons, wind damage, anthracnose, bacterial wilt, fruit flies, and leaf hoppers, according to Bureau of Agricultural Statistics or BAS (2008).

MATERIALS AND METHODS

Description of the Study Area

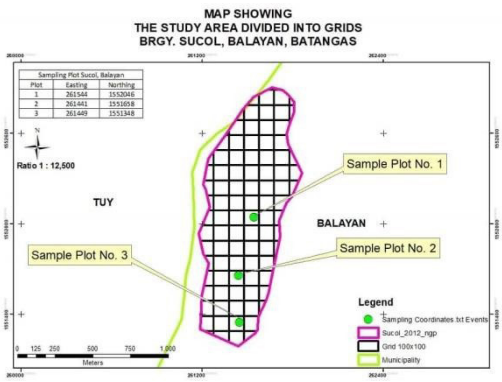
The Municipality of Balayan belongs to 1st district of Batangas with land area of about 10,873 hectares covering 48 barangays. Balayan is located at geographic coordinates 14° 53 latitude and 120°43 longitude. It is bounded on the north by the Municipality of Tuy; on the east by Municipality of Calaca; on the south by the Balayan Bay and on the west by the Municipality of Calatagan and Lian. It is about 107 km from Manila via the scenic route through Tagaytay Ridge and about 48 km from Batangas City, the capital of the province. It is also accessible from all points via the Balayan Bay on the southern side of the Municipality. It is a lowland town in the western region of Batangas and the centermost town of the first district of the province. The Municipality has a total land area of 10, 873 hectares consisting of industrial, agricultural, swamp and forest lands. The Municipality has a total of 1,888.5 hectares of forest lands composed of mangrove/swamp and upland that are subject for management considering its actual land use. The forest and forest land in the Municipality of Balayan covers eight (8) Barangays (San Piro, Palikpikan, Navotas, Dalig, Palincaro, Patugo, Sucol and Duhatan). Barangay Sucol has existing re-sources such as grassland, cave, spring, naturally grown, and harbors diverse life forms. Its existing land uses include coconut plantation, agricultural lands and fruit trees plantations (LGU Balayan FLUP, 2018; DENR- CENRO Calaca, undated).

The Municipality of Calaca, Batangas is one of many coastal Municipalities in Balayan Bay. It is situated east of the Municipalities of Balayan, Tuy and Nasugbu, west of the Municipalities of Lemery and Laurel and North of Balayan Bay. It is politically belongs to the First (1st) Congressional District of the Province of Batangas. It is locat-ed at 120°46' 36.92" - 120°51' 10.58" longitude and 13°55' 14.52" - 14°3' 9.91 latitude at the south western mouth of the Luzon Island along the western part of Batangas Province. It lies within the southwestern slopes of the Tali-say Caldera. It is located 126 kilometers (109.361mi) south of Manila, a two-hour and nine minute-drive via the scenic route of Tagaytay Ridge and Tagaytay- Nasugbu Highway and Tanza–Trece Martires Road. It is 38.75 kil-ometres (24.08 mi) away from Batangas City, the provincial capital. Calaca is a first (1st) class Municipality, and is one of the eight (8) Municipalities of the 1st Congressional District of the Province of Batangas. Its land area of 11,064.03 hectares [computed using GIS] is politically subdivided into 40 barangays with a total population of 70,521 (PSA, 2010) and a total labor force of 41,705. Its topography is characterized as gently sloping to undulat-ing terrain, with majority (51.93% or 5,745.31 has) of slope 3-8%. The highest elevation, rising more than 600 me-ters, is located in Barangay Cahil near the boundary of Cavite Province. At present, Calaca's land area is dominat-ed by agricultural area (9,410.25 hectares or 85.05% of the total area) and it is followed by forest area (642.01 hec-tares or 5.80% of the total area) and residential area (570.88 hectares or 5.16% of the total area). Generally, Calaca have a good soil and weather condition, which makes it very suitable for farming, while the Municipality's direct access to the sea through the port is an advantage of the town for the expansion of their industrial economy. More-over, the business climate has been good and the local economy has become more vibrant since the establishment of the industrial zones in the coastal areas of the Municipality.

Potential investors and tourist are being attracted with it facilities and tourist spots from scientific facilities to unique sceneries in its upland community. Its people are also considered as assets as the functional literacy of the Calaqueños is high at 92.40% (LGU Calaca CLUP, 2014-2023).

This study was conducted from January to May 2020 within the selected localities in the District 1 of the Province of Batangas namely: Calaca and Balayan. These are upland communities with beneficiaries that are engaged into Fruit farming. For the sampling procedure, a guideline in conducting the third party performance evaluation of NGP areas was adopted (DENR-FMB, 2018). The 5% Sampling Intensity (SI) was applied in every site where the three (3) sampling plots in each site were randomly determined. The maps of study area were divided by grid using the grid system model. This system is a comprehensive database for sustainable development planning, field operations, and monitoring which divides the whole area into a certain grid size (Bantayan, 2006) and as cited by Peras (2008). An inventory was carried on the identified non-permanent sampling plots recording all the target spe-cies. At each sampling plot, the diameter at breast height (DBH) which is at 1.30 m from the ground was measured for the perennial fruit trees while for the Coffee and Calamansi (i.e. grafted), were measured at diameter at mer-chantable height (DMH) using a conventional measuring tape.

Geo-referenced points were gathered right from the study sites and the use of existing office files especially from the DENR and NAMRIA was Geo-referenced points were gathered right from the study sites and the use of existing office files especially from the DENR and NAMRIA was beneficial as well. All the fruit bearing plants that were found within the plot was measured and recorded using the prepared field data form and the geographic coordinates and altitudes of all individual species were recorded using Garmin eTrex 10 GPS receiver. With regard to the conduct of carbon sequestration of fruit



trees, data on actual number of fruit trees including their respective DBH and DMH were gathered. The data generated from the field works were logged in Microsoft Excel where all statistical procedures were performed. Meanwhile, maps were generated using open source GIS Software (e.g. QGIS). The analysis of the above ground biomass (AGB) was done following Brown's Allometric Equation (1997) (Eq. 1). Meanwhile, the computation for the carbon sequestration was done using the prescribed formula by Lasco & Pulhin (2003) (Eq. 2)

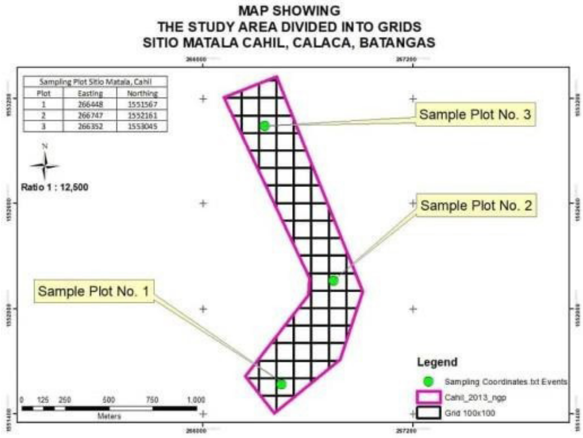
Eq. 1

Y = exp {-2.134 + 2.530*ln(D)}

$$Y = \exp\{-2.134 + 2.530 \cdot \ln(D)\}$$

where:

Y = biomass per tree (kg) D = dbh (cm)



Eq. 2

C = ABG * % Carbon in tree

where:

C = Carbon in tree biomass ABG= Above Ground Biomass

% Carbon in tree which is 45 %

RESULTS AND DISCUSSION

Fruit-Based Production System in the Study Sites

Start of Fruit Farming. Some of the respondents have started to engage into fruit farming as early as the 1970s while majority of them started in 1990s particularly in the year 1992. The kinds of fruit trees that they grow and their reasons why they engaged into Fruit farming are discussed in Table 4 and Table 5, respectively.

Kinds of Fruit Grown by the Respondents and their Fruiting Season

It can be deduced from Table 1 that there are about 13 species of fruit trees being grown by the respondents. The top three (3) most grown fruit trees are Coconut, Avocado and Langka with 23, 21, and 19 growers, respectively. Among these 13 fruit trees, for (4) of them can bear fruits all throughout the year and these are coconut, coffee, banana, and papaya.

Reasons why farmers engaged in Fruit production

When farmers were asked why they engaged into fruit farming, all of them (100%) mentioned that it is because of less inputs which means less expenses, less labor, and it is introduced by Government Agency, specifically the Department of Environment and Natural Resources (DENR). About 96 percent of the respondents affirmatively reasoned out that Fruit farming is resilient to Typhoons/heavy rains/droughts and resilient to pests and diseases. Unfortunately, there is only one respondent who answered the increase in income (Table 2).

Fruit Production Operations in the Study Sites

As presented in Table 3, it can be deduced that Coconut has

Table 1. Kinds of fruit-bearing plants and their fruiting season.

Local / Common Name	Fruit Trees* Scientific Name	f	%	Fruiting Period/Season
Calamansi	*Citrofortunella microcarpa (Bunge)*	15	58%	May-August
Guyabano	*Annona muricata Linn.*	18	69%	July-December
Avocado	*Persia amaricana Mill.*	21	81%	February-August
Coconut	*Cocos nucifera L.*	23	88%	All Year round
Langka	*Artocarpus heteropyllus Lam.*	19	73%	November-May
Kasoy	*Anacardium occidentale L.*	11	42%	December-April
Dalandan	*Citrus aurantium Linn.*	2	8%	Aug-Dec
Indian Mango	*Mangifera indica L.*	10	38%	January-May
Rambutan	*Nephelium lappaceum L.*	1	4%	May-September
Atis	*Annona squamosa Linn.*	1	4%	May-September
Coffee	*Coffea Arabica Linn.*	10	38%	All Year round
Banana	*Musa spp.*	12	46%	All Year round
Papaya	*Carica papaya Linn.*	1	4%	All Year round

*Multiple responses

the largest area being planted by the respondents with 4.96 hectares on the average. This is closely seconded by Indian Mango with about 4.63 hectares on the average. Atis has the lowest recoded area planted with about 1.35 hectares on the average. In terms of the average number of trees planted by the respondents, it appeared that Coffee (1,310 trees) has the highest number followed by Coconut (273 stands). Meanwhile, Indian Mango has the highest recorded volume

Table 2. Reasons why farmers engaged in Fruit production.

Reasons*	Frequency	Percentage	Remarks
a.Higher Income	1	4%	Long-term source of income
b.Less inputs, hence, less expenses	26	100%	
c.Less Labor	26	100%	
d.Resilient to Typhoons/heavy rains/droughts	25	96%	It has become the practice of our ancestors
e.Resilient to pests and diseases	25	96%	
f.Introduced by relatives/ friends	19	73%	
g.Introduced by Government Agency	26	100%	

*Multiple responses

of production with about 1,009.44 kilograms on the average and this is followed by Coconut. On the other hand, the most expensive in term of price per kilogram is Coffee with 56.67 pesos and this is followed by Kasoy (Cashew) with 47.14 pesos per kilogram on the average.

Table 3. Fruit production operations of the Respondents

Fruit Tree	Average Area Planted (Ha.)	Average No.ofTrees	Average Volume of Production (Kg)	Average Priceper Kilogram (Kg)	Average Income (PhP)
Calamansi	2.40	93.13	28.67	20.33	583.33
Guyabano	3.35	57.47	52.00	19.33	1048.33
Dalandan	3.70	5.00	55.00	20.00	1100.00
Avocado	3.06	43.87	190.25	24.25	4607.50
Coconut	4.96	273.04	766.21	10.61	7726.32
Coffee	4.55	1310.00	138.33	56.67	6783.33
Indian Mango	4.63	36.56	1009.44	3.78	3386.11
Kasoy	1.67	23.20	14.57	47.14	728.33
Langka	3.56	14.78	192.14	30.00	3810.00
Banana	2.50	200.00	-	-	-
Atis	1.35	6.50	20.00	20.00	400.00
Rambutan	1.90	20.00	-	-	-

*Multiple responses

Tree Charting of the Recorded Species in each Plot

It is presented in Figure 1 the distribution of fruit bearing plants in Plot #1 situated in Sitio Matala, Barangay Cahil, Calaca, Batangas. It is observed that this plot this dominated by Coffee (Coffea Arabica Linn.) followed by Guyabano (Annona muricata Linn.). The same is true with Plots #2 and #3 where it is dominated by Coffee followed by Coconut (Cocos nucifera L.). On the other hand, Barangay Sucol, Balayan, Batangas, it is presented in Figures 4 and 5 that these plots are dominated by Calamansi (Citrofortunella microcarpa (Bunge)) followed by Coconut (Cocos nucifera L.). Meanwhile, Plot #3 is dominated by Coconut while the least dominant fruit plant being grown is Kasoy (Anacardium occidentale L.).

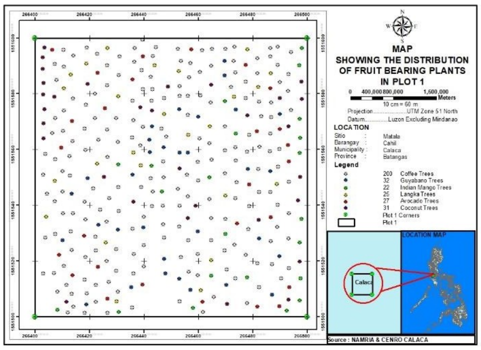


Figure 1. Distribution of fruit bearing plants in Plot #1 situated in Sitio Matala, Barangay Cahil, Calaca, Batangas.

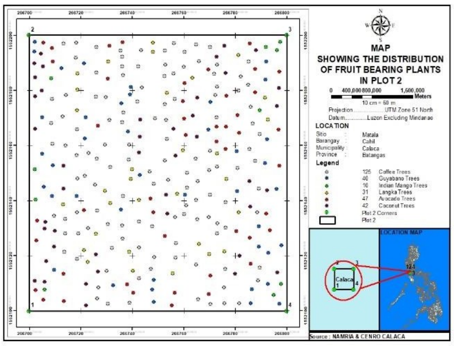


Figure 2. Distribution of fruit bearing plants in Plot #2 situated in Sitio Matala, Barangay Cahil, Calaca, Batangas.

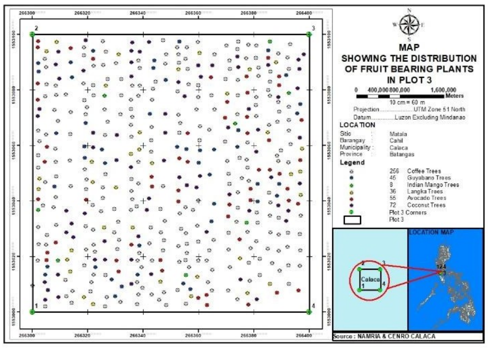


Figure 3. Distribution of fruit bearing plants in Plot #3 situated in Sitio Matala, Barangay Cahil, Calaca, Batangas.

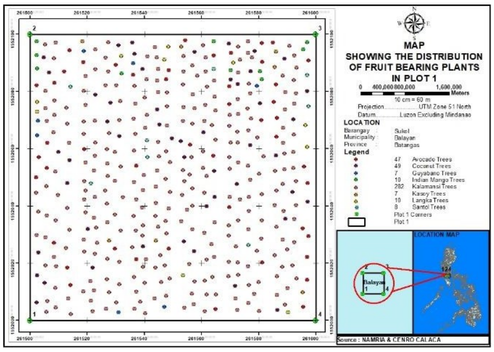


Figure 4. Distribution of fruit bearing plants in Plot #1 situated in Barangay Sucol, Balayan, Batangas.

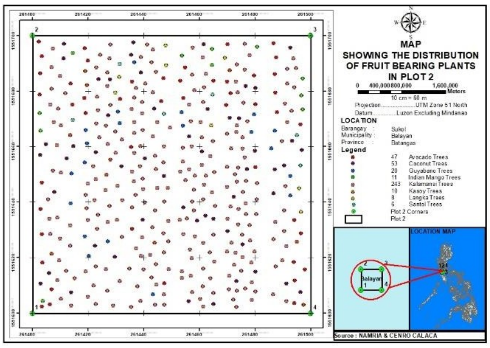


Figure 5. Distribution of fruit bearing plants in Plot #2 situated in Barangay Sucol, Balayan, Batangas.

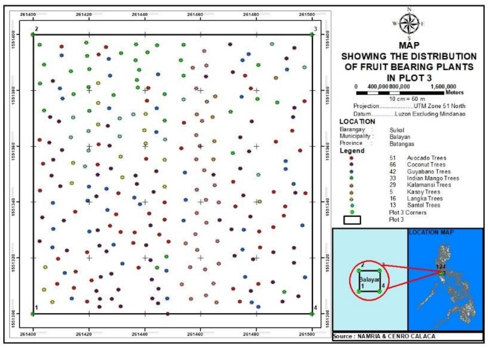


Figure 6. Distribution of fruit bearing plants in Plot #3 situated in Barangay Sucol, Balayan, Batangas.

Changes in Land Cover (2010 and 2015)

Using an open-sourced GIS Software, land cover maps were prepared consisting of two periods, 2010 and 2015. It is important to mention that shapefiles were acquired from the National Mapping and Resource Information Authority (NAMRIA) and this information were processed in order to project the land cover in the two (2) study sites. Figure 11 and 12 present the Land Cover in each study site. It is presented in Figure 10 the changes in land cover in study site 1 at Sitio Matala, Cahil, Calaca, Batangas while Figure 11 shows the changes in land cover in study site 2 at Barangay Sucol, Balayan, Batangas. As shown in Figure 7, majority of the areas in 2010 in Sitio Matala, Cahil, Calaca, Batangas are covered with Perennial Crops with an area of about 40.77 hectares. This is followed by Annual Crops with an area of about 19.25 hectares. Meanwhile, as presented in the same figure, the 2015 Land Cover shows a decrease in the areas of Perennial Crops to 6.29 hectares. The areas for Annual Crops have also decreased from 9.25 hectares in 2010 to 11.31 hectares in 2015. It can be noticed that there is a huge track of land that is covered with brush/shrubs with about 42.42 hectares which are not present in 2010. On the other hand, majority of the areas in 2010 in

Barangay Sucol, Balayan, Batangas are covered with Perennial Crops with an area of about 68.54 hectares. Moreover, about 3.96 hectares in this study site is covered with shrubs and about 1.66 hectares is Annual Crops. In 2015, there was no recorded areas that are covered with Perennial Crops while the areas covered with shrubs have significantly increased to 54.69 hectares. Moreover, about 17.2 hectares is an Open Forest (Figure 8).

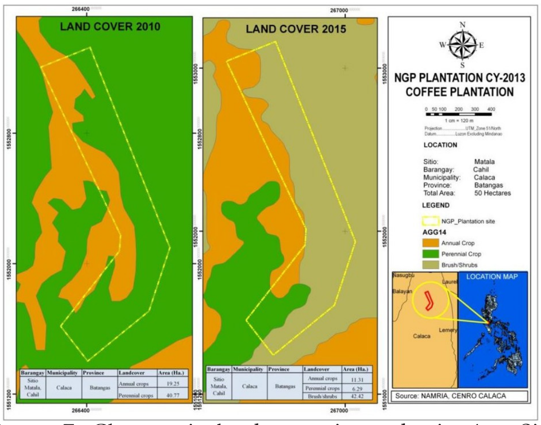


Figure 7. Changes in land cover in study site 1 at Sitio Matala,Cahil, Calaca, Batangas.

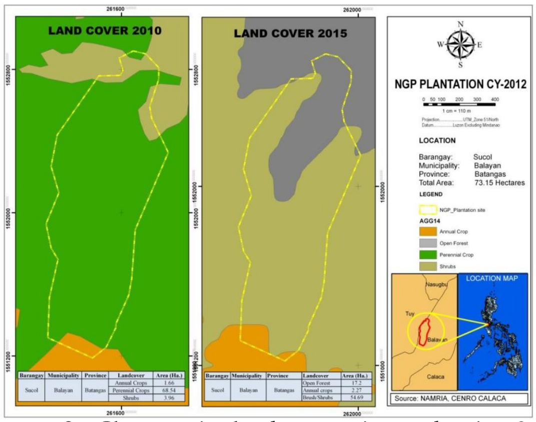


Figure 8. Changes in land cover in study site 2 at Barangay Sucol, Balayan, Batangas.

Impacts of Climate Change to the Farmers and their Interventions

Experience on Climate-related Phenomena and the Cost of Damage

The respondents were asked about their experiences on the five (5) identified climate- related phenomena. With these, there are three (3) climate-related phenomena that have been experienced by all (100%) the fruit growers and these are Typhoon, Heavy Rains and Drought. Among the 26 respondents, 25 of them have provided answers on the estimated cost of damage to them by such climate-related phenomena. It can be deduced from Table 10 that drought appeared to be the most damaging with the average cost of 12,200 pesos. This is followed by typhoon with an average cost of damage of 9,520 pesos and heavy rains with 8,320 pesos. With these, however, among these climate-related phenomena, heavy rain is the most frequently experienced (Table 4).

Table 4. Experience on climate-related phenomena and the cost of damage.

Climate-related Phenomena	Frequency	Percentage	Average Estimated Cost (PhP) of Damages
Typhoon	26	100%	9520
Heavy Rains	26	100%	8320
Floods	0	-	-
Droughts	26	100%	12200
Landslides	0	-	-

**Multiple Responses*

Effects of Climate Change to the Fruit Growers

The respondents were informed about the possible impacts/effects of climate change to them. Among the eight (8) indicators that were asked to them, it appeared that they are highly affected on: Damage to fruit trees; Decrease fruit production; and Decrease in sales with a weighted mean of 4.54, 4.38, and 4.36, respectively. Meanwhile, the respondents were found to be affected on: Increase expenses to production inputs and Increase incidents of pest and diseases. Fortunately, it can be deduced from the table that the fruit growers are not affected on: Damage to properties; Increase mortality of livestock; and Loss of lives with a weighted mean of 1.40, 1.31, and 1.00, respectively.

Table 5. Effects of climate change to the Fruit growers.

Effects	5	4	3	2	1	Weighted Mean	Qualitative Description
Damage to fruit trees	2.69	1.85	-	-	-	4.54	Highly Affected
Damage to properties	0.20	0.16	0.12	0.08	0.84	1.40	Not Affected
Decrease fruit production	2.31	1.85	0.23	-	-	4.38	Highly Affected
Increase expenses to production inputs	0.77	3.08	0.12	0.08	-	4.04	Affected
Decrease in sales	1.80	2.56	-	-	-	4.36	Highly Affected
Increase incidents of pest and diseases	0.19	2.92	0.58	0.08	-	3.77	Affected
Increase mortality of livestock	0.19	-	-	0.31	0.81	1.31	Not Affected
Loss of lives	-	-	-	-	1.00	1.00	Not Affected

**Multiple Responses*

Interventions or Coping Strategies of Fruit growers to the Effects of Climate Change

In response to the effects/impacts of climate change, the respondents have strategized on how to cope up with the effects. Presented in Table 6 are the answers of the respondents which were grouped accordingly and translated into English. It can be seen from the table that a lot of them (10 out of 26) are engaging themselves to carpentry or construction works in order to gain income and continuously support the needs of their family and farm. Some (19%) of them are also focusing on backyard livestock production which they sell whenever needed or consumed by the family, hence, they need not to buy which may significantly add up to the family expenditures. Some (4 out of 26) are borrowing money from their children and there are those that work as laborer in sugarcane farms. Moreover, in order to cope with the effects of climate change, few of them are use savings to buy basic needs and farm supply. They even temporarily migrate to the nearby provinces such as Cavite and Laguna in search of jobs. Few of them also are engaged into vegetable trading, do farm preparation after the damage, and participating actively in the NGP activities.

Table 6. Coping strategies of fruit growers to the effects of climate change.

Coping Strategies	Frequency	Percentage
Focused on backyard livestock production for selling and consumption	5	19%
Accept carpentry/construction works	10	38%
Borrow money from children to support farm inputs	4	15%
Participate in the NGP activities	1	4%
Use savings to buy basic needs and farm supply	3	12%
Engage into vegetable trading	2	8%
Farm preparation after the damage	1	4%
Temporary migration to the nearby provinces such as Cavite and Laguna in search of jobs	3	12%
Work as laborer during harvesting of sugarcane	4	15%

Fruit Farming as a Means to Prevent and/or Reduce the Effects of Climate Change

The fruit growers were asked if Fruit farming has contributed significantly to prevent and/or reduce the effects of climate change to them and their family. Surprisingly, all (100%) the respondents have affirmatively answered. It is presented in Table 7 the responses of the Fruit growers. There are so many statements mentioned by the respondents but these were grouped according to the similarity in thoughts and they are grouped accordingly and translated into English. As shown in the table, all (100%) of the respondents identified Fruit farming as an important source of income and food and through this, it helps a lot in order to prevent and/or reduce the effects of climate change to them. A lot of them have mentioned the following significant contributions: Fruit trees were planted in hilly areas serve as erosion control to protect the planted vegetables and add fertility to the soil; Help us adapt to the changing climate condition; and Fruit trees protect as from various hazards. Meanwhile, few (4 out of 26) of them have mentioned about its help in order for them to stop charcoal making operations. Two respondents have mentioned that fruit trees serve as nurse trees to some of our cash crops. The respondents believed that all these statements have contributed significantly in order to prevent and/or reduce the effects of climate change to their lives.

Table 7. Significant contribution of Fruit farming to address climate change effects.

Responses	Frequency	Percentage
Source of additional income and food	26	100%
Fruit trees were planted in hilly areas serve as erosion control to protect the planted vegetables and add fertility to the soil	6	23%
Fruit trees serve as nurse trees to some of our cash crops	2	8%
Help us adapt to the changing climate condition	6	23%
Able to stop charcoal making operations	7	27%
Fruit trees protect as from various hazards	6	23%

**Multiple Responses*

Carbon Sequestration Potential of the Fruit Bearing Plants in the Study Areas

The computation of the above ground biomass was done following the prescribed formula by Brown (1997) while the analysis of the carbon sequestration was based on Lasco and Pulhin, 2003. It is important to note that researcher had gathered the data on Diameter at Breast Height (DBH) in centimeter, which is an important parameter in the analysis of the carbon sequestration potential of a given species. Meanwhile, there are instances during the actual gathering of data in the field whereby certain species e.g. Coffee and Calamansi, are intentionally controlled with their growth i.e. according to the fruit growers, it will be easier for them to harvest the fruits if the trees are not too high. With this, the data on DBH cannot be acquired, instead, the researcher considered acquiring the Diameter at Merchantable Height (DMH) in centimeter. In the first study site which is in Sitio Matala at Barangay Cahil, Calaca, Batangas, it has an area of about 50 hectares with three (3) sampling plots that were assessed. On the other hand, the study site in Barangay Sucol, Balayan, Batangas has an area of about 73.15 hectares, however, only 50 hectares were considered in this study mainly because the remaining portion of the 73.15 hectares were purely planted with forest trees which is not covered as per objectives of this study. With this, three (3) plots were also considered in Barangay Sucol, Balayan, Batangas for the assessment.

Study Site 1: Sitio Matala at Barangay Cahil, Calaca, Batangas

Table 8 shows the computed average above ground biomass per species in the three (3) plots including their respective carbon sequestration potential. It can be seen from the table that Indian Mango (Mangifera indica L.) has the highest average above ground biomass and carbon sequestration amongst the six (6) fruits that are present in this study site with an average AGB of 18,854.95 kilograms and carbon sequestration of about 8,484.73 kilograms. This is followed by Avocado (Persia amaricana Mill.) with an average AGB and carbon sequestration of 14,165.83 kilograms and 6,374.62 kilograms, respectively. Next to Avocado is Langka (Artocarpus heteropyllus Lam.) with a computed average AGB of 12999.02 kilograms and about 5849.56 kilograms sequestered carbon. It is important to mention that Indian Mango and Avocado have the biggest recorded DBH due to the fact that these fruit trees have already been in the sites even prior to the introduction of the National Greening Program. Some of these standing fruit trees were introduced in the '90s during the ISF Program. Meanwhile, Guyabano (Annona muricata Linn.) ranked fourth with 7977.10 kilograms AGB and a computed carbon sequestration of 3,589.70 kilograms. In addition, Coffee (Coffea Arabica Linn.) has the least recorded AGB with 2,669.24 kilograms and the carbon sequestration is 1,201.16 kilograms. On the other hand, the researchers decided to gather only the count of the Coconut (Cocos nucifera L.) and not its corresponding measurements since Coconut has almost the same measurements considering its morphology.

Table 8. Carbon sequestration per hectare in Sitio Matala, Barangay Cahil, Calaca, Batangas.

No	Species	Scientific Name	No. of Trees	Above Ground Biomass (Kg)	Carbon Sequestration (Kg)
1	Coffee	*Coffea arabica Linn.*	200	2669.24	1201.16
2	Langka	*Artocarpus heteropyllus Lam.*	25	12999.02	5849.56
3	Guyabano	*Annona muricata Linn.*	32	7977.10	3589.70
4	Avocado	*Persia amaricana Mill.*	27	14165.83	6374.62
5	Indian Mango	*Mangifera indica L.*	22	18854.95	8484.73
		TOTAL	306.00	56666.14	25499.76

Study Site 2: Barangay Sucol, Balayan, Batangas

Table 9 shows the computed average above ground biomass per species in the three (3) plots including their respective carbon sequestration potential. It can be seen from the table that Indian Mango (Mangifera indica L.) has the highest average above ground biomass and carbon sequestration amongst the eight (8) fruits that are present in this study site with an average AGB of 55,170.89 kilograms and carbon sequestration of about 24,826.90 kilograms. This is followed by Avocado (Persia amaricana Mill.) with an average AGB and carbon sequestration of 15,837.12 kilograms and 7,126.71 kilograms, respectively. Again, it is important to mention that Avocado and Indian Mango have the biggest recorded DBH due to the fact that these fruit trees have already been in the sites even prior to the introduction of the National Greening Program. Some of these standing fruit trees were introduced in the '90s during the ISF Program. Next to Avocado is Santol (Sandoricum koetjape (Burm.f.)) with a computed average AGB of 9,994.15 kilograms and about 4,497.37 kilograms sequestered carbon. Meanwhile, Guyabano (Annona muricata Linn.) ranked fourth amongst the eight (8) fruits covered in this site with about 2,330.15 kilograms AGB and a computed carbon sequestration of about 1,048.57 kilograms. In addition, Langka (Artocarpus heteropyllus Lam.) has about 1,525.75 kilograms AGB and a computed carbon sequestration of about 686.59 kilograms. Next on the list is Kasoy (Anacardium occidentale Linn.) with a computed AGB of about 817.55 kilograms and about 367.90 kilograms sequestered carbon. Calamansi (Citrofortunella microcarpa (Bunge)) has the least recorded AGB with 184.32 kilograms and the carbon sequestration is 82.94 kilograms. On the other hand, the researcher decided to gather only the count of the Coconut (Cocos nucifera L.) and not its corresponding measurements since Coconut has almost the same measurements considering its morphology. According to the farmers, some of the coconuts were infected by the "Cocolisap" way in back in 2015 but some have survived and even able to recover even after the onslaught of typhoon Glenda sometime in September 2015. Also, according to the farmers it is the natural way to eradicate the pest. Some farmers also mentioned that some agencies like the Department of Agriculture (DA) and the Philippine Coconut Authority

(PCA) in coordination with the LGU thru the Municipal Agriculturist, have helped in spraying enormous pesticides in order to control the situation but there are some who were not able to avail on the supports. The affected coconuts were already replaced through the initiatives of the farmers and according to farmers some Coconut seedlings were provided by the Municipal Agriculture Office of Balayan. Meanwhile, according to some of the farmers, the planted Avocado during the ISF Program is now serving as the mother trees of which they initiated to produce avocado seedlings to replace dead seedlings in NGP sites. They further mentioned that they opted to replant Avocado since there is a market in Avocado fruits and the price is stable. The farmers expressed their interest in planting more Avocados and Coconuts since these commodities are in demand and have a good price. They usually sell these products at their farm (with competitive farmgate price) even if they need not to go to market to sell the products. Like with the other plots, it was also observed in this plot that there is an irregular spacing of the fruit trees and the fruit growers are practicing mixed cropping. Moreover, the trees were not planted at the same year.

Table 9. Carbon sequestration per hectare Barangay Sucol, Balayan, Batangas.

No	Species	Scientific Name	No. of Trees	Above Ground Biomass (Kg)	Carbon Sequestration (Kg)
1	Indian Mango	*Mangifera indica L.*	10	55170.89	24826.90
2	Calamansi*	*Citrofortunella microcarpa (Bunge)*	282	12999.02	5849.56
3	Langka	*Artocarpus heteropyllus Lam.*	10	1525.75	686.59
4	Guyabano	*Annona muricata Linn.*	7	2330.15	1048.57
5	Avocado	*Persia amaricana Mill.*	47	15837.12	7126.71
6	Santol	*Sandoricum koetjape (Burm.f.)*	8	9994.15	4497.37
7	Kasoy	*Anacardium occidentale Linn.*	7	817.55	367.90
		TOTAL	371.00	85859.92	38636.97

CONCLUSION

The study delimits the conduct of this assessment specific to the two identified sites of the National Greening Program of the Philippine government. Nevertheless, the assessment made in these sites provides relevant and important information which could serve as an input for an improved policy and institutional support mechanisms. Based on the results of the study, the following conclusions are drawn:

There are about 13 species of fruit trees being grown by the respondents. Among these 13 fruit trees, five (5) of them can bear fruits all throughout the year. The top three (3) most grown fruit trees are Coconut, Avocado and Langka. Less farm inputs, less expenses and less labor are the primary reasons why they engaged into Fruit farming. Other reasons include: Fruit farming is resilient to typhoons/heavy rains/droughts and resilient to pests and diseases.

Coconut has the largest area being planted by the respondents followed by Indian Mango while Atis has the lowest recoded area planted. Coffee has the highest number of trees followed by Coconut. Indian Mango has the highest recorded volume of production followed by Coconut. The most expensive in term of price per kilogram is Coffee followed by Kasoy (Cashew). All the fruit growers suffered from typhoon, heavy rains and drought. Drought appeared to be the most damaging followed by typhoon and heavy rains. Heavy rain is the most frequently experienced.

There is a considerable change in land cover from 2010 to 2015 in the two study sites with a decrease in the area of perennial crops while an increase in the area of brush/shrub land. The respondents are highly affected on: Damage to fruit trees; Decrease fruit production; and Decrease in sales. They are affected on: Increase expenses to production inputs and Increase incidents of pest and diseases but they are not affected on: Damage to properties; Increase mortality of livestock; and Loss of lives. To cope up with the effects, they engage themselves to: carpentry or construction works; some are also focusing on backyard livestock production; borrowing money from their children; work as laborer in sugarcane farms; use savings to buy basic needs and farm supply; temporarily migrate to the nearby provinces to search for jobs; engage into vegetable trading; do farm preparation after the damage, and participating actively in NGP activities.

Avocado (Persia amaricana Mill.) has the highest average above ground biomass and carbon sequestration potential amongst the six (6) fruits that are present in study Site No. 1 followed by Indian Mango (Mangifera indica L.). Coffee (Coffea Arabica Linn.) has the least recorded AGB and carbon sequestration potential. In site No. 2, Indian Mango (Mangifera indica L.) has the highest average above ground biomass and carbon sequestration amongst the eight (8) fruits followed by Avocado (Persia amaricana Mill.). Calamansi (Citrofortunella microcarpa (Bunge)) has the least recorded AGB and carbon sequestration.

Recommendations

Based on the findings and the conclusions that were drawn in this study, we recommend the following:

While the top three (3) most grown fruit trees are Coconut, Avocado and Langka, the fruit growers should put into consideration the planting of fruit trees that could bear fruits all year round. Considering the enormous positive benefits of NGP as identified by the respondents, they should be encouraged to promote the program to their relatives and friends due to the proven positive changes in their lifestyle. Also, there is a need to prepare necessary documentations highlighting several success stories in the study sites to be prepared by the DENR which could serve as a benchmark document for the other NGP sites in the country. The need to assess the existing land cover in the study sites as of this year in order to determine the significant changes in vegetative cover over the past years is also recommended.

Necessary interventions with the help of science and technology need to be in place in order to mitigate the impacts of climate change most especially on the aspects of minimizing the effects on damage to fruit trees, decrease in fruit production and decrease in sales. In addition order to enhance their coping strategies, there is a need to organize a skills training (i.e. by TESDA) on the aspect of carpentry or construction works, backyard livestock production and vegetable production and marketing, among others. There is also a need for them to undergo financial management training in order to capacitate them in the proper handling of finances so as to prevent them from continuous borrowing of money from lenders.

Finally, the estimated amount of carbon sequestered in the study sites can be pushed by the DENR for emission trading, clean development mechanism, and joint implementation mechanisms here and abroad.

REFERENCES

Bantayan, N.C. (2006). *GIS in the Philippines: Principles and Applications in Forestry and Natural Resources.*173p. PARRFI and AKECU, Los Baños, Laguna, Philippines.

Bureau of Agricultural Statistics (BAS). (2008). *Selected Statistics on Agriculture 2008*. Department of Agriculture.https://psa.gov.ph/sites/default/files/Selected%20Statistics%20on%20Agriculture%20 2008.pdf. Accessed on January 24, 2020

Briones, R. M. (2008). Agricultural Diversification and the Fruits and Vegetables Subsector: Policy Issues and Development Constraints in the Philippines. *Philippine Journal of Development. 35(2)*, 65.

Brown, S. (1997). *Estimating biomass and biomass change of tropical forests. A primer. FAO Forestry* Paper 134. Food and Agriculture Organization of the United Nations, Rome, Italy.

CENRO Calaca. (2012). *National Greening Program Annual Accomplishment Report*

CENRO Calaca. (2013). *National Greening Program Annual Accomplishment Report*

CENRO Calaca. (2017). *Enhanced National Greening Program (E-NGP)* Annual Accomplishment Report

CENRO Calaca. (2018). *Enhanced National Greening Program (E-NGP)* Annual Accomplishment Report

Department of Environment and Natural Resources (DENR). (2015). Executive Order No. 193, series of 2015. *Expanding the Coverage of the National Greening Program.*

Department of Environment and Natural Resources. (2009). Assessing Progress towards the 2010 Biodiversity Target: *The 4th National Report to the Convention on Biological Diversity.*

DENR-FMB. (2018). FMB Technical Bulletin No. 23. T*hird Party Performance Evaluation of NGP Plantations*. Retrieved from https://ngp.denr.gov.ph/images/PDF/TB/TB23.pdf.

Eslava, F., (2004). "*Community Forestry in the Philippines*: A Country Report". In: Sim, H., Appanah, S. and Lu, W. (eds.). Forests for Poverty Reduction: Can Community Forestry Make Money? Bangkok: Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO). (2008). *An Introduction to the Basic Concepts of Food Security.* Retrieved from https://www.fao.org/3/al936e/al936e00.pdf

Guiang, E.S., Borlagdan, S.B. & Pulhin, J.M. (2001). *Community-Based Forest Management in the Philippines: A Preliminary Assessment.* Project Report. Ateneo de Manila University, Quezon City: Institute of Philippine Culture.

Kumar, C., Saint-Laurent, C., Begeladze, S. and Calmon, M. (eds.). (2015). *Enhancing Food Security Through Forest Landscape Restoration:* Lessons from Burkina Faso, Brazil, Guatemala, Viet Nam, Ghana, Ethiopia and Philippines. Gland, Switzerland: IUCN. pp. 5-217.

Lasco, R.D. & F.B. Pulhin. (2003). Philippine forest ecosystems and climate change: Carbon stocks, rate of sequestration and the Kyoto Protocol. *Annals of Tropical Research* (in press).

LGU-Balayan. (2018). *Draft Forest Land Use Plan (FLUP) of the Municipality of Balayan*, Province of Batangas.

LGU-Calaca. (2014). *Calaca Comprehensive Land and Water Use Plan 2014-2023.* Municipality of Balayan, Province of Batangas.

National Economic Development Authority (NEDA). (2011). *Philippine Development Plan 2011-2016.* http://www.neda.gov.ph/wp-content/uploads/2013/10/pdprm2011-2016.pdf. Accessed on: January 24, 2020

Peras, J. R. (2008). *Biodiversity Conservation Priority Area Selection for the Real-Infanta Mangrove Forest in Quezon Province*, Luzon, Philippines.

Philippine Statistics Authority (PSA). 2010. *Batangas Census of Population and Housing.* pp8. Retrieved from https://psa.gov.ph/sites/default/files/attachments/hsd/pressrelease/CALABARZON.pdf

Senate Economic Policy Office (SEPO). (2015). *Philippine Forest at a Glance. Senate of the Philippines.* AG-15-01. Retrieved from https://legacy.senate.gov.ph/publications/SEPO/AAG%20on%20Philippine%20 Forest_Final.pdf