Business Guide on

Natural.green Tech

2017 Compendere of ITDI Technologies

Industrial Technology Development Institute
Department of Science and Technology

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Export Marketing Bureau
Department of Trade and Industry

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The Department of Science and Technology (DOST) was originally established as the National Science and Development Board on 13 June 1958. It was later reorganized on 17 March 1982 to become the National Science and Technology Authority vested with broader policy-making and program implementing functions. NSTA was elevated as a Department on 30 January 1987 under Executive Order No. 128.

The Industrial Technology Development Institute, as one of the Department's research and development institutes, is tasked to increase private sector participation, improve delivery of technological services, and assist in attainment of national sustainable development.

The responsibility for this publication rests with the Industrial Technology Development Institute.

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Table of Contents

Preface

In support of the conduct of the project "2017 ITDI Techno Offering" held from October 12, 2017 to February 15, 2018, the Technological Services Division of the Industrial Technology Development Institute is publishing a compendium.

While an ordinary compendium on the technologies pitched during the event series will simply compile and present to interested parties those technologies, DOST-ITDI is increasing its functionality.

The aim is to raise the compendium's purpose of publication – from the first stage, information and awareness of target audience, to the second stage, which is adoption of technologies by businesses.

DOST-ITDI worked to achieve this by enhancing the content of the compiled technologies through conduct of a Technology Readiness Assessment or TRA Review. A TRA is a systematic, metric-based process and report that assesses the maturity of certain technologies called Critical Technology Elements.

This TRA Review specifically used a schematic adopted from the Air Force Research Laboratory. Developed by William Nolte of AFRL, the Excel-based Technology Readiness Level Calculator Version 2.2 was lifted from the open sources of the Defense Acquisition University.

Definitions covered technology/technical; manufacturing and quality; and programmatic aspects, such as customer focus and documentation. It measured the Technology Readiness Level of 27 technologies and their Project Readiness to Transition level.

A technology maturation plan for each technology completed the review. In doing so, the collection may thus serve as a tool to guide businesses in their selection, adoption, and commercialization of technologies developed by the institute.

Further, while "compendium" is a Latin word, it is not Classical Latin, but a much more recent development first attested in the late 1500s. It stems from "cum pendere", which is (Classical) Latin for "to weigh together."

Since the project is the result of the "WEIGHING TOGETHER" of the measurement of the readiness level of DOST-ITDI technologies presented during the "2017 ITDI Techno Offering," the institute saw fit to use instead the Latin word for COMPENDIUM in the publication title, which is COMPENDERE, spelling as prescribed by the Merriam-Webster Dictionary.

Further, while DOST-ITDI is still at the initial stages of going green, it has been, as a matter of policy, developing technologies following the green framework. Undoubtedly, there is room for focus on several of the principles of the framework. Currently, however, the institute centered on:

- Ensuring that all material and energy inputs and outputs in the 27 technologies are as inherently safe as possible;
- Minimizing depletion of natural resources used as raw materials in the technologies; and
- Striving to prevent waste and make full use of it during technology generation.

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It is good business to harmonize these concepts together in the publication title, which thus reads as

Business Guide on Natural.green Tech
2017 Compendere of ITDI Technologies.

Foreword

The year 2018 was a year of new beginnings for us at the Technological Services Division of DOST- ITDI.

We were bold in our plans and decisions. We took on a new technology check strategy to rank market readiness of 27 ITDI-developed technologies. Then we collaborated with the Export Marketing Bureau and called for conduct of a Technology Readiness Assessment or TRA Review.

As is, TRA is a tool for managing technology risks; reducing company vulnerability to adoption of young technology, as well as; buoying prudent use of government funds and other resources. These, I believe are goals vital to boost sustainability of our industries.

Using the tool, we led 22 technology generators and a project management team of 10 in the review of 12 of DOST-ITDI's food processing, 6 health and wellness, 6 green engineering, and 3 nano technologies.

We then engaged with six trade partners from DTI-EMB and 15 industry influencers selected from a short list of 229 top companies of the country to form five TRA Teams.

DTI-EMB further rendered its expertise on determining technologies, which make business sense and have business value. They defined how best to develop and expand export trade prospects of technologies; and assisted in selecting which technology/ product to trade and further develop following current market trends.

Together, these teams assessed the readiness of the 27 technologies and their Project Readiness to Transition level. The reviews were held on September 26 to 28, 2018 for the teams on health and wellness and green engineering. Meanwhile, the teams on food innovation/processing and advanced technologies conducted the review on October 10-12.

Clearly, it was a most stimulating intellectual exercise. The results, however, are eye-openers. You will find those in this 226-page compendere, which is expected to influence some 115,748 establishments of the manufacturing sector; 119,718 accommodation and food service; and 56,466 other services establishments.

We know that you will find this to be a must-read business guide.

NELIA ELISA C. FLORENDO
Chief, Technological Services Division
Industrial Technology Development Institute
Department of Science and Technology

Message

My congratulations and best wishes to ITDI for having published its first Compendere on Technology Readiness Level (TRL). I know that a few challenges were thrown your way in the course of completing a procedure for ranking market readiness of technologies developed by ITDI, but you succeeded with flying colors.

While only a few may recognize the significance of this undertaking, this effort is indeed valuable for the Science and Technology (S&T) Community as it provides a standardized process that uses clear and applicable criteria that allows a fair comparison between developing technologies creating a more predictable timeframe for technology development and mechanism to assess the readiness of technological solutions.

I am, thus deeply proud that you have proven through the Compendere that this TRL will improve quality of research, increasing efficiency of planning, and provide major opportunities for our technology generators to cause effective transfer of technologies to succeed. Because we want our technology generators, the backbone of S&T development, to not only focus on their existing technologies but to see the threat coming from below.

Furthermore, we want everyone to know that, as much as we are working to reduce company vulnerability to adoption of budding technologies, prudent use of government funds and other resources are matters of great interest as well.

In the end, DOST's mandate is to provide central direction, leadership, and coordination of scientific and technological efforts, and ensure that the results therefrom are geared and utilized in areas of maximum economic and social benefits for the people.

Again my greetings to ITDI and I am looking forward to the succeeding publication of the TRL Compendere.

FORTUNATO T. DE LA PEÑA
Secretary, Department of Science and Technology

Message

My warmest greetings and best wishes to the Industrial Technology Development Institute (ITDI) for the conduct of the first Technology Readiness Assessment (TRA) Review and publication of a supporting compendere on the Technology Readiness Levels achieved by its technologies. My sincerest congratulations to the Technological Services Division of ITDI for hosting the launch of the compendere.

The Research and Development Institutes and Research Councils of the Department of Science and Technology take great joy in supporting efforts like this to advance market readiness and credibility of developed technologies of ITDI. We keep in mind that such undertakings should aim to, not only sustain, but also boost collective creativity in achieving technology performance goals. In so doing, this supports the long term vision of DOST as the "provider of world-class scientific, technological and innovative solutions that will lead to higher productivity and better quality of life."

Again congratulations. *Mabuhay ang ITDI! Kaisa nyo kami.*

ROWENA CRISTINA L. GUEVARA, Ph.D.
Undersecretary for Research and Development
Department of Science and Technology

Message

With great pride, we would like to present the Compendere on Technology Readiness Level (TRL) of the 27 developed Technologies of the Industrial Technology Development Institute (ITDI). Our collective efforts have brought us the conduct of the first Technology Readiness Assessment (TRA) Review among the Research & Development Institutes (RDIs) and Research Councils of the Department of Science and Technology (DOST) which led to the publication of a supporting business guide in the form of a Compendere. The highlighted technologies are categorized into FIC-HITS, Other Food Processing; Health and Wellness; Green Engineering; and Nanotechnology.

The TRA Review is our strategy to reduce risks in technology development and to ensure that adequate technological maturity is attained. With standardized measurements and criteria, TRA is a tool to identify technologies at risk and determine the time-to-market. The TRA also provides a mechanism of identifying potential partners in technology development as well as comparing various technological routes and evolving stages, thus strengthening industry collaboration and partnership. This Compendere of ITDI Technologies would be beneficial to the different industry sectors that are interested to invest and adopt for commercialization.

My felicitations and greetings to the Technological Services Division of ITDI for spearheading the TRA.

The publication of this Compendere would not be made possible without the funding support from DOST and the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD).

Special thanks to the Department of Trade and Industry-Export Marketing Bureau for the technical expertise rendered to us as partner.

ANNABELLE V. BRIONES, Ph.D.
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Acronyms used in this Guide

ABS	acrylonitrile–butadiene–styrene
ADLE	Additional Deduction for Labor Expense
AFMech Law	Agricultural and Fisheries Mechanization Law
AO	Administrative Order
APAC	Asia Pacific
ASEAN	Association of South East Asian Nations
ASIN Law	An Act for Salt Iodization Nationwide or Republic Act 8172
BAFE	Bureau of Agriculture and Fisheries
BAFS	Bureau of Agriculture and Fisheries Standards
BPS	Bureau of Product Standards
BSE	bovine spongiform encephalopathy
CAGR	Compound Annual Growth Rate
CALABARZON	Cavite, Laguna, Batangas, Rizal, and Quezon
CAMANAVA	Caloocan, Malabon, Navotas, and Valenzuela
CFBW	composting facilities for biodegradable wastes
CIDAMI	Cacao Industry Development Association of Mindanao
CIF	cost, insurance, freight
CTE	Critical Technology Elements
DA	Department of Agriculture
DA-BSWM	Bureau of Soils and Water Management
DENR	Department of Environment and Natural Resources
DENR-EMB	Environment Management Bureau
DENR-ERDB	Ecosystems Research and Development Bureau
DOD	Department of Defense

DOH	Department of Health
DOST	Department of Science and Technology
DOST-FNRI	Food and Nutrition Research Institute
DOST-FPRDI	Forest Products Research and Development Institute
DOST-ITDI	Industrial Technology Development Institute
DSWD	Department of Social Welfare and Development
DTI	Department of Trade and Industry
EC	European Commission
ERS	environmental recycling system
ESA	European Space Agency
EU	European Union
F&B	Food and Beverage
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
FOB	Free On Board",
FOGs	Fats, Oils, and Grease
FSMA	Food Safety Modernization Act
GATT-UR	General Agreement on Tariffs and Trade-Uruguay Round
GDP	Gross Domestic Product
GI	Glycemic Index
GMO	genetically modified organism
GMP	Good Manufacturing Practices
GSP	Generalised Scheme of Preferences
GVC	Global Value Chain
HPMC	hydroxy propyl methyl cellulose

IDD	Iodine Deficiency Disorder
IPP	Investment Priorities Plan
JETRO	Japan External Trade Organization
LAMEA	Latin America, Middle East, and Africa
LGUs	Local Government Units
LP	locally-produced
LPG	liquefied petroleum gas
MAP	Modified Atmosphere Packaging
MEA	Middle East and Africa
MOSYMU	*Malunggay* (*Moringa oleifera*) leaves, *duhat* (*Syzgium cumini*) leaves, and *saba* banana (*Musa sapientum*) fruit extracts in capsule
MS	Municipal Solid Waste
MSME	Micro, Small, and Medium-Scale Enterprise
NASA	National Aeronautical Space Administration
NGAs	National Government Agencies
NGOs	Non-Government Organizations
NISQ	not in sufficient quantity
NLP	not locally available
NOAP	National Organic Agriculture Program
NSWMC	National Solid Waste Management Commission
OEP	Orient Europharma
PCCI	Philippine Chamber of Commerce and Industry
PE	polyethylene plastic
PETSSI	Philippine Environmental and Technological Systems and Services Inc.
PEZA	Philippine Economic Zone Authority

PhilFIDA	Philippine Fiber Industry Development Authority
PITAHC	Philippine Institute of Traditional and Alternative Health Care
PNS	Philippine National Standard
POPCOM	Population Commission
PPIA	Philippine Plastics Industry Association, Inc.
ppm	parts per million
PRBABE	Professional Regulatory Board of Agricultural and Biosystems Engineering
PS	Product Standard
PS	polystyrene
PSA	Philippine Statistics Authority
PSAE	Philippine Society of Agricultural Engineers
QSR	Quick Service Restaurants
RA	Republic Act
ROW	Rest Of The World
RTD	Ready-to-Drink
RTE	Ready-to-Eat
SARS	Severe Acute Respiratory Syndrome
SIAP	Seaweed Industry Association of the Philippines
SIM	Salt Iodization Machine
SIPP	Strategic Investment Priorities Plan
SME	Small and Medium Enterprise
SOCSKSARGEN	South Cotabato, Cotabato Province, Sultan Kudarat, Sarangani, and General Santos
SRP	Suggested Retail Price
SSCFs	small-scale composting facilities
SUP	Stand Up

TAMA Law	Traditional and Alternative Medicine Act
TDF	Total Dietary Fiber
TPS	Thermoplastic Starch
TRA	Technology Readiness Assessment
TRAIN Law	Tax Reform for Acceleration and Inclusion Law
TRL	Technology Readiness L:evel
UNIDO	United Nations Industrial Development Organization
UPLB-AMTEC	University of the Philippines Los Baños – Agricultural Machinery Testing and Evaluation Center
USDA	United States Department of Agriculture
USFDA	US Food and Drug Administration

TRA Review Results

Electric plastic densifier

Ref. No.: TRA-2017EPD1

TRL 1

Basic principles observed and reported

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Development of safer establishment, operation, and maintenance procedures
- Reduction in excessive emission of fumes
- Documentation of more scientific references/bases of study
- Conduct and documentation of further research studies and trial tests
- Revision of financial analysis to include major cost components and cash flow projections

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Description

The ITDI electric plastic densifier is an alternative technology for recycling plastic wastes through a melting process powered by electricity. It converts melted plastic into usable products such as fruit baskets, decorative goods, and other items made of plastic.

It is an economical prototype, which has an estimated production rate of four kilograms of PE bags/ day. The prototype is a single screw densifier that requires no oiling.

Limitations. The equipment is designed solely for conversion of plastic bags made from PE. In addition, its production capacity is suited to recycling wastes at household and barangay levels.

Business Environment

Source of Material for Recycling. Residents of Manila produce 25 percent or 675,000 tons of the Philippine's plastic trash.

World-wide, the country as a whole is the third largest dumper of plastic wastes in the ocean. It generates 2.7 million tons of plastic garbage each year, 20 percent or 521,000 tons of which ends up there. Studies show that 74 percent of

these plastics is garbage that collected previously by haulers and garbage trucks.

Further, a 2012 World Bank study reported that MSW that will be generated by Philippine cities will go up by 165 percent from 29,315 tons to 77,776 tons per day by 2025. The projection is based on an approximate 47.3 percent increase in urban population.

Further, an Asian Development Bank report said that the current amount of trash generated in Metro Manila alone has increased by 19.4 percent since 2012.

Local Policy. Several LGUs in Metro Manila have already pushed for the banning of use of plastic bags in commercial establishments in their area, including Pasig, Quezon City, Muntinlupa, Las Piñas, and Pasay. More LGUs are poised to follow.

This may partially but, not totally reduce the volume of PE plastic wastes. In addition, the local plastics manufacturing industry of carrier bags is made up of about 300 local manufacturers and processors, and employs about 175,000 workers.

The PCCI on the other hand is pushing for segregation, collection, and recycling of plastic bags, instead of outright ban on use of plastic.

Plastic is a widespread and pervasive material. In the Philippines, industries such as the electronics, construction, food, cosmetics, packaging, and automotive are aligned with the viability of the plastics industry. Having a local source of plastic materials actually benefits all sectors.

Investment Prospects

Market. The global recycled plastics market is estimated at USD36.93 billion in 2017 and is projected to reach USD50.36 billion by 2022, at a CAGR of 6.4 percent between 2017 and 2022.

The market is witnessing growth due to the increasing awareness regarding beneficial effects on the environment of use of recycled plastics.

Low cost and increasing use in industries of recycled plastics in packaging, automotive, electrical and electronics, and textiles will further accelerate growth of the recycled plastics market.

Competitors. Two large local firms are into plastic recycling machinery distribution. These are Arlington Plastics Machinery and Waste Care.

The former has a huge inventory of used plastic extrusion equipment such as densifiers, granulators, and shredders. The latter offers the largest and broadest selections of balers, compactors, crushers, shredders, grinders, recycling equipment, waste equipment and other related products and services.

Improved charcoal carbonizer

Ref. No.: TRA-2017ICC2

TRL 2

Technology concept and/or application formulated

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Redesign of machine
- Development of safer establishment, operation, and maintenance procedures
- Organization and documentation of scientific references/bases of study, technology's research and test results, including wastes generated and their disposal
- Conduct of further research and development studies and trial tests

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- Revision of financial analysis to include major cost components and cash flow projections

Description

The DOST-ITDI modified carbonizer is an updraft flow type vertical carbonization equipment with cooling system for tar recovery. It has a 9 kg/hr charcoal rated capacity, which produces charcoal briquettes from select fruit and root crop peels.

Resulting charcoal briquettes have a high heating value, are environment-friendly, and produces less smoke and ash. These can be used as alternative fuel for heating and cooking purposes in homes and production facilities abroad.

Business Environment

Although charcoal briquettes are not very well known in the Philippines, the product is already a household fuel in Europe and America. In some Asian countries, hotels and big restaurants use it for roasting.

In 2013, a survey by DOST-FPRDI showed that there is high demand for charcoal briquettes abroad. Foreign buyers often buy in large quantities and most cannot compete with our country's top charcoal briquette makers.

Competitors. Two competitors provide similar/ alternate technologies to DOST-ITDI's charcoal carbonizer machine. The first is DENR-ERDB, which also developed a charcoal briquette technology. This utilizes organic raw

materials, which are carbonized and compacted to produce charcoal briquettes. The technology is considered as renewable energy similar to biomass, which mostly comes from waste materials. It is considered as more cost efficient than using unprocessed fuelwood.

The second, Azeus Machinery is a China firm. Their self-researched biomass briquette machine and charcoal briquette machine have been exported overseas. These make full use of agro wastes and displays reduced hazardous gas emission.

Their product list includes charcoal briquette machine, barbecue charcoal machine, charcoal powder briquette machine, carbonization furnace, and charcoal briquette plant.

Investments Prospects

The biggest strength of this technology is the huge demand for briquettes in the USA, Europe, Japan, Korea, and Malaysia.

Likewise, as an alternative fuel, briquettes in the future can replace much of the country's expensive energy sources such as LPG and kerosene. Other strengths include use of green and innovative raw materials.

The problems of the industry, on the other hand, include sustainability of the raw materials, the very stiff competition in the global market, and high cost of transporting the product abroad.

Difficult to operate and of low capacity, briquetting machines are hard to sell. Low publicity has led also to low acceptability in the local market.

Market. All appliances (wood, charcoal, and gasifier stoves) for briquettes are targeting two main market segments:

- The mass domestic market, consisting of normal households that use wood or charcoal in daily cooking; and
- Business and institutional consumers, which includes restaurants, hotels, and other similar establishments.

Both segments are driven by consumer decisions, which are normally based on price comparisons between biomass briquettes and traditional solid fuels. Willingness to pay a higher price for briquettes are not restricted to industrial countries, whereas examples of niche markets for higher priced briquettes can be found also in developing countries.

Dietary fiber from calamansi waste

Ref. No.: TRA-2017DFCW2

TRL 2

Technology concept and/or application formulated

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Conduct of clinical tests on humans
- Exploration of new market and expansion of market footprint
- Revision of financial analysis to include major cost components and cash flow projections

Description

PSA reported in 2017 that production volume of calamansi (*Citrus microcarpa* Bunge) in 2016 was 118.2 thousand metric tons. With these, great amounts of wastes (peel, pulp, and seeds) are currently unutilized. In addition, fermented wastes from calamansi cause many environmental problems. The technology on processing of dietary fiber from calamansi wastes was thus developed.

It is comprised of six steps, as follows:

1. Wet milling of calamansi wastes;
2. Treating wet milled wastes with metaphosphate;
3. Filtering to separate fiber from filtrate;
4. Washing calamansi fiber with water and alcohol;
5. Drying; and
6. Grinding of calamansi fiber.

DOST-ITDI developed dietary fiber from calamansi wastes, which contains TDF of about 80 percent with 7.2 percent soluble fiber. (Dietary fibers or roughage is the indigestible portion of food products derived from plants. The two major types include soluble and insoluble. Soluble fiber can dissolve in water and is fermented in the colon. Insoluble fiber passes through the digestive system in nearly its original form. It promotes regularity in digestion.)

To determine functionality and quality of calamansi's dietary fiber content, it was used as fill-in for wheat bran and uncooked oats in high fiber cookies.

Business Environment

Market. North America leads the global dietary fiber market with a share of 36% followed by Europe (31%) and Asia-Pacific (17%) in terms of

revenue in the year 2011. However, it is still the Asia-Pacific region that is on the rise with a CAGR of 20 percent from 2012 to 2017.

The dietary fiber market by application is segmented into the key segments as food and pharmaceutical applications. Although, food applications occupy a major share in the consumption market, the dietary supplement segment, boosted by the soluble fiber requirements, is expected to be the fastest-growing segment.

The major drivers for dietary fiber global market growth are the rising aging population, growing consumption by the supplement segment, low cost, and new consumer perception about health benefits of fibers.

Policies. R&D initiatives by companies and government have helped foreign manufacturers to get the first mover advantage on the basis of stability during processing. However, locally, lengthy and costly product testing and approval by FDA currently pose the most formidable barriers to entry in this industry sector.

Further, compliance with existing regulations during the manufacturing stage can increase production costs to prohibitive levels for all but the well-capitalized firms. Such factors can act as restraints in an otherwise promising market scenario.

Implementation of the TRAIN Law effective January 1, 2018, may also pose concerns for some processors. Nevertheless, for start ups there are tax Incentives available for enterprises registered with PEZA. These direct tax incentives are as follows:

1. 4 to 8 years income tax holiday;
2. Tax and duty exemption on imported capital equipment and raw materials; and

3. Tax rebate for the purchase of domestic capital good.

For SME owners, indirect tax under IPP include:

1. Exemption from wharfage dues and export tax, duty import, and fees;
2. ADLE; and
3. Additional deduction for necessary and major infrastructure works.

Raw Material Supply. From 2012 to 2014, calamansi production in the country was declining by an average rate of 5.07 percent per year. From 178,500 MT in 2012, it went down to 164,000 MT in 2013. It was further reduced to 160,700 MT in 2014. Average production of calamansi was 167,800 MT.

There were no imports of calamansi during the reference years. Calamansi exports decreased from 35 MT in 2012 to 29 MT in 2013. By 2014, exports rose to 45 MT.

Total net food disposable exhibited a downtrend. From 167,800 MT in 2012, it dropped to 154,200 T in 2013. In 2014, it slid to 151,000 MT. Annual per capita net food disposable was 1.74 kilograms in 2012, 1.57 kilograms in 2013, and 1.51 kilograms in 2014.

Investment Prospects

Market. The global dietary fibers market size was worth over USD3 billion in 2016 and will surpass 800,000 T by 2024. It is expected to surpass USD9 billion in value by 2024 according to a new research report by Global Market Insights.

The APAC dietary fibers market alone will value over USD2 billion by 2024. Growing preference for healthy and nutritious food products owing to increasing

geriatric population is driving the regional demand. Increasing cases of diabetes and high blood cholesterol are expected to provide lucrative opportunities for manufacturers.

Further, rising consumer awareness pertaining to the benefits offered by fiber-fortified products fuel dietary fibers market growth. Trends toward consumption of functional food along with increase in consumer affordability are enhancing product penetration.

As per industry estimates, over 50 percent of functional foods in super/ hypermarkets are currently fiber-fortified. Changing eating patterns accompanied by modern lifestyles will thus remain as key driving factors.

Soluble Dietary Fiber Market. The soluble dietary fibers market, on the other hand, was valued at over USD1.2 billion in 2016. North America is estimated to be the most lucrative market for soluble dietary fibers.

Improved insulin sensitivity due to glycemia, along with easy blending capabilities are key benefits offered by the product. Additional benefits of consumption of soluble dietary fiber include improved immunity, anti-inflammatory effects, weight management, and mood enhancement, which will propel this segment's growth.

Insoluble Dietary Fiber Market. In 2016, insoluble dietary fiber's share in market was 55 percent. North America's share is projected to grow over a CAGR of 12 percent from 2016 to 2024. Coupled with improved standards of living this will drive consumption of processed and convenience food products thus instigating demand for additional dietary supplements. Developed distribution channels enables convenient procurement of products thus, further propelling regional industry growth.

Competitors. Global industry share is fragmented due to the presence of various regional as well as international players in the industry. The few key

players include Cargill, Inc., ADM Company, Lonza Group AG, Nexira, Ingredion Inc., DuPont, and Roquette Freres. Acquisition of small-scale firms, expansion of regional footprint, and increased investments in research and development are major strategies adopted by market players to enhance their market share.

In terms of raw material (waste) application, agricultural production, and pharmaceuticals are the technology's competing segments. As well, there are other sources of dietary fiber more commonly known and used by local and international processors.

4C oil spill adsorbent

Ref. No.: TRA-20174COSA3

TRL 3

Analytical and experimental critical function and/or characteristic proof of concept established

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Determination of other industrial applications of the technology
- Identification of mitigation and bio-remediation measures to deal with future possible environmental problems brought about by use of technology
- Determination and provision of supporting research studies
- Revision of financial analysis to include major cost components and cash flow projections
- Development of production and user's manual to include

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mitigation strategies, risk and hazard management, waste management, and safety measures

Description

4C oil spill adsorbent is a material made of chitosan and calcium carbonate composite sourced from waste shrimp and chicken eggshells.

This adsorbent material is used as a loose oil spill sock for post-oil spill management during mechanical containment and recovery.

It can be an alternative solution to address problems on oil spill aside from traditional methods of oil spill clean-up which is costly and labor intensive. Further, conversion of waste materials such as shrimp shells and chicken eggshells into a useful product can aid in their waste disposal.

Business Environment

Oil spill management mainly entails use of technologies to prevent oil spills, devising appropriate clean-up strategies post spilling, and implementing techniques to minimize waste and devastating ecological effects of the spilt oil.

The market is mainly driven by need for managing operational oil spills from sectors such as exploration and production, refining and marketing, and chemical. These sectors are involved in a variety of pipeline transportation by sea of crude oil and chemicals.

In recent years, hefty penalties borne by prominent oil companies for the devastating effect they caused to the ecology and economy due to operational oil spills have boosted demand for proper oil spill management mechanism.

Policies. Presidential Decree No. 006, Section 7 dictates on the responsibility and liability of parties on oil spills. It instructs the person in charge of the vessel to notify immediately the Philippine Coast Guard, giving particulars of the name of the ship and company, location of spill, type of oil spilled, and volume.

In addition, the weather, tide, sea conditions, and cause of spill should be reported. Any person in charge of a vessel who fails to notify the Coast Guard of any oil or oily mixture discharged from his vessel is liable to a fine of PHP10,000 or imprisonment of not more than six months but not less than 30 days. The owner or operator of a vessel or facility, which discharged the oil or oily mixture may be liable to pay for any clean-up costs.

Competitors. A similar research by an international team led by Dr. Justin Chalker at Flinders University is turning wastes from industry into an adsorbent polymer. The material can quickly soak up crude oil from seawater. It is made from used cooking oil, sodium chloride, and sulfur, which are sustainable and cheap to produce. Because sulfur and cooking oils are hydrophobic, the resulting low-density polysulfide polymer is able to soak up hydrocarbons such as crude oil and diesel while repelling water.

Natural-based analgesic balm

Ref. No.: TRA-2017NBAB3

TRL 3

Analytical and experimental critical function and/or characteristic proof of concept established

Investment Cost

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Maturation Plan

- Conduct of clinical tests on humans
- Modification of application of technology projections, and assumptions
- Revision of financial analysis to include major cost components and cash flow projections

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Description

A natural-based analgesic balm containing pain-relieving effects of natural essential oils intended for external application to the skin. It is natural in color with soothing ginger-like odor. The balm consists of natural essential oils of ginger, which provides 94.3 percent protection against pain, and lemongrass at 56.5 percent protection, as active ingredients.

Using the Plantar test or Hargreaves method, DOST-ITDI developed analgesic exhibited 80 percent protection as against 67 percent of the commercial product when bio-assayed against Sprague-Dawley rats. Dose of the test material used was 0.50 g/kg weight. The balm was further subjected to dermal irritation test (Modified OECD Guidelines #404) using adult albino rabbits.

The product remained stable and retained its analgesic activity and physical properties for two years. It costs PHP10.30/ 22 g; the commercially available costs PHP16.50/ 18 grams.

Business Environment

In a 2018 briefer, the Chemical Industries Association of the Philippines estimated the country's pharmaceutical market to expand at its fastest pace in decades. It reported that the market has been growing at a rate of 12–14 percent annually. Further, the Filipino drug market reached USD4.3 billion in 2014. This put the country at par with Taiwan and Indonesia, in terms of size.

On the other hand, the population of the Philippines amounted to approximately 99.2 million in 2013, making it the 12th most populated country in the world. Population growth has primarily been due to a high birth rate and rising life expectancy.

In 2018, the number of people aged 60 and above is expected to grow according to the projections of POPCOM. The number of elderly Filipinos or those over 60 years old is projected to increase by 0.23 percent over 2017 and will most likely be over 8 million Filipino senior citizens by the end of the year, POPCOM said. This will constitute 8.2 percent of the country's total population. Of this figure, 5 million will be aged 65 and older or 4.7 percent of the country's population.

In 2012, foreign pharmaceutical companies captured 70 percent of the Filipino market, 10 percent less than the previous year. GlaxoSmithKline, Novartis and Sanofi are among the largest foreign pharmaceutical companies doing business in the Philippines. Among domestic drug companies, United Laboratories, Pascual Laboratories, GC International and Natrapharm are the largest.

The generics segment is increasingly important in the Philippines. In addition to local manufacturers, many foreign manufacturers are entering the market. Some of the fastest growing companies include Novartis' generic arm Sandoz, Taiwan's OEP and Getz Pharma of Pakistan.

To compete with these generic and off-brand products, many multinational companies are reducing the prices of some brand name drugs by as much as 50 percent. Drug pricing levels are higher in the Philippines than in almost any other Asian country. Poor purchasing practices by Filipino hospitals, high retail markups, and the prohibitive cost of importing pharmaceutical ingredients are just a few reasons for this. Other reasons include low rates of health insurance and low rates of coverage for outpatient drugs.

To increase healthcare access, the Filipino government has mandated price controls on certain essential drugs. In 2008, it passed the Universally Accessible Cheaper and Quality Medicines Act. This act granted the president and the secretary of health the power to impose maximum retail prices on drugs included in the Philippines' Essential Drug List.

Investment Prospects

Market. Analgesic balms are used as first aid product that functions as a topical painkiller. It gives the people the idea of portable medication for every day pain. It is also commonly used by athletes and people who overuse their muscles at work. People now are also looking for all natural medications believing that there are no side effects to using it. In, 2016, external analgesics posted sales of USD734 million.

The Global Analgesics Market is expected to earn USD26.4 billion by 2022, registering a CAGR of 7.1 percent during the forecast period of 2015-2022.

In the Philippines, the value of the pharmaceutical market amounted to USD4 billion in 2013, and is expected to increase at a CAGR of 9.4 percent to reach approximately USD8 billion in 2020. The positive trend in the healthcare market of the Philippines can be attributed to the following:

- Generic substitution in both public and private sectors;
- Increased expenditure on medicines by LGUs;
- Government initiatives in prevention and management of chronic diseases; and
- Improved and updated regulatory environment.

Hard-shell carrageenan capsule from red seaweeds

Ref. No.: TRA-2017HACCRS3

TRL 3

Analytical and experimental critical function and/or characteristic proof of concept established

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Conduct of comparative study with similar products produced in other countries
- Initiation of FDA regulatory compliance procedures
- Referencing of test reports on raw materials for pharmaceutical applications to FDA guidelines
- Revision of financial analysis to include major cost components, cash flow projections, and assumptions about carrageenan. i.e., safety requirement for organic ingredients, supply and demand for carrageenan capsules from red seaweeds

Description

The invention provides a simplified manufacturing process utilizing carrageenan from red seaweed *Kappaphycus alvarezii* as the primary composition material to produce hard-shell capsules. DOST-ITDI developed hard-shell carrageenan capsule containing 12-16 percent water. It consists of two cylindrical parts - a "body" with hemispherical base and a "cap" of the same shape.

Carrageenan is used as substitute for the imported gelatin capsules that are from animal sources.

Benefits/ Uses. Local manufacturers of hard-shell capsules import gelatin derived from animal protein (pork skin, animal bones and skin, and fish bones), plant polysaccharides, or their derivatives (HPMC, starch, pullulan, and others) mainly from European countries.

However, the outbreak of BSE or "mad cow" disease in Europe, heightened awareness of the origins of gelatin and the inherent risks of contracting diseases spread through consumption of animal-based products.

In addition, gelatin produced from animal renderings is unsuitable for use or consumption by an increasing number of vegetarians, people of certain religious beliefs, and members of certain animal welfare groups.

To offset this problem, DOST-ITDI used carrageenan for the manufacture of hard-shell capsules. Comparable to gelatin capsules, the technology allows use of this indigenous raw material and will reduce, eventually, importation of animal-based gelatin and gelatin capsules.

Business Environment

Product Segment. Empty capsules are conventionally used as dosage form for both prescription and over the counter drugs, herbal products, and nutrient supplements either in powder or pellet form. In addition, these are also used for filling liquids and semi-solid dosage forms, especially for drugs that have low bioavailability, poor water solubility, critical stability, low dose/high potency, and low melting points.

Empty capsules offer some advantages over soft-gelatin capsules such as constant capsule dimensions and low sensitivity to oxygen permeability. In addition, these capsules can be manufactured in small batches and can be developed and manufactured in-house.

Global and Local Sources of Carrageenan. The global carrageenan industry was worth USD762.35 million in 2013. World carrageenan production exceeded 56,000 tons in 2013 and it has a very competitive market in Argentina, Canada, Chile, Denmark, France, Japan, Mexico, Morocco, Portugal, North Korea, South Korea, Spain, Russia and the USA.

China is the main exporter of carrageenan to both the USA and Europe. In the USA, carrageenan has found a major application in chocolate milk where it is used for keeping chocolate in suspension.

However, among the world's top exporters, the largest producer for carrageenan is the Philippines, which accounts for around 77 percent of the world's supply. Nonetheless, there remains much room for growth in the manufacture of carrageenan through investments in the production of seaweeds and advanced technology for its processing.

Applications of Carrageenan. Current local demand for seaweed-based food additive and beauty ingredients is pushing demand for semi-refined

carrageenan orders from Asia and in the Philippines itself. Specifically, carrageenan continues to be used in dairy-based and enriched beverages, mainly in chocolate milk and chocolate milk applications such as syrups and powdered mixes.

However, SIAP is now looking at the beauty and cosmetics sectors as the next "big thing" for the seaweed industry, while DTI is urging seaweed processors and exporters to explore another market other than United States, as well as other seaweed or carrageenan applications.

With the recent decision of the USDA to retain carrageenan in the list of allowed substances for organic products in the USA, the industry sees a promising future.

Despite these, SIAP acknowledges that maximum growth of the seaweed industry in the Philippines has not been reached. A recent planning workshop on the role of different sectors in the industry aimed to assess industry practices, identify problems and remedial measures, including projects to solve these.

Investment Prospects

In 2016, Future Market Insights valued the global empty capsules market at USD1.433 billion. This is expected to expand at a CAGR of 7.3 percent over the forecast period 2016–2026.

In the Philippines, currently no local or foreign manufacturer is commercially producing hard-shell empty capsules from carrageenan. All gelatin capsules used by local pharmaceutical and cosmetic firms as dosage form are from animal sources. As well, these are all imported.

Dual drum composter equipment for solid waste management

Ref. No.: TRA-2017DDCESWM3

TRL 3

Analytical and experimental critical function and/or characteristic proof of concept established

Investment Cost

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Maturation Plan

- Accomplishment of compliance documents
- Identification of machine component/s that requires safety measures/ precautions
- Expansion of pilot area
- Regular monitoring of machine performance in expanded pilot area
- Comparative analysis of machine's advantages and disadvantages with other existing technology/s
- Data analysis of establishment, operation, and maintenance costs

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- Revision of financial analysis to include major cost components and cash flow projections
- Data assessment of output product (compost) from distribution to delivery

Description

The dual drum composter equipment is a small-scale motorized composter developed for the management of 100 kg of biodegradable solid waste. It follows a standardized process with compost as endproduct.

Easy to operate, maintain. and with no leachate production, it can be an alternative for community-based management of solid biodegradable wastes generated by barangays, restaurants, canteens, schools, and food processing firms.

Business Environment

The composting industry has grown tremendously in the past 30 years, and there now is a need to develop an industry-wide understanding of this sector in order to help composters achieve industry-specific goals.

These goals consist of increasing sales of compost and compost-amended products, increasing support from federal, state and local officials interested in increasing recycling rates, increasing the understanding of the industry by

bankers and investors (to financially sustain growth), and promoting legislation that benefits the composting industry.

The types of data needed to fully understand and characterize the composting industry are widespread. Examples include: Composter locations; incoming waste tonnages; compost (and screened overs) production; compost sales; product quality data; investments in land, equipment and permits; employment data; and local economic impact of composters' employees.

Much of this data is uncollected; only incoming waste tonnages are reported routinely to state regulatory agencies, and some of that data is out-of-date.

However, in 2015, a report from NSWMC showed that the country's solid wastes typically contained more organic components than other materials.

These include 52% biodegradable wastes, followed by 28% recyclable waste, and 18% residuals. These wastes come from households and from commercial establishments.

The significant shares of biodegradables and recyclables indicate that composting and recycling have potential in reducing solid wastes.

Technology Adoption Constraints. Still, the composting technology remains to be poorly adopted. One of several reasons is the high labor input involved in making compost and applying it as fertilizer.

The labor demand is about six percent higher than when chemical fertilizer alone is used. The intensive manpower input involved, i.e., gathering of substrates, piling substrates into heaps, and applying a large volume of compost to the field, deter many from adopting the technology.

Filipino farmers prefer to buy commercial organic fertilizer (if this is available), rather than make their own compost.

Other major constraints in making compost in farms include:

- Lack of animal manure as a source of nitrogen and phosphorus;
- Lack of plants rich in nitrogen; and
- Water shortage during dry months.

In many parts of the country, the dry season can last from two to four months.

Competitors. At DA-BSWM, their program called NOAP prepared a PHP100-million package of CFBW and small-scale composting facilities for national distribution. The program includes a bio-fertilizer machine to help raise adopters' capabilities in sorting, collecting, and composting their community wastes and to lessen dependence of farmers on commercial fertilizers.

Meanwhile, DENR, in cooperation with JERS Corp. of Japan, is implementing ERS, a high-speed composting (fermentation and drying) system which can convert a batch of organic matter or waste into value-added products such as fertilizer or animal feed within 2 to 24 hours.

ERS reproduces the natural circulation system at a shorter period of time. Materials such as organic wastes, food processing wastes, and sludge, among others are thrown into the reactor under a state of vacuum. An ideal condition for high-speed composting is thus provided.

Investment Prospects

As landfill space and openings decrease, there will undoubtedly be more pressure to compost food waste along with all organic wastes. As tipping fees

increase and it becomes prohibitively more expensive to landfill, composting may be an attractive alternative for cities and municipalities as well as a value-added opportunity.

A law already exists that requires the country to manage solid wastes. Municipalities may soon be developing resolutions that will require businesses to compost all of their organic waste including food wastes.

Most may not currently be considering the technology at all, but as agricultural practices continue to exhaust soils and deplete organic matter, compost will be integral in maintaining soil fertility anywhere.

Landscape, nursery, public agency, and homeowner demand for high quality compost will continue to increase. Compost is an essential product in increasing amounts of land reclamation projects. Compost also plays an important role in more environmentally regulated and environmentally aware agricultural systems such as livestock, poultry, and large-scale agricultural operations. For these, compost and composting may be the best choice as well as opportunity for added income

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Slimming agent
in a fat-burner cream

Ref. No.: TRA-2017SAFBC3

TRL 3

Analytical and experimental critical function and/or characteristic proof of concept established

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Conduct of clinical tests on humans to substantiate claims of product
- Research collaboration with NGAs and private stakeholders
- Revision of financial analysis to include major cost components and cash flow projections

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Description

Novel slimming agent in a topical fat burner cream is formulated with caffeine from coffee grounds and grapefruit oil extract as their active ingredients. These were chosen for their natural and proven bioactive effects or their ability to exercise an effect on living tissues.

Fat burners or thermogenics help burn stored body fat by using the body's fat reserves as a source of energy.

The cream does not increase metabolism. It works by loosening up the adipose tissue or temporarily dehydrating them. This helps a body's natural metabolism to make use of this fat as an energy source. Rather than using consumed energy the body thus burns stored fat. The process is called lipolysis or fat burning mechanism.

The formulation has been tested in an eight-week clinical trial test. Results showed significant reduction in weight, waist, and hip measurements among test respondents.

However, the topical cream cannot be used as a standalone fat reducer. It works best in combination with daily exercise and a healthy diet regimen. Permanent results can be expected with a healthy life style change. In support to adopters, assistance in establishment of sources of herbal materials will be provided, as well as training program to acquire necessary skills in processing the product.

Business Environment

A 2015 Pulse Asia Survey found Filipinos to be health-conscious with three out of five individuals citing staying healthy as an urgent personal concern. Further, the survey showed that many Filipinas are conscious of their body and weight, and continually works to avoid getting fat. There were also women who wanted to be slim. Use of the new fat-burner cream can be an additional or alternative option for them.

Competitors. There are six local competing products with various claims at different price points as follows:

Comparison of Product Claim and Price of DOST-ITDI's Bioactive Slimming Cream and Six Foreign Slimming Cream Brand in the Philippines. TSD 2017.

Brand Name	Unit Price (PHP)	Price/ 100 g (PHP)
DOST-ITDI's Phyto-Bioactive Slimming Cream, 20 g	23.50	115.50
Kustie Slimming Cream, 200 g	135.00	67.50
Fat Burning Cream Gel Weight Loss Skin Anti-Cellulite Chili Body Slimming Cream, 85 g	55.94	65.81
Ginger + Chili Fat Burning Cream All Natural Buttocks & Belly Fat Cream, 200 g	1,069.96	534.98
Dream Woman 7 Days Slimming Cream/Lotion, -- g	170.00	--
Body Slimming Gel Slimming Hot Cream for the Ever Wanted Slim Waist, 85 g	475.57	559.49
AFY Slimming Cream for Tummy Weight Loss Cream to Burn Fat Easily, 100 g	962.65	962.65

Investment Prospects

In the May 2018 Euromonitor International report, it cited strong growth reflecting consumers' increasing view of beauty and personal care as priority products. Slimming creams is one of thousands of products categorized in this segment.

It added that in 2017, beauty and personal care in the Philippines continued to record healthy growth, benefiting from favorable economic conditions, a rising standard of living, prominent global trends, the further development of the country's retail industry, and the growing influence of social media thus contributing to rapidly changing consumer behavior. All of these factors affected consumers' choice of beauty and personal care products.

Local brands are gaining ground due to expanding retail space and online sales. The review also said that the market witnessed significant expansion of retail space across the country due to construction of many new malls in small towns and rural areas. Competition, however, continues to intensify between categories and products. The forecast said competition may prove to be challenging for manufacturers, especially start-ups in the business.

Nevertheless, the influence of social media will continue to empower product and brand owners but also consumers because of product reviews.




Anti-diabetes supplement from *malunggay, duhat,* and *saba* (MOSYMU)

Ref. No.: TRA-2017ADSMDS3

TRL 3

Analytical and experimental critical function and/or characteristic proof of concept established

Investment Cost

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Maturation Plan

- Submission of product to compliance procedures for health supplements and other similar products
- Revision of financial analysis to include major cost components (i.e., licensing permits from regulatory bodies), cash flow projections, and break-even point

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Description

This anti-diabetes dietary supplement capsule derives its anti-diabetic properties from extracted ethanol of three plants, namely, *malunggay* (*Moringa oleifera*) leaves, *duhat* (*Syzgium cumini*) leaves, and *saba* banana (*Musa sapientum*) fruit. The process involves extracting ethanol from *malunggay* leaves, *duhat* leaves and unripe *saba* fruits separately. Each extract is spray dried and combined in a 1:1:1 ratio. The resulting product contains phytochemicals such as saponins, glycosides, amino acids, tannins, alkaloids, flavonoids, and anthaquinones.

In efficacy tests, the supplement's performance was recorded as comparable to Glibenclamide, an over the counter drug commonly used to treat Type-2 Diabetes and hyperglycemia. Here, the *malunggay-duhat-saba* supplement significantly lowered blood sugar levels using a dose of 400 mg/kg body weight in experiments conducted on rats. In addition, a pre-clinical study on safety showed that the formulation is safe for human consumption.

Business Environment

In 2008 to 2011, health supplements market in the Philippines grew by 40.35 percent, while market for personal care products increased by 34.25 percent. However, in 2009, these same products posted only a slight growth of 2.8 percent and 7.1 percent, respectively. The decrease in market for personal care

products was caused by the decrease in imports by Australia and Malaysia, two of the top importers of Philippine personal care products.

Meanwhile, market volume for dietary supplements from herbal plants posted the biggest leap, growing from 13 percent in 2009 to 111 percent in 2011. Their continuous annual increase in exports can be attributed to the increase in demand for organic and natural health products in the world market.

However, consumer spending on dietary supplements in 2011 dropped compared to 2012 because of the entry of low-priced brands of health and wellness products. This may further be explained by the regard of some target consumers in rural areas of vitamins and dietary supplements as luxury goods and not as a healthy lifestyle necessity. There is, however, a growing group that are becoming more health conscious and are relying on herbal medicine/ traditional product as preventive medication.

At present, multinational and local companies cater to the expanding demand of the domestic and international markets, with 85 percent of processors belonging to the MSME category and 15 percent classified as large-scale.

Dietary supplement products can be categorized into two. These are:

1. Natural ingredients such as essential oils, extracts, semi-processed plant parts, and plant parts; and
2. Finished products like herbal medicines, traditional medicines, cosmetics, health supplements, green fertilizers and pesticides, household and homecare products, and veterinary/animal products.

Policies. With the institutionalization of the TAMA Law, through the creation of PITAHC, processing of dietary supplements like MOSYMU is now supported by DOH. PITAHC supports research and development activities and

transfer of economically viable technologies on traditional and alternative health care.

It is also tasked to formulate policies that will stimulate and sustain the industry through public awareness campaign/education, development of continuing training programs for medical practitioners, and to coordinate with other institutions and agencies involved in the research on herbal medicines.

Further, start ups are advised to take great concern in labeling food/ product that is marketed for special dietary uses, like diabetes prevention. This should include information concerning its vitamin, mineral and other dietary properties as required by FDA and in a manner that fully informs purchasers of the product's intrinsic value in terms of its special use.

Competitors. There are nine local and foreign dietary supplements offering the same benefit as MOSYMU. Of the nine, Buah Merah Mix and First Vita Plus derive its therapeutic claims from several plant extracts. The rest utilize *malunggay* as source of extract.

An over the counter anti-diabetes drug, Glibenclamide is the cheapest at PHP0.75/ tablet. Yelixir is the most expensive at PHP4,240/ bottle.

Investment Prospects

The food supplement from MOSYMU is highly marketable to some 285 million worldwide who are suffering from diabetes and hyperglycemia. Meanwhile, the Philippine market is also considerably large. In the 2016 report of the International Diabetes Federation, 6 percent of the adult population of Filipinos, or 3.5 million between 20-79 years, are diabetic; 1.84 million of those are undiagnosed.

It is further forecasted that the diabetes rate in the Philippines will double to 7.8 million by 2030. However, while the primary consumer base of the product are those with diabetes, secondary users are those that practice living healthy.

The market therefore for the anti-diabetes dietary supplement MOSYMU has a relatively fixed and growing share. Since the technology has a low cost of entry, even small-scale Philippine pharmaceutical companies can be potential adopters of the supplement.

In addition, the technology behind extraction and production are relatively accessible. Individuals and communities that have farming spaces to accommodate all three base materials can avail themselves of the technology.

Ready-to-Eat chicken *arroz caldo*

Ref. No.: TRA-2017RTECAC4

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Improvement of engineering design
- Development of waste management plan
- Provision in system design to accommodate use of deboned chicken breast and peeled garlic for big volume production
- Inclusion in system design application of international regulations/ restrictions on meat products
- Documentation of all production aspects

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- Revision of financial analysis to include major cost components and cash flow projections

Description

RTE chicken *arroz caldo* or rice porridge is a standardized formulation and production process for mass distribution as disaster relief food. It aims to address immediate hunger of disaster victims. The formulation is ready to eat without preparation and drinkables. Packed in retort pouches for easy storage, it is shelf stable for at least one year and can be transported by land and sea surface, or aerial dropped from a height of 20 feet.

The product has undergone field testing and validation studies in collaboration with DSWD and several local government units. It is currently available as one variant but development of more variants are underway.

A patent application for the formulation and production process has been filed under Trademark No. 42018002264 and Trademark "Pack of Hope." Adopters can purchase the license for production of RTE chicken *arroz caldo* in retort pouches for an upfront fee of PHP180,000.00. Payment of royalty of three percent (based on gross sales) to the technology generator begins on the second year. Included in the license is training on the formulation and production process and assistance in setting-up the production facility.

Benefits/ Uses. The Philippines, as one of the most disaster prone countries in the world, experiences great difficulty during those times with victims and survivors having limited or no access to food and water, especially those in

distant areas. In addition, most food relief packages contain canned goods, not suitable for aerial drops, and instant noodles, which have minimal nutritional value and requires water during preparation.

RTE chicken *arroz caldo* can provide for those times. It does not merely satisfy hunger but offers a nutritious yet convenient alternative. Commercially available similar products are complementary foods in paste form and were developed to meet nutritional requirement of children (aged 6 months to 3 years) but not adults.

Business Environment

The Philippines is one of the largest markets in Southeast Asia with an estimated 103 million people. As the 12th largest population and the 30th largest economy, the World Bank ranked the Philippines at 103rd out of 185 economies for ease of doing business.

The major challenges for doing business include bureaucracy, corruption, restrictions on ownership of land by foreign companies, and restrictions on investment in certain sectors. However, the Philippines is strategically placed among high growth countries like Mainland China, Malaysia, and Singapore, which makes it easier to export to these Asian countries.

Targeting both the local and foreign markets for RTE chicken *arroz caldo*, Mordor Intelligence reports that the global ready-to-eat food products market, in terms of value, is expected to expand at a CAGR of 7.2 percent during the forecast period 2016–2026. It is estimated to be valued at USD195.3 billion by the end of 2026.

Market. Further, Mordor Intelligence and Future Markets Insights said that the growth in quick service restaurants, increasing population of working

women, millennial population, busy work schedules, and retail chains are the key contributors to increasing awareness about RTE products among consumers.

The global RTE food products market is segmented by product type, packaging and distribution channel. The meat/poultry segment is projected to account for the largest share by value, which bodes well for RTE chicken *arroz caldo*.

Both market research firms cited that in developed countries, food consumption is expected to arise mainly from the slow rate of population growth rather than the excess in per capita consumption. Developing countries, on the other hand, are expected to account for an increased food demand, due to mounting population, as well as surplus per capita food consumption.

However, unhealthy substitutes, low quality, taste and shift towards a healthier lifestyle is likely to hinder market growth over the coming years. A large chunk of consumers are still price conscious, which poses a challenge to the ready-to-eat food manufacturers and suppliers.

Investment Prospects

As an emergency food reserve, the product may be marketed to local government units and national government agencies, social civic organizations, and local and international NGOs. As a ready-to-eat product, it can also be offered for retail in supermarkets, groceries, convenience stores, and other food service establishments.

The improving consumer lifestyle, rapid urbanization, high disposable income, are increasing demand for on-the-go convenience foods, thereby fueling the ready-to-eat food market growth. Further, innovative products based on function, convenience, and organic ingredients including advancements in packaging technology are expected to provide a future growth opportunity in the sector.

Ready-to-Drink coconut milk

Ref. No.: TRA-2017RTDCM4

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Re-design of process flow for big volume processing
- Conduct of up-scaling tests to ensure consistency of product quality
- Replacement of current equipment and acquisition of new, modern equipment for high volume coconut milk processing
- Revision of financial analysis to include major cost components and cash flow projections

Description

RTD coconut milk in SUP retortable pouches is an alternative milk drink. Its targets are the lactose intolerant, vegetarian consumers, and those looking for a healthier milk drink alternative.

Business Environment

Global Market. According to Stratistics MRC, the Global Dairy Alternatives Market was valued at USD8.51 billion in 2016 and expected to grow at a CAGR of 12.5 percent to reach USD19.45 billion by 2023.

Among these dairy alternatives, organic coconut milk is expected to be the most favored among consumers. Although conventional coconut milk has high revenue share, the attractiveness of the conventional coconut milk segment is expected to remain low as compared to the organic segment. Revenue from the organic coconut milk segment is expected to increase at a CAGR of 8.2 percent during the forecast period and is anticipated to contribute close to 30 percent revenue share by the end of 2027.

The organic segment was estimated to be valued at more than USD220 million in 2017 and is projected to reach a market valuation in excess of USD500 million by the end of 2027, creating absolute dollar opportunity of USD12.2 million in 2017 over 2016 and an incremental dollar opportunity of USD288.3 million between 2016 and 2027.

The conventional segment by nature was estimated to be valued at more than USD600 million in 2017 and is expected to increase at a CAGR of 7.0 percent over the forecast period. It is likely to reach a market valuation of more than USD110 million by the end of 2027 creating absolute dollar opportunity of USD39.3 million in 2017 over 2016 and an incremental dollar opportunity of USD618.9 million between 2016 and 2027.

Some of the international key players in the global dairy alternatives market are Blue Diamond Growers, Döhler GmbH, Earth's Own Food Company Inc., Eden Foods Inc., Freedom Foods Group Limited, Nutriops S.L, Sanitarium Health and Wellbeing Company, Sunopta Inc.,The Hain Celestial Group, Inc, The Whitewave Foods Company, Triballat Noyal, and Valsoia S.P.A.

Local Market. RTD coconut milk has not been market tested yet. There are no performance records of its market presence in the Philippines.

Policies. Current legislations that regulate the industry include Republic Act 8048 also known as the Coconut Preservation Act of 1995. This was amended into Republic Act No. 6260 known as the Coconut Investment Act.

Investment Prospects

The Global Coconut Milk Market is segmented into North America, Europe, Asia Pacific, and ROW. North America region has the major market share followed by Asia Pacific.

A global coconut milk market report and forecast to 2023 by Market Research Future identified changing life-styles, such as adoption of a vegetarian and healthy diet by consumers in the Asia-Pacific as generator of a high revenue during the given forecast period.

The USA, Germany, China, UK, and Japan are leading the higher demand for heath drinks with lesser calories. The import and export of coconut milk in these developed countries are found to be rising at a steady growth rate.

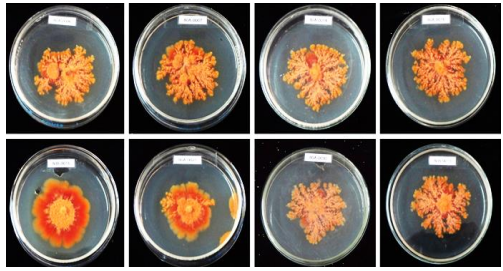
During 2015, the Americas dominated this market space and is projected to remain to be the largest market for coconut milk until the end of 2020. One of the

major factors for this growing demand is the rising lactose intolerant population in the region who are not able to digest the lactose present in dairy milk.

Extensive projections on the market from 2016-2020 carried out by TechNavio analysts have shown that nearly 86 percent of the population in Brazil and 61 percent of the population in Argentina are lactose-intolerant.

An industry analysis and opportunity assessment of Future Market Insights for 2017-2027 of RTD coconut milk indicate that increasing consumption of vegan desserts and ice creams will boost the coconut milk market. Rising number of vegan individuals particularly in Europe is a major factor driving the growth in consumption of organic and conventional coconut milk and associated products. Increased demand for vegan ice creams and desserts even in hotels is driving the sales of plant-based substitutes for regular milk.

Future Market Insights added in its report that the trend has extended to Asian cuisine, which has gained immense popularity among food lovers across the globe. A substantial increase in taste for cuisines that include coconut or coconut milk is being seen in countries such as the USA and Canada owing to increasing tourist population visiting countries in Asia. Sales of Asian food at Asian restaurants in the USA have almost doubled in the past few years, indicating that preference has grown substantially in a short span of time.



Food colorant from *Monascus purpureus*

Ref. No.: TRA-2017FCMP4

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Development of method to produce product in commercial scale
- Development of more applications in order to establish and document other product risks and hazards
- Characterization of physical and chemical properties to determine generated bio wastes
- Drafting of documents on design and product scaling
- Comprehensive documentation to support technology

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- Revision of financial analysis to include major cost components and cash flow projections

Description

Food colorant is produced from two improved strains of the mold *Monascus purpureus*. It is produced from the first strain using rice as substrate. Production in the second uses an aqueous media that is applied with heat and moisture modified starch.

Food colors from this mold ranges from yellow, orange, and red.

Color from the rice substrate is extracted with ethanol followed by solvent evaporation while color from the aqueous media is spray-dried to obtain colorant in powder form.

Business Environment

Existing colorants in the market are mostly synthetic which opens up health concerns such as use of ingredients that may be carcinogenic, allergenic, or those that can increase/ result in hyperactivity in children. Many of these synthetic colorants are not safe for human consumption even, thus DOST-ITDI explored use of alternative natural sources.

Currently, there is no local company that produces alternative natural colorants. However, a recent joint venture between TNC Chemicals Phils., Inc. and

Shanghai Dyestuffs Research Institute Co., Ltd. now offers the local market a new source of top quality colors for food, beverage, pharmaceutical, cosmetics, and feed applications. Their product, Lion Head ® Food Colors, is FDA approved and US certified. But, it is not clear if the product is natural, synthetic or both.

The second local colorants producer is NECO Philippines, Inc., which trades chemicals for food and non-food uses.

Market. PR News Wire estimated that the Global Forecast from 2015 to 2023 on the Food Colors Market is to be USD3.88 billion in 2018 and is projected to reach USD5.12 billion by 2023, at a CAGR of 5.7 percent during the forecast period. The demand for natural food colors is increasing significantly across all regions. The various health benefits associated with their consumption are major factors driving their growth.

The demand for food with a natural and clean label is increasing as well across the world owing to heightened health awareness, higher spending power of consumers, and increasing instances of food scares related to adulteration of food.

Investment Prospects

The food colors market is one of the segments of the global food additives market. Food colors are used by the food and beverages industry to improve the color of the food, which is lost during food processing. It is projected to reach USD2.5 billion by 2020 and growing at a CAGR of 4.5 percent for the period.

The market is driven by easily available raw materials, which includes fruits and vegetables. In addition, growing food safety concerns in the global food markets are pressuring the manufacturing sector to adopt clean labels.

As well, the industry is facing a growing awareness on the ill effects of synthetic colors. This has triggered demand for natural colorants, which are pricier compared to synthetic colorants.

The increasing disposable incomes, changing lifestyles in emerging countries are driving demand for processed foods. Thus, to attract the target segment, companies tend to add food colorants.

New stringent food standard regulations by FDA and several regulatory bodies are proving to be a constraint for manufacturers. These have forced them to look at alternatives in the form of innovations in natural colorants.

Ken Research noted that, in the Philippines, an increasing awareness of the beneficial effects of eating healthy has led to a shift in consumption of products made from natural and organic ingredients. Features like sustainable and locally sourced, organic, and GMO-free food ingredients have gained consumer attention, especially among millennials in the country.

Their willingness to pay more for organic, sustainably sourced, and natural products indicates that there is leaning toward purchase of products with natural ingredients.

Furthermore, increased use by retailers and manufacturers of e-commerce as a platform to sell their products proved to be effective and profitable. Social networking Websites and Web advertisements have become the way to communicate to millennials. Additionally, the rest of the local buying public have become more conscious of keeping healthy owing to reports on increasing early deaths from obesity and its complications, and cardiovascular diseases.

Food ingredient manufacturers in the Philippines are thus focusing on launching new products with a higher proportion of natural ingredients in them, as well as,

importing healthy and high-quality food ingredients from major countries such as the USA, UK, and Netherlands, among others.

Abaca fiber-reinforced composite 4

Ref. No.: TRA-2017AFC4

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Conduct of further research and study to support marketability
- Development of waste management plan
- Marking of other applications
- Conduct of waste analysis and risk management
- Conduct of further tests on product durability
- Establishment of partnership with motorcycle firms on marketing, costing, financial assessment, and sourcing of raw materials
- Drafting of an operation and user's manual

- Marking of suppliers to ensure continual supply of raw materials
- Revision of financial analysis to include major cost components and cash flow projections

Description

As a way to protect the environment, stringent legislative policies are forcing many industries to seek new materials for various industrial applications that are renewable, recyclable, biodegradable, and sustainable to replace traditional materials derived from non-renewable sources.

DOST-ITDI explored thus use of abaca fiber or Manila hemp as an alternative source of new material. Renewable, endemic, and abundant in the Philippines abaca is one of the strongest natural fibers. It is also more resistant to saltwater decomposition than most vegetable fibers.

The product, abaca fiber-reinforced composite, is an environment-friendly and lightweight material with good thermal insulation and fuel-saving properties suitable as roofing material for driver's seat and sidecars of motorized tricycles.

It is a good substitute material for metals like stainless steel and iron that are used commonly as roofing material, body for sidecars, and other automotive parts/components in tricycles.

Performance/Field tests of a prototype using the composite as roofing material for tricycles is ongoing.

Business Environment

Asia Pacific is the largest market for abaca fiber in terms of production and consumption over the past few years and the trend is expected to continue over the forecast period.

The Philippines, being the world's largest abaca producer, holds the major market share in the Asia Pacific market. A considerable portion of the supply is used domestically while a major portion is exported to various countries including the USA, Japan, and other European countries.

Currently, abaca fiber is explored as substitute for glass fiber reinforced plastics components. Investor friendly initiatives taken by PhilFIDA are anticipated to push market growth over the forecast period.

Raw Material Supply. With supply of abaca fiber not nearly being enough, the Philippine government took initiatives to increase production levels of high quality abaca fiber for domestic consumption and export. The Philippine Abaca Industry Roadmap 2017-2022 sets the direction of the Philippine abaca industry for the next five years and is targeted for implementation to meet the volume of abaca fibers required by the domestic and international markets. The roadmap indicates the following:

- Extensive abaca expansion and rehabilitation efforts from 2018 to 2019 to meet the targeted 239,666 hectares of total area planted to abaca by 2022. Bulk of the expansion and rehabilitation activities will be conducted in Regions V, VIII, and other regions of Mindanao;
- The rehabilitation and expansion of abaca plantations will increase output to 76,385 MT this year; 79,576 MT in 2019; 117,519 MT in 2020; 176,715 MT in 2021; and 216,761 MT in 2022;
- The annual abaca output of the Philippines is marked at 72,734.71 MT;

- In terms of targets, 69,364 hectares planted in 2018 and 44,167 hectares in 2019 will provide for an estimated total abaca fiber demand of 160,444 MT in 2020 with an increase of 12 percent annually. Corporations and farmers have committed to plant abaca in more areas depending on the availability of planting materials.

By 2022, with the targeted farm expansion and rehabilitation of 146,248 hectares, an estimated fiber production of 216,761 MT will be attained. Tasked to do this is DA through a new, five-year program for abaca production. The PHP5 billion program intends to place 90,000 hectares under abaca cultivation. Priority will be accorded to the acquisition of modern technology, improved planting materials, fertilizers and state-of-the-art stripping machines.

To locate in Southern Leyte, a further 1,500 hectares will be brought under abaca cultivation with an initial PHP100 million release. Under the industry's current technology, 1,500 seedlings are being planted per hectare. With the new technology that will be introduced, planting can be tripled or 4,000 seedlings per hectare.

Technology Adoption Constraints. Initial meetings with manufacturers/ fabricators of tricycle sidecars indicated slight resistance to use of the material due to newness of technology and unfamiliar physical appearance of material. Proof of its properties, advantages, and benefits may need to be shown first to prospective adopters. Further, they raised objection on cost of fabrication of sidecar.

Competitors. Reinforced bioplastics are relatively new class of composites that have attracted a lot of attention due to increasing concern about management of plastic wastes. However, bioplastics may be environment-friendly but they have poor thermal and mechanical stability. Recent studies showed that bio-composites made of bioplastics and bio-fibers can compete with conventional engineered plastics.

Investment Prospects

The Philippine abaca industry continues to generate significant foreign-exchange revenues. In the early part of 2017, exports of abaca products ran at a rate double that of the preceding year or USD11 million. The progress of the new program for the abaca industry should lead to an even higher rate especially with the revival of ports that have historically been closely associated with the abaca export trade, such as Tabaco City in Albay and Malitbog in Southern Leyte.

However, there are so far no available data on production or market of abaca composite board. Further, the industry of abaca fiber-reinforced composite is dependent on its various applications. Albeit no data on market and production of abaca composites are available, its high functionality potential merits a target market list as follows:

- Automotive industry for interior door lining panels, upholstery and seat backs;
- Construction industry for window/door frames, roofing, decking, insulated panel building systems, building panels, roofing sheets, door frames;
- Sports industry for bicycle frames, tennis racket, surfboards;
- Fabricators of tricycle roofing and side car;
- Major players of the abaca fiber market including Ching Bee Trading Corporation, Peral Enterprises, MAP Enterprises, Tag Fibers, Inc., Yzen Handicraft Export, and Selinrail International Trading;
- Licensed Abaca producers/processors in the Philippines; and
- Licensed Abaca Traders in the Philippines.

Nanoclay from local bentonite ore

Ref. No.: TRA-2017NLBO4

4

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Completion of all CTEs marked with "N"
- Upscaling of research study on chemical waste treatment and safety issues
- Upscaling of volume of raw material to ensure repeatability of process
- Specification of safety factors and toxicity levels
- Revision of financial analysis to include major cost components and cash flow projections

Description

Using Philippines' deposit of bentonite ore coming from Iloilo, nanoclay, a high-value product from synthesized sodium activated montmorillonite was produced from previously unbeneficial bentonite. The synthesized nanoclay was compared to commercial organoclay.

Nanoclay from local bentonite ore have many applications such as in wastewater treatment, bleaching oil, mud drilling, as fillers in polymers, catalysts, and thickeners. In recent years, nanoclay composites have drawn the attention of researchers as well as manufacturers because of their excellent capacity to withstand thermal and mechanical stress without significant compromise in impact and/or clarity.

Improvements due to the presence of nanomaterials in the clay provide the product with material enhancing properties such as tensile strength, stiffness, and toughness. It can serve as gas barrier and has flame retardant properties. It is also stable making it erosion and chemical resistant.

Business Environment

Politically, the mining industry in the Philippines is being stunted by non-alignment of local policies with national policies.

The power of the local government appears to be stronger than that of the national government. Local officials like the city or town mayor can invoke their power under the Department of Internal and Local Government. In support of the anti-mining sentiment of some local government officials are the civic environmental activists and the Catholic Church which continue to influence business leaders and civil servants. The American-style of democratic freedom is

exercised by Philippine media and it is one of the strongest critics of mining, especially when it comes to reporting mining disasters and anti-mining rallies.

The Philippines has 26.77 million MT of bentonite reserves. Bentonite ores could be processed into high value-added product called nanoclay. Value-addition of bentonite creates potential applications especially in plastics/polymers, rubber, paints, and adhesives, among others.

SAILE Industries is the Philippines largest commercial mining and processor of zeolite and bentonite ore for domestic, commercial, agricultural, and industrial applications throughout the Philippines. The mineral ore processing facilities of SAILE Industries has the capacity to give a variety of coarse, granular and finely milled products specifically tailored to suit customer requirements and market applications.

Some of the major players operating in the local market are Southern Clay Products Inc., FCC China, Nanocor Corporation, Techmer, Kowa Company Ltd., Elementis Specialties, Unicoop, Sum Chemical, Kunimine Industries and Ube Industries, Kunimine Industries Co. Ltd, UBE Industries, Mineral Technologies Inc., Elementis Specialties Inc, RTP Co., and Techmer PM and many more.

Key global market players include BYK Additives, Nanophase Technologies, ESPE, Laviosa Chimic Mineraria Spa, Powdermet, Inframat Corporation, Hybrid Plastics, Axson Technologies SA, Zyvex Technologies, Elementis Specialties Inc, Evonik Degussa GmbH, Du Pont (EI) De Nemours, Foster Corporation, and Cabot Corporation.

Investment Prospects

The global nanoclays market is highly fragmented and the major players have used various strategies such as new product launches, expansions, agreements,

joint ventures, partnerships, acquisitions, and others to increase their footprint in this market. The report includes market shares of nanoclays market for global, Europe, North America, Asia Pacific, and South America.

According to Allied Market Research, nanoclays or polymer nanocomposites market was valued at USD5.276 billion in 2015, and is expected to reach USD11.549 billion by 2022. It is supported by a CAGR of 10.9 percent during the forecast period 2016 to 2022.

Polymer nanocomposites market segmentation by type include carbon nanotubes, nanoclays, metal oxide, and ceramics, among others. By application, it is segmented into applications in construction, automotive, electrical and electronics, and packaging. It finds market in North America, Europe, the Asia-Pacific, and LAMEA.

Market Volume. The global market, in unit terms, should reach 733,220 MT by 2021 from 308,322 MT in 2016 at a CAGR of 18.9 percent, from 2016 to 2021.

Clay nanocomposites accounted for the largest portion of total nanocomposite consumption by value in 2015 with a market share of 56.2 percent. This share is projected to increase to 57.4 percent by 2021.

Global polymer nanocomposites market is expected to reach above USD5.1 billion by 2020 growing at a significant CAGR from 2014 to 2019.

The Asia-Pacific region dominated the polymer nanocomposites market in terms of values in 2013 and it is expected to grow at a higher CAGR, from 2014 to 2020. Large packaging industry and increasing automotive and aerospace industry in Asia-Pacific region helped it to dominate the global market.

Generally, the booming manufacturing activities in Europe and Asia Pacific are likely to offer lucrative growth opportunities to the global nanoclay market.

Market Segments. Among the end user industries, the food packaging industry uses nanoclays to a great degree due to their incredible strength, barrier properties, durability, and moisture stability. Nanoclays that contain montmorillonite, such as DOST-ITDI's nanoclay, are gaining immense popularity in the plastic packaging area due to their peculiar properties. Citing these reasons, the packing segment of the overall market will expand at a CAGR of 12.7 percent during the forecast period.

North America was the leading regional segment in the global nanoclay market. During the forecast period, it is expected to expand at a CAGR of 12.9 percent. The demand of nanoclays in North America is dominated by the automotive segment, while the packaging industry also makes a significant mark by being the leading consumer.

In terms of revenue, use of nanoclay reinforcements in automotive parts is expected to grow at the fastest CAGR of 23.6 percent from 2015 to 2022. Rising demand because of material enhancing characteristics including toughness, stiffness, dimensional stability, thermal resistance, chemical resistance, enhanced barrier properties, and flexibility at high temperatures is expected to boost growth over the next seven years.

Asia-Pacific is expected to grow at a highest CAGR and secure its leading market position by 2020, with developing new application areas in the automotive, and electrical and electronics market. In Europe the use of polymer nanocomposites continues to increase in automotive industries to replace the other conventional composites that reduce the weight of vehicles and increase the mileage.

Nanoclay is being utilized as a drug vehicle in the field of medicine. Its ability to control release of drugs in a better way as compared to other polymer nanocomposites is turning out to be a very important application and is expected to boost growth over the forecast period.

Biodegradable polymer

Ref. No.: TRA-2017BP4

4 4

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Determination of shelf life of product
- Completion of all CTEs marked with "N"
- Establishment of partnership with BOI
- Determination of product inclusion in BOI's latest SIPP.
- Submission of product to increased in-plant testing
- Exploration of other uses of product as binding agent

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- Revision of financial analysis to include major cost components and cash flow projections

Description

TPS-Nanoclay pellets are cornstarch-based raw materials of high availability locally and used for plastic production. The pellets are mixed with other plastic materials making the formulation biodegradable.

The product replaces the synthetic polymeric materials commonly used for plastic materials that pose environmental concerns.

Nanotechnology is used to produce biodegradable thermoplastic polymer from starch and nanoparticles to replace conventional petroleum that can be used for the production of various green packaging materials.

Business Environment

The Philippine downstream plastics industry refers to the plastic fabricators and manufacturers which convert plastic resins to industrial and consumer finished products.

Main production processes include: film and sheet extrusion; injection moulding; compression moulding; extrusion blow moulding: injection blow moulding; injection stretch blow moulding; pipe and profile extrusion; net and twine extrusion; woven sack extrusion and weaving; sheet thermoforming, printing, lamination, slitting and bag forming; and recycling.

Plastic is a widespread and pervasive material that is used by a multitude of industries in the production of numerous products. In the Philippines, industries such as the electronics, construction, food, cosmetics, packaging, and automotive are aligned with the viability of the plastics industry. Having a local source of plastic materials benefits all sectors with its adaptive, just in-time delivery capabilities, and more importantly softens the impact brought about by dollar and import requirements.

Majority of the plastics companies are situated in Metro Manila, particularly in the CAMANAVA area, while others are from Manila, Pasig and CALABARZON. There are some in Iloilo and Cebu in the Visayas, and Davao in Mindanao.

Prices of Similar Products in the Market. TSD 2018.

Product	Cost/ Per Order	Company
Gh601 100% Biodegradable Biobased Corn Starch Plastic	USD3,500 4500 / Ton 40 Bags (Min. Order)	Shanghai Guanghe Bio-Tech Co., Ltd.
PLA Modified Starch Plastic Resin Pellet	USD2,831 3194 / Metric Ton 1 Metric Ton (Min. Order)	Anhui Jumei Biological Technology Co.,
Corn Starch Plastic Granules Raw Materials	USD5,000 6000 / Metric Ton 5 Metric Tons (Min. Order)	Wuhu Bridge Trade Co., Ltd.

Global Production of Polymer. The plastics industry has developed considerably since the invention of various routes for the production of polymers from petrochemical sources. Plastics have substantial benefits in terms of their low weight, durability, and lower cost relative to many other material types.

Worldwide polymer production was estimated to be 260 million MT per annum in the year 2007 for all polymers including thermoplastics, thermoset plastics, adhesives and coatings, except for synthetic fibers.

This indicates a historical growth rate of about 9 percent per annum. Thermoplastic resins constitute around two-thirds of this production and their annual usage is growing at about 5 percent globally.

Consumption. Plastics represent one of the most pervasive raw materials that are essential in the manufacture and packaging of goods produced by various industries. Its global consumption is expected to reach 297.5 million tons by 2015 and Asia-Pacific economies are seen as the emerging growth drivers for the manufacture of plastic products. Capacity utilization is at 50-75 percent.

Local industry estimates downstream investments cost at PHP600 billion. The major components of the cost are plant, property and equipment, coupled with the raw materials, the power and the labor force's salary. Total employment in the industry is approximately around 650,000 workers.

The Philippines plastics exports weakened recently, dropping 5.8 percent due to low demand from its top buyers, the U.S., China, and Japan. The semiconductor and electronics industries account for the majority of the country's exports. Various measures are instituted to boost exports, such as GSP of EU, which creates lower or no duties on exports to the EU.

Local Policies. DTI-BPS lists certain plastic products as among the products for mandatory certification under mechanical/building and construction materials and chemicals and other consumer products.

The certification of plastic products, such as mono bloc chair, stool, and plastic table is guided by the PS Quality and Safety Certification Mark Scheme. As

well, there is a PNS for plastics, plastic and plastic products, specifications for compostable plastics, monobloc chair, stool and plastic table, and PVC resin.

Investment Prospects

A survey conducted by PPIA in May of 2012 reveals that most companies adapt top of the line, state of the art technologies from Europe for their operations, especially large-scale industries with high quality and volume demands.

On the other hand, companies using old, outdated, and cheap equipment remain for small-scale industries where volume requirements are low. The strength of these smaller companies is that they keep their overhead low and are capable of modifying and retrofitting their machines to improve its efficiency. For this, the industry is given an internal overall medium rating for their operations.

Market. Biodegradable and natural based polymers have been the focus of research in the plastic industry since legislative laws are leading to minimize, if not totally ban use of plastics.

With this tendency, there are huge potential/opportunities for TPS–nanoclay pellets as raw materials for plastic production with its wide range of application in the plastic industry.

Only a few players (pre-processors) in the local plastic industry are into producing starch-based polymers since raw materials for plastic, which is mostly synthetic, are imported.

Cacao bean roaster

4

Ref. No.: TRA-2017CBR4

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Re-design of machine to reduce volume of cacao bean wastage as well as widen functionality to include coffee and other similar crops
- Revision of financial analysis to include major cost components and cash flow projections

Description

The DOST-ITDI Cacao Bean Roaster was designed to speed up production and improve quality of cacao-based chocolate, as well as reduce its production costs. It is easy to operate and is better than the traditional roasting pan and drums. The material used is food grade and made of stainless steel. It is LPG-fueled and is equipped with a thermostat to allow control of roasting temperature.

Business Environment

Asia and the Philippines are the recently fastest growing consumers of cacao, experiencing a 12 percent growth. According to DA, the average annual cocoa consumption in the Philippines is 50,000 MT and Euromonitor International forecasts it to reach 100,000 MT by year 2020.

According to DA, the following are some factors that are contributing to the increasing demand for cocoa:

- Increasing awareness of health benefits of, and preference for, chocolate. There is no substitute for cacao in chocolate making;
- Expanding range of applications in food, beverage, cosmetics, and pharmaceuticals; and
- Increasing disposable income of the middle class.

The market opportunity for *tablea* and cocoa products is growing, as there is an increasing number of cafes and restaurants offering chocolate drinks. Moreover, the trend toward wellness and a healthy lifestyle is seen as another opportunity for cocoa, as it is being positioned and marketed as a health food given its natural components and health benefits.

It is projected that by 2020, there is an additional one million tons of cacao needed to meet global demand, while an additional 30,000 tons are needed to meet local demand. As such, cacao growers and cocoa manufacturers in the country are well-positioned to translate these market opportunities into a profitable reality.

Benefits/ Uses. Roasting is one of the most important steps in the production of Philippine *tablea*. Variables such as temperature, scale of roasting, type of roaster used, and a host of other variables are within the Philippine *tablea* maker's control, and all make significant impact on the flavor of the final product.

The development of standard specifications and test procedures for the cacao roaster is therefore essential in order to regulate the physical and chemical reaction that occur during roasting. These include determining the desired roasting temperature and roasting time.

Policies on Engineering Standards. The implementation of Republic Act 10601 also known as the AFMech Law of 2013 mandated BAFS to develop standard specifications and test procedures for agricultural and fisheries machinery and equipment.

The Bureau, in collaboration with BAFE, concerned agriculture bureaus and attached agencies, PRBABE, PSAE, and UPLB-AMTEC, embarked on a project entitled "Development of Philippine National Standards/ Philippine Agricultural Engineering Standards for Various Agricultural Machinery." This project includes the development of standards for cacao roaster. DOST-ITDI thus designed the machine following the standards for cacao roaster as stipulated under Republic Act 10601.

Investment Prospects

Cacao is the key ingredient in the production of chocolate and thus, one of the world's most highly traded tropical crop. In 2015, this industry is valued at approximately USD9 billion. The cocoa-chocolate GVC, in which cacao bean is a key product, is also growing rapidly.

Total trade in the cocoa-chocolate GVC has doubled over the past 10 years, reaching nearly USD44 billion in 2015. In terms of value, chocolate exports capture 56% of the total exports in the industry, followed by cacao beans 20%, cocoa butter 12%, cocoa liquor/paste 7%, and cocoa powder 5%.

The growing global demand represents an opportunity for the Philippines to grow its economy. However, the Philippines' participation in the cocoa-chocolate GVC is limited, despite many competitive advantages. Despite its centuries-long history of cocoa production, and good climatic and geographical conditions exports have remained low.

Globally, the country ranks 72nd in exports with a global market share of less than 0.01 percent or just over USD24 million in 2015.

Improved salt iodization machine

Ref. No.: TRA-2017ISIM4

44

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Drafting and inclusion of GMP protocol in production design
- Conduct of more promotion activities
- Revision of financial analysis to include major cost components, cash flow projections, break-even point,

Description

SIM is a continuous, screw-type iodization machine, which automatically, precisely, and consistently iodizes refined table and solar salt with a spray of potassium iodate solution. It is capable of iodizing salt at specified levels of iodine content in ppm.

SIM can produce 750 kg/h of iodized salt with a 10 percent moisture content.

The machine is low cost and ideal for small-scale salt producers and processors. It is a great aid in implementation of Republic Act 8172 or ASIN Law. The target market for the technology includes salt producers and manufacturers in the country with a total production capacity of 134,000 to 185,000 metric tons/year. There are also the marketers/traders involved in the distribution of salt products.

Business Environment

The Philippines currently relies heavily on imported salt with 80 percent of its requirements imported from big salt-producing countries like Australia and China.

In 1990, provinces like Bulacan, Pangasinan, Occidental Mindoro, and Cavite can supply almost 85 percent of the country's annual salt requirement. DOST, in a report said that, the local salt industry has since been crippled by the country's vulnerability to climate change.

Large producers from Las Piñas, Cavite, and Bulacan were forced to close down their salt farms, or convert their areas into fishponds or other profitable ventures for residential or commercial use. Dwindling local salt production thus gave rise to more salt importation.

Now, only 20 percent, roughly 590,000 MT, of the country's salt is produced locally. Occidental Mindoro is one of the biggest salt-producing provinces in the country. It currently supplies 12 percent of the national salt requirement or 75,000 MT.

Three big salt companies are currently supplying local salt demand. These are Artemis Salt Corp., which leads trading in the country and imports from India, China, and Australia; Salinas, a salt technology company; and Arvin International, which primarily imports and distributes both local and international salt brands.

Policies. Republic Act No. 8172, is a major step to end the silent but huge nutritional problem called IDD through the cost-effective preventive measure of salt iodization. It requires all salt manufacturers in the country to iodize the salts they produce, manufacture, import, trade, and distribute.

Investment Prospects

While the potential of the salt industry is huge because of universal need, a recent conference of the Philippine Population Association reported that abnormal weather patterns have decimated the Philippine salt industry. Salt farmers are also reporting that they have been highly vulnerable to erratic weather patterns because their farms were dependent on solar evaporation, the traditional way of producing salt.

In places where salt beds are adjacent to rivers, flooding has been a frequent problem.

An online news site bulatlat.com also reported economic globalization as an equaly important reason for the shrinking of the local salt industry. Cheap salt

imports started flooding the country after 1994, when the Philippines ratified GATT-UR.

Unable to compete, many salt farms started closing one after the other, and salt farmers were forced to sell to land developers.

However, with the ASIN Law requiring all salt manufacturers in the country to iodize salts they produce, manufacture, import, trade, and distribute, dwindling local sources is no longer a great concern where even salt importation in the country is regulated and the product required to be iodized.

Finally, introduction of SIM will be supported by a new DOST-ITDI technology to improve harvests in salt farms in Occidental Mindoro. The new technology utilizes an improved saltern design and layout to enhance salt production.

Cacao *tablea* – chocolate liquor in bar

Ref. No.: TRA-2017CTCLB4

44

TRL 4

Component validated in laboratory environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Description

Maturation Plan

- Scaling up of machines and process for big volume production
- Identification and analysis of physical and chemical properties of product for waste characterization
- Evaluation and management of big volume residual wastes production including expired products
- Revision of financial analysis to include major cost components and cash flow projections

Tablea or chocolate liquor in bar can be a thick disc, flat, or square in form used to make a hot chocolate beverage. It is made from local cacao beans using fermentation and roasting processes that have been improved and standardized to give the best quality chocolate beverage.

DOST-ITDI's product makes use of design and specifications from three cacao processing equipment, namely, grinder, desheller/ winnower, and roaster.

The standardized process and formulation is used in the *tablea,* which will allow cacao processors to produce products of better quality and higher value. It is less grainy (particle size of T255) resulting in drinks with a smooth mouth feel, without the burnt aftertaste, and with better processing consistency.

While the process innovation of the *tablea* is anchored on use of three equipment developed by DOST-ITDI, the institute is still scouting to license fabricators of these machines. Currently available equipment in the market may be used instead but these may require some retrofitting, an activity which is not included in the institute's package of assistance.

Business Environment

The production of cacao as a commercial production activity is among the preferred activities listed in IPP 2014-2016. With the IPP-identified market opportunities in the cacao industry, several support mechanisms have been set-up by the government particularly for the micro, small, and medium enterprises.

The Philippine cacao industry with Mindanao in the lead, particularly Davao Region, is targeting to produce 100,000 MT of cacao beans annually starting 2020.

Cacao Production and Processing. Mindanao's share in the country's cacao production is approximately 90 percent. Of the 4,366.52 MT of cacao beans produced in Mindanao, 88 percent comes from the Davao Region. Northern Mindanao had the second highest production although its volume is only about five percent of Davao's production.

Meanwhile, in the International Cocoa Organization report, the Philippines produced only around 5,000 MT of cocoa out of the global total of over 4 million MT in year 2014. Nevertheless, Euromonitor International forecasted in 2013 that the Philippine chocolate market is set to grow 13 percent or USD306.3 million in the next four years.

Mindanao accounts for the greater bulk of cocoa production. Davao has the widest range of cocoa products and the widest market outreach. The region produces and trades dried fermented beans and all its key by-products. Dominant product currently produced and traded in the domestic region by other regions in Mindanao is the *tablea* or the cocoa liquor in tablet form.

The *tablea* subsector utilizes about 19 percent of the wet cacao beans in Mindanao. While the main product in Mindanao is *tablea* or cocoa liquor, its cocoa processing group is comprised mainly of *tablea* processors from home-based informal enterprises. Most of them have small cacao farms and *tablea* is sold to traders and retailers within the province or region.

Competitors. Established and known chocolate and *tablea* companies in Mindanao are Malagos Farm/Puentespina, Kablon Farms, Maestrado, CSI, and Roteo Farms, among others. These sell to specialty shops and supermarkets within and outside of the region including Cebu and Metro Manila. CSI may be the only company producing cocoa blocks. Prices of *tablea* bars or discs currently ranges from PHP100.00 to PHP600.00.

However, the Top Three largest chocolate producers in the country are Universal Robina Corporation, Commonwealth Foods, Inc., and Delfi Foods, Inc.

Other chocolate manufacturers are Multirich Foods Corp. (Choco Mucho), Columbia International Food Products, Inc. (Klicx Cruncher and Chocquick bars), Monde Nissin (Snitch Choco Bar), Twin Oaks Foods Corp. (Mayfair), Stateline Snack Food Corp. (Stateline Nimble Chocolates), New Unity Sweets Mfg. Corp. (Choc-Nut), Annie Candy Manufacturing (Hany Milk Chocolate), and Gracepoint Enterprises (Lala).

Investment Prospects

Cacao Production. The supply of cocoa has fluctuated in recent years due to climate and economic factors. The El Nino phenomenon that hit the country in 2009 greatly reduced cacao bean production in the following years. The extreme weather conditions added to the impending financial crises to limit both supply and demand for cocoa products. Cocoa supply is still decreasing even if the demand is rising.

Many entrepreneurs and governments have been looking into cacao production recently as demand for chocolate rises. They are looking to compete with the top producer of the plant, which is Africa. They produce more than 70 percent of the global cocoa supply. On the other hand, Netherlands and the USA are the largest consumers of cacao beans; both consuming billions of dollars worth of the product.

According to the United Nations Commodity Trade Statistics Database, the Philippines has shifted from a massive importer of cacao beans into a steady exporter of the bean. Local entrepreneurs are seeing the potential of the cacao bean industry. The increase in demand and the falling supply was obvious, thus providing the impetus to grow the plant in larger areas.

The Philippine government has also been encouraging farmers to grow cacao beans because of the shortage. They are assisting farmers and the industry by supplying land and tested procedures in order to increase Philippine production. The Philippines has the right climate and soil for growing the plant which leaves to government the task of spreading the knowhow on planting and harvesting the crop.

Currently, local farmers are making steady progress in competing with other world cacao producers. In support, government is preparing to overcome the projected cacao shortage in 2020 and targets to increase production to 100,000 MT. Although the country is currently failing to meet annual local demand of 30,000 MT, the strong effort and government support are hoped to change matters in years to come.

Cacao Processing. The country exports and imports cacao beans and cocoa products which includes chocolate confectionery containing cocoa in various forms and sizes, other food preparations containing cocoa in various forms and sizes, other chocolate confectionery containing cocoa in various forms and sizes, and other chocolate confectionery containing cocoa in tablets or pastilles.

Total import of cocoa and cocoa products in 2012 amounted to 3,662 tons, with CIF value of almost USD12 million. On the other hand, total exports in 2012 is 512 tons, with a total FOB value of USD1.8 million.

Currently, around 2,000 tons of cacao beans are processed into *tablea* as estimated by CIDAMI. About 80 percent of households have at least two to three cacao trees in their backyard. *Tablea* makers buy either directly from farmers or from traders and wet markets. In many cases, home-based *tablea* makers also have their own cacao farms

The Northern Mindanao commercial *tablea* makers get their cocoa beans within and outside Davao. The region supplies commercial *tablea* makers in the region (Davao), Northern Mindanao, Cebu, Manila, and SOCCSKSARGEN. The region has one commercial producer, Kablon Farm, which sources beans from its own farm and local farmers. *Tablea* is sold to institutional buyers, specialty stores, supermarkets, and other retail outlets.

The market opportunities for *tablea* and cocoa products is growing, as there is an increasing number of cafes and restaurants offering chocolate drinks. Moreover, the trend towards wellness and a healthy lifestyle is seen as another opportunity for cocoa products, as it is being positioned and marketed as a health food given its natural contents and health benefits. It is projected that by 2020, there is an additional one million tons of cacao beans needed to meet global demand, while an additional 30,000 tons are needed to meet local demand. As such, cacao growers and cocoa manufacturers in the country can translate these market opportunities into a profitable reality.

Vacuum frying technology

Ref. No.: TRA-2017VFT4

44

TRL 4

Component validated in laboratory environment

Investment Cost

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Maturation Plan

- Redesign of processing facilities layout
- Development of waste management plan
- Development of products with flavor
- Modification of packaging material
- Conduct of shelf-life and nutritional value analyses
- Submission of product to HACCP and GMP compliance procedures
- Revision of financial analysis to include major cost components, cash flow projections

Description

Conventional frying requires high temperature (around 190°C) to cook food. This causes excessive darkening or scorching of the food product even at a state of being half-cooked. Moreover, repeated use of cooking oil may result in adverse health effects due to degradation of oil composition.

Vacuum frying, on the other hand, applies lower temperature and pressure (below atmospheric pressure) to improve quality of fried fruits, vegetables, and rootcrops. This results in prolonged shelf-life at much shorter time of processing. It also lowers the final oil content of fried food products and preserves their natural color and nutritional compounds. Furthermore, oil life is also extended because it is subjected to much lower temperature and reduced oxidation compared to conventional method of frying.

The vacuum fryer design of DOST-ITDI is of small capacity and is not suitable for big volume production. This results in higher production costs. Currently, the said lab-scale size fryer is being offered to interested start-up companies with the following toll process rates:

- Use of Facility with License:

  Package 1: (Carrot + Squash + Sweet Potato) - PHP52,100.00/ batch
  Package 2: (Carrot + Banana + Jackfruit) - PHP52,100.00/ batch

- Use of Facility with Training – PHP11,000.00 per product

The vacuum fryer machine is locally designed and fabricated. No importation fees are needed to acquire the equipment. Moreover, compared to other foreign products, development, repair, and after-sales services for the equipment is

locally available. Support services from the agencies of DOST will also be an advantage to those clients that are willing to adopt the technology.

Benefits. The Pontificia Universidad Catolica in Chile conducted a study on the health benefits of vacuum frying and published in the Journal of Food Science.

Findings showed that vacuum-fried potato chips contained 50 percent less oil than regular potato chips as well as retaining 95 percent of their Vitamin C content.

Business Environment

Present day consumer preference for fat-free and low-fat products has been the driving force for the food processing industry to produce low-oil content products while retaining the desirable texture and flavor.

Locally, Filipinos are leaning toward a healthy lifestyle. Healthy benefits of foods and snacks are one of the main concerns of consumers when buying.

In general, women seem to show more interest than men toward healthy food. Women are responsible for the purchase of groceries and they are more aware about the nutritional aspects of food products than men. A study on organic food shows that preference for healthy food and the tendency to spend more for healthy food increases with increase in income level.

The Philippine FDA's Statistical Report of Establishments for 2004 lists a total of 11,601 food-processing establishments nationwide. A single proprietor owns most of the companies. This is common among micro, cottage, and small industries. However, there are still a significant percentage of SME processors, especially in provincial areas.

In the second quarter of 2014, food manufacturing grew by 10.7 percent. It contributed to the growth of the manufacturing industry and led overall economic growth during the 2nd quarter by 7.8 percent.

Availability of Equipment. Only a few local machine shops fabricate vacuum fryers. Available vacuum fryer suppliers that sell their product online are China, India, Spain, and South Korea.

Policies on Processed Food. US-FSMA, signed into law by President Barack Obama in 2011, requires that food facilities renew their registrations with FDA during "the period beginning on October 01 and ending on December 31 of each even-numbered year."

Following this requirement, therefore, renewals should have been done in 2018 within the period October 01 - December 31. Shipments from the Philippines may be refused entry to the United States when the associated food facility registration is not renewed properly. The related USFDA information can be accessed via the link https://www.fda.gov/Food/Guidance Regulation/FoodFacility Registration /ucm324780. htm.

For first time food exporters to the US, the relevant guidance link on food facility registration is https://www.fda.gov/Food/ GuidanceRegulation/FoodFacility Registration/ default.htm.

The USFDA finalized new rules that mandate significant changes to the Nutrition Facts labels for food, beverages and dietary supplements . These will take effect January 01, 2020.

Investment Prospects

The Philippines is the fastest growing fry import market in the world, with demand up 74 percent to 121,652 tonnes in the year ending April 2017. That month, 10,841 tonnes of fries were imported, an increase of 29.7 percent on the April 2016 figure.

The average price of fry imports in April 2017 was PHP41,671/tonne, up 15.3 percent on the same month last year. However, the year ending price when calculated in US dollars in April 2017 was up by only 4.9 percent to USD816/tonne.

All four of the world's main fry exporting nations have benefitted from the increase in demand from the Philippines. USA fry imports rose by 30 percent to 52,344 tonnes in the year ending April 2017 and there was an 11.2 percent increase in April 2016 to 4,225 tonnes. The average price of USA fries has increased by 11.4 percent to PHP42,543/tonne over the year.

USA exporters to the Philippines are being helped by some stability in the value of the Peso against the US dollar. The current rate of USD1 = PHP51.2, which is 10.4 percent stronger than a year ago, is similar to the rate at the beginning of 2017.

Compact wastewater treatment system

Ref. No.: TRA-2017CWTS4

TRL 4

Component validated in laboratory environment

Investment Cost

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Maturation Plan

- Conduct of further research studies to test safety, related hazards of the technology, and effects to humans exposed to micro-organisms from a defective system
- Conduct of system utilization tests in an operational environment
- Identification of the measures for safe operation of the system
- Drafting of operator and end-users' manual on operation and troubleshooting of the system
- Revision of financial analysis to include major cost components,

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cash flow projections, break-even point, and financial risk of adopting the system

Description

The DOST-ITDI compact wastewater treatment system is a low cost, sustainable, and compact treatment system used to treat wastewater coming from stand-alone QSRs. It treats organic wastes such as FOGs generated by QSRs that can result in sewer blockage and flash floods. The system is designed in compliance with the standards and regulatory requirements of the Philippine Clean Water Act of 2004.

Even with enforcement of the Water Act, discharge of domestic, industrial/commercial wastewater, and agricultural runoff continues. These have caused extensive pollution of the country's receiving water-bodies. Discharged effluents are in the form of raw sewage, detergents, fertilizer, heavy metals, chemical products, oils, and even solid waste. Each of these pollutants has a different deadly effect that influences human lives and livelihood and translates into economic costs.

Annual economic losses caused by water pollution are estimated at PHP67 billion and 55 deaths per day. These include PHP3 billion for losses in lives and health costs, PHP17 billion for fisheries production, and PHP47 for tourism. The Philippines has many water-related laws, but their enforcement is weak and beset with problems that include inadequate resources, poor database system,

and weak cooperation among different agencies and units. Actions may be required from the sectors that contribute to the pollution.

Business Environment

During the year 2010, a total number of 675 establishments are engaged in water collection treatment and supply. An estimated of 25,823 workers are employed in such enterprises with an average annual wage of PHP283,132.

Nearly 2.2 million MT of organic pollution are produced annually by domestic (48%), agricultural (37%), and industrial (15%) sectors.

In the four water-critical regions, water pollution is dominated by domestic and industrial sources. Untreated wastewater affects health by spreading disease-causing bacteria and viruses, makes water unfit for drinking and recreational use, threatens biodiversity, and deteriorates overall quality of life.

Known diseases caused by poor-quality water include gastro-enteritis, diarrhea, typhoid, cholera, dysentery, hepatitis, and more recently, SARS. The number of water-related health outbreaks including deaths reported in newspapers is going up.

However, awareness regarding the need for improved sanitation and water pollution control, reflected by the willingness-to-pay and connection to a sewerage system where they are easily available, is very low.

A recent World Bank report pointed out that Metro Manila was second to the lowest in sewer connections among major cities in Asia and links less than 7% compared to 20% for Katmandu, Nepal and 30% for Dhaka, Bangladesh.

Policies. Under the Philippine Clean Water Act of 2004, start ups will be required to follow the regulations set to protect the country's water bodies

from pollution from their establishment's activities. Commercial food establishments are required to treat wastewater through the installation of a wastewater treatment facility.

Competing Technologies. Four treatment systems are available in the market. These include physico-chemical treatment, anaerobic treatment, aerobic treatment, and waste coolant recovery and reuse system as follows:

1. Physico-chemical treatment is applied for removal of heavy metals, oils and greases, suspended matter and emulgating organic substances, organic and inorganic components, difficult to decompose nonpolar organic substances, toxic pollutants or high salt concentrations, and phosphorus. The physico-chemical wastewater treatment techniques are used as pre-treatment, final treatment, as well as, specific treatment for wastewater reuse as process water;
2. Anaerobic treatment employs bacteria in the digestion of organic matter and bio-solids in the absence of oxygen. One major feature of anaerobic digestion is the production of biogas, which can be used in generators for electricity production or in boilers for heating purposes;
3. Aerobic treatment refers to removal of organic pollutants in wastewater by bacteria that require oxygen to work. Water and carbon dioxide are the end products of the aerobic wastewater treatment process; and
4. Waste coolant recovery and reuse system, which treats the waste coolant and recovers it to the extent where it can be reused again as a fresh coolant for machines thus achieving a step towards zero discharge and saving of valuable cutting oil.

Investment Prospects

A 2015 report of the DENR-EMB listed 126,108 registered accommodation and food services in the Philippines, which includes QSRs, hotels, resorts, and other types of accommodation services.
It cited a UNIDO study, which approximates that Metro Manila residents improperly dispose of some 2,000 cubic meters of solvent wastes, 22,000 tons of heavy metals, infectious wastes, biological sludge, lubricants, and intractable wastes, as well as, 25 million cubic meters of acid/ alkaline liquid wastes.

Furthermore, only 10 percent of wastewater in the country is treated while 58 percent of groundwater is contaminated.

Nano precipitated calcium carbonate

Ref. No.: TRA-2017NPCC5

TRL 5

Component validated in relevant environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Completion of CTEs marked with "N"
- Conduct of final tests with collaborator
- Submission of project to SETUP for funding
- Establishment of partnership with BOI to promote project to inventors
- Revision of financial analysis to include major cost components, cash flow projections, break-even point, and financial risk of adopting the system

Description

DOST-ITDI developed an innovative process to produce NPCC from local limestone minerals sourced in Negros Oriental.

NPCC is a nanomaterial that has wide range of industrial applications in areas of papermaking, rubber, plastics, pharmaceuticals, agriculture, and food, among others. It is used commonly as filler or additive to improve processing and enhance its properties.

During NPCC production, limestone is processed into food grade nano precipitated calcium carbonate through carbonation. DOST-ITDI developed the technology to make use of the country's 29 billion tons of non-metallic minerals and limestone deposits. The Philippines is an importer of limestone despite its huge deposits of calcium carbonate.

NPCC can help local processors of calcium carbonate to meet the quality of product requirements of the paper and plastic industries. Conventional processing usually produces calcium carbonate laden with impurities like calcite. Because local processing is confined to calcining and simple grinding, processors cannot produce calcium carbonate in its original state of purity.

Investment Prospects

Global Market and Demand for NPCC. The global ground and precipitated calcium carbonate market is expected to reach an estimated USD23.5 billion by 2022 with a CAGR of 4.6 percent from 2017 to 2022. The major growth drivers for this market are increasing per capita paper consumption and growth in plastic demand in the building and construction industries.

Emerging trends, which have a direct impact on the dynamics of the ground and precipitated calcium carbonate industry, include growing consumption of nano-

precipitated calcium carbonate and the emergence of green product for low carbon footprint.

The global nano calcium carbonate market size was USD4,320.8 million in 2015 and is expected to witness growth owing to rising demand from end-use industries including rubber, plastic, and paper. Growing product use in sealant industry as rheological material (its thixotropic structure helps achieve desired slump and viscosity control) is expected to drive market growth over the next eight years.

Further, growing use of nano calcium carbonate as reinforcing fillers in automotive and construction sealants is expected to drive the demand over the forecast period. Furthermore, rising emphasis by the regional governments in the matured economies such as USA and Europe to reduce the carbon footprint by reducing energy consumption in the production process is likely to fuel the industry growth over next eight years.

The global nano calcium carbonate market is expected to reach USD9.65 billion by 2024, according to a new report by Grand View Research, Inc. Rising demand for nano calcium carbonate owing to increasing product usage in the end use industries including inks and pharmaceuticals on account of its superior dispersion properties is expected to drive the demand over the forecast period. Rising trend of people moving to urban centers in emerging regions including Asia Pacific and the Middle East is expected to drive the market over the next eight years.

Surging application scope in the paper industry pertaining to increasing usage of the product in paper processing is expected to drive the demand over the next eight years.
Building and construction accounted for over 25 percent of the market in terms of revenue in 2015. The growth is accounted by increasing use of the product in building materials such as sealants and adhesives to improve the thermal

expansion and resistance and improved workability. This, in turn, is likely to drive the market demand over the next eight years.

The global nano calcium carbonate market demand in terms of volume was around 19 million tons in 2015 and is expected to cross 40 million tons by 2024, recording a CAGR of 8.7 percent from 2016 to 2024.

Plastics is expected to be the fastest growing application segment registering a CAGR of around 9 percent from 2016 to 2024 accounting for over 20 percent of total market volume in 2015. Growing product demand in the plastics industry on account of its improved stability, easy processing, wear resistance and low-cost availability is likely to fuel the demand over the next eight years.

Rubber industry is expected to register a CAGR of over 8.3 percent from 2016 to 2024. Growing application scope of nano calcium carbonate in rubber processing industry on account of its ability to improve the toughness, hardness, and wear resistance of ABS rubber is likely to fuel the growth over the forecast period.

Other segments include applications in automotive, inks, and pharmaceuticals. This segment is expected to grow at a CAGR of 8.9 percent from 2016 to 2024. Growing use of adhesives and sealants in the automotive industry to join various metal and material substrates in the vehicle body fabrication coupled with rising R&D activities to improve the overall vehicle performance is likely to drive the demand for nano calcium carbonate in the automotive industry over the forecast period.

In the USA, a steady increase in demand in all four applications is seen from 2013 to 2024.

Competitors. The industry is moderately fragmented with the presence of a large number of prominent market participants across the globe. Some leading companies operating in the global market include Specialty Minerals Inc.,

Imerys Performance Minerals, Omya, Enping Yueyi Chemistry Industry Co.,Ltd, Fujian Sanmu Nano Calcium Carbonate Co.,Ltd, and Mittal Enterprises (ShengdaTech, Inc.). Yuncheng Chemical Industrial Co., Ltd. has been specializing in manufacturing nanometer colloidal calcium carbonate, precipitated calcium carbonate as well as basic magnesium carbonate and gymnastic chalk and powder.

Drum-dried mango flakes

Ref. No.: TRA-2017DMF5

TRL 5

Component validated in relevant environment

Investment Cost

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Maturation Plan

- Development of other products
- Submission of product to GMP and HACCP certification
- Conduct of market research; determination of target market, and direct and indirect competitors
- Replacement of machine with new and cheaper unit
- Conduct of in-plant tests
- Revision of financial analysis to include major cost components, cash flow projections, break-even point, and financial risk of adopting the system

Description

Drum drying is the process of producing fruit flakes, using fresh mango, banana, or makapuno. The process removes moisture from pastes, purees, and liquids using a dryer with a rotating heated drum. During processing, the equipment is set at low temperature to retain the raw material's organoleptic properties, such as, color, aroma, and taste.

Resulting product is crunchy, crisp, shelf-stable, and possesses characteristic color, aroma, and flavor of the fruit.

Drum-drying technology preserves the natural state of the product's raw ingredients; it also prolongs its usefulness or shelf life. In addition, it eases and speeds up preparation of food, a convenience feature favored by most consumers.

Benefits/ Uses. Consumers are becoming more health conscious such that more and more companies are developing/innovating on products suited for different lifestyle needs. Drum drying of mango, banana, or *makapuno* allows local food processors to expand product offerings and tap the health and wellness market.

To date, there is no known locally fabricated drum drying equipment available in the Philippines. Technology adopters will have to purchase/import foreign-made drum dryers for their commercial-scale production.

Resulting products of drum drying technology may be marketed as healthy snack food alternatives for all ages or as an intermediate material or ingredient into several consumer products, such as ice creams, juices, and confectionaries. The growing demand for food products with longer shelf life and seasonal products across the year is driving the growth of the dehydrated food market.

Business Environment

The Philippines has been an important player of the fresh and dried fruits global market since the 1980s. Exports took off in the 1990s, accounting for an average of 10 percent of world fresh and dried mango trade. Leading processors, which are locally owned firms, started their businesses in the mid-1970s and, with the exception of the past years given low yields, have been steadily gaining access to regional and global markets. The Philippines is the seventh largest exporter of mango worldwide. With USD91 million in total mango exports in 2015, the country contributed 4 percent to globally traded supply, including fresh and dried mango. The country's competitiveness in the world market is most influenced by its export variety quality; the native *Carabao* variety is considered one of the finest and sweetest mangoes in the world.

During the period January to March 2018, production of mango dropped by 9.4 percent, from 107.83 thousand MT in 2017 to 97.70 thousand MT this year. The decrease could be attributed to the incidence of cecid fly, capsid bug, and other fruit flies, and late flowering of trees in the provinces of Pangasinan, Nueva Ecija, and Zambales.

Ilocos Region topped the mango producing regions, contributing 55.6 percent to the national total production. Central Luzon ranked second with 18.2 percent share and Western Visayas, 6.2 percent. *Carabao* mango comprised 81.8 percent of total mango output this quarter.

For the period January to March 2018, production of banana went up by 2.1 percent from 2.10 million MT in 2017 to 2.14 million MT this year. This was brought about by the following:

- Increased area planted to banana, increased number of bearing hills, and bigger bunches harvested in Davao del Norte and Davao del Sur Provinces due to sufficient rainfall and increased fertilizer use;

- Initial harvesting from additional bearing hills and expanded area of production by Del Monte Banana Plantation and other corporate farms in Sultan Kudarat and Bukidnon Provinces, respectively; and
- Increase in bearing hills particularly of the *saba* variety attributed to recovery from Typhoon Karen during the 4th quarter of 2016 in Quirino Province.

More than one third or 36.7% of total banana production was from Davao Region. Northern Mindanao followed with 24.4%, and SOCSKSARGEN with 13.0%.

Cavendish variety recorded the highest level at 1.19 million MT representing 55.7 percent of the total banana production this quarter. *Saba* ranked second with 25.6 percent share and *Lakatan* with 9.0 percent.

Policies on Processed Fruits. The manufacture of dried mangoes as a commercial processing activity can be considered among the preferred activities listed in the country's IPP for 2014-2016. It qualifies, however, that commercial processing of agricultural products should involve the use of domestically-produced raw or semi-processed agricultural products, unless these inputs are NLP or are NISQ. If a business is, using imported raw or semi-processed agricultural products that are LP or ISQ, the project may qualify for registration, provided that the finished/final product is for export, or the project qualifies for pioneer status.

FSMA, signed into law by President Barack Obama in 2011, requires that food facilities renew their registrations with FDA during "the period beginning on October 01 and ending on December 31 of each even-numbered year." Following this requirement, therefore, renewals should be done this year within the period October 01 - December 31, 2018. Shipments from the Philippines may be refused entry to the United States when the associated food facility

registration is not renewed properly. The related USFDA information can be accessed via the link https://www.fda.gov/Food/GuidanceRegulation/ FoodFacility Registration /ucm324780.htm. For first time food exporters to the USA, the relevant guidance link on food facility registration is https://www.fda.gov/ Food/Guidance Regulation/FoodFacilityRegistration/ default.htm.

The USFDA finalized new rules that mandate significant changes to the Nutrition Facts labels for food, beverages and dietary supplements will take effect January 01, 2020.

Investment Prospects

Dried mangoes are among the more competitive food manufactured products in the Philippines. The country's brand of dried mangoes is well recognized around the world, with 85 percent of total dried mango local production exported to key markets, such as USA, China, Japan, South Korea, and other Asia Pacific countries. Because of the wide acceptability of dried mangoes worldwide, the Philippines can reap greater benefits by expanding its market coverage and deepening the value of dried mango production in the country.

Compared to its competitors, Philippine dried mangoes are known for its premium cuts of *carabao* mango, a variety that is abundant in the Philippines and is more efficient to use because of its thick flesh ("cheek"). Because of the high quality of this raw material, Philippine dried mangoes are also distinguished from its competitors for its naturally sweet, juicy, and fresh taste. Through the available technology used by local processors, the potential for growth in dried mango production lies in increasing the raw material base – that is, by establishing more efficient mango tree plantations – and improving the firms' marketing and supply chain operations.

Several demand factors show the huge potential for export sales in dried mangoes. Looking into its key markets, consumers in developed countries have increasingly turned to natural and organic products for their nutritional needs. Dried mangoes are seen as a healthier and more natural snack option compared to the regular potato chips or artificial sweets and candies.

Further, dried mangoes have been used increasingly in confectionery and bakery products. Spurred by consumption of overseas Filipino workers, increased tourist presence in the Philippines, and high population with disposable income, there is huge export potential and local demand for Philippine dried mangoes. Finally, due to the recent inclusion of the Philippines in the EU GSP+, there is an untapped market potential for European consumers of natural food products particularly dried mangoes.

Citing the above, this is where resulting products of drum drying technology may be marketed as a completely new healthy snack food alternative for all ages or as an intermediate material or ingredient into several consumer products, such as ice creams, juices, and confectionaries. The growing demand for food products with longer shelf life and seasonal products across the year is driving the growth of the dehydrated food market.

Competitors. The Top 3 mango processors in the country are Profood International Corporation, FPD Food International Inc. (7D Brand), and M'Lhuillier Food Products, Inc.

Freeze drying technology

Ref. No.: TRA-2017NLBO5

TRL 5

Component validated in relevant environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Re-design of system for scaling up
- Conduct of product suitability tests to determine other fruits that may be freeze-dried
- Conduct of tests to determine oxypilin levels in avocado; development of ways to reduce oxypilin levels to reduce bitter aftertaste
- Conduct of shelf-life and nutritional analyses
- Utilization of spices and sugar coating to improve flavor

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- Conduct of market research; determination of target market, and direct and indirect competitors
- Development of waste utilization/ management plan
- Re-design of packaging system; replacement of material that allows for longer shelf-life, retention of physical properties of product particularly color
- Submission of product to labeling compliance procedures
- Revision of financial analysis to include major cost components, cash flow projections, break-even point, and financial

Description

Freeze-drying is an alternative method to preserve certain seasonal fruits and vegetables, and make them available all year around. Freeze-drying is one effective method to extend shelf life or make the material more convenient for transport while preserving their nutrients and value prior to consumption. Using this technology will enable locally processed products to enter the export market.

However, the machine being used is a prototype and is suited only for small batch production. In addition, it is limited by high-energy requirement resulting in high production cost. The availability of other drying techniques, such as spray drying, are impacting the market since they are relatively lower in costs as compared to freeze-drying.

Benefits/ Uses. Freeze-drying is the most effective method in preserving nutritional content of fruits, vegetables, and other food without use of excessive heat thus maintaining their nutritional value naturally. Further, it helps to preserve most of the initial raw material's properties such as appearance, color, flavor, aroma, shape, and size.

They do not require refrigeration, and can last for months or years. Freeze-dried foods can also be rehydrated very quickly, unlike dehydrated foods. It can be rehydrated using either cold or hot water, so these can be carried without worry. Once the water is removed from foods, they become very light. This makes for easier portability of large amounts of food and cheaper transportation costs.

Freeze-dried foods are used by astronauts, campers, backpackers, food manufacturers and the military. One can also purchase freeze-dried foods for home use or use entire meals in freeze-dried form, as almost all foods can be freeze-dried. With this technology, shelf life can be extended from 2 to 5 years for freeze-dried foods packed in resilient packaging.

The main disadvantage of freeze-dried foods is that they are quite expensive due to the specialized equipment needed for the process. Freeze-dried foods also take up almost as much space as fresh foods, while dehydrated foods take up less space.

Business Environment

Policies on Processed Fruits. FSMA, signed into law by President Barack Obama in 2011, requires that food facilities renew their registrations with FDA during "the period beginning on October 01 and ending on December 31 of each even-numbered year. Following this requirement, therefore, renewals should be done this year within the period October 01 - December 31, 2018. Shipments from the Philippines may be refused entry to the USA when the associated food facility registration is not renewed properly. The related USFDA information can be accessed via the link https://www.fda.gov/Food/Guidance Regulation/FoodFacility Registration /ucm 324780.htm. For first time food exporters to the USA, the relevant guidance link on food facility registration is https://www.fda.gov/Food/Guidance Regulation/ oodFacilityRegistration/ default.htm.

The USFDA finalized new rules that mandate significant changes to the Nutrition Facts labels for food, beverages and dietary supplements will take effect January 01, 2020.

Market. There has been a surge in the market for all forms of preserved food, owing to the trend of increasingly busy lifestyles. This, in turn, has resulted in increased demand for quick meal solutions and convenience food. Since preserved food products are easy and fast to prepare, they offer a perfect solution to this problem.

Further, with growing urbanization and increasing population of working women, the demand for processed foods in the market has seen a remarkable boost. The expanding food processing sector and the huge demand for RTE food products among consumers have considerably increased the demand for freeze-dried products.

Meanwhile, Volume Global Freeze Drying Market is triggered by huge demand of freeze drying products and services, not only in food, but in pharmaceutical and biotechnology markets as well. Global Freeze Drying Market is expected to grow at a CAGR of around 7 percent during 2016-2021 due to significant adoption of freeze drying products in varied domains including pharmaceuticals, dairy plants, fruits storage and other cold storages across the globe.

In the food sector, freeze-dried fruit is the largest segment, by type, accounting for almost 53 percent share of the overall freeze-dried foods market. Most of the freeze-dried food processing is concentrated with the freeze-dried fruit segment, because of the ability of these fruits to retain most of the original taste. The texture of freeze-dried fruits is also crispy and their chips-like form appeals to many consumers.

Current major players in the global market are Chaucer Freeze Dried, OFD Foods Inc., Dohler, Nestle, and Unilever, among others. These players occupy a total market share of 59 percent of the global freeze-dried food market.

The rest of the market is occupied by smaller players, who also has a good presence. Majority of the manufacturers focus on freeze-dried fruits, dairy, dairy culture, meat/seafood, and coffee products.

Asia-Pacific is the fastest-growing market for freeze-dried foods, among other developing regions, globally. It accounted for 21.81 percent of the total market share in 2016. The market for freeze-dried foods in Asia-Pacific (China, India, Japan, and Australia) is growing, owing to the rising economy and changing lifestyles. The increasing workload of consumers and rising number of working women are contributing to the growth of the market.

In the Philippines, JustFruit Inc. is the first freeze dried fruit manufacturer in the country and has a newly operated facility in the south of the Metro. The company was established to provide Filipinos with a healthy fruit snack that has nothing

but “just fruit.” This is to cater to the growing demand for natural and healthy food products. While keeping people healthy, the company also keeps the economy healthy by supporting and sourcing from local farmers. RXGenerics Pharma Inc. distributes vacuum freeze dryers made in China.

Multi-layer, high-barrier packaging technology for frozen durian

Ref. No.: TRA-2017MHPTFD5

TRL 5

Component validated in relevant environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Development of a packaging system that will extend shelf-life to more than a year
- Development of a sustainability plan that will consider replacement or reduction in use of polymer as packaging material
- Submission of product to market tests to determine acceptable SRP
- Re-design of system facility to accommodate huge volume of waste; development of new product utilizing waste material

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- Revision of financial analysis to include major cost components, cash flow projections, and break-even point

Description

The packaging technology uses a double wrapping technique, which consists of:

1. Wrapping the pre-cooled durian flesh using high barrier film against flavor and aroma, and
2. Vacuum packaging the product using a laminated pouch, which serves as barrier against flavor and aroma. Of adequate strength, it can protect contents from external forces.

The objective of this technology is to address the migration of aroma and flavor. The result is odor-free, frozen durian, which can last for one year at -18^{o}C.

The flavor and aroma-barrier packaging system allows frozen durian products to be kept in the freezer for storage without concern about migration of durian flavor and aroma to other foods either in the freezer or cold storage warehouse. This provides increased ease and convenience in handling and consumption of frozen durian products.

A carry box made of either expanded PS or coated corrugated board plus the use of cooling agents can keep products frozen up to 24 hours. This allows tourists to transport and bring home frozen durian.

Business Environment

While the market and demand for multiple**,** high-barrier packaging materials are yet to be created, other uses for these may be explored. As such, a global view on their demand and other applications can provide insight on its business environment.

According to Smithers Pira, the worldwide authority on Packaging, Print, and Paper supply chains, the total market for consumer and industrial flexible packaging, such as those being used in DOST-ITDI's packaging technology, was almost USD230 billion in 2017. It showed that global demand for plastic packaging was valued at USD270 billion in 2014 but is expected to reach USD375 billion in 2020, growing at a CAGR of 4.8 percent between 2015 and 2020. In terms of volume, the global plastics packaging market stood at 81,750 kilo tons in 2014.

Sales of packaging are concentrated in Asia, which accounted for 36 percent of the total in value terms in 2012. North America and Western Europe totaled shares of 23 percent and 22 percent respectively. In 2012, Eastern Europe was the fourth largest consumer of packaging with a global share of 6 percent, closely followed by South and Central America with 5 percent. The Middle East represents 3 percent of the global demand for packaging, while Africa and Australasia each have a 2 percent share.

The report explores numerous reasons for this expected growth in the world packaging market, including technical developments, cost per package, sustainability initiatives and, perhaps most importantly, the growth of the consumer class in the Asia-Pacific, South and Central America, and Eastern Europe.

The world consumer flexible packaging market has picked up significantly since the global economic downturn of 2008-2009. The market tonnage in this

segment was at 24.3 million tons in 2013 and grew at a CAGR of 4.1 percent during the period 2013-2018 or a total of 29.8 million tons.

The Asia-Pacific region in particular has registered both volume and value growth for flexible packaging during the 2012-2013 period. Asia-Pacific has the largest regional flexible packaging market size with 38 percent of global market volume, and is also predicted to be the fastest growing market for consumer flexible packaging over the forecast period. Meanwhile, the US is the largest national market for this type of packaging, with a volume share of nearly 14 percent in 2013.

Policies. The ASEAN Standards for Durian dictates use of packaging in such a way as to keep the produce properly. It states that material used inside the packages must be clean, and of a quality such as to avoid causing any damage to produce. The use of materials, particularly of paper or stamps bearing trade specification, is allowed provided the printing or labelling has been done with a non-toxic ink or glue. It adds further that durian should be packed in each container in compliance with the Recommended International Code of Practice for Packaging and Transport of Fresh Fruit and Vegetables (CAC/RCP 44-1995).

Competitors. Neighboring countries like Thailand, Indonesia, Malaysia, and other Southeast Asian countries are the competition in producing and exporting durian. Prevailing export rate of frozen durian ranges from USD5-8/kg or PHP 270-432/kg.

In terms of technology, MAP and edible coating are some of the methods being used for fresh cut fruit packaging. However, in the Philippines, there is no established report yet that such are being used in fresh cut durian. Key packaging material competitors include styrofoam packaging and microwavable plastic containers.

Investment Prospects

Davao Region as top producer of durian produces 80 percent of the country's total production, 70,063 MT in 2013. There is an estimate of 40 or more durian producers in Davao according to DA RFU XI-AMAD records. The Durian Industry Council said that currently they are exporting 30 MT to Singapore since 2013 and 18 MT to HK since 2014, and the next potential market will be Japan. There is an increasing demand for fresh compared to processed fruits not only domestically but abroad. Main producers of durian like Malaysia, Indonesia, and Thailand exported relatively small percentage since production is insufficient to meet domestic demand; the global market has yet to be satisfied.

Market Trends. Between 2003 and 2013, consumption of fresh foods has gone up by 20 percent to over 100 billion servings worldwide and continues to increase with each passing year. As consumers express their desire for more wholesome, natural foods, they are beginning to pull away from sugar and artificial ingredients.

This trend has contributed to falling sales in once popular foods and beverages. One of the most striking indicator of the shifting tastes is the 25 percent decline in soda sales over the past two decades.

The growing middle class in developing countries, changing birthrates and life expectancies, shifting cultural norms and values all change global consumption patterns that affect industry, including the plastics packaging industry.

For example, the middle class women who are working preferred convenience; thus packaging designs now consider easy to use packaging.

Despite widespread interest in food, consumers generally do not want to spend time preparing meals from scratch, instead opting for foods that offer convenience and quick preparation. At the same time, there is a move toward

fresh and minimally processed foods rather than traditional store-packed food products. This latter factor will restrain growth for converted flexible packaging in some markets, as will competition from rigid, single-serve formats such as cups and small trays.

Spray drying
technology for food application

Ref. No.: TRA-2017SDTFA5

TRL 5

Component validated in relevant environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Development of more products to create bigger target market
- Submission of product to market tests to determine acceptable SRP
- Development of risk management plan
- Development of appropriate packaging material
- Submission of product to shelf-life and nutritional analyses
- Re-design of machine for production scale up
- Revision of financial analysis to include major cost components, cash flow projections, and break-even point

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Description

Spray drying is the process of producing powdered egg white and other foods like *bagoong balayan*, bile from ruminant livestock, calamansi juice concentrate, cucumber, pork blood, and *sukang pinakurat* (spiced coconut vinegar) into powder form. It can provide food processors with an alternative method in processing these raw materials into easy store, easy transport, high-value commodities with long shelf-life.

The technology involves a rapid and continuous process of milling a variety of raw materials except those that are sugary, fatty, and pulpy. It is cost-effective, reproducible, and scalable.

Because the machine being used is a prototype, it is suited only for small-scale production conversely the process is not optimized in large-scale production. Nutritional evaluation results of the product are still unavailable while study on sensory evaluation is yet to be conducted.

In the Philippines, many companies use spray-drying technology. McCormick Philippines Inc., Nestle Philippines Inc., Magnolia Inc., and Unilever Philippines for the Knorr products are some of the large-scale manufacturing companies that conduct their own research studies on spray dying technology.

Egg whites are used significantly in the baking industry. Powdered egg whites are useful as it has longer shelf life than raw eggs; recipes that do not include egg yolk pose no problem. In addition, the possibility of salmonella

contamination is ruled out due to employment of heat treatment or pasteurization during the spray drying process.

Business Environment

Policies on Processed Food. FSMA, signed into law by President Barack Obama in 2011, requires that food facilities renew their registrations with FDA during "the period beginning on October 01 and ending on December 31 of each even-numbered year." Following this requirement, therefore, renewals should be done this year within the period October 01 - December 31, 2018. Shipments from the Philippines may be refused entry to the USA when the associated food facility registration is not renewed properly. The related USFDA information can be accessed via the link https://www.fda.gov/Food/GuidanceRegulation/FoodFacilityRegistration/ucm 24780.htm. For first time food exporters to the USA, the relevant guidance link on food facility registration is https://www.fda.gov/Food/ GuidanceRegulation/ FoodFacility Registration/ default.htm.

USFDA finalized new rules that mandate significant changes to the Nutrition Facts labels for food, beverages, and dietary supplements will take effect January 01, 2020.

Volume of Production. In the poultry subsector, the gross value of production which amounted to PHP52.9 billion at current prices was higher by 2.18 percent from last year's record. Higher prices and improved production triggered the increases in gross output values of chicken eggs by 11.02%, duck by 8.41%, and duck eggs by 6.34%. Because of price cut, gross receipts from chicken contracted by 0.71 percent.

The subsector, which contributed 15.35 percent to total agricultural production, inched up by 1.88 percent in the first quarter of 2017. Production of chicken

eggs went up by 3.13 percent as a result, of the expansion in commercial layer farms in Central Visayas, Eastern Visayas, and SOCSKSARGEN.

Prices inched up by an average of 0.29 percent. Sustained demand from processors and consumers pushed up the price of chicken eggs by 7.65 percent and that of duck eggs by 4.42 percent.

While supply and demand for chicken/duck eggs are feasible, adoption of the spray drying technology is supported by the presence of a country distributor of spray drying equipment for dairy products and a toll processor/ spray drying service provider for any kind of liquid as follows:

- Tetra Pak Philippines, Inc.
  7/F Net One Ctr., 26th St. cor. 3rd Ave.
  Crescent Park, West District, Bonifacio Global City
  Taguig City, Metro Manila
  Landline: (02) 818-1306
- Forturo Foods Manufacturing
  Bay 5, 2nd Street Cervantes Compound
  Km 17 South Super Hi-Way, Paranaque City 1700
  Landline: (02)810-5895 or (02)796-0938
  Mobile: 0917-590-1078
  Email: forturo.foods@gmail.com

Investment Prospects

The food industry accounts for the largest market share of spray-drying equipment. According to Technavio, the food spray-drying equipment market was valued at USD1.2 billion in 2016 and is projected to increase to USD1.5 billion by 2021. The largest market for spray-drying equipment is for milk products and was valued at USD420 million in 2016.

Single-fluid nozzle atomizers account for the largest market share, amounting to 45 percent. Two-stage spray-dryers are the fastest growing and have the largest market share at 40 percent. Co-current flow spray-dryers also dominate the food market.

North America dominates the global spray-drying equipment market and Asia-Pacific is the fastest-growing market. The global spray-dried food market is predicted to grow at 4.2 percent a year during the next five years.

The primary factor driving this market is its versatility and speed. This technique's one-step ability to complete the drying process, within seconds, gives it an edge over other available industrial drying techniques, like the fluidized bed drying technique. It is a versatile process and adaptable to a wide-range of industries and their feedstock and product specifications. Spray drying produces dried food of controllable particle size and good quality and can also manipulate characteristics of food particles like bulk density, the degree of crystallinity, and moisture content levels. These controlling parameters make spray dried food process desirable for the food industry.

High demand from the dairy industry is a major driving factor for the spray drying market, as it is more suitable for milk and milk products. Moreover, spray drying is useful for obtaining products in powdered form, as they do not agglomerate or clump together. Other dried powder techniques (such as drum drying) require milling before packaging while spray dried powders do not require any further milling before packaging.

Even though it is more economical than freeze-dried technique, the equipment and continuous operation of spray drying leads to enormous costs. Main and auxiliary equipment are equally expensive, regardless of atomizer type and dryer capacity.

Additionally, spray dryers that utilize two-fluid nozzles require compressed gas for atomizing, which results in higher prices. Other restraints hindering this market are maintenance issues of the machinery - like the nozzle used, cleaning costs, and competition from other types of techniques.

Alternative sugar from nipa sap

Ref. No.: TRA-2017ASNP5

TRL 5

Component validated in relevant environment

Investment Cost

Consult with Technology Transfer Officer for investment cost

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Maturation Plan

- Re-design of equipment and integration of technology
- Submission of product to shelf-life and nutritional analyses, and toxicology tests
- Maintenance of current nipa palm estates and establishment of new holdings to ensure continual supply of nipa sap
- Revision of financial analysis to include major cost components, cash flow projections, and break-even point

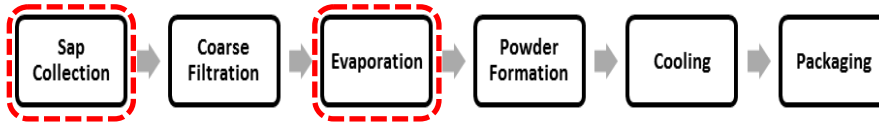
Description

Production of alternative sugar from nipa sap (*Nypa fruticans*), commonly known as the nipa palm, follows the basic five-step process of:

1. Collection;
2. Filtration;
3. Cooking;
4. Cooling; and
5. Packaging.

Two new innovations were incorporated in the first and third steps to produce nipa sugar of better quality.

Production Process Flow of Alternative Sugar from Nipa Sap. DOST-ITDI 2017.



While the first step in the process of sugar production from nipa sap has been traditional, nipa sap collection does not commonly observe hygienic methods.

To improve on the first step, DOST-ITDI used flexible, disposable pouches or sterile plastic bags tied securely around the stalk for a more hygienic collection of sap. The use of disposable (one-time use) pouches minimizes inversion and fermentation of sap.

In the third step, the innovation entails use of a modified, stainless steel, fine tube, steam-jacketed kettle. The kettle reduces contact with direct heat, such as in open pans traditionally used by processors, to prevent scorching of the product.

Benefits/ Uses. Alternative sugar from nipa sap is a healthy organic substitute for common sugar and synthetic sweeteners. Among these benefits are as follows:

- Medium GI -- Studies have shown that alternative sugar made from nipa sap has a lower GI when compared to normal sugars (30–35 compared to 60) hence it does not cause sudden sugar spikes in the bloodstream when consumed;
- Natural -- Compared to artificial sweeteners, nipa sap sugar is all-natural, better for health, and safer. In addition, synthetic sweeteners are now slowly losing momentum as research studies confirm that they are bad for health;
- Simple, easy to adapt processing technique -- Following the two simple process innovations, local processors will be able to produce nipa sap sugar of consistent quality that follows market standards; and
- Nutritional value -- While refined sugar is processed to the point where many of its natural nutrients are lost, palm sugar continues to retain its original nutrient contents such as potassium, iron, zinc, and Vitamins B_1, B_2, B_3, and B_6.

Business Environment

The development of this technology provides farmers engaged in nipa farming in Northern Luzon option to utilize the sap in sugar production hence providing opportunity for additional livelihood with an assured market bigger than *tuba, lambanog* or vinegar production.

In 2012, DA partnered with the private sector to draft a master plan to promote local coconut sap sugar overseas and get a share of the USD1.1 billion global alternative sweetener market. Nipa sugar may be able to tap the same market.

In regions where nipa palm is abundant, nipa sap is usually made into wine or vinegar such as *sukang paombong* that have been patronized by locals for generations. Some adoption resistance among local nipa farmers have been observed because nipa sap sugar is a competing product for the same raw material.

However, as production of palm sugar requires limited knowhow, technological barriers to enter the market are relatively low.

Competitors. The primary competition for palm sugar are other similar products most notably raw cane sugar and coconut sugar. Of these, the first is priced much lower than coconut and palm sugar, but also has fewer health benefits.

Well-known among these other alternatives are Marisco Coconut Sugar, Cocowonder Coco Sugar, Suchero (organic coconut sap sugar), and Wholesome Sweetener Raw Cane Sugar. Prices range from PHP30.00 per 100 g to PHP51.75 per 100 g.

Aside from competition from other sugars, palm sugar competes with natural sweeteners like corn and agave syrup and apple concentrate. These sweeteners are increasingly used to replace sugar, especially as food ingredients. Compared to these products, palm sugars are expensive and more difficult to process, even though they are healthier.

Moreover, palm sugar competes with stevia as well, a healthy natural sweetener. Stevia, however, is associated with slightly bitter aftertaste.

Policies. DENR AO No. 15 governs utilization, development, and management of mangrove resources. Recognizing the multiple uses of mangroves, the DENR issued AO No. 15 in 1990 to conserve, protect, rehabilitate and develop the country's remaining mangrove resources, among which is the nipa palm, to sustain optimum productivity.

Currently, there is no law or regulation that directly relates to nipa sugar both in the local and global scene. Applicable laws and regulations are those relating to foods and food ingredients including RA 3720 or the Food, Drug, and Cosmetics Act, which was enacted to ensure the safety and purity of foods, drugs, and cosmetics made available to the public.

Startup firms are further informed that the label of food marketed for special dietary uses, e.g., diabetic foods, must include information concerning its vitamin, mineral, and other dietary properties as required by FDA, and in a manner that fully informs purchasers of the product's intrinsic value in terms of its special use.

Investment Prospects

Adopter and Customer Chain. Nipa farmers in Northern Luzon are targeted as adopters of this technology. The simple innovation will help them standardize their process and be able to produce sugar of consistently better quality. The biggest potential primary market for nipa sugar are diabetics, overweight, and health-conscious individuals in the local and global markets. With the number of overweight and diabetic people steadily increasing, demand for organic and healthy food have shown an upward trend as consumers are increasingly looking for "healthier" product alternatives.

As of 2011, there are 366 million people with diabetes worldwide. The number is expected to grow to 552 million by 2030. The Philippines is one of the world's emerging diabetes hot spots. Ranked in the top 15 in the world for diabetes

prevalence, Philippines is home to more than four million people diagnosed with the disease; a large unknown number still are unaware they have diabetes.

Worldwide obesity has more than doubled since 1980. As of 2014, more than 1.9 billion adults, 18 years and older, are overweight. Of these, over 600 million are obese. In the Philippines, a 2011 survey by DOST-FNRI showed that 22.3 percent of Filipino adults are overweight and 6.1 percent are obese.

Lastly, strong consumer confidence and greater health awareness among Filipino consumers have driven the health and wellness industry in the country to perform better in 2013 compared to 2012. The growth was buoyed by the intensive marketing campaigns from manufacturers that set their products apart. Notably, more Filipino consumers are purchasing products, which are positioned as healthier alternatives.

As secondary market, the Food and Beverage industry, has been introducing alternative sweeteners into their products to meet the rising demand for healthier foods.

Thermal processing using DOST-developed water retort

Ref. No.: TRA-2017WT5

TRL 5

Component validated in relevant environment

Investment Cost

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Maturation Plan

- Re-design of machine for production scale up
- Development of more products to create bigger target market
- Submission of product to shelf-life and nutritional analyses
- Development of risk management plan
- Development of an appropriate packaging material to maintain quality of product
- Revision of financial analysis to include major cost components and cash flow projections

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Description

Thermal processing using water retort is a food processing method using the application of high temperature with predetermined pressure on food products that are tightly sealed in containers. It ensures safety of food and extended shelf life that enables food manufacturers to use fewer or no additives at all.

It is utilized for the production of shelf-stable products and preserves it for a minimum of one year without spoiling. Food products can be packed in retortable pouches, tin cans, or glass jars, and can be sold as RTE food. Different packaging materials enable better presentation with increased convenience for consumers.

Complementary products such as retort pouches and tin cans are available in the Philippines on a per order basis and with a required minimum quantity per order. Several types of retort vessels are available in the market that varies in process and use different heating substances. It can be either vertical or horizontal and rotary or static, such as water immersion retort, steam-air retort, saturated steam retort, and water spray retort.

DOST-ITDI offers the use of the water retort equipment and licenses the process technology with the following toll process rates:

- Use of Facility – PHP2,823.00/ batch

- Use of Facility with License

    - PHP22,500.00 (chili in oil plain + any 1 variant)/ batch
    - PHP57,000.00 (rice milk shake + any 1 variant + any 1 flavor)/ batch

- Use of Facility with Training – PHP12,600.00 (*Bangus* in Oil/ *Tuyo* in Oil)/ batch

Business Environment

One of the strengths of the product is the large number of suppliers of water retort equipment and packaging materials available locally and globally. In addition, continuous support services from DOST-ITDI in innovating unique products open opportunities to create new market niches and enter the export market.

Numerous types of food products can be explored using thermal processing especially with increasing demand for RTE food products. However, there are several thermal processing methods available in the public domain, thus opening the market to more, new local or foreign manufacturers and suppliers. Currently, majority of suppliers of the water retort are from China.

Market. The Philippine market has a strong consumer base. While overall per capita income is USD2,792, the 10 million population in and around the capital of Manila has a per capita income of USD8,300 or three times the national average. Roughly, 90 percent of the Philippine F&B processing industry's output is consumed locally.

Consumption growth in the coming years is underscored by the country's robust economy, including a fast-growing, highly urbanized population with increasingly

sophisticated tastes and ever-growing access to supermarkets. As the quality and competitiveness of Philippine processed F&B products further improve, exports are expected to rise.

Food manufacturing is the most dominant manufacturing sector that accounts for 40 percent of its total manufacturing output and contributing 20 percent to the GDP of the Philippines. The Philippine FDA listed 11,601 food-processing establishments during the year 2004. It is the largest sector in the said industry.

According to Euromonitor, forecast in retail sales in packaged foods, majority of which need to be thermally processed, is expected to reach USD10 billion by the year 2017. Food category includes pasta, ready meals, dried processed food, snacks, and canned/preserved food, noodles and soup.

The growth in quick service restaurants, increasing population of working women, millennial population, busy work schedules, and retail chains are key contributors in increasing awareness about thermally processed ready-to-eat products among consumers.

The global ready-to-eat food products market is segmented by product type, packaging, and distribution channel. The meat/poultry segment is projected to account for the largest share by value. In developed countries, food consumption is expected to arise mainly from the slow rate of population growth rather than the excess in per capita consumption. Developing countries, on the other hand, are expected to account for an increased food demand, due to growing population, as well as surplus per capita food consumption.

The increase in net national disposable income (9.2 percent from 2016 to 2017) and consumer preferences for healthy and convenient food coupled with the rising demand for snacks and fried food products are expected to further boost the demand for thermally processed ready-to-eat food products.

Globally, the growth of organized retail has led to a widespread supply of ready-to-eat food products through a wide distribution network. These factors are expected to bolster the growth of the global ready-to-eat food products market in the coming years. However, unhealthy substitutes and low quality and taste along with an increasing shift towards a healthier lifestyle is likely to hinder market growth in the coming years.

Competitors. One local brand that offers almost the same product with DOST-ITDI's *Bangus* in Oil and *Tuyo* in Oil are "Premium Local." Some of their products are *Bangus Adobo*, *Bangus* Belly *Bistek* Style in Olive Oil, *Bangus* Belly Portuguese Style in Olive Oil, *Bangus* Fillet *Bistek* Style in Olive Oil, and Gourmet *Tuyo* in Pure Olive Oil. The price ranges from PHP220.00 to PHP375.00 (8oz to 10oz).

In Dagupan City, Bonuan *Bangus* sells bottled *bangus* in olive oil, corn oil, tomato sauce, and adobo, priced at PHP95.00 to PHP130.00. Lastly, in Southern Mindanao, Sarangani Bay Milkfish in Corn Oil is sold at PHP140.00.

Policies on Processed Food. The food processing sector is one of the priority areas of the Government. It supports activities for the development of the sector to support SMEs in the country. It implements and enforces standard practices like GMP and guidelines such as Republic Act No. 3720 to ensure safe and reliable food products. GMP or Administrative Order 153 of 2004 gives food handlers a set of sanitation guidelines for the physical and processing operations in a food processing/manufacturing plant. The goal is to ensure ideal working environment for clean, safe, and high quality food products for consumers.

Start-ups on RTE food must therefore comply with all USDA guidelines related to processing, washing, drying, cooling, freezing, and packaging.

Investment Prospects

Food accounts for nearly half of the total output of the country's manufacturing sector, which contributes around 23-24 percent of the annual GDP. With an average annual growth rate of 8-10 percent, the food manufacturing industry has been identified by the Philippine government as a priority sector for attracting foreign investment under special economic zones.

As of 2016, the Philippines' food manufacturing growth remains the second fastest in ASEAN. JETRO reported that the Philippines has become a favored country for Japanese manufacturers given its low production cost, which is considered as one of the lowest in Asia. Labor productivity has significantly increased by as high as six percent in 2015.

As of 2015, the Philippines FDA tallied around 12,000 food-processing establishments nationwide, most owned by single proprietors. This is common among micro, cottage, and small industries.

According to Stratistics MRC, the Global Retort Packaging market is estimated at USD30.2 billion in 2015 and is expected to reach USD49.5 billion by 2022 growing at a CAGR of 7.3 percent during the forecast period 2015 to 2022.

In terms of value, the global RTE food products market is expected to expand at a CAGR of 7.2 percent during the forecast period (2016–2026) and is estimated to be valued at USD195.3 by the end of 2026.

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Glossary

Glossary

BREADBOARD: Integrated components that provide a representation of a system/subsystem and which can be used to determine concept feasibility and to develop technical data. Typically configured for laboratory use to demonstrate the technical principles of immediate interest. May resemble final system/subsystem in function only.

HIGH FIDELITY: Addresses form, fit, and function. High fidelity laboratory environment would involve testing with equipment that can simulate and validate all system specifications within a laboratory setting.

LOW FIDELITY: A representative of the component or system that has limited ability to provide anything but first order information about the end-product. Low fidelity assessments are used to provide trend analysis.

MODEL: A reduced scale, functional form of a system, near or at operational specification. Models will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.

OPERATIONAL ENVIRONMENT: Environment that addresses all of the operational requirements and specifications required of the final system to include platform/packaging.

PROTOTYPE: The first early representation of the system, which offers the expected functionality and performance expected of the final implementation. Prototypes will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.

RELEVANT ENVIRONMENT: Testing environment that simulates the key aspects of the operational environment.

SIMULATED OPERATIONAL ENVIRONMENTAL: Environment that can simulate all of the operational requirements and specifications required of the final system or a simulated environment that allows for testing of a virtual prototype to determine whether it meets the operational requirements and specifications of the final system.

TECHNOLOGY MATURATION PLAN: A TMP details the steps necessary for developing technologies that are less mature than desired to the point where they are ready for project insertion.

TECHNOLOGY READINESS ASSESSMENT: An assessment of how far technology development has proceeded. It provides a snapshot in time of the maturity of technologies and their readiness for insertion into a project design and execution schedule.

TECHNOLOGY READINESS LEVEL: A metric used for describing technology maturity. It is a measure used by many government agencies to assess maturity of evolving technologies (materials, components, devices, etc.) prior to incorporating that technology into a system or subsystem.

TECHNOLOGY READINESS LEVEL CALCULATOR: A tool developed by the U.S. AFRL for applying TRLs to technology development programs. In its present stage of development, the calculator is a Microsoft Excel spreadsheet application that allows the user to answer a series of questions about a technology project.

TRL Description

TRL Description

Technology Readiness Level, US DOD, 2009.

Technology Readiness Level	Description
1 **Basic principles observed and reported**	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.
2 **Technology concept and/or application formulated**	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3 **Analytical and experimental critical function and/or characteristic proof of concept**	Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4 **Component and/or breadboard validation in laboratory environment**	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.

Technology Readiness Level, US DOD, 2009, *cont*.

Technology Readiness Level	Description
5 **Component and/or breadboard validation in relevant environment**	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high-fidelity" laboratory integration of components.
6 **System/ subsystem model or prototype demonstration in a relevant environment**	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7 **System prototype demonstration in an operational environment.**	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).
8 **Actual system completed and qualified through test and demonstration.**	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation (DT&E) of the system in its intended weapon system to determine if it meets design specifications.
9 **Actual system proven through successful mission operations.**	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation (OT&E). Examples include using the system under operational mission conditions.

TRA Review Work Groups

TRA Team

Team 1: FIC-HITS Technologies

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TRA Team

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Technology, Generator

Cluster 1: FIC-HITS Technologies

DOST Spray Drying Technology for Food Application
Oliver C. Evangelista

Drum Dried Mango Flakes
Maria Elsa M. Falco

Freeze Drying Technology
Oliver C. Evangelista

Thermal Processing using DOST-developed Water Retort
Rommel C. Belandres

Vacuum Frying Technology
Rommel C. Belandres

Scribes
Engr. **Joannalene T. Tuazon**
Engr. **Marvin P. Mendoza**

Technology Generator

Cluster 2: Other Food Processing Technologies

Alternative Sugar from Nipa Sap
Charito M. Villaluz

Cacao Bean Roaster
Dr. **Norberto G. Ambagan**

Cacao *Tablea* – Chocolate Liquor in Bar
Maria Dolor L. Villaseñor

Food Colorant from *Monascus purpureus*
Dr. **Ursela P. Guce-Bigol**

Multi-layer, High-Barrier Packaging Technology for Frozen Durian
Floridel V. Loberiano, Daisy E. Tañafranca, Dane Archibald Balanon, Ericson Nolasco

Ready-to-Drink Coconut Milk in Stand Up Retortable Pouches
Ma. Lourdes S. Montevirgen

Ready-to-Eat Chicken *Arroz Caldo*
Daisy E. Tañafranca, Floridel V. Loberiano, Grace D. Noceja

Scribes
Cristopher C. Bauzon
Jhovi Ann E. Duquiatan

Technology, Generator

Cluster 3: Health and Wellness Technologies

Hard-Shell Carrageenan Capsules from Red Seaweeds
Dr. **Annabelle V. Briones**

Herbs-Based Analgesic Balm
Dr. **Rosalinda C. Torres**

High Dietary Fiber from Calamansi Waste Production Technology
Dr. **Annabelle V. Briones**

MOSYMU, Antidiabetic Health Supplement from Malunggay (*Moringa oleifera*), Duhat (*Syszygium jambolanum*), and Saba Banana (*Musa acuminata*)
Dr. **Rosalinda C. Torres**

Novel Slimming Agent in a Fat-Burner Cream
Dr. **Rosalinda C. Torres**

Salt Iodization Machine
Engr. **Carlos J. De Vera**

Scribes
Sammuel S. Sario
Engr. **Anthony G. Del Rio**

Technology, Generator

Cluster 4: Green Engineering Technologies

4C Oil Spill Adsorbent Technology
Dr. **Emelda A. Ongo**

Abaca-Fiber Reinforced Composite
Dr. **Marissa A. Paglicawan**

Compact Wastewater Treatment System Design
Engr. **Rochelle L. Retamar**

Dual-Drum Composter Equipment for Solid Waste Management
Dr. **Myra L. Tansengco**

Electric Plastic Densifier
Dante C. Vergara

Improved Charcoal Carbonizer
Engr. **Apollo Victor O. Bawagan**

Scribes
Cristopher C. Bauzon
Jhovi Ann E. Duquiatan

Technology, Generator

Cluster 5: Advanced Technologies

Biodegradable Polymer Production
Dr. **Marissa A. Paglicawan**

Nano Precipitated Calcium Carbonate (NPCC) Production from Indigenous Limestone Minerals
Josefina C. Celorico, Mar Christian O. Que

Production of Nanoclay from Local Bentonite Ore
Dr. **Blessie A. Basilia**

Scribes
Sammuel S. Sario
Engr. **Anthony G. Del Rio**

Project Management Team

Position	Name	Area of Expertise
Chair	Nelia Elisa C. Florendo	Research & Development Technology Management
Vice-Chair	Dr. Violeta B. Conoza	Knowledge Management Science Communication
Proponent/ Team Leader	Adelia M. Guevarra	Business Administration Project Management Science Communication
Asst. Team Leader	Delia D. Gotis	Business Administration
Scribe	Cristopher C. Bauzon	Entrepreneurship
Scribe	Jhovi Ann E. Duquiatan	Marketing
Scribe	Engr. Joannalene T. Tuazon	Mechanical Engineering
Scribe	Sammuel S. Sario	Mechanical Engineering
Scribe	Engr. Marvin P. Mendoza	Electrical Engineering
Scribe	Engr. Anthony G. Del Rio	Industrial Engineering

Work Committee

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Work Committee

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Afterword

Afterword

183 workdays – from the first meeting on April 23, 2018 up to the last day of the TRA Review on October 12, 2018 -- were what took us at TSD-ITDI to launch the newest technology check strategy in the country.

All the other brave souls before us, since its inception in NASA in 1974 and formally defined in 1989, call it the Technology Readiness Assessment or TRA Review.

As with all good and great things, we were not alone in this undertaking.

We collaborated with DTI-EMB to rank market readiness of 27 technologies developed by DOST-ITDI and called for conduct of a TRA Review.

A systematic, metric-based process and report, TRA assesses the readiness level and maturity of technologies. It covers aspects of technology; manufacturing and quality; and programmatic such as customer focus and documentation.

Adelia M. Guevarra of TSD-ITDI, TRA Review proponent and project leader, explains that, as is TRA is a tool for:

- Managing technology risks;
- Reducing company vulnerability to adoption of young technology;
- Buoying prudent use of government funds and other resources;
- Redirecting DOST-ITDI's research and development policies and thrusts; and
- Encouraging collaboration among researchers within the institute while building partnerships with industry.

With Nelia Elisa C. Florendo as project chair, Dr. Violeta B. Conoza as co-chair, and Delia D. Gotis as assistant project leader, TSD-ITDI led 22 technology generators and a project management team of 10 in the review of 12 of ITDI's food processing, 6 health and wellness, 6 green engineering, and 3 nano technologies as follows:

Team 1, FIC-HITS Technologies with Engr. Marvin P. Mendoza and Engr. Joannalene T. Tuazon as scribes -- Drum Dried Mango Flakes of Ma. Elsa M. Falco; Freeze Drying Technology and DOST Spray Drying Technology for Food Application of Oliver C. Evangelista; and Thermal Processing using DOST-developed Water Retort and Vacuum Frying Technology of Rommel C. Belandres.

Team 2, Other Food Processing Technologies with Cristopher C. Bauzon and Jhovi Ann E. Duquiatan as scribes -- Cacao *Tablea* of Ma. Dolor L. Villaseñor; Ready-to-Eat Chicken *Arroz Caldo* of Daisy E. Tañafranca, Floridel V. Loberiano, and Grace D. Noceja; Alternative Sugar from Nipa Sap of Charito M. Villaluz; Ready-to-Drink Coconut Milk in Stand Up Retortable Pouches of Ma. Lourdes S. Montevirgen; Food Colorant from *Monascus purpureus* of Dr. Ursela P. Guce-Bigol; Multi-layer, High-Barrier Packaging Technology for Frozen Durian of Floridel V. Loberiano, Daisy E. Tañafranca, Dane Archibald Balanon, and Ericson Nolasco; and Cacao Bean Roaster of Dr. Norberto G. Ambagan;

Team 3, Health and Wellness Technologies with Sammuel S. Sario and Engr. Anthony G. Del Rio as scribes -- Hard-Shell Carrageenan Capsules from Red Seaweeds and High Dietary Fiber from Calamansi Waste Production Technology of Dr. Annabelle V. Briones; Salt Iodization Machine of Engr. Carlos J. De Vera; and Novel Slimming Agent in a Fat-Burner Cream, Herbs-Based Analgesic Balm, and MOSYMU Antidiabetic Health Supplement from Malunggay (*Moringa oleifera*), Duhat (*Syszygium jambolanum*), and Saba Banana (*Musa acuminata*) of Dr. Rosalinda C. Torres;

Team 4, Green Engineering Technologies with Christopher C. Bauzon and Jhovi Ann E. Duquiatan as scribes -- Improved Charcoal Carbonizer of Engr. Apollo Victor O. Bawagan; Compact Wastewater Treatment System Design of Engr. Rochelle L. Retamar; Electric Plastic Densifier of Dante C. Vergara; Dual-Drum Composter Equipment for Solid Waste Management of Dr. Myra L. Tansengco; 4C Oil Spill Adsorbent Technology of Dr. Emelda A. Ongo; and Abaca-Fiber Reinforced Composite of Dr. Marissa A. Paglicawan; and

Team 5, Advanced Technologies with Sammuel S. Sario and Engr. Anthony G. Del Rio as scribes -- Production of Nanoclay from Local Bentonite Ore of Dr. Blessie A. Basilia; Nano Precipitated Calcium Carbonate Production from Indigenous Limestone Minerals of Josefina C. Celorico and Mar Christian O. Que; and Biodegradable Polymers Production of Dr. Marissa A. Paglicawan.

Here, DOST-ITDI used a schematic adopted from AFRL. Developed by William Nolte of AFRL, the Excel-based TRL Calculator Version 2.2 was lifted from the open sources of the Defense Acquisition University.

DOST-ITDI further engaged 6 trade partners from DTI-EMB and 15 industry influencers selected from a short list of 229 top companies of the country to form five TRA Teams. Here, DTI-EMB rendered its expertise on determining from among the technologies which make business sense and have business value; how best to develop and expand export trade prospects of the 27 technologies; and selecting which from the 27 technologies/products to trade and further develop following current market trends.

Together, the teams assessed the readiness of the 27 technologies and their Project Readiness to Transition level. The reviews were held on September 26-28, 2018 for the teams on health and wellness and green engineering. Meanwhile, the teams on food innovation/processing and advanced technologies conducted the review on October 10-12.

Results of the project are now compiled into this 226-page compendere supported by 27 TRA full reports. These are expected to impact some 115,748 establishments of the manufacturing sector; 119,718 accommodation and food service; and 56,466 other services establishments.

To date, DOST-ITDI is the first in the Science Department and may be the 10th agency to use the tool after the NASA, DOD, FAA, DOE, and the oil and gas industry of the USA; EC in Belgium; ESA in France; Turkish Department of Defense; and the Building Canada Innovation Program.

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