**DOST Form 2 (for Basic/Applied Research)**

# DETAILED RESEARCH & DEVELOPMENT PROJECT PROPOSAL

**(1) PROJECT PROFILE**

Program Title: GIA

Project Title: **Compatibility Testing of Indigenous Crops with Cacao for the Formulation of New Chocolate Products**

Project Leader/Sex: **Dr. Romeo R. Lerom**

Project Duration (number of months): **1 year**

Project Start Date: **November 2023**

Project End Date: **November 2024**

Implementing Agency (Name of University-College-Institute, Department/Organization or Company): **Western Philippines University**

Address/Telephone/Fax/Email (Barangay, Municipality, District, Province, Region):
**Bgy. San Juan, Aborlan, 3rd District, Palawan, MIMAROPA/ romeo.lerom@wpu.edu.ph**

**(2) COOPERATING AGENCY/IES** (Name/s and Address/es)

**Angeleah Montilde- KoKoMo Chocolates/ 214 Pacdal, Purok Tiptop, Baguio City, Benguet**

**(3) SITE(S) OF IMPLEMENTATION**

| IMPLEMENTATION SITES NO. | COUNTRY | REGION | PROVINCE | DISTRICT | MUNICIPALITY | BARANGAY |
|---|---|---|---|---|---|---|
| 1. | **Philippines** | **MIMAROPA** | **Palawan** | **3rd District** | **Aborlan** | **San Juan** |
| 2. | | | | | | |
| 3. | | | | | | |
| 4. | | | | | | |
| 5. | | | | | | |

**(4) TYPE OF RESEARCH**

__/___ Basic

_____ Applied

**(5) R&D PRIORITY AREA & PROGRAM (based on HNRDA 2017-2022)**

__/__ Agriculture, Aquatic and Natural Resources
Commodity: _**Cacao**_____

_____ Health
Priority Topic: _____

_____ Industry, Energy and Emerging Technology
Sector: _____

_____ Disaster Risk Reduction and Climate Change Adaptation

_____ Basic Research
Sector: _____

**Sustainable Development Goal (SDG) Addressed**

Goal No. 2. Zero Hunger: (i.e promote sustainable agriculture)
Goal No. 8. Decent Work and Economic Development
Goal No. 9: Industry, Innovation, and Infrastructure (i.e promote inclusive and sustainable industrialization and foster innovation)
Goal No. 10: Reduced inequalities
Goal No. 12: Responsible Consumption and Production

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**(6) EXECUTIVE SUMMARY** (not to exceed 200 words)

Cacao planting is another agricultural endeavor that Southern Palawan farmers have been interested in, aside from vegetable farming. The towns of Aborlan, Brooke's Point, and Bataraza are locations where this high-value crop is concentrated. To locate a steady market that is willing to buy their products at a fair price, as well as to achieve a profitable value for their dried beans, cacao producers face obstacles and hurdles. When waiting for a buyer to show up and purchase their goods, these cacao farmers could only sell their dried beans for a maximum of Php150 per kilogram while combating the risk of spoiling. The farmers were able to identify strategies to improve their practices to produce dried beans that would be marketable by enlisting the help of cacao experts from Baguio which was introduced to them by DOST-MIMAROPA. They also want to try their hand at manufacturing chocolate as a backup plan for unsold beans.

With their dried beans and certain local crops, this R&D project might produce new chocolate items that are marketable in quality. One of these native plants is the Dugyan (*Durio graveolens* Becc.), a fruit native to Palawan with a taste that would undoubtedly complement the bitter taste of raw chocolate. It is an odorless fruit Durian, unlike the common durian which would not prevent people from eating Durian because of its strong odor. Moreover, *Anacardium occidentale will be the priority considering the abundance of this crop in the province. Artocarpus champenden*, *Dioscorea alata*, and *Terminalia catappa*, are possible sources of materials that could be studied for this research.

**(7) INTRODUCTION**

In recent years, cacao farming has escalated in popularity among high-value crop farmers of Southern Palawan. Most established cacao plantations in the province have already reached their fruiting stage, however, these farmers encountered problems such as dealing with pests and diseases on their cacao plants and lack of consistent market for their dried beans. Some of these farmers resort to processing their dried beans into cheap *tablea* or selling them to local dealers who consolidate the stocks for more prominent corporations such as Kennemer Food International. Some farmers who gained knowledge of proper post-harvest techniques could sell their dried beans for Php150 per kilogram while those who don't are haggled for prices as low as Php1.00 per pod. This reality is very far from what is promised to them by the provincial government a decade ago. Because of these tremendous losses, some farmers decided to chop down their cacao trees to give room for more profitable crops. Value addition to these dried beans is a solution to help this dying industry recover. With the help of outsourced cacao experts engaged through the iSTART Program of DOST, the cacao farmers are offered a new perspective to look at in terms of marketing their valuable beans. They found out that craft chocolate makers could bid for properly fermented and dried beans for as high as P200.00 per kilogram which is twice the price they are usually bargained for. For the highly sought-after native criollo variety, however, interested chocolatiers are willing to pay up to P300/kg due to its rarity.

On the other hand, Palawan is rich in other crops that have the potential to be complemented with chocolate to create new products such as several indigenous fruits like red durian. Seasonal fruits like cashews and pineapples are also seen as potentials for infusion with chocolate that could create new trendy products.

The purpose of this proposed basic research is to discover new chocolate products from the infusion of locally sourced raw materials to the highly sophisticated cacao plant. With the Western Philippines University as the pioneering institution in agricultural research in the province, this project is set to generate new products that could utilize hidden potentials from our indigenous and highly cultivated crops that are oftentimes failing to meet a profitable market. This initiative is expected to promote sustainable agriculture which is part of the zero-hunger goal of the UN's SDG. Agriculture in far-flung provinces like Palawan could only become sustainable if economically, demand and supply complement each other and farmers are getting the support they rightfully need from our government. This research could promote economic development mainly if more local commodities could be utilized into value-added products to support tourism and the local market. As a way of fostering innovation, some indigenous crops that are usually ignored could be innovated into more marketable items that could eventually become a cultural identity for the province – an addition to the Palawan cuisine. Most of these cacao farmers however are ill-informed about the potential products that could be derived from the cacao fruit. Even though some are venturing into *tablea*, these are primarily substandard and oftentimes did not even reach the chocolate paste consistency like those of the Europeans. This is also mainly due to a lack of proper equipment for chocolate processing and proper training from an experienced chocolatier. This is where academe and research institutions share the

same platform for research collaborations. Input from an experienced chocolatier would also be beneficial in this project, which is why KoKoMo Chocolate's Ms. Angeleah Montilde is an essential addition to the team of researchers.

**(7.1) RATIONALE/SIGNIFICANCE** (not to exceed 300 words)

The purpose of this project is to find new products that have the potential to be marketable while the raw materials are locally present in Palawan and currently underutilized despite their potential. The cacao fruit, which, despite being considered a high-value crop, suffers from being haggled at low prices by local buyers, causing tremendous losses from our local farmers. These cacao farmers have a higher chance of manipulating the demand curve if they are given ideas on how to value-add their cacao beans.This project transpired from the series of consultations the Provincial Science and Technology Office-Palawan did with the cacao farmers in Palawan under the implementation of the iSTART Program. iSTART stands for Innovation, Science and Technology for Accelerating Regional Technology-Based Development, a recently-developed program of the DOST that aims for the strategic alignment of the DOST technology transfer programs and projects, engagement of RSEs, and conduct R&D activities needed for the creation or improvement of MSMEs in support to the development of the countryside. The consultations held shone light to the needs of our cacao farmers in the post-harvest and processing. It was found out that the cacao industry in Palawan is not receiving enough support from the government which resulted to the dismay of many cacao farmers despite the huge potential of this high-value crop. Indeed, research and development of new chocolate products infused with indigenous fruits and crops is an excellent strategy to find ways we can help our cacao farmers.

**(7.2) SCIENTIFIC BASIS/THEORETICAL FRAMEWORK**

To support reasonable profits among farmers, they should be given marketable product ideas that are sustainable, locally sourced, and whose raw materials are underutilized. In the case of cacao farmers, they can achieve increased profit through value-addition on their dried cacao beans. If they could make various products out of their cacao fruits, they could reach untapped markets such as tourist souvenir shops, local stores, and even online shops. This could lessen their chance of partaking in risky bargains with local buyers of dried beans thereby reducing inequality. If they could also tap into the underutilized local raw materials such as indigenous fruits and crops, they could lessen their production costs in venturing into these new products. In addition, a cacao variety, white-colored beans, could be a good source for combination with Red Durian to produce a new red-colored chocolate not yet available in the market. Moreover, providing products for health-conscious people by adding culinary herbs and spices with known therapeutic properties will support the growing demand for these products in the market.

**(7.3) OBJECTIVES**

General:

1. To discover new chocolate products with the infusion of locally sourced cacao beans and indigenous crops to aid cacao farmers in marketing their cacao beans through value-addition, which will lead to the development of an R&D Program as part of iSTART's objective of engaging RSEs who will support technology-based investments and projects in the region.

Specific:

2. To study indigenous crops present in the locality that have the potential of being infused with tempered chocolate to create new chocolate products, particularly its distribution and fruiting season.
3. Provide alternative markets to the cacao farmers of Palawan by exploring potential unique products with high market value.
4. Ensure that cost is minimal in the value-addition process by prioritizing underutilized indigenous crops.
5. To test the compatibility of indigenous crops with cacao present in Palawan for the formulation of new chocolate products
6. To conduct acceptability and cost analysis of the chocolate products developed.

**(8) REVIEW OF LITERATURE**

Indigenous knowledge can naturally dissipate as practices are modified or when knowledge remains unused for an extended period (Gayao, Meldoz, and Backian, 2018). The gradual fading of indigenous knowledge systems is linked to the evolving needs and interests of indigenous peoples. Recognizing the potential of indigenous knowledge for sustainable development and its significance in addressing the threats of climate change (Camacho et al., 2016; Bruyere et al., 2016), governments and other stakeholders must take this matter seriously, as highlighted in the work by Gayao, Meldoz, and Backian (2018).

Cacao, commonly associated with the production of chocolate, undergoes processing into "tableya," a traditional chocolate confection employed in dessert preparation in the Philippines. The country holds a competitive advantage in cacao production within the Asian context, attributable to its strategic geographic positioning, favorable climatic conditions, and conducive soil quality. Despite these advantages, domestic cacao production falls short of satisfying the escalating demands of the burgeoning cacao-based industry. Consequently, the nation resorts to the importation of cacao beans from other producer countries. According to data sourced from the Philippine Statistics Authority (PSA), the country's cacao bean production reached 9,341 metric tons in 2020. The Davao region emerged as the primary contributor, producing 7,258 metric tons of cacao beans, followed by Central Luzon and Zamboanga Peninsula, which recorded cacao bean outputs of 338 and 329 metric tons, respectively. Some of the challenges hindering cocoa production in the country include the absence of properly labeled high-yielding varieties (HYVs) for cultivation, leading farmers to often resort to planting low-yield and inferior-quality materials. There is also a lack of information regarding the genetic characteristics essential for enhancing the yield and quality of cocoa beans. Additionally, issues such as low survival and yield in nurseries and plantations due to pest and disease infestations, insufficient preventive and control measures against pests and diseases, decreased yield from unproductive or aged cocoa plantations, a lack of reliable maps and information on existing cocoa plantings and suitable areas for cocoa cultivation, as well as the absence of suitable innovative equipment for early detection of defects in cocoa processing to prevent low-quality products and improper waste management in cocoa post-harvest and processing, further contribute to the impediments faced by the industry, as per the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARD, n.d.).

Primary cocoa processing involves the creation of cocoa liquor (CL), derived by grinding cocoa nibs, from which cocoa butter (CB) and cocoa powder (CP) are obtained through pressing. These resulting products can be combined with sugar and milk to create solid or semi-plastic food products commonly used at home. Presently, various types of chocolates have evolved, influenced by a diverse range of culinary factors. Nevertheless, the fundamental chocolate categories include dark, milk, and white chocolates, each varying in their proportions of cocoa solids, milk fat, and CB. Dark chocolate, also referred to as bittersweet or semisweet, typically contains a minimum of 35% total cocoa solids, including CL, CB, and CP, along with sugar, and occasionally milk components. Milk chocolate contains a minimum of 15–25% total cocoa solids and 12–14% total milk solids. On the other hand, white chocolate is a blend of at least 20% CB, a minimum of 14% total milk solids, and sugar. Various local and national standards define the necessary minimum values and permissible ingredients for these types of chocolate. However, manufacturers have significant flexibility in determining their specific formulations. Chocolate is crafted from an exclusive primary ingredient:

cocoa beans. However, its composition can vary based on the type of chocolate. The origins of cocoa hold historical significance in the tropical regions of the Americas, especially in pre-Columbian Central America. The Mayan civilization (250–900 AD) made a remarkable discovery that fermented and roasted cocoa beans possessed a distinct flavor, leading to the creation of a beverage called "chocolate." This beverage held cultural and religious importance and even served as a form of currency. Montagna et al, (2019) as cited in Ditchfield et al, (2023).

As cited by Ojimelukwe et al., (2023), food processing unit operations are used to achieve the desired changes in the raw materials. Edimah-Nyah et al. (2023) produced acceptable snack bars, from blended flours of underutilized cereals and legumes. Such food products have extended shelf-life, reduced antinutrients, and diversified diets. When local food crops are used to produce convenience foods such as snack bars, nutrient-fortified food products are developed, sensory acceptability and convenience are improved, and importation and foreign exchange are reduced. Creation of awareness, documentation of forgotten food products, and processes that require upgrading for improved food and nutrition security are important for the sustainability of food systems., Traditional food products are disappearing from the local foodscapes due to social and ecological changes that affect their production. Documentation of local knowledge, about them will help to recover cultural heritage and promote food security (Herera et al., 2022).

There are several issues affecting the sustainability of the world cocoa economy. The value cocoa farmers get for their cocoa within the value chain is unsustainable as it does not allow them to achieve a decent standard of living for themselves and their families. This has created a crisis on the production side due to farmers not properly taking care of their farms and younger generations of farmers leaving the countryside to migrate to cities in search of jobs. Currently, there are several efforts, led by various stakeholders in the cocoa sector, to determine what the living income for cocoa farmers should be, how to calculate it, and ultimately how to apply it within the cocoa value chain (International Cocoa Organization, 2023).

“In order to strengthen the chocolate industry in the country, the government is doing its best to sustain and make globally competitive the main source of table a which is cacao. Towards this end, the Philippine Cacao and Chocolate Industry Roadmap 2021-2025 was formulated,” as reported by the Department of Agriculture (2022).

Nonetheless, despite numerous strengths within the cacao industry, the nation's export numbers are relatively modest, placing it at the 72nd position in terms of exports. Its share in the global market is less than 0.01%. Also, the country is still an importer of cocoa products such as chocolate, cocoa powder, cocoa beans, cocoa paste, cocoa butter, and cocoa husks. The large import of cocoa powder and export value of chocolate is being credited to major chocolate manufacturers in the country that seldom buy local cocoa beans. Instead, they use imported powder and cocoa butter for their raw materials. This in effect increases the importation of cocoa powder making it the leading cacao product import in 2014, Department of Trade Industry (n.d.), as cited in Lirag et al, (2023). In addition, Certainly, the cacao and chocolate sector in this nation has yet to achieve stability and sustainability. It's crucial to promote the advancement of new chocolate and confectionery products. Despite the array of local chocolates already present, there remains a necessity to introduce innovation beyond the conventional locally-made chocolates.

Chocolate Market

According to Mordor Intelligence Research & Advisory. (2023), the Chocolate Market is projected to expand from USD 111.97 billion in 2023 to USD 133.18 billion by 2028, with an estimated compound annual growth rate (CAGR) of 3.53% during 2023-2028. Key market drivers encompass the rising demand for organic, vegan, sugar-free, and gluten-free chocolates, driven by increasing awareness of the adverse effects of synthetic products on health and the environment. Seasonal demand, particularly during occasions like Easter and Christmas, significantly influences premium chocolate sales. Additionally, functional chocolates tailored for health-conscious consumers are gaining popularity. A notable trend in the market is the growing demand for artisanal chocolates, emphasizing unique cocoa bean flavors and high-quality production processes, with some companies opening their own shops to promote their brands.

The Chocolate Market is seeing notable trends, including a rise in the demand for single-origin and certified chocolate, particularly fine-flavor cocoa in regions like Europe and North America. This trend is driven by health consciousness and a desire for exclusive products. Premium cocoa market growth is accelerated by sustainability certification and single-origin focus. Manufacturers are introducing their single-origin and premium chocolate products to cater to this demand, leading to increased profit margins and a positive brand image. An example is Jacobean Studio Inc. in Canada, utilizing cacao from Mexico and Peru to create various chocolate goods, benefitting from government support to enhance marketing and production operations, Mordor Intelligence Research & Advisory. (2023).

The European market for chocolate is dominant, with consumers in the region placing a strong emphasis on chocolate quality due to health concerns associated with cheaper alternatives and a growing preference for fine cocoa. European consumers are willing to pay more for chocolate that meets their quality demands, particularly leaning toward high-quality options like single-origin, organic, handmade, and artisan chocolates. Dark chocolates are in high demand due to their lower sugar content and intense cocoa flavor. The UK is a significant consumer of chocolate in Europe, with plain chocolate being the most popular choice, though premium dark chocolate is gaining popularity. There's a rising trend in confectionery sales and demand for chocolates tailored to specific consumer preferences. Companies are responding to this by developing free-from and vegan chocolates to cater to the increasing demand for such products, meeting various dietary needs. An example is Godessi Limited, which offers a range of premium chocolates in diverse flavors that are gluten-free, dairy-free, soy-free, and vegan as reported by Mordor Intelligence Research & Advisory. (2023).

Chocolate Innovation

Overall Industry Growth and Trends: The chocolate confectionery industry demonstrates promising and consistent growth, propelled by continuous innovation. Key trends include the rise of vegan and innovative chocolate flavors, as well as the prominence of single-origin and premium chocolate ingredients.

Innovations with Healthy Ingredients: Innovations in the chocolate industry focus on healthier ingredients, attracting diabetic consumers with options like stevia, honey, lactose-free ingredients, and non-hydrogenated fats. These innovations drive the growth of various chocolate products.

Demand for Unique Savory Flavors: Consumers increasingly seek unique savory flavors in their chocolate snacks, leading to the inclusion of ingredients like salt and spices. Craft chocolate makers respond to this demand by incorporating innovative flavor blends, showcasing the versatility of chocolate.

Rise of Sugar Alternatives: Growing concern about sugar intake has driven the popularity of sugar alternatives in the chocolate industry, particularly among diabetic and obese populations. Consumers prefer natural sweeteners like honey and stevia, contributing to the rise of "low/no sugar" chocolate products.

Focus on Sustainable and Clean Ingredients: A trend toward organic cocoa and chocolate ingredients is observed, particularly in regions like the U.K., Germany, and France. Clean and clear labeling, utilization of natural ingredients, and reduced usage of chemical additives demonstrate the demand for cleaner chocolate products.

Exploring Healthy Ingredients and Cannabis: Innovations extend to incorporating vegetables and nuts into chocolates, gaining popularity in regions like Asia. Hazelnuts, peanuts, almonds, and various cereals are prominent ingredients. Additionally, the integration of cannabis into edibles like chocolates aligns with the trending recreational marijuana use in certain regions.

Some of the Developments in the Innovative Chocolate Products and Ingredients Category (2018 – 2020):

- In August 2020, Halo Labs Inc. announced its acquisition of Outer Galactic Chocolates, LLC. This acquisition helped the company to produce various cannabis-infused chocolates and edibles.

- In April 2020, Kinnerton (Confectionery) Company Limited launched its first vegan chocolate which claims to be free- from foods.
- In March 2020 Undercover Chocolate Co., LLC, launched a new pomegranate-flavored dark chocolate that is sold only on online retail.
- In February 2020, Kind LLC launched a variety of flavor blend chocolates such as dark chocolate with sea salt and almonds, salted caramel and almonds, and roasted peanuts.
- In December 2019, Nestlé SA launched KitKat Chocolatory Cacao Fruit Chocolate in Japan. This chocolate is entirely made from cacao fruit.
- In September 2019, Barry Callebaut AG launched its clean-label cocoa powder produced from chicory root fibers.
- In September 2019, Barry Callebaut AG launched two varieties of chocolate which are sweetened using cacao fruit. These chocolates are sugar-free.
- In August 2019, General Mills, Inc. launched a range of chocolate products under its brand name Natural Valley. These chocolate products had various healthy ingredients such as oats, dark chocolate, and granola.
- In August 2018, Divine Chocolate Limited launched a variety of organic chocolate bars.

Furthermore, consumer trends show a heightened emphasis on health and well-being, notably influenced by the COVID-19 pandemic. According to a Global Data survey, a significant 85% of consumers globally consider health impacts when making choices regarding products or services. As home snacking rises, consumers are becoming more discerning about the ingredients used in chocolate while still seeking pleasure in consuming it. This presents a challenge for chocolate brands, urging them to strike a balance between indulgence and health consciousness by finding innovative ways to reduce sugar without compromising the delicious taste of chocolate. One such approach gaining traction is incorporating fruits into chocolate, utilizing the natural sugars present in fruits to reduce added sugar. This not only aligns with the clean label trend but also sparks innovation, creating new flavors and enhancing the appeal of chocolate through combinations like ginger, citrus, and red fruits, Aptunion (2021).

The fruit of *Durio graveolens* stands out as distinctive among other Durio spp. due to its red, dark-colored flesh, characterized by a unique and robust aroma and a soft-textured aril. The distinctive flesh color sets it apart from other Durio spp. plants, constituting a notable advantage for this particular durian variety. In addition to serving as an exotic commodity, it also represents a reservoir of genetic diversity originating from Kalimantan, Indonesia, with the potential for developing superior durian varieties (Kurniadinata, Wenpei, Rusdiansyah, 2020). As referenced in the research conducted by Sujang et al. (2023): Susilawati et al. (2018) highlight that the color of durian flesh plays a significant role in influencing durian consumption. Beyond its aesthetic appeal, the coloration of durian pulp (yellow, orange, and red) is indicative of high levels of carotenoids, anthocyanins, and polyphenols, as corroborated by Tan et al. (2020), wherein Black Thorn exhibited a reddish-orange pulp color with the highest total carotenoid content. The presence of carotenoids in the fruit underscores its antioxidant properties, conferring potential health benefits such as promoting eye, brain, and heart health, preventing cancer, offering UV protection, and stimulating the immune system (Eggersdorfer et al., 2018; and Kandylis, 2022).

*Terminalia catappa* fruit exhibits dimensions ranging from 4.46 to 6.71 cm in length and 3.32 to 4.19 cm in width, displaying an ellipsoidal shape that is more pointed at the apex than at the base. It is slightly flattened, featuring a prominent base on both sides and at the tip, a characteristic contributing to its capacity to float over long distances in the sea. Within the fruit, there is a seed, and a fully ripe seed is edible, resembling the taste of almonds, from which its nomenclature derives. The seed attains readiness for consumption when the fruit transitions to a red hue. Similar to numerous other fruits and berries, the almond tree's fruit undergoes a color transformation, progressing from green to yellow before achieving a ripe red state (Marjenah and Putri, 2017). Additionally, the tree has been conservatively estimated to yield approximately 75 kg of fruits annually, a substantial portion of which has historically gone to waste in the field (Apata, 2011, as cited in Marjenah and Putri, 2017). Previous investigations into the nutrient composition of TCK indicate significant protein content ranging from 18.39% to 40.9% and oil content from 43.36% to 63.65%. Moreover, it contains 9.97% total dietary fiber, 7.68% carbohydrates, 6.23% moisture, and 3.78% ash (Monnet et al., 2012;

Adepoju et al., 2014; Ng et al., 2015; Ladele et al., 2016; Santos et al., 2020, as cited by Jahurul, Adeline, Norazlina et al., 2022).

Pineapples and their derivatives constitute the nation's third-largest export commodity, following bananas and coconut oil. Annually, the Philippines yields approximately 2.7 million metric tons (MT) of pineapples, cultivated across a land area exceeding 66 thousand hectares (ha), as reported by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARD, n.d.), with the specific date of the information not provided.

As referenced by Srivichai and Hongsprabhas (2020), two distinct investigations affirm that Dioscorea spp. stands as a significantly vital crop, acting as a primary dietary staple for millions of individuals residing in tropical and subtropical regions (Hahn, 1995). Notably, in the Southeast Asian context, *Dioscorea alata* and *Dioscorea esculenta* are recognized as the predominant species cultivated in the Philippines, as indicated by Cornago et al. (2011).
The fruit of *Artocarpus champeden* is suitable for consumption in both ripe and unripe states, corresponding to its mature or immature stages. Both the edible flesh and seed of *A. champeden* are utilized, whereas the inedible skin and core are discarded as waste. According to Lim et al. (2011), the edible flesh is typically consumed in its fresh form, deep-fried to produce fritters, processed into a revitalizing juice, dried to create chips, or creamed for the preparation of jams and cakes. The seed can undergo a drying process and be ground to produce flour suitable for baking. The seed flour derived from it serves as a substantial source of dietary fiber and resistant starch, as indicated by Zabidi and Aziz (2009) as cited in Lim et al., (2011). It is a common practice to cultivate *A. champeden* through seed propagation, with this approach necessitating a five-year period before the tree begins to bear fruit.

The nutritional nut tree Anacardium occidentale L has a global distribution in tropical regions but is predominantly cultivated in India, Vietnam, Indonesia, the Philippines, Brazil, and Nigeria. According to Akbar (2020), cashew nuts from this tree are particularly high in monounsaturated fatty acids. Anacardium occidentale is commercially valuable. As stated in the study by De Brito, De Oliveira Silva, Rodrigues, (2018), *Anacardium occidentale* is commercially valuable. The cashew tree, typically evergreen and varying in size but generally reaching a height of 8–15 m, yields the nut as its main fruit—a brown, reniform achene consisting of the pericarp (shell) and the almond. The peduncle, referred to as the cashew apple, constitutes 90% of the total weight and is technically a pseudofruit, displaying colors ranging from yellow to red. Both components are edible; however, the removal of the nut from its shell is necessary due to the presence of a corrosive liquid termed "cashew nut shell liquid."

**(9) METHODOLOGY**

The following shall be the major steps during the implementation of the project:

**Source and transport of raw materials**

Locally sourced cacao beans will be fermented and dried in the drying shed established beside the WPU Food Processing Center where the next steps will be done. Several samples of indigenous crops will be collected for study and compatibility testing with cacao.

**Compatibility test of cacao and selected indigenous fruits**

A food technologist and botanist from Western Philippines University by the name of Ms. Marie Frances Sitcharon and Dr. Romeo R. Lerom respectively, will study the product compatibility of these initially identified fruits with the help of a chocolate manufacturing expert from KoKoMo Chocolate by the name of Ms. Angeleah Montilde.

**Development of new chocolate products**

The research team will develop new chocolate products with the use of the following indigenous crops found in Palawan:

a. *Anacardium occidentale* (also known as cashew)
b. *Durio graveolens*, (locally known as Dugyan)
c. *Artocarpus champenden*, (locally known as Badak)
d. *Terminalia catappa* (locally known as Talisay)
e. *Dioscorea alata* (also known as Yam)
f. *Ananas comosus (*also known as Pineapple*)*

Furthermore, some chocolate products will be flavored with some health-containing benefits such as culinary herbs and spices available in Palawan such as ginger, turmeric, and indigenous vegetables like horseradish among others. Likewise, those beans that do not pass the quality for the production of premium chocolate products will be used for hot chocolate drinks, 'tablea and other products that can be developed. Moreover, coconut oil will be considered as one of the ingredients in the formulation of chocolate products.

Products developed will not only be for local consumption but also the priority for international market will be considered since this kind of products are in demand in the world market considering many are now health conscious because of increasing health risk of people in consuming animal based products chocolates and low supply of cacao beans in the international market.

**(10) TECHNOLOGY ROADMAP** (if applicable) (use the attached sheet)
N/A

**(11) EXPECTED OUTPUTS (6Ps)**

Publication
Publication regarding the successful implementation of the project in local newspapers and website publications will be done as well as national publications on DOST's website and social media accounts.

Patent/Intellectual Property
The chocolate products developed through this study will be applied by the Western Philippines University to the IPOPhil.

Product
The product of this project will be new chocolate products infused with indigenous crops.

People Service
The cacao farmers of Aborlan will benefit from this project the most. The prevalence of cacao-related problems among these farmers has proven to be a burden for them for the past decade. Aside from the usual pests and disease concerns in these cacao plants, the cacao farmers are complaining about the low price set by local buyers on their treasured cacao beans. These farmers are mostly powerless in these bargaining scenarios since the endpoint of the value chain is monopolized by these traders. With this project, we could give these farmers some alternative value chain direction through value-adding utilizing ready-to-eat chocolate products. By cutting the monopoly of traders we could reduce inequality and promote a more sustainable agriculture. This project could also provide an additional livelihood to women in the community once they are trained in chocolate production.

Place and Partnership
The project will take place in the municipality of Aborlan, where raw materials are gathered from cacao farmers. The food processing laboratory is located in Western Philippines University Main Campus, Bgy. San Juan, Aborlan, Palawan. This project is a partnership of Western Philippines University, DOST-MIMAROPA, and KoKoMo Chocolate.

**(12) POTENTIAL OUTCOMES**

The potential outcomes of this project are the development of new chocolate products derived from locally sourced raw materials as carried out by researchers from Western Philippines University and the collaboration with KoKoMo Chocolates. **Cacao farmers can generate higher income and other farmers growing other crops that would be potential as raw material for the new chocolate products will be able to earn income those plants identified will be planted by farmers with potential markets also.**

**(13) POTENTIAL IMPACTS (2Is)**

The development of new chocolate products will enable our cacao farmers to become market-resilient as we can offer them alternatives for their traditional end product which is the dried beans. With these new options, they can expand their market thereby eliminating monopoly among cacao bean buyers. The cacao farmers in Palawan will be able to sell their beans at a higher price and at the same time can be able to add value to their beans using nuts, fruits, vegetables, and cereals which are readily available in the province. In addition, farmers producing these crops added to the cacao beans will also benefit because their harvest will also be higher since the chocolate infused with different locally available raw materials will be provided by these farmers. Lastly, indigenous underutilized and widely available can be identified and known for their economic potential as a crop to be planted by farmers with new potential markets.

**(14) TARGET BENEFICIARIES**

The target beneficiaries of this project are the local cacao farmers of Palawan who are already producing dried cacao beans, fruit and nut growers, and vegetable and cereal growers.

**(15) SUSTAINABILITY PLAN** (if applicable)

The KoKoMo Chocolates aside from becoming a consultant to the project is a huge market of chocolate both locally and internationally. With the co-founder's engagement with French chocolatiers, she is able to market locally-grown cacao beans into the international market. The company boasts of its Single Origin Cacao trademark having established these origins to be Isabela, Bohol, and Cordillera which are title holders for the most unique beans with the native criollo as its ancestral gene source. With the three initial provinces, the KoKoMo Chocolates was able to craft a signature chocolate flavor for each province labeling them as the province's pride and identity. It is targeted that with this collaboration, the company could craft a new Single Origin line dedicated to Palawan. To sustain this project, the linkage between the farmers and serious buyers like KoKoMo Chocolates must be established. The possibility of developing chocolate processing as an industry in the province of Palawan is also an outcome expected from this project. Collaboration with other government agencies like the DTI, DA, and DOLE is also an angle seen to be the driver of the cacao industry's sustainability in the province. The Palawan Cacao Council was established a year ago and the coordination between different agencies has been established since then. The council is planning to establish a community processing facility dedicated to cacao only. Good Agricultural Practices for cacao farms must be instilled in the cacao farmers to ensure that agricultural practices in these farms are sound and sustainable, this also should be applied to the other indigenous fruits that are the subject of this project.
The project implementers will also establish the data on the distribution and fruiting season of the indigenous crops that will be used in this project to provide a reference for future studies.
After the completion of this project, the project implementers will consider proposing another project under CRADLE as a follow-through project focused on commercialization.

**(16) GENDER AND DEVELOPMENT (GAD) SCORE** (refer to the attached GAD checklist)

The total GAD score for the project identification and design stages is 17. This implies that the project is gender-responsive.

**(17) LIMITATIONS OF THE PROJECT**

Some indigenous crops are seasonal which means some could not be obtained fresh at the time of the study. However, the technology of freeze drying is already available in the WPU Food processing center which enables the researchers to preserve the samples before the actual conduct of study. The

researchers have yet to determine the quality of the created products with the use of freeze-dried samples of indigenous crops. Other limitations of this project if no Criollo cacao variety is available and the intended fruits are out of season no raw material will be used in the experiment. Otherwise, the study will be hampered due to the unavailability of raw materials both cacao beans and the possible sources of indigenous fruits.

**(18) LIST OF RISKS AND ASSUMPTIONS RISK MANAGEMENT PLAN** (List possible risks and assumptions in attaining target outputs or objectives.)

The following are the risks and assumptions identified by the researchers:

**Unavailability of target raw materials since some of them are seasonal fruit trees**

-The Action plan for this includes:

1. Freeze drying of materials in advance
2. Looking for alternative raw materials available

**Not passing the sensory evaluation or the materials are not compatible in nature**

The Action plan for this includes:

1. Consultation with Ms. Angeleah Montilde, an expert chocolatier on how to remedy these minor failures.
2. Low-grade cacao beans could be used in alternative products like hot cacao drinks.

**The procurement process of equipment might take longer than expected**

The Action plan for this includes:

Dr. Lerom will closely coordinate with Western Philippines University's procurement Office for constant follow-up.

**(19) LITERATURE CITED**


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**(20) PERSONNEL REQUIREMENT**

| Position | Percent Time Devoted to the Project | Responsibilities |
|---|---|---|
| Project Leader | **20%** (1.6 hours daily) | One who directly plans, organizes, and supervises the overall activities of an S&T program and is directly responsible for the conduct of at least one of the projects under the said program |
| Project Staff Level 2 | **30%** (2.6 hours daily) | Those whose basic function is the actual day-to-day implementation of the S&T program/project. For Level 2, this involves professional, technical, or scientific work in a non-supervisory or supervisory capacity. |
| S&T Consultant | **20%** (1.6 hours daily) | One engaged to provide special expertise, special assistance, and /or services to an S&T or other related project outside the capability of the agency |
| Project Coordinator | **40%** (3.2 hours daily) | One who manages, coordinates and monitors the overall implementation of S&T programs/projects which are funded by sources (local or foreign) other than the agency. |
| Project Support Staff | **20%** (1.6 hours daily) | Those who render technical, administrative or management-related services/Assistance, including research utilization practitioners, e.g. information, education, and communications, among others, in the conduct of an S&T activity. |

**(21) BUDGET BY IMPLEMENTING AGENCY**

| IMPLEMENTING AGENCY | PS | MOOE | EO | Total |
|---|---|---|---|---|
| Year 1 | | **34,000.00** | **336,000.00** | **370,000.00** |
| Year 2 | | | | |
| Year n | | | | |
| **TOTAL** | | **34,000.00** | **336,000.00** | **370,000.00** |

**(22) OTHER ONGOING PROJECTS BEING HANDLED BY THE PROJECT LEADER:** _0_____ (number)

| Title of the Project | Funding Agency | Involvement in the Project |
|---|---|---|
| None | N/A | N/A |
| | | |
| | | |

**(23) OTHER SUPPORTING DOCUMENTS** (Please refer to page 2 for the additional necessary documents.)

**I hereby certify the truth of the foregoing and have no pending financial and/or technical obligations from the DOST and its attached Agencies. I further certify that the programs/projects being handled are within the prescribed number as stipulated in the DOST-GIA Guidelines. Any willful omission/false statement shall be a basis for disapproval and cancellation of the project.**

| | SUBMITTED BY (Project Leader) | ENDORSED BY (Head of the Agency) |
|---|---|---|
| Signature | | |
| Printed Name | **DR. ROMEO R. LEROM** | **ATTY. JOSELITO C. ALISUAG PhD. CSEE** |
| Designation/Title | **Professor IV** | **OIC-President** |
| Date | **October 16, 2023** | |

*Note: See guidelines/definitions at the back.*

**DOST Form 2 (for Basic/Applied Research)**
**DETAILED R & D PROJECT PROPOSAL**

**I. General Instruction:** Submit through the DOST Project Management Information System (DPMIS), http://dpmis.dost.gov.ph, the detailed R&D proposal for the component project together with the detailed proposal of the whole Program, project workplan, line-item budget (LIB), 1-page curriculum vitae of the Project Leader, and Certificate of Incorporation or DTI Registration (if applicable) and other applicable supporting documents required under item II.23 below. Also, submit four (4) copies of the proposal together with its supporting documents. Use Arial font, 11 font size.

**II. Operational Definition of Terms:**

**1. Title**- the identification of the Program and the component projects.

**Project**- refers to the basic unit in the investigation of specific S&T problem/s with predetermined objective/s to be accomplished within a specific time frame.

**Project Leader**- refers to a project's principal researcher/implementer.

**Project Duration**- refers to the grant period or timeframe that covers the approved start and completion dates of the project, and the number of months the project will be implemented.

**Implementing Agency**- the primary organization involved in the execution of a program/project which can be a public or private entity

**2. Cooperating Agency/ies**- refers to the agency/ies that support/s the project by participating in its implementation as collaborator, co-grantor, committed adopter of resulting technology, or potential investor in technology development or through other similar means.

**3. Site/s of Implementation**- location/s where the project will be conducted. Indicate the barangay, municipality, district, province, region, and country.

**4. Type of Research**- indicates whether the project is basic or applied.
**Basic research**- is an experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular or specific application or use in view.
**Applied research**- is an investigation undertaken in order to utilize data/information gathered from fundamental/basic researches or to acquire new knowledge directed primarily towards a specific practical aim or objective with direct benefit to society.

**5. R&D Priority Area and Program**- based on the Harmonized National R&D Agenda 2017-2022, indicates which R&D agenda the project can be categorized in: Agriculture, Aquaculture and Natural Resources; Health; Industry, Energy, and Emerging Technology; Disaster Risk Reduction and Climate Change Adaptation; and Basic Research. Indicate also the specific Commodity/Sector, whether crops, livestock, forestry, agricultural resources or socio-economics; fisheries or aquatic resources; biotechnical, pharmaceutical, or health services; biotechnology, information technology, material science, photonics or space technology; industry, energy, utilities or infrastructure.

**Sustainable Development Goal (SDG) Addressed-** indicates which among the 17 SDGs adopted by the United Nations Members States are addressed by the project

**6. Executive Summary-** briefly discusses what the whole proposal is about

**7. Introduction**- a formally written declaration of the project and its idea and context to explain the goals and objectives to be reached and other relevant information that explains the need for the

project and aims to describe the amount of work planned for implementation; refers to a simple explanation or depiction of the project that can be used as communication material.

**7.1. Rationale-** brief analysis of the problems identified related to the project

**Significance**- refers to the alignment to national S&T priorities, strategic relevance to national development and sensitivity to Philippine political context, culture, tradition and gender and development.

**7.2. Scientific Basis-** other scientific findings, conclusions or assumptions used as justification for the research

**Theoretical Framework-** the structure that summarizes concepts and theories that serve as basis for the data analysis and interpretation of the research data.

**7.3. Objectives**- statements of the general and specific purposes to address the problem areas of the project.

**8. Review of Literature**- refers to the following: (a) related researches that have been conducted, state-of-the-art or current technologies from which the project will take off; (b) scientific/technical merit; (c) results of related research conducted by the same Project Leader, if any; (d) Prior Art Search, and; (e) other relevant materials.

**9. Methodology**- discusses the following: (a) variables or parameters to be measured and evaluated or analyzed; (b) treatments to be used and their layout; (c) experimental procedures and design; (d) statistical analysis; (e) evaluation method and observations to be made, strategies for implementation (Conceptual/Analytical framework).

**10. Technology Roadmap** (if applicable)**-** a visual document that communicates the plan for technology. It is a flexible planning technique to support strategic and long-range planning by matching short- and long-term goals to specific technology solutions.

**11. Expected Outputs (6Ps)-** deliverables of the project based on the 6Ps metrics (Publication, Patent/Intellectual Property, Product, People Service, Place and Partnership, and Policy).

*Publication*- published aspect of the research, or the whole of it, in a scientific journal or conference proceeding for peer review, or in a popular form.

*Patent/Intellectual Property*- proprietary invention or scientific process for potential future profit.

*Product*- invention with a potential for commercialization.

*People Service*- people or groups of people, who receive technical knowledge and training.

*Place and Partnership*- linkage forged because of the study.

*Policy*- science-based policy crafted and adopted by the government or academe as a result of the study.

**12. Potential Outcomes**- refer to the result that the proponent hopes to deliver three (3) years after the successful completion of the project.

**13. Potential Impacts**

*Social Impact*- refers to the effect or influence of the project to the reinforcement of social ties and building of local communities.

*Economic Impact*- refers to the effect or influence of the project to the commercialization of its products and services, improvement of the competitiveness of the private sector, and local, regional, and national economic development.

**14. Target Beneficiaries**- refers to groups/persons who will be positively affected by the conduct of the project.

**15. Sustainability plan**- refers to the continuity of the project or how it shall be operated amidst financial, social, and environmental risks.

**16. Gender and Development (GAD) Score**- refers to the result of accomplishing GAD checklists (for project monitoring and evaluation/project management and implementation) to highlight the contribution of the project in the achievement of the objectives of Republic Act 7192, "Women in Development and Nation Building Act," interpreted as gender-responsive, gender-sensitive, has promising GAD concepts, or GAD is invisible.

**17. Limitations of the Project**- refer to restrictions or constraints in the conduct of the project.

**18. Risk**- refers to an uncertain event or condition that its occurrence has a negative effect on the project.

**Assumption**- refers to an event or circumstance that its occurrence will lead to the success of the project.

**19. Literature Cited**- an alphabetical list of reference materials (books, journals and others) reviewed. Use standard system for citation.

**20. Personnel Requirement**- details on the position of personnel to be involved in the project, percent time devoted to the project, and responsibilities.

**21. Budget By Implementing Agency**- personnel services (PS), maintenance and other operating expenses (MOOE), and equipment outlay (EO) requirement of the project by implementing agency for Year 1 and for the whole duration of the project. Please refer to the DOST-GIA Guidelines for the details (Section IX.B of DOST Administrative Order (A.O.) 011, s. 2020).

a. **PS**- total requirement for wages, salaries, honoraria, additional hire and other personnel benefits.

b. **MOOE**- total requirement for supplies and materials, travel expenses, communication, and other services.

c. **EO**- total requirement for facilities and equipment needed by the Program.

**22. Other Ongoing Projects Being Handled By the Project Leader**- list of ongoing projects being handled by the Project Leader funded by the DOST-GIA Program and other sources, and the accompanying responsibilities relevant to the project.

**23. Other supporting documents required**- as stated in Section VII of DOST A.O. No. 011, Series of 2020 – Revised Guidelines for the Grants-in-Aid Program:

a. Detailed breakdown of the required fund assistance to indicate the counterpart of the proponent and other fund sources including letter/s of commitment from the implementing, collaborating and coordinating agency/entity/ies;[1]
b. A counterpart fund, in kind and/or in cash, shall be required from the implementing agency/entity as one of the application requirements. All projects must have a minimum of 15% counterpart contribution except for projects involving public good;[1]
c. Curriculum Vitae or Personal Data Sheet (PDS) of Project Leader and other co-researchers/implementers. The service record may be requested if needed;[1]
d. Clearance from the DOST or the Funding Agency (e.g., DOST Councils) on previously funded completed projects handled by the Project Leader;[1]
e. Approval from the institution's ethics review board for research involving human subjects or in the case of animal subjects, approval from the Bureau of Animal Industry (BAI) (for PCAARRD- and PCHRD-monitored projects);
f. Clearance from the DOST Biosafety Committee (DOST-BC) shall be required for research proposals involving the use of GMOs under contained use (i.e., experiments done in laboratories, screen house, green house). For projects other than contained use, they shall be referred to the appropriate agency. The DOST Sectoral Councils, after determination as to whether or not the proposal has biosafety implications, shall endorse the same to the DOST-BC in accordance with the prescribed format under Annex 3 of the

Philippine Biosafety Guidelines for Contained Use of Genetically Modified Organisms (series of 2014) (if applicable); and

g. For the private non-profit/non-government/people's organizations and startups:
    i. Up-to-date Securities and Exchange Commission (SEC) registration, or Department of Trade and Industry (DTI) registration, or Cooperative Development Authority (CDA) registration certificate, or other authenticated copy of latest Articles of Cooperation and other related legal documents;
    ii. Co-signers Statement (if applicable);
    iii. Copy of latest Income Tax Return;
    iv. Mayor's permit where the business is located;
    v. Audited Financial Statements for the past three (3) years preceding the date of project implementation or in case of those with operation of less than 3 years, for the years in operation and proof of previous implementation of similar projects (or in the case of startups, at least for one (1) year);
    vi. Document showing that NGO/PO has equity to 20 percent of the total project cost, which shall be in the form of labor, land for the project site, facilities, equipment and the like, to be used in the project;
    vii. Disclosure of other related business, if any;
    viii. List and/or photographs of similar projects previously completed, if any, indicating the source of funds for implementation;
    ix. Sworn affidavit of secretary of the NGO/PO that none of its incorporators, organizers, directors or officers is an agent of or related by consanguinity or affinity up to the fourth civil degree to the official of the agency authorized to process and/or approved the proposed MOA, and release of funds;
h. For CSOs, compliance to regulations as required by the General Appropriations Act (GAA) pertaining to fund transfers to Civil Society Organizations (CSOs); and
i. For foundations, DOST certification as accredited by the Science and Technology Foundation Unit

[1] *required of all proposals*

**III. Criteria for Evaluation:**

A. **Criteria for Evaluating Proposals**

| Criterion | Definition |
|---|---|
| Relevance or Significance | Aligned to national S&T priorities, strategic relevance to national development and sensitivity to Philippine political context, culture, tradition and gender and development |
| Technical / Scientific Merit | Sound scientific basis to generate new knowledge or apply existing knowledge in an innovative manner |
| Budget Appropriateness | The proposed budget is commensurate to the proposed work plan and deliverables. |
| Competence of Proponent | Proponent's expertise is relevant to the proposal and with proven competence to implement, manage and complete R&D programs/projects within the approved duration and budget. |

B. **Governing Council / Board and EXECOM's Evaluation Criteria**

| Criteria | Indicators | Raw Score |
|---|---|---|

| | | |
|---|---|---|
| A. Soundness of Proposal (20%) | R&D addresses relevant sectoral need (applicable to pressing concern) | 5 |
| | Solution provided is most effective (compared to other proposed solutions) | 5 |
| | Proposed budget is reasonable (project is not expensive vis-a-vis output) | 5 |
| | Work plan is doable in a given timeframe | 5 |
| B. Suitability of Output (30%) | R&D output is cost-effective (cost is competitive in relation to new or existing products or process) | 5 |
| | Has identified partners to adopt the technology (with letter of support from the head of the company) | 5 |
| | Output can be commercialized (through an existing manufacturer, spin-off or start-up company) | 5 |
| | R&D utilization is timely (output should not be overtaken by other solutions) | 5 |
| C. Significance of Outcome (30%) | Economic: increase in productivity, increase in income, new jobs generated, high return of investment (ROI) | 5 |
| | Social: working partnerships established, training opportunities provided, policies adopted, increased access to basic services (i.e., food, health, education); political, cultural, gender sensitivity and inclusivity | 5 |
| | Environment: enhanced environmental health standards, no adverse effect to the environment | 5 |
| | Sustainability: sustainability mechanisms established in terms of institutional, financial and human resources capability (submission of a new proposal to sustain a completed or ongoing proposal does not constitute sustainability of the project) | 5 |
| D. Competence of Proponent (20%) | Proponent's expertise aligned with the proposal | 5 |
| | Collaboration with relevant agencies and/or industry partners | 5 |
| | Thorough understanding of the proposal's deliverables | 5 |
| | DOST has good experience with the proponent | 5 |

C. **Additional Criteria on Gender and Development (GAD)**