HARMONIZED NATIONAL RESEARCH AND DEVELOPMENT AGENDA

2017-2022
<table>
<thead>
<tr>
<th>Table of Contents</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>5</td>
</tr>
<tr>
<td>Harmonized National R&amp;D Agenda (HNRDA) Framework</td>
<td>6</td>
</tr>
<tr>
<td>SECTION I</td>
<td></td>
</tr>
<tr>
<td>National Integrated Basic Research Agenda (NIBRA)</td>
<td>8</td>
</tr>
<tr>
<td>SECTION II</td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>14</td>
</tr>
<tr>
<td>SECTION III</td>
<td></td>
</tr>
<tr>
<td>Agriculture, Aquatic and Natural Resources (AANR)</td>
<td>23</td>
</tr>
<tr>
<td>SECTION IV</td>
<td></td>
</tr>
<tr>
<td>Industry, Energy and Emerging Technology</td>
<td>30</td>
</tr>
<tr>
<td>SECTION V</td>
<td></td>
</tr>
<tr>
<td>Disaster Risk Reduction and Climate Change Adaptation (DRR &amp; CCA)</td>
<td>37</td>
</tr>
<tr>
<td>Annexes: Roadmaps</td>
<td>Page No.</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>NIBRA</td>
<td></td>
</tr>
<tr>
<td>Annex 1</td>
<td>TUBIG Program (Tubig ay Buhayin at Ingatan)</td>
</tr>
<tr>
<td></td>
<td>SAPAT Program (Saganang Pagkain Para sa Lahat)</td>
</tr>
<tr>
<td>Annex 2</td>
<td>LIKAS Program (Likas Yaman sa Kalusugan)</td>
</tr>
<tr>
<td></td>
<td>ALERT Program (Alternative Energy Research Trends)</td>
</tr>
<tr>
<td>Annex 3</td>
<td>SAKLAW Program (Saklolo sa Lawa)</td>
</tr>
<tr>
<td>Annex 4</td>
<td>ATIN Program (Ang Tinig Natin)</td>
</tr>
<tr>
<td>Health</td>
<td></td>
</tr>
<tr>
<td>Annex 5</td>
<td>National Unified Health Research Agenda</td>
</tr>
<tr>
<td>Agriculture, Aquatic and Natural Resources (AANR)</td>
<td></td>
</tr>
<tr>
<td>Annex 6</td>
<td>Crops: Abaca</td>
</tr>
<tr>
<td>Annex 7</td>
<td>Crops: Coconut</td>
</tr>
<tr>
<td>Annex 8</td>
<td>Crops: Legumes - Mungbean</td>
</tr>
<tr>
<td>Annex 9</td>
<td>Crops: Mango</td>
</tr>
<tr>
<td>Annex 10</td>
<td>Crops: Rootcrops - Sweet Potato</td>
</tr>
<tr>
<td>Annex 11</td>
<td>Crops: Tropical Fruits - Citrus</td>
</tr>
<tr>
<td>Annex 12</td>
<td>Crops: Tropical Fruits - Papaya</td>
</tr>
<tr>
<td>Annex 13</td>
<td>Crops: Tropical Fruits - Pummelo</td>
</tr>
<tr>
<td>Annex 14</td>
<td>Livestock: Dairy</td>
</tr>
<tr>
<td>Annex 15</td>
<td>Livestock: Dairy Goat</td>
</tr>
<tr>
<td>Annex 16</td>
<td>Livestock: Native Chicken</td>
</tr>
<tr>
<td>Annex 17</td>
<td>Livestock: Swine</td>
</tr>
<tr>
<td>Annex 18</td>
<td>Aquatic: Inland - Aquafeeds</td>
</tr>
<tr>
<td>Annex 19</td>
<td>Aquatic: Inland - Milkfish</td>
</tr>
<tr>
<td>Annex 20</td>
<td>Aquatic: Inland - Shrimp</td>
</tr>
<tr>
<td>Annex 21</td>
<td>Aquatic: Marine - Abalone</td>
</tr>
<tr>
<td>Annex 22</td>
<td>Aquatic: Marine - Oyster</td>
</tr>
<tr>
<td>Annex 23</td>
<td>Aquatic: Marine - Sea Cucumber</td>
</tr>
<tr>
<td>Annex 24</td>
<td>Aquatic: Marine - Tuna</td>
</tr>
<tr>
<td>Annex 25</td>
<td>Forestry &amp; Natural Resources: Cacao</td>
</tr>
<tr>
<td>Annex 26</td>
<td>Forestry &amp; Natural Resources: Rubber</td>
</tr>
<tr>
<td>Annex 27</td>
<td>Environmental Services: Corals</td>
</tr>
<tr>
<td>Annex 28</td>
<td>Environmental Services: Climate Change</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>Page No.</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Industry, Energy and Emerging Technology</strong></td>
<td></td>
</tr>
<tr>
<td>Annex 29</td>
<td>Competitive Industries: ICT, Electronics and Semiconductor</td>
</tr>
<tr>
<td>Annex 30</td>
<td>Delivery of Social Services: DRR/CCA</td>
</tr>
<tr>
<td>Annex 31-33</td>
<td>Delivery of Social Services: Space Technology Application</td>
</tr>
<tr>
<td>Annex 34-38</td>
<td>Intelligent Transportation Solutions</td>
</tr>
<tr>
<td>Annex 39-40</td>
<td>Renewable Energy and Energy Storage Solutions</td>
</tr>
<tr>
<td><strong>Disaster Risk Reduction and Climate Change Adaptation</strong></td>
<td></td>
</tr>
<tr>
<td>Annex 41</td>
<td>DRR-CCA R&amp;D Roadmap</td>
</tr>
<tr>
<td>Annex 42</td>
<td>PAGASA Roadmap</td>
</tr>
</tbody>
</table>
Introduction

The DOST, in consultation with government and private research and development institutions, the academe, industry and other concerned agencies, prepared the Harmonized National R&D Agenda (HNRDA) 2017-2022 to ensure that results of S&T endeavors are geared towards and are utilized in areas of maximum economic and social benefit for the people. The formulation of the HNRDA is in line with the DOST’s mandate of providing central direction, leadership and coordination of the scientific and technological efforts in the country.

The HNRDA is aligned with *AmBisyon Natin 2040: matatag, maginhawa at panatag na buhay para sa lahat*. It has three pillars: *Malasakit* (enhancing the social fabric), *Pagbabago* (reducing inequality) and *Kaunlaran* (increasing potential growth). *AmBisyon Natin 2040* and the three pillars form the foundation for more inclusive growth, a high-trust and resilient society and a globally competitive knowledge economy.

On 21 October 2016, the DOST hosted the 1st National R&D Conference (NRDC) to harmonize the country’s research and development priorities and align them with the thrusts of the current administration. Comments and recommendations raised during the 1st NRDC were considered in the final version of the HNRDA which was presented to stakeholders during the 2nd National R&D Conference on 15 February 2017.

One of the outcomes identified in the Philippine Development Plan 2017-2022 is to increase the country's potential growth by building the foundation for a globally competitive knowledge economy where accelerated technology adoption and stimulated innovation are envisioned to be achieved. The HRNDA, therefore, articulates our national priorities and will serve as guide for public investment in R&D while ensuring a cohesive convergence and integration of R&D efforts towards the shared goal of inclusive socio-economic growth and a better life for Filipinos.

The HNRDA is organized into 5 sectors: Basic Research; Agriculture Aquatic and Natural Resources; Health; Industry, Energy and Emerging Technology; and Disaster Risk Reduction and Climate Change Adaptation. The Agenda was formulated by the National Research Council of the Philippines (NRCP), Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), Philippine Council for Health Research and Development (PCHRD), Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD), Philippine Institute of Volcanology and Seismology (PHIVOLCS), and Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) in cooperation with stakeholders in the respective sectors.
The Harmonized National Research and Development Agenda (HNRDA) is divided into five (5) sectors. It is aligned with AmBisyon Natin 2040, and is founded on the three pillars of Malasakit, Pagbabago and Kaunlaran.
SECTION I

National Integrated Basic Research Agenda (NIBRA) 2017-2022

The National Research Council of the Philippines (NRCP), a collegial body of over four thousand researchers, scientists, and experts, is mandated to promote and support fundamental and basic research in the country as provided in the 9th Philippine Legislature Act No. 4120 passed on 8 December 1933. It is likewise mandated to provide advice on problems and issues of national interest.

Along this line, the NRCP supports research that is directed primarily towards developing a new and fuller scientific knowledge or understanding of any subject which may or may not have practical applications. Basic researches results from intellectual curiosity aimed at proving the unknown, or it may seek new knowledge required for practical application in the future (Ref: Science Act of 1958 as amended by RA 3589).

For 2017-2022, the NRCP’s National Integrated Basic Research Agenda (NIBRA) will prioritize fundamental research in support of the Philippine Development Plan, the National Security Plan, and the Science for Change Program led by the Department of Science and Technology. It has six issue-based NIBRA programs, namely:

A. Water Security – TUBIG Program (Tubig ay Buhayin at Ingatan)
B. Food and Nutrition Security – SAPAT Program (Saganang Pagkain Para sa Lahat)
C. Health Sufficiency – LIKAS Program (Likas Yaman sa Kalusugan)
D. Clean Energy – ALERT Program (Alternative Energy Research Trends)
E. Sustainable Community – SAKLAW Program (Saklolo sa Lawa)
F. Inclusive Nation-building – ATIN program (Ang Tinig Natin)

Among these six, the top three priority areas for 2017-2019 are SAKLAW, ATIN, and LIKAS Programs. Outputs of NRCP-funded researches are journal and scholarly publications, policy advisories, patent applications, and products used for community and public engagements such as books, manuals, monographs, among others.

The NIBRA is a product of a series of consultations and forums which started in 2016. The thirteen disciplinal Divisions of NRCP generated their respective basic research agenda. These are the Divisions of Governmental, Educational and International Policies (Division 1), Mathematical Sciences (Division II), Medical Sciences (Division III), Pharmaceutical Sciences (Division IV), Biological Sciences (Division V), Agriculture and Forestry (Division VI), Engineering and Industrial Research (Division VII), Social Sciences (Division VIII), Physics (Division IX), Chemical Sciences (Division X), Humanities (Division XI), Earth and Space Sciences (Division XII), and Veterinary Medicine (Division XIII).
The divisions’ basic research agenda were further harmonized by the NRCP clusters before the NIBRA was approved by the Governing Board and confirmed by the General Membership Assembly.

A. Water Security

**TUBIG Program (Tubig ay Buhayin at Ingatan)**

1. Watershed studies
   a. Biological, chemical and physical characterization
   b. Water supply stress index
   c. Population growth impacts on water resource availability
2. Water quality, accessibility and availability
   a. Pollutants/contaminants (surface and ground waters)
   b. Analysis of historical flows, sediment and toxicity loads of lakes and rivers
   c. Weather modification for increasing water supplies in special localized areas

**Priorities for 2017-2019**

Ensuring an adequate supply of quality water that is accessible to a growing population is TUBIG Program’s priority for 2017-2019. Specific topics include:

a. Characterization of water resources (ground water)

**Priorities for 2020-2022**

Studies on rivers, reservoirs, dams and other surface water resources will be the priority for 2020-2022 which will include:

a. Characterization of water resources (surface water)

B. Food and Nutrition Security

**SAPAT Program (Saganang Pagkain Para sa Lahat)**

1. Biodiversity studies
   a. Biological Pollution
   b. Biology and population dynamics of pests, diseases, and natural enemies
   c. Taxonomy of flora and fauna
   d. Environmental scanning of physical marine and terrestrial resources
      (taxonomy, systematics, ecology)
   e. Genetic analysis (biochemical, cytogenetics, molecular)
   f. Taxonomy of eco-friendly species (e.g. arthropods and microorganisms) for Integrated Pest Management
   g. Exploring allelopathic potentials of indigenous botanicals

2. Food safety
   a. Safety analysis of food supplements and cosmeceuticals in the market
b. Livestock and poultry diseases (epidemiological studies, re-emerging and emerging diseases)
c. Diseases and pathogens of important crops
d. Identification and characterization of food/feed contaminants
e. Epidemiology of food- and feed-borne contaminants

Priorities for 2017-2019
Basic research along two strands is SAPAT Program’s priority in the next three years.
a. Taxonomy and systematics of flora and fauna for food. Specific topics include genetic analysis, morphological analysis and allelopathic analysis.
b. Safety analysis of cosmeceuticals and food supplements. Specific topics include epidemiology, microbiology, chemical analysis, cost-benefit and socio-economic studies.

Priorities for 2020-2022
There will be the same priorities in 2020-2022, but focus will be on:
a. Bio-ecology studies of flora and fauna for food
b. Safety analysis of raw and processed food products

C. Health Sufficiency
LIKAS Program (Likas Yaman sa Kalusugan)
1. Fundamental Studies on Potential Sources of Natural Products
   a. Bioprospecting (e.g. marine organisms for biomedical use)
   b. Bioinformatics
   c. Characterization and structure elucidation of plants or foods/food components
   d. Pharmacogenomics and toxicogenomics
2. Basic Veterinary Studies
   a. Economically important animal diseases and those transmitted to humans
   b. Characterization, isolation and bioassay of novel antimicrobial compounds from indigenous sources and plant species
   c. Herbal veterinary pharmacopeia
   d. Identification and characterization of zoonotic diseases
3. Social Dimensions on Health
   a. Filipino perceptions and concepts on health
   b. Herbal and folkloric medicine
   c. Models for good governance in health management

Priority for 2017-2019
Fundamental studies on potential sources of natural products in various ecosystems such as marine sediments, rivers, and rare environments (e.g. caves, mangroves, mined out areas, mesophotic reefs) is the priority of the LIKAS Program. This primarily includes bio-prospecting studies for medicinal applications with focus on marine ecosystems in 2017-2019.
For the basic veterinary studies, priority will be on zoonotic diseases.

**Priority for 2020-2022**
The same type of studies will be prioritized in 2020-2022, but focus will be on the other types of ecosystems, specifically rare environments as potential sources of natural products for medicinal use.

For basic veterinary studies, research will focus on the other economically important diseases.

D. Clean Energy

**ALERT Program (Alternative Energy Research Trends)**

1. Alternative Energy
   a. Identification and characterization of alternative sources of energy (wind, solar, biofuels, hydro)

**Priority for 2017-2019**
In the next three years, NRCP will support the conduct of resource assessments of potential alternative sources of energy.

**Priority for 2020-2022**
By 2020, priority will be on conduct of commercial viability studies of the potential alternative sources of energy identified from previous studies.

E. Sustainable Communities

**SAKLAW Program (Saklolo sa Lawa)**

1. Vulnerable Ecosystems
   a. Lakes, rivers, and wetlands
   b. Oceans and marine studies
   c. Soil science
   d. Carrying capacity models of ecosystems
   e. Environmental scanning of physical marine and terrestrial resources
   f. Endangered species
   g. Economic valuation of ecosystems, natural capital, and cost-benefit analyses
   h. Evaluation of adaptive socio-ecological systems in a changing environment
   i. Assessment studies on the resource sustainability of various ecosystems
   j. Models and frameworks for enhancing adaptive capacities of vulnerable communities

2. Data Analytics of Natural Phenomena
   a. Database of pollutants present in abandoned mined out areas (terrestrial and aquatic)
b. Computational and numerical modelling and simulations for ecological processes

c. Simulations for applications in physical and life sciences, and in complex systems

d. Regional climate modelling and sensitivity analysis

3. Environment and Anthropogenic Activities

a. Geogenic health hazards

b. Processes in heavy metals sequestration from mine tailings, agriculture, farms, etc.

c. Impact studies of anthropogenic activities on the environment (e.g. mining and resource extractive industries)

d. All-systems risk modelling for DRR/CCA

e. Human dimensions research on climate change (drivers, impact, responses, adaptive capacities)

f. Risk assessment of mining wastes and effluents

g. Bioremediation studies

**Priorities for 2017-2019**

SAKLAW Program is the topmost priority of NRCP for 2017-2019 and it will focus on the following topics:

a. Lake assessment studies -- carrying capacity models and metrics; water quality parameters and baseline studies; resource assessment and valuation; resource utilization and management; socio-economic and policy studies. Both big lakes and small lakes in the country will be included in the program.

b. Coastal vulnerabilities -- risk assessment; geohazard mapping; adaptive capacities; marine geology; computational and numerical modelling. The focus will be on DENR-identified highly vulnerable ecosystems.

c. Resource extractive industries – fundamental studies of all types of mining areas

**Priority for 2020-2022**

Similar types of basic research will be supported but focus will be on rivers and other bodies of water, and other ecosystems.

**F. Inclusive Nation-Building**

**ATIN program (Ang Tinig Natin)**

1. Data Collection and Analysis of Social Phenomena
   a. Computational and numerical modelling and simulations for social processes
   b. Indigenous knowledge systems and practices on DRR and CCA
   c. Gender in nation-building and DRR/CCA

2. Documentation of Indigenous Knowledge
   a. Documentation of traditional health practices in the Philippines
   b. Extant cultural heritage of ethnolinguistic groups
   c. Dictionary of cultural metaphors
d. Retrieval and documentation of indigenous technology in Filipino expressive culture

e. Documentation of indigenous sustainable farming, fishing, and aquaculture practices

f. Early human life and civilization in the Philippines

3. Education
   a. Pedagogies in Philippine educational system
   b. Mathematics, language, music in indigenous Filipino expressive culture
   c. K12 studies

4. National Security and Sovereignity
   a. Peace studies and conflict resolution
   b. Sovereignty issues
   c. Human security (community, political, health, economic, environmental, personal)

5. Arts, History and Culture
   a. Extant cultural heritage of ethnolinguistic groups
   b. Filipinnovation in music, theatre, dance, literature, performing arts
   c. Codification of endangered Philippine languages

Priorities for 2017-2019
ATIN Program is the second priority for 2017-2019. Among the five themes above-mentioned, the topmost priority will be:
   a. Documentation of indigenous knowledge (art and art forms, practices, technologies, early human life and civilization in the Philippines)
   b. National security and sovereignty -- to include studies on internal conflict and peace, human security as well as maritime and geopolitical studies.

Priority for 2020-2022
For 2020-2022, the same topics will be supported in addition to new developments that may arise.

For all the NIBRA programs, basic research on the cross-cutting themes of gender, KAPS (knowledge, attitude, practices, skills), policy studies, valuation and cost benefit-analysis, impact studies, and DRR/CCA dimensions will be considered.

The NIBRA Roadmaps are on pages 44-47.
For details, visit http://www.nr cp.dost.gov.ph/
Republic Act No. 10532 or the Philippine National Health Research System (PNHRS) Act of 2013 recognizes and mandates the Philippine Council for Health Research and Development (PCHRD-DOST) as the national coordinating body for health research in the country. Together with the PNHRS core agencies: Department of Health (DOH), Commission on Higher Education (CHED), and National Institutes of Health – University of the Philippines Manila (NIH-UPM), the National Unified Health Research Agenda (NUHRA) was developed. The NUHRA serves the following purposes: it is the national roadmap for health research in the Philippines; it provides focus and direction for health research and development efforts; it guides policy makers, funding and donor agencies and researchers; it provides evidence-based solutions to pressing health problems; and it serves as basis for maximizing resource utilization and minimizing duplication of research efforts.

The research priorities for health research and development (R&D) is a product of consultations with experts and stakeholders from the private and public sectors including other line agencies of government, academe, and industry. Consultations were done through meetings, workshops and focused group discussions (FGDs). The research priority setting activities were guided by the DOST’s S&T thrusts, emerging and re-emerging health concerns and other national and global development concerns. The health R&D priorities comprise the health S&T component of the NUHRA.

**RESEARCH PRIORITIES for HEALTH RESEARCH and DEVELOPMENT**

A. Diagnostics  
B. Drug discovery and development  
C. Functional foods  
D. Hospital equipment and biomedical devices  
E. Information and communication technology for health  
F. Dengue  
G. Nutrition and food quality and safety  
H. Disaster risk reduction  
I. Climate Change Adaptation  
J. Molecular technologies for health (Platform technology across research priorities)
A. Diagnostics

- Development of diagnostics for early detection and/or prediction of disease and mortality, utilizing existing technologies and/or novel technology. Such technology will also look at the genetic or biological markers associated with lifestyle diseases like diabetes mellitus, cardiovascular diseases and cancer.

1. Priority diseases:
   a. Communicable diseases
      - Neglected Tropical diseases
      - Emerging infectious diseases
      - Organisms associated with Multi Drug Resistance
      - HIV AIDS
      - Gastro urinary tract (GUT), Gastrointestinal tract (GIT) and Hepatitis
      - Respiratory diseases
      - Tuberculosis, all forms
   b. Non-communicable diseases
      - Malignant neoplasms, all sites
      - Neurodegenerative and mental health disorders
      - Metabolic Diseases, diabetes & other endocrine-related disorders
      - Autoimmune/immunologic diseases or deficiencies
      - Cerebrovascular disease
      - Diseases of the cardiovascular system

2. Specific topics:
   a. Point of care
      - Diagnostic test done at the time and place of patient care
   b. Screening / confirmatory / prognostic
      - Screening to detect early disease or risk factors for disease
      - Confirming the presence or absence of disease
      - Prognosticating and predicting the likely outcome of disease, susceptibility and chances of recovery
   c. Technologies
      - Latex agglutination
      - Lateral flow assay/Dipstick
      - Isothermal technology
      - Biosensors/Chemical sensors
      - Nucleic Acid Testing
      - Immunochemistry
      - Lab-on-a-chip (Microfluidics, paper technology, Nanotechnology, Aptamers or a combination)
      - Immunoassay
      - Radio-labelled assays
Priorities for 2018
Proof of concept for screening, confirmatory and prognosis for 13 priority diseases (tropical diseases; malignant neoplasms; emerging infectious diseases; neurodegenerative and mental health disorders; diseases associated with multi-drug resistance; metabolic diseases, diabetes and other endocrine-related diseases; auto-immune/immunologic diseases and deficiencies; cerebrovascular; diseases of the cardiovascular system; GUT, GIT and hepatitis; respiratory; and tuberculosis)

Priorities for 2019-2022
Target identification and validation, prototype development, laboratory performance testing, and field testing of diagnostic kits for 13 priority diseases.

B. Drug discovery and development
- Development of standardized herbal drugs and discovery of new drugs from local sources for development up to the pre-clinical stage. Drugs will be developed for:
  1. Infectious diseases
     - Bacterial infections (*M. tuberculosis*, *Enterococcus faecium*, *S. aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumanii*)
     - Viral diseases (e.g. dengue, influenza)
     - Fungal infections
  2. Non-communicable diseases
     - Lifestyle-related diseases (e.g. diabetes, cardiovascular diseases (CVDs), etc.)
     - Cancer (colon, breast, lung)
     - Respiratory diseases
     - Neurodegenerative diseases

Priorities for 2018
- Cultural management/propagation of priority organisms
- Development of standardized herbal drugs
  - Formulation of standardized herbal drugs for platelet enhancement related to dengue, inflammation, diabetes, gout, hypertension
- Pre-clinical drug development
  - Bioactive hits isolation from marine and terrestrial organisms for identified priority diseases
- Development and/or validation of standard processes and protocols for various stages of drug discovery and development

Priorities for 2019-2022
- Cultural management/propagation of priority organisms
- Development of standardized herbal drugs
  - Pre-clinical evaluation of standardized herbal drugs for platelet enhancement related to dengue, inflammation, diabetes, gout, hypertension
Identification and screening of next set of priority plants for formulation for identified priority diseases

- Pre-clinical drug development
  - Lead optimization of candidates from marine and terrestrial organisms for identified priority diseases
- Development and/or validation of standard processes and protocols for various stages of drug discovery and development

### C. Functional Foods

- Food or food components that provide health benefits beyond basic nutrient function
- Determination of health benefits and safety assessment of food or food components in reducing risk for disease occurrence, specifically lifestyle related diseases such as cardiovascular disease, diabetes, and cancer

#### 1. Priority Foods

- Local Fruits (guyabano, tiesa, mangosteen)
- Local Vegetables (malunggay, okra, saluyot)
- Rootcrops, tubers and starchy food (yacon, sago, sweet potato varieties, purple yam)
- Rice (pigmented)
- Local berries (duhat, lipote, aratiles, bignay)
- Herbs and spices (tanglad, pandan, ginger e.g. turmeric)
- Nuts (pili)
- Seaweeds (lato, red seaweed)
- Edible mushrooms

#### 2. Specific topics

- Characterization of food and food components
- Safety assessment
- Establishment of health benefits
- Product development

### Priorities for 2018

- Safety assessment of mangosteen, malunggay, sweet potato varieties, and ginger
- Characterization of guyabano (leaves, fruit, etc.) tiesa, yacon, sago, pili, lato, red seaweed, and edible mushroom

### Priorities for 2019-2022

- Establishment of health benefits and product development of mangosteen, malunggay, sweet potato varieties, and ginger
• Safety assessment, establishment of health benefits and product development of
guyabano (leaves, fruit, etc.) tiesa, yacon, sago, pili, lato, red seaweed, and edible
mushroom
• Characterization, safety assessment, establishment of health benefits, and
product development of okra, saluyot, purple yam, pigmented rice, duhat, lipote,
aratiles, bignay, tanglad, and pandan

D. Hospital Equipment and Biomedical Devices
• Design and development of affordable, safe, and reliable hospital equipment and
biomedical devices

Specific topics

Priorities for 2018
Design and development of hospital equipment and biomedical devices for the
following:
• Respiratory failure support
• Artificial body part replacement (prosthesis)
• Rehabilitation medicine
• Minimally invasive surgical procedures
• Eye health

Priorities for 2019-2022
Design and development of hospital equipment and biomedical devices for the
following:
• Hemodialysis (consumables)
• Orthopedic surgery
• Post-operative care
• Spinal disorders
• Wound care
• Primary health care
• Persons with disabilities (PWD) assistive devices
• Hospital waste management
• Personal protective equipment

E. Information and Communication Technology (ICT) for Health
• User-friendly ICT solutions to accelerate the gathering and processing of health and
related information for policymaking and delivery of quality health care services

Specific topics

Priorities for 2018
• Public health surveillance
• Health intelligence system
• ICT-enabled medical devices and services
• Software and applications

**Priorities for 2019-2022**
• Monitoring proximity to predict possible epidemics
• Verbal autopsy system
• Applications development for online nutrition services
• Automatic body mass index (BMI) assessment

**F. Dengue**
• Dengue R and D intends to reduce transmission of dengue and development of an early warning system for the prediction of dengue outbreak.

**Specific topics**
• Vector biology
• Vector surveillance and integrated vector management (IVM)
• Dengue case management
• Dengue outbreak management

**Priorities for 2018**
**Vector surveillance and IVM**
• Molecular characterization
• Guidelines for the use of ovitraps
• Insecticide resistance survey

**Dengue outbreak response**
• Dengue outbreak prediction
• Development of system for yearly monitoring of prevailing dengue serotypes

**Priorities for 2019-2022**
**Vector surveillance and IVM**
• Epidemiological and molecular survey of mosquito borne viruses
• Genome editing of *Aedes aegypti*
• Gene silencing mosquito spray

**Dengue outbreak response**
• Intensive profiling of dengue trends using rapid diagnostics

**G. Nutrition and food quality and safety**
• Nutrition researches seek to address the nutrition problems in the country i.e., micronutrient and macronutrient deficiencies, overnutrition, and nutrition related diseases, and to explore avenues and other opportunities that can be tapped, in order to lessen if not stop these problems.
• Food quality and safety refers to the assurance that food will not cause harm to the consumer when prepared or eaten according to its intended use.
Specific topics

- Food fortification
  - Fortified multi-nutrient growth mix products
  - Rice extrudate
- Development/revision of nutrition tools and standards
  - Nutritional guidelines
  - Food exchange list
  - Body composition assessment
- Nutritional assessment and monitoring
  - In-depth and correlation studies (dietary risk factors to non-communicable diseases)
  - Nutrition surveys
- Designing nutrition intervention programs
  - Nutrition delivery system for complementary feeding promotion
- Food quality and safety
  - Enhancement of food composition database for dietary exposure assessment
  - Exposure assessment of selected nutrients, food contaminants, and food additives in commonly consumed foods

H. Disaster Risk Reduction

- Based on the Sendai Framework
- Innovations which will reduce risks to health

Specific topics

**Priorities for 2018**

- Innovations for emergency medical care services, water, sanitation, hygiene and nutrition
  - Technology development for search and rescue, triage and emergency health
  - Ready to use therapeutic food (RUTF)
  - Food for emergencies
  - Environmental health (water quality; waste disposal)
- Psychosocial adaptation capacity of communities

**Priorities for 2019-2022**

- Intervention models to reduce prevalence of infectious diseases
- Post disaster solutions to access health care services, e.g. maternal, newborn and child health, sexual and reproductive health, food security, nutrition, housing, education

I. Health and Climate Change Adaptation

- Covers cross-cutting researches on climate change adaptation, which have direct implications on public health
Specific topics

Priorities for 2017-2022

• Researches relating to human health with hydrologic/meteorological information
• Climate change sensitive diseases
• Resilience studies at institutional, community and individual levels
• Implementation science regarding existing tools and interventions on health and climate change
• Green health facilities

J. Molecular Technologies for Health

• Utilize molecular technology platforms in developing local technologies for the development of personalized medicines, diagnostics, therapeutics as support to health and clinical practice guidelines and policies

• Priority diseases based on the top causes of mortality and morbidity (e.g. CVD) malignant neoplasms, pneumonia and other chronic respiratory diseases
• Prevalent emerging and re-emerging infectious diseases
• Neurological/ Neurodegenerative/ mental health conditions
• Disease conditions of special interest in the Philippines, e.g. X-linked dystonia-parkinsonism syndrome (XDP)
• Other applications / topics of national interest or significance

Specific topics

• Omics Technologies for Health and Wellness
• Bioinformatics and Systems Biology
• Novel Technologies for Therapeutics
• Biobanking, Data Mining and Population Studies for Human Health, Ethnicity and Forensic Applications

Priorities for 2018

Omics Technologies for Health and Wellness

• Omic Research Programs on Neurological/ Neurodegenerative/ Mental Health Conditions (susceptibility and drug response)
• Validation of candidate genomic markers on susceptibility and drug response for CVD and type 2 diabetes mellitus (T2DM)
• Human host and viral markers of dengue severity (knowledge generation on pathophysiological and molecular mechanisms of dengue severity)
• Nutrigenomics

Bioinformatics and Systems Biology

• Development of computational approaches and formulating bioinformatics pipeline to study Filipino genomes
• Data mining for lung or breast cancer tissues
**Novel Technologies for Therapeutics**
- Development of molecular vehicles for targeted drug delivery

**Biobanking, Data Mining and Population Studies for Human Health, Ethnicity and Forensic Applications**
- Developing Forensic Methods used in criminal investigations, kinship analysis and victim identification
- Studies on Filipino DNA markers for Forensic Applications
- Characterization of Filipino Genomic Variations (22 regional groups and 24 ethno-linguistic groups- sample collection)
- Establishing a Biobanking Resource of Filipino Samples and their Associated Data (Genomic, Proteomic etc.)

**Priorities for 2019-2022**

**Omics Technologies for Health and Wellness**
- Validation of Candidate genomic markers on susceptibility and drug response for Neurodegenerative/ Mental Health Diseases
- Omic Research Programs on Rare Diseases in the Filipino Population (susceptibility and drug response)
- Omic Research Programs on Human Host and Infectious Disease Markers of Susceptibility, Severity and Therapeutic Response
- Nutrigenomics

**Bioinformatics and Systems Biology**
- Developing the national capability for bioinformatics, chemoinformatics, computational biology and big data analytics for the medical and health sciences
- Validation and Testing of Computational Approaches and Formulating Bioinformatics Pipelines to Study Filipino Genome

**Novel Technologies for Therapeutics**
- Validation, pre-clinical and clinical testing of molecular vehicles for targeted drug delivery

**Biobanking, Data Mining and Population Studies for Human Health, Ethnicity and Forensic Applications**
- Validation of use of Molecular Technologies for Forensics for the use in criminal investigations, kinship analysis and victim identification
- Validation of Filipino DNA markers for Forensic Applications
- Data Mining of Filipino Genomic Variations (22 regional groups and 24 ethno-linguistic groups- sample collection)
- Management of Biobanking Resource of Filipino Samples and their Associated Data (Genomic, Proteomic etc.)

SECTION III

AGRICULTURE, AQUATIC AND NATURAL RESOURCES (AANR)
Research and Development Agenda
2017 – 2022

The Harmonized National R&D Agenda in AANR (HNRDA-AANR) 2017-2022 is an integration of the existing R&D agenda of government agencies conducting R&D in AANR and inputs from various stakeholders.

The HNRDA-AANR 2017-2022 is a product of multi-sectoral consultations. Initially, a Roundtable Consultation was conducted by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) with representatives from government agencies performing R&D functions in AANR on October 13, 2016 at PCAARRD, Los Baños, Laguna. The output of the consultation, an initial draft agenda, was then presented during the National R&D Conference on October 21, 2016 held at Crowne Plaza Hotel Galleria, Quezon City. The conference was attended by representatives from government, the academe and private sector and civil society groups. The draft HNRDA-AANR was also presented to the Regional R&D Consortia during the Joint Regional R&D Consortium Chairpersons and Directors meeting held at PCAARRD on November 28, 2016. In addition, it was sent to heads of agencies involved in R&D in AANR for validation, and further discussed during the 2nd Round Table Consultation held on February 10, 2017 at PCAARRD.

The AANR sector supports the use of advanced and emerging technologies such as biotechnology, genomics, bioinformatics, nanotechnology, nuclear technology, space technology, electronics and automation, and ICT as R&D tools to find S&T solutions to AANR problems or develop new products with significant potential impact to the sector.

The sector supports organic agriculture, halal food production, food safety and traceability initiatives, and the development of genetically modified organisms as long as it is compliant with biosafety rules and regulations.

The AANR sector also supports Farm Mechanization, as mandated by RA 10601, otherwise known as the Agricultural and Fisheries Mechanization Law, to modernize the sector and increase agricultural productivity, efficiency and competitiveness.
## Commodity Focus

<table>
<thead>
<tr>
<th>AGRICULTURE</th>
<th>AQUATIC</th>
<th>FORESTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crops</strong></td>
<td><strong>Livestock</strong></td>
<td><strong>Timber</strong></td>
</tr>
<tr>
<td>Abaca and other fiber crops</td>
<td>Abaca and other fiber crops</td>
<td>Abaca and other fiber crops</td>
</tr>
<tr>
<td>Coconut</td>
<td>Coconut</td>
<td>Coconut</td>
</tr>
<tr>
<td>Rice</td>
<td>Rice</td>
<td>Rice</td>
</tr>
<tr>
<td>Corn and Other Grains</td>
<td>Corn and Other Grains</td>
<td>Corn and Other Grains</td>
</tr>
<tr>
<td>Fruit Crops</td>
<td>Fruit Crops</td>
<td>Fruit Crops</td>
</tr>
<tr>
<td>- Mango</td>
<td>- Mango</td>
<td>- Mango</td>
</tr>
<tr>
<td>- Banana</td>
<td>- Banana</td>
<td>- Banana</td>
</tr>
<tr>
<td>- Other tropical fruits (e.g. durian, jackfruit, pummelo, papaya, pineapple, citrus)</td>
<td>- Other tropical fruits (e.g. durian, jackfruit, pummelo, papaya, pineapple, citrus)</td>
<td>- Other tropical fruits (e.g. durian, jackfruit, pummelo, papaya, pineapple, citrus)</td>
</tr>
<tr>
<td>Legumes (e.g. mungbean, peanut and soybean)</td>
<td>Legumes (e.g. mungbean, peanut and soybean)</td>
<td>Legumes (e.g. mungbean, peanut and soybean)</td>
</tr>
<tr>
<td>Natural Sources of Dye</td>
<td>Natural Sources of Dye</td>
<td>Natural Sources of Dye</td>
</tr>
<tr>
<td>Pili and Cashew</td>
<td>Pili and Cashew</td>
<td>Pili and Cashew</td>
</tr>
<tr>
<td>Ornamentals (e.g. cutflowers and foliage)</td>
<td>Ornamentals (e.g. cutflowers and foliage)</td>
<td>Ornamentals (e.g. cutflowers and foliage)</td>
</tr>
<tr>
<td>Medicinal Plants</td>
<td>Medicinal Plants</td>
<td>Medicinal Plants</td>
</tr>
<tr>
<td>Plantation Crops</td>
<td>Plantation Crops</td>
<td>Plantation Crops</td>
</tr>
<tr>
<td>- Cacao</td>
<td>- Cacao</td>
<td>- Cacao</td>
</tr>
<tr>
<td>- Coffee</td>
<td>- Coffee</td>
<td>- Coffee</td>
</tr>
<tr>
<td>- Oil Palm</td>
<td>- Oil Palm</td>
<td>- Oil Palm</td>
</tr>
<tr>
<td>- Rubber</td>
<td>- Rubber</td>
<td>- Rubber</td>
</tr>
<tr>
<td>- Sugarcane</td>
<td>- Sugarcane</td>
<td>- Sugarcane</td>
</tr>
<tr>
<td>Rootcrops (e.g. sweet potato, cassava)</td>
<td>Rootcrops (e.g. sweet potato, cassava)</td>
<td>Rootcrops (e.g. sweet potato, cassava)</td>
</tr>
<tr>
<td>Sericulture and Apiiculture</td>
<td>Sericulture and Apiiculture</td>
<td>Sericulture and Apiiculture</td>
</tr>
<tr>
<td>Vegetables (e.g. tomato, white potato, mushroom)</td>
<td>Vegetables (e.g. tomato, white potato, mushroom)</td>
<td>Vegetables (e.g. tomato, white potato, mushroom)</td>
</tr>
<tr>
<td><strong>Livestock</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Swine</td>
<td>- Swine</td>
<td>- Swine</td>
</tr>
<tr>
<td>- Goat</td>
<td>- Goat</td>
<td>- Goat</td>
</tr>
<tr>
<td>- Sheep</td>
<td>- Sheep</td>
<td>- Sheep</td>
</tr>
<tr>
<td>- Cattle (dairy and meat)</td>
<td>- Cattle (dairy and meat)</td>
<td>- Cattle (dairy and meat)</td>
</tr>
<tr>
<td>- Carabao (dairy and meat)</td>
<td>- Carabao (dairy and meat)</td>
<td>- Carabao (dairy and meat)</td>
</tr>
<tr>
<td>- Rabbit</td>
<td>- Rabbit</td>
<td>- Rabbit</td>
</tr>
<tr>
<td>Poultry</td>
<td>Poultry</td>
<td>Poultry</td>
</tr>
<tr>
<td>- Chicken (meat and egg)</td>
<td>- Chicken (meat and egg)</td>
<td>- Chicken (meat and egg)</td>
</tr>
<tr>
<td>- Duck (meat and egg)</td>
<td>- Duck (meat and egg)</td>
<td>- Duck (meat and egg)</td>
</tr>
<tr>
<td>- Quail</td>
<td>- Quail</td>
<td>- Quail</td>
</tr>
<tr>
<td>Native animals</td>
<td>Native animals</td>
<td>Native animals</td>
</tr>
<tr>
<td>Feed Resources</td>
<td>Feed Resources</td>
<td>Feed Resources</td>
</tr>
<tr>
<td><strong>Inland</strong></td>
<td><strong>Aquafeeds</strong></td>
<td><strong>Marine</strong></td>
</tr>
<tr>
<td>Mangrove crab</td>
<td>Mangrove crab</td>
<td>Mangrove crab</td>
</tr>
<tr>
<td>Milkfish and other brackishwater fishes (e.g. Kitang, Pompano)</td>
<td>Milkfish and other brackishwater fishes (e.g. Kitang, Pompano)</td>
<td>Milkfish and other brackishwater fishes (e.g. Kitang, Pompano)</td>
</tr>
<tr>
<td>Mussel</td>
<td>Mussel</td>
<td>Mussel</td>
</tr>
<tr>
<td>Tilapia and other freshwater fishes (e.g. Goby/Pijango, Pigek)</td>
<td>Tilapia and other freshwater fishes (e.g. Goby/Pijango, Pigek)</td>
<td>Tilapia and other freshwater fishes (e.g. Goby/Pijango, Pigek)</td>
</tr>
<tr>
<td>Shrimp</td>
<td>Shrimp</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Aquafeeds</td>
<td>Aquafeeds</td>
<td>Aquafeeds</td>
</tr>
<tr>
<td><strong>Timber</strong></td>
<td><strong>Non-Timber</strong></td>
<td><strong>Biodiversity</strong></td>
</tr>
<tr>
<td>Tree plantations (e.g. yemane, falcata)</td>
<td>Tree plantations (e.g. yemane, falcata)</td>
<td>Tree plantations (e.g. yemane, falcata)</td>
</tr>
<tr>
<td>Bamboo</td>
<td>Bamboo</td>
<td>Bamboo</td>
</tr>
<tr>
<td>Rattan</td>
<td>Rattan</td>
<td>Rattan</td>
</tr>
<tr>
<td>Sago</td>
<td>Sago</td>
<td>Sago</td>
</tr>
<tr>
<td>Tiger grass</td>
<td>Tiger grass</td>
<td>Tiger grass</td>
</tr>
<tr>
<td>Vines and other non-timber</td>
<td>Vines and other non-timber</td>
<td>Vines and other non-timber</td>
</tr>
<tr>
<td>Feed Resources</td>
<td>Feed Resources</td>
<td>Feed Resources</td>
</tr>
<tr>
<td><strong>Marine</strong></td>
<td><strong>Biodiversity</strong></td>
<td><strong>Microbial</strong></td>
</tr>
<tr>
<td>Abalone</td>
<td>Abalone</td>
<td>Abalone</td>
</tr>
<tr>
<td>Blue Swimming Crab</td>
<td>Blue Swimming Crab</td>
<td>Blue Swimming Crab</td>
</tr>
<tr>
<td>Cephalopods – cuttlefish, octopus, squid</td>
<td>Cephalopods – cuttlefish, octopus, squid</td>
<td>Cephalopods – cuttlefish, octopus, squid</td>
</tr>
<tr>
<td>Oyster and other shellfish</td>
<td>Oyster and other shellfish</td>
<td>Oyster and other shellfish</td>
</tr>
<tr>
<td>Sardines</td>
<td>Sardines</td>
<td>Sardines</td>
</tr>
<tr>
<td>Sea cucumber</td>
<td>Sea cucumber</td>
<td>Sea cucumber</td>
</tr>
<tr>
<td>Seaweeds</td>
<td>Seaweeds</td>
<td>Seaweeds</td>
</tr>
<tr>
<td>Tuna</td>
<td>Tuna</td>
<td>Tuna</td>
</tr>
</tbody>
</table>

## RESEARCH PRIORITIES for AGRICULTURE, AQUATIC AND NATURAL RESOURCES (AANR)

### A. Crops R&D Agenda
1. Germplasm evaluation, conservation, utilization and management
2. Varietal improvement and selection
3. Production of good quality seeds and planting materials
a. Development/optimization of seed production protocols
b. Establishment of sustainable seed system

4. Cultural Management Practices
a. Soil health, nutrient and water management
b. Development of biofertilizers and soil fertility enhancers
c. Development of eco-friendly pest and disease management and control strategies
d. Development of crop disease diagnostic kits/techniques and disease management protocols
e. Organic Agriculture

5. Crop production systems research
a. Smart farming approaches
b. Off-season production and cultivation
c. Development of climate-resilient technologies
d. Decision support systems

6. Postharvest, processing and product development

Priorities for 2018-2019
- Breeding to develop improved crop varieties, including genomic studies to improve yield and other economically important traits of crops
- Development of good agricultural practices
- Optimization of crop production protocols
- Mapping/surveillance of pests and diseases, including emerging ones
- Use of biologically-based approaches as well as nanotechnology in crop cultural management (e.g. soil nutrient management, pest and disease management)
- Product development from various crops

Priorities for 2020 onward
- Multilocation trials of various technologies
- Mass production of pest and disease resistant varieties of various crops
- Roll out of various mature technologies

B. Livestock R&D Agenda
1. Breed development and genetic improvement (for meat, dairy and draft)
2. Reproductive biotechniques for priority livestock species
3. Nutrition, feeds and feeding system
4. Conservation and improvement of native animals
5. Vaccine, biologics and diagnostics development
6. Detection of chemical residues and anti-microbial resistance
7. Production and management decision support systems
8. Product development and processing
Priorities for 2018-2019

- Native Animals R&D Program
- Application of genomics in breeding and selection
- Improvement of cultural management protocols
- Forage processing, development alternative feed ingredients and feeding systems
- Development of animal breed registry, diagnostic protocols and test kits, traceability systems
- Processing and product development

Priorities for 2020 onward

- Development of quality standards for dairy products
- Pilot testing and/or roll out of various technologies

C. Aquatic R&D Agenda

1. Application of genomics in the study of diseases of aquatic species, improving fish resistance to climate change; molecular phylogenetics; population genetics
2. New cultivable species for culture
3. Development/Refinement of culture systems (broodstock management, hatchery, nursery, grow-out)
4. Fish health, disease diagnostics and disease management
5. Nutrition, feeds and feeding systems
6. Postharvest handling, processing and new product development
7. Mechanization and automated systems for feeding, water and culture management and post production
8. Fishkill warning and mitigation systems and environmental management for sustainable aquaculture
9. Management of fisheries

Priorities for 2018-2019

- Genetic studies and marker development, selective breeding
- Bioinformatics analysis, population genomics
- Improving fish health and nutrition, feeds and feeding systems for improved production performance
- Development/refinement and field testing of culture technologies on economically important species
- Biology, ecology and stock enhancement and population studies
- Ecosystem based fisheries management
- Postharvest handling and processing
Priorities for 2020 onward

- Pest and disease management/surveillance
- Product development, including harnessing pharmaceutical and other uses of aquatic species
- Improving the management of fishery resources
- Offshore fisheries and oceanography
- Roll out of various technologies

D. Forestry R&D Agenda
The following agenda are in support of the government’s Enhanced National Greening Program (ENGP):

1. Development and sustainable management practices
2. Development of high yielding varieties (HYVs) of priority timber species with superior traits
3. Production protocols for the propagation of quality timber and non-timber forest planting materials
4. Development of sustainable harvesting and postharvest techniques/technologies and marketing strategies for timber and non-timber forest species/products

Priorities for 2018-2019

- Genomics assisted breeding for economically important traits of forest species
- Germplasm conservation and management of selected indigenous tree species
- Assessment of forest genetic materials of different tree species
- Pest and disease control
- Establishment of nursery facility for plantation trees

Priorities for 2020 onward

- Roll out of technologies such as high yielding clones, furnace type lumber dryer, engineered bamboo
- Development of high value products

E. Natural Resources and Environment R&D Agenda

1. Sustainable utilization, conservation and management of biodiversity in terrestrial, forestry and marine ecosystems
2. Sustainable watershed management and utilization
3. Management and rehabilitation of problem, degraded and polluted agricultural soils through remediation
4. Development of high value products from agricultural and forest wastes
5. Strategies/decision management tools for climate change resilient environment
6. Resource and ecosystems assessment and monitoring
7. Habitat management for fishery and ecosystem sustainability
8. Marine environmental management (to include Harmful Algal Blooms, coastal integrity/erosion, fish kills and eutrophication)
9. Innovative management systems for unique landscapes and ecosystems

**Priorities for 2018-2019**

- Germplasm conservation of endangered plants
- Development of molecular tools for characterizing harmful algal blooms (HABs), including modelling techniques for prediction/mitigation of HABs
- Molecular and phylogenetic studies of marine resources
- Propagation techniques for economically important species
- Economic valuation and accounting of biodiversity
- Community-based ecotourism projects
- Development of biodiversity products
- Adoption of community-based management protocols in watershed monitoring
- Nuclear studies on corals and marine ecosystem and resources
- Deep resource assessment and monitoring
- Oceanographic and connectivity studies, renewable energy studies and coastal erosion and bathymetric studies

**Priorities for 2020 onward**

- Propagation of economically important plants
- Promotion of livelihood and ecotourism for sustainable watershed management
- Purification of toxins from HAB-selected organisms
- Promotion of community-based PES modules/protocols in selected watersheds
- Pilot testing of biodiversity products
- Proteomic studies on HABs
- New detection and monitoring techniques for HABs
- Development of early warning systems
- Roll out of technologies

**F. Climate Change Adaptation and Disaster Risk Reduction**

1. Mitigation and adaptation studies (including protected agriculture, vertical agriculture)
2. Development of smart farming approaches (including organic agriculture, integrated farming, ICT application) and other climate-resilient agricultural production technologies
3. Development of strategies/decision management tools for climate change resilient environment (e.g. farm diversification)
4. Enhancing sustainable development through lifescape-landscape approach

**Priorities for 2018-2019**

- Development of decision support systems for selected ecosystems
- Rehabilitation strategies for critical mangrove and coastal forest
- Monitoring and detection of ecosystem changes
**Priorities for 2018 onward**
- Rehabilitation of vulnerable ecosystem to climate change
- Enhancement of resiliency of communities

**G. Technology Transfer**
1. Development of innovative and improvement of traditional extension modalities for the efficient transfer of technologies to end-users
2. Upscaling of agricultural technology transfer and commercialization

**H. Socio-Economics and Policy Research**
1. Continuing review of existing policies affecting the AANR sectors
2. Policy research on natural resources/environment-related issues, agricultural trade, supply chain/value chain related issues and R&D governance, compliance to standards across the value chain
3. Impact assessment of technologies, AANR programs and projects
4. Socio-economic studies on production and marketing efficiencies, role of social institutions in technology adoption, labor migration, development of social enterprise models, gender and development
5. Agriculture and resource economic studies including market research, agrarian/asset reform, environmental valuation, economies of scale/collective farming
6. Policy studies on global competitiveness of Philippines AANR sector

The AANR ISP Roadmaps are on pages 62-84.
SECTION IV

INDUSTRY, ENERGY AND EMERGING TECHNOLOGY

Research and Development Agenda
2017 – 2022

Seventeen sectors covering various industries, the energy and transportation sectors, and high impact fields like biotechnology and nanotechnology are within the purview of the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD-DOST). The overarching objective of DOST-PCIEERD is to strengthen these sectors through research and development (R&D) support, human resource and institution development, information and technology diffusion, and development of enabling policies. These programs contribute to the Department of Trade and Industry’s strategy of promoting industry competitiveness - to sustain the tremendous growth in the services and manufacturing sectors experienced over the last six years as well as develop business opportunities in frontier sectors. Such goals are anchored on the Government’s long term goal of attaining genuine and inclusive growth.

The Harmonized National R&D Agenda (HNRDA) for the Industry Sector for 2017-2022 is formulated through targeted consultations with the private sector, National Government Agencies (NGAs) and the academe. This was presented during the National R&D Conference in 2016 and finalized in February 2017. The foundation of the HNRDA are the consolidated individual DOST-PCIEERD sectoral R&D roadmaps which were crafted through a consultative process with key stakeholders and aligned with NGA priorities. To ensure its continued relevance with rapid technological changes and an increasingly globalized economy, each R&D roadmap is periodically assessed and updated during the period 2017-2022.

To secure a truly harmonized R&D strategy within government, the DOST-PCIEERD has entered into several memorandum of agreement with NGAs essentially to seamlessly integrate R&D efforts strategically and even fiscally (through co-implementation and co-funding of projects). By mid-2017, partnerships would have been forged with more than a dozen NGAs including the Department of Energy, Department of Public Works and Highways and Department of National Defense.

Industry competitiveness will focus on micro, small and medium enterprises (MSMEs) and much effort will be provided toward countryside development. Many R&D projects will leverage on existing resources and focus on waste utilization, value-addition of traditional products and efficient manufacturing processes. Lastly, it is noteworthy that four new fields of research are to be included as priority areas for 2017-2022. These are deemed to be emerging industries and critical to national development.

- Space Technology Applications
- Artificial Intelligence and Data Science
- Human Security and Defense Research
- Creative Industries
RESEARCH PRIORITIES for INDUSTRY, ENERGY AND EMERGING TECHNOLOGY

A. Food and Nutrition Security
   Nutritious, safe and affordable food for all, at all times

B. Countryside Development
   More micro, small and medium enterprises (MSMEs) developing and producing competitive and world class products and services

C. Competitive Industry
   More industries enabled by state-of-the-art R&D, technologies and science-based policies, moving up the value chain and attracting foreign direct investments

D. Delivery of Social Services
   Innovative, accessible, affordable and efficient social services for all

E. Intelligent Transportation Solutions

F. Renewable Energy and Energy Storage Solutions

G. Human Security
   Protection of the country and its citizens against national threats

A. Food and Nutrition Security

1. Food Safety and Quality
   a. Affordable Tests for Food Contaminants
      • Rapid test kits, electronic sensors for common food contaminants (Microbiological contaminants, Histamine)
      • Migration test kit for various food packaging materials (paper and plastic)
   b. Development of Food Safety Rating and Grading System for Food Service Establishments
   c. Safe and Regulatory-Compliant Food Products and Processes
   d. Improvement of Food Shelf-life
   e. Innovative Food Products

Priorities for 2018
   • Baseline Studies on Microbiological and Chemical Hazards on Food
   • Science-Based Quality Assurance System for Priority Products (e.g. fresh and processed banana)
   • Value-adding of Fishery By-Products (e.g. fish oil, chitin, collagen)

B. Countryside Development

1. Agro-Processing, Utilization and Value-Adding
2. Natural Products Development
3. Improvement of Textile Processing
4. Halal Processing Technologies for Food and Non-Food
5. Metrology and Testing Methods for Laboratory Analysis  
6. Shop Floor R&D and Innovations  
7. Regional Consortia R&D  

C. Competitive Industries  

1. ICT, Electronics and Semiconductor  
   a. Big Data Analytics  
   b. Artificial Intelligence  
   c. Internet of Things  
   d. Advanced Electronics and Communications (e.g. photonics & opto-electronics devices, semiconductor materials, etc.)  

Priorities for 2018  
• Artificial Intelligence for Industry, Transport, and Education Application  
• Big Data Analytics (Government Data Integration)  
• R&D for Creative Industries  

2. Mining and Minerals - Technologies and processes for small and large scale mining in support to responsible mining  
   a. Green Mining Technology  
   b. Clean Metallurgical Processes  

Priorities for 2018  
• Development of Value-Adding Technologies for Copper, Iron, Chromite, Nickel, Chromium and Gold Minerals for Industrial Application  
• Geological Assessment of Untapped/Undiscovered Minerals (i.e. Black Sand and Trace and Rare Earth Elements)  
• Green Mining Technologies  
• Clean Metallurgical Processes  
  o Hydrometallurgical  
  o Pyrometallurgical  
  o Electrometallurgical  

3. Metals and Engineering  
   a. Advanced Machine-Based or Machine Aided Metalworking and Testing Procedures  
   b. Technologies for Disposal, Recycling, and Treatment of Metal Wastes  

Priorities for 2018  
• Cost Efficient Manufacturing Processes and Equipment to Increase Local Content of Aerospace, Automotive and/or Train Parts and Components  
• Design, Development and Prototyping of Food Processing Equipment for MSMEs
4. Construction  
   a. New Construction Materials and Techniques

5. Packaging  
   a. Smart and Green Packaging Technology  
   b. Appropriate Packaging System for Various Products

6. Industrial Application of Nuclear Technology  
   a. Food and Non-Food Processing  
   b. Non-Destructive Testing  
   c. Product Development  
   d. Environment Monitoring

D. Delivery of Social Services

1. Environment and Pollution Control  
   a. Wastewater Management  
      • Cleaner and safer technologies for application to industrial wastewater, waste management, safe and potable drinking water, and other pressing environmental problems  
      • Field-testing/application of cleaner technologies for the benefit of the industry, domestic households and general public  
      • Materials that detoxify harmful substances in water  
      • Removal and decomposition of spill contaminants and heavy metals  
      • Mineralization of pollutants  
      • Potable water  
      • Storm water and storage and rainwater technologies  
      • Waste Water Remediation  
      • Materials and processes for desalination  
      • Alternative materials and processes that will reduce or eliminate hazardous substances in the environment and manufacturing sites  
      • New wastewater purification technologies and reuse of wastewater purification technologies and wastewater treatment/rehabilitation technologies  
      • Treatment, control, and monitoring sensors and systems  
   b. Air Pollution Control and Management  
      • Reduction of risks of H₂S emission in the environmental and industrial sectors  
      • Emission reduction focusing on efficient and clean technologies  
      • H₂S gas sensor  
      • Spatial data acquisition and management technologies (i.e. Tempospatial Distribution of atmospheric particles (Transboundary))  
      • Nuclear techniques for air pollution monitoring
• Zeolite/bentonite applications in pollution control and mitigation
• Alternative anti-pollutant agents
• Development of optical techniques for air quality monitoring
• Development of sensors for air quality monitoring

c. Solid Waste Management
• Impact on emission of pollution from solid waste
• New product development from solid waste Solid waste minimization

Priorities for 2018
• Water Environment R&D
  o Wastewater Management
• Air Quality R&D
  o Air Pollution Control and Management
• Solid Waste Management
• DRR/CCA Proofing Infrastructure Systems and Techniques
  o Urban infrastructure rainfall inflow-outflow modeling and early warning systems
• Hazards and Risk Assessment Tools and Systems Program
  o Liquefaction Hazard Assessment
• Instrumentation for early warning, monitoring and rapid assessment
  o Forecast Based Financing and Weather Based Insurance Mechanism
• Marine Geology and Oceanography Program
• Human Security
• R&D for Unmanned Aerial Vehicles (UAV), Airborne and Space Technology

2. Space Technology Application (STA)
   a. Development of micro-satellites and space technologies
   b. Use of STA for resource mapping
   c. Application of global navigation satellite system (GNSS)
   d. Airborne and UAV systems for high resolution mapping and other applications

E. Intelligent Transport Solutions

1. Alternative Mass Transport Systems and Components
   a. Land Transport - Develop a sustainable integrated, responsive, effective, efficient and safe land transport systems
      • Cost-effective alternative mass transport systems and components
      • Intelligent vehicle-to-vehicle connectivity and information sharing of speed, lane changing and potential intersection crash warning data for safe vehicle driving
      • Digital infrastructure needs assessment for internet of vehicles implementation
      • Development of ITS control system
      • Expert system for pavement, rail management
• Development of traffic data collection system utilizing CCTV
b. Sea/Water Transport - Develop a safer, cleaner and efficient maritime transport systems and services
• Cost-effective sea-worthy hull design using alternative lightweight materials for passenger and fishing vessels and standard model design
• Low carbon and improving energy efficiency of water craft, e.g. vessel design and sea craft
• Managing maritime traffic and safety systems, such as development localized prototyped automatic identification system (AIS)

2. Traffic/Mobility
a. Intelligent Transport Systems
• Commuters and public utility vehicle information systems
• Intermodal and traffic simulation modeling tools
• Automated traffic monitoring, violation detection, public utility vehicle (PUV) tracking and safety signaling systems
• Traffic signalization mechanization system
b. Other Modes of Mobility
• Unmanned aerial/sea surface vehicle for logistics delivery and humanitarian assistance

Priorities for 2018
• Intelligent Transport System
  o Vehicle-to-vehicle connectivity and information sharing
  o Road infrastructure-to-vehicle
  o Automated Parking Space Detection System
  o Harmonized radio frequency identification (RFID)/wireless sensor network (WSN) using multi-path transmission protocol & cognitive frequency
  o PUV tracking for fleet management & driving behavior
• Sea Transport Research on Marine Vessels
  o Standard sea-worthy hull design using alternative indigenous lightweight materials
  o Navigational Route Capacity Measurement & Analysis for inter-island connectivity
• Mass Transport Systems (Train, PUV)
  o Prototype double decker bus development and fuel efficiency analysis in compliance to Euro 4 Standards
  o Development of Positive Train Control (PTC) components for railway system

F. Renewable Energy and Energy Storage Solutions

1. Energy Efficiency/Alternative Fuels and Conservation
   a. Energy-efficient technologies for industry and buildings
   b. Standards development
2. Renewable Energy (RE) Systems & Bioenergy Technologies - Increase the adaptation and adoption of renewable energy systems
   a. Cost-effective RE technologies and business models integration for sustainable off-grid power supply
   b. Efficient micro-hydro and hydrokinetic turbines
   c. Bioenergy technologies
   d. Wind energy
   e. Solar power concentrators (SCP)
   f. Solar heating and cooling (SHC)
3. Functional materials for alternative energy sources and energy conversion and storage - Systems and processes for surface modification of various materials
   a. Superconducting wires, liquid electrode material systems, superconducting transformers
   b. Cost competitive solar cells
   c. Platinum - and palladium - based anode catalyst for direct ethanol fuel cell
   d. Direct ethanol fuel cell powered LED emergency light

Priorities for 2018
- Smart Energy Efficient Systems for Low Carbon Economy
  o Efficient hydrokinetic energy harvesting systems
  o Sustainable urban waste to energy conversion
- Renewable Energy (RE) Systems
  o RE technologies and business models integration for sustainable off-grid power supply
  o Thermo/electro/biochemical hydrogen production
  o Solar power concentrators (SPC)
  o Solar heating and cooling (SHC)

G. Human Security
   1. Food Defense
   2. Biosecurity
   3. Cybersecurity

Industry, Energy and Emergency Technology Roadmaps are on pages 85-96. For details, visit http://pcieerd.dost.gov.ph/
The 2017-2022 Harmonized National Research and Development Agenda for Disaster Risk Reduction and Climate Change Adaptation (HNRDA DRR-CCA) represents the priorities of government organizations and stakeholders involved in DRR and CCA, consistent with related local and international development initiatives.

The HNRDA DRR-CCA consolidates the priorities of the DOST Sectoral Councils, which have conducted multi-sectoral consultations, DOST agencies and DOST regional offices. The research priorities were evaluated and harmonized by a team from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) with reference to related national plans, such as the National Disaster Risk Reduction and Management Plan, the National Climate Change Action Plan, and global initiatives such as the Sustainable Development Goals and Sendai Framework for Disaster Risk Reduction. Disaster Risk Reduction and Climate Change Adaptation are cross-cutting concerns in the health, agriculture, environment, energy and industry sectors.

The 2030 Agenda for Sustainable Development was adopted by the United Nations (UN) General Assembly in September 2015. It sets out 17 Sustainable Development Goals (SDGs) with 169 associated targets and describes a number of international mechanisms for supporting implementation.

DOST supports the Agenda by focusing substantial efforts to contribute to Goals 9, 11 and 13.

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 13. Take urgent action to combat climate change and its impacts
The Sendai Framework for Disaster Risk Reduction (2015-2030) addresses “the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters, caused by natural or manmade hazards as well as related environmental, technological and biological hazards and risks. It considers climate change as one of the drivers of risk. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors.

DOST supports the Framework by subscribing to the Four Priorities for Action it identified, namely:

Priority 1. Understanding disaster risk
Priority 2. Strengthening disaster risk governance to manage disaster risk
Priority 3. Investing in disaster risk reduction for resilience
Priority 4. Enhancing disaster preparedness for effective response, and to “Build Back Better” in recovery, rehabilitation and reconstruction
The research priorities in the agenda are organized into topics that address the four major action themes for Disaster Risk Reduction and Management:

- Monitoring and Forecasting (Observation and Monitoring Networks, Technology Development and Application for Monitoring, Modelling and Simulation for Improvement of Monitoring and Forecasting)
- Hazard and Risk Assessment (Hazards, Vulnerability and Risk Assessment)
- Warning (Warning and Risk Communication)
- Proper and Timely Response (Technology Development and Application for Climate Change Mitigation and Adaptation, Technology Development and Application for Disaster Risk Management, and Policy Research).

**RESEARCH PRIORITIES for DISASTER RISK REDUCTION and CLIMATE CHANGE ADAPTATION (DRR CCA)**

A. Observation and Monitoring Networks  
B. Technology Development and Application for Monitoring  
C. Modelling and Simulation for Improvement of Monitoring and Forecasting  
D. Hazards, Vulnerability and Risk Assessment  
E. Warning and Risk Communication  
F. Technology Development and Application for Climate Change Mitigation and Adaptation  
G. Technology Development and Application for Disaster Risk Management  
H. Policy Research

**Priorities for 2017 onwards (Items A. to E.)**

**A. Observation and Monitoring Networks** – Development of state-of-the-art observation and monitoring systems for weather, climate, geologic and oceanographic processes.

1. Weather/Climate Observation Systems
2. Hydro-meteorological systems
3. Ocean observation systems (including storm surges, waves)
4. Volcano (seismic, geodetic, geochemical)
5. Earthquake (seismic, intensity meter, accelerometers)
6. Tsunami
7. Landslide
8. Sensor networks
9. Space Systems and Facilities
   a. Small satellite technology
   b. High- to fine-resolution, multi- and hyperspectral sensor payloads
   c. Synthetic Aperture Radar
   d. Integration and Testing Facility
   e. Ground control stations
B. Technology Development and Application for Monitoring – Development of instruments and data processing and analysis systems, application of technologies for improved monitoring of weather, climate, geologic and oceanographic processes.
   1. Hydro-meteorological and oceanographic Instruments
   2. Volcano, earthquake, tsunami and landslide monitoring instruments
   3. Instrument test bed facilities
   4. Radar data processing technologies
   5. LiDAR data processing technologies
   6. Remote sensing (airborne, space) technologies
   7. Data Assimilation System for in-situ and remotely-sensed data

C. Modelling and Simulation for Improvement of Monitoring and Forecasting – Modelling and simulation for improved forecasting and simulation of disaster and climate scenarios.
   1. Numerical Weather, Sub-seasonal and Seasonal Climate Prediction, Climate Change Projection
   2. Quantitative Precipitation Forecasting (QPF) using Numerical Weather Prediction Models
   3. High-Impact Weather (HIW) Forecasting and Warning
   4. Projecting future 1.0°C and 1.5°C Philippine climate using Regional Climate Models and their impacts to different sectors (Health, Food security, Water resources, etc.)
   5. Data analytics and predictive modelling for flood monitoring and management
   6. Geophysical, Geochemical, Geodetic, and related modelling and simulation for geological hazards monitoring and warning
   7. Potential for large-scale eruptions, earthquake, tsunami and landslide generation

D. Hazards, Vulnerability and Risk Assessment – Assessment of hazards, development and update of exposure data base, assessment of vulnerabilities of exposed elements such as communities and specific sectors, structures, livelihood and economy, and potential impacts and losses due to natural disasters and climate change; development of appropriate tools for hazard, vulnerability and risk assessment.
   1. Hazards Assessment (Geological, Hydro-meteorological, Climate-related, etc.)
   2. Exposure Information, Database and Tools
   3. Vulnerability, Capacity and Risk Assessment
   4. Climate Risk (by sector)
      a. DRR/CCA for Agriculture (vulnerability to food insecurity, diversified farming, livelihood, impact assessments, food resiliency in emergencies, etc.)
      b. Climate Resiliency of highly vulnerable groups and communities (women, fisher folks, Indigenous People, coastal communities, etc.)
E. **Warning and Communication of Information** – Development and use of warning and information systems and protocols, determination of stakeholder information needs, for improved warning and communication of information of impending hazardous events and impacts for appropriate preparedness and response.

1. Warning Communication (Geological, Hydro-meteorological, Climate-related hazards, and Impacts)
2. Impact-based/risk-based modelling and forecasting
3. Philippine Unified Meteo-Hydrological Information System
4. Web-based and Mobile phone-based warning and information
5. Geological Disaster Information Portal
6. Risk communication
7. Community traditional media systems
   a. Expansion of lexical domain (i.e. IEC materials)
   b. Indigenous knowledge systems and practices
8. Communicating uncertainties of climate change projections for DRR/CCA

**Priorities for 2018 onwards (Items F. to H.)**

F. **Technology Development and Application for Climate Change Mitigation and Adaptation** – Development and application of instruments, tools, systems, protocols to mitigate climate change by reducing greenhouse gas emissions and to adapt to climate change in all sectors, including food, water, health, environment, businesses, infrastructure and settlement towards a climate change resilient society.

1. Reduction of Greenhouse Gases Emissions
2. Bio-Fuel from Forest Residues
3. Energy-efficient products, Non-fossil fuels
5. Resource efficient and cleaner production for industries
6. Advanced Transport
7. Food, Water, Health Security
8. Decision management tools for climate change-resilient environment

G. **Technology Development and Application for Disaster Risk Management** – Assessment of people’s hazards, climate change and disaster risk perception, gaps and needs and development and application of appropriate options for risk management, development and application of instruments, tools, protocols, and products in all the phases of risk management, from preparedness, mitigation, response and recovery.

1. Stakeholders-needs and disaster-information gap assessment and bridging for disaster
2. Hazards and risk perception or behavior
3. Institutional or social preparedness and response
4. Projections and impact scenarios for preparedness to respond and recover
5. Interactive and dynamic platform for products and services
6. Tools (including software) for mainstreaming DRR-CCA into contingency planning and local development and planning process
7. Technologies and products for disaster mitigation (disaster-prone) and recovery (disaster-stricken) of communities
8. Technologies for addressing drought (i.e. cloud seeding)
9. Climate and disaster resilient infrastructure
10. Climate and disaster resilient livelihood / business (business continuity)
11. Gender equality and integration in science and technology for DRR and CCA partnership

H. Policy Research – Development of policies for climate mitigation and adaptation and disaster risk management
   1. Policy research for Climate Change Mitigation and Adaptation
   2. Policy research for Disaster Risk Management

For details, visit http://www.phivolcs.dost.gov.ph/
http://www.pagasa.dost.gov.ph/
ANNEXES: Roadmaps
1. WATER SECURITY

*TUBIG Program (Tubigay Buhayin at Ingatan)*

<table>
<thead>
<tr>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characterization of water resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GROUNDWATER</strong></td>
<td><strong>RIVERS, RESERVOIR, DAMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impacts on water supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. El Nino</td>
<td>b. La Nina</td>
<td>c. Regional Climate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Water quality assessment for policy per geographical area
- Water availability index

2. FOOD and NUTRITION SECURITY

*SAPAT Program (Saganang Pagkain para sa Lahat)*

<table>
<thead>
<tr>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxonomy and Systematics of flora and fauna for food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Genetic analysis</td>
<td>- Morphological</td>
<td>- Allelopathic</td>
<td>- Ecol-ecology studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw or processed food products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmeceuticals &amp; food supplements</td>
<td>Epidemiology</td>
<td>Microbiology</td>
<td>Chemical</td>
<td>Cost-benefit analysis</td>
<td>Socio-economic analysis</td>
<td></td>
</tr>
</tbody>
</table>

- Regulatory Policies
- Regulatory Policies
3. HEALTH SUFFICIENCY

LiKas Program (Likas Yaman sa Kalusugan)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT</td>
<td>Bio-prospecting for Medicinal Use</td>
<td>RARE ENVIRONMENTS (Caves, Mangroves, mangosporic reefs)</td>
<td>MARINE ECOSYSTEMS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Veterinary studies</td>
<td>ECONOMICALLY IMPORTANT DISEASES</td>
<td>ZOONOTIC DISEASES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Policy recommendation for Republic Acts
- Compounds for potential medicinal use
- Herbal veterinary pharmacopoeia

4. CLEAN ENERGY

ALERT Program (Alternative Energy Research Trends)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT</td>
<td>Alternative Energy</td>
<td>RESOURCE ASSESSMENT OF POTENTIAL ALTERNATIVE ENERGY SOURCES</td>
<td>COMMERCIAL VIABILITY STUDIES</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Inputs for RDIs, Councils and Industry
5. SUSTAINABLE COMMUNITIES

SAKLAW Program (Sakolo sa Lawa)

<table>
<thead>
<tr>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OUTPUT**

- Assessment of lakes;
- Policy recommendations for lake development and conservation

**Coastal Vulnerabilities**

- a. Risk assessment
- b. Geohazard mapping
- c. Adaptive capacities
- d. Marine geology
- e. Oceanography
- f. Computational and numerical modelling

**Highly vulnerable ecosystems (DENR)**

**Resource Extractive Industries**

- Mining areas (logging, quarrying)

**OUTPUT**

- Regulatory policies, remediation strategies
### 6. Re-engineering the Philippines towards inclusive Nation-Building

#### ATIN Program (Ang Tinig Natin)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Retrieval and Documentation Studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Indigenous culture (culture, practices, technologies)</td>
<td>b. Popular culture (culture, practices, technologies; social media)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MINDANAO/ VISAYAS/ LUZON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### NIBRA Roadmaps

**OUTPUT**

- Documentation of Philippine indigenous and popular culture
- Documentation and preservation of Philippine arts and art forms

---

### 6. Re-engineering the Philippines towards inclusive Nation-Building

#### ATIN Program (Ang Tinig Natin)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>National Security</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Governance (Federalism)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal conflicts and Peace Studies (models &amp; frameworks, socio-economic impacts, metrics and in dices, KAPS, governance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maritime and geopolitical studies (WFS): strategic issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASEAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OUTPUT**

- Case studies
- Models
- Policy Recommendations
The health R&D agenda in the Harmonized National R&D Agenda (HNRDA) 2017-2022 will be part of the National Unified Health Research Agenda (NUHRA) for 2017-2022. The NUHRA, a major document of the Philippine National Health Research System, serves as the country’s template for health research and development efforts. The NUHRA 2017-2022 will be launched in August 2017.

**BACKGROUND INFORMATION**

The National Unified Health Research Agenda or the NUHRA, a major document produced by the Research Agenda Committee (RAC) of the Philippine National Health Research System (PNHRS), serves as the country’s template for health research and development efforts. The very first NUHRA specified the health research areas and topics that need to be addressed for 2006-2010. It was launched in 2006 and then updated in 2008. The NUHRA was a product of a series of regional and national consultations with stakeholders.

With the conclusion of the 5-year research agenda in 2010, an assessment of the NUHRA 2006-2010 to include the updated NUHRA 2008-2010 was done to determine its relevance and implementation. Findings of the assessment revealed that the NUHRA’s formulation process was perceived as highly participatory and effective involving various stakeholders at the provincial, regional, and national levels. Despite limitations in budget and time, the NUHRA was developed, with the health research priorities perceived as relevant to the country’s public health situation particularly addressing the health issues of the poor and disadvantaged segments of the population. On the downside, private sector participation in the process was perceived as minimal. Further, the research priorities were seen as too public health oriented and too many with the limited resources for research. With regard to the process of formulating the NUHRA 2011-2016, some respondents opined that having a new series of consultations would not yield new health research priorities since the country’s public health situation has not changed.

The new NUHRA 2011-2016, still a product of consultation, is a consolidation of the research priorities of the four core agencies of the PNHRS, namely the Department of Health, the Philippine Council for Health Research and Development – Department of Science and Technology, the Commission on Higher Education, and the National Institutes of Health, University of the Philippines – Manila. Each of the core agencies had their respective research priority setting activities where stakeholders’ consultation is integral in the formulation of their research agenda.

In the light of the NUHRA assessment findings, the RAC resolved to focus the research agenda on research priorities where there is greater assurance of funding and commitment from the core agencies.
NATIONAL UNIFIED
HEALTH RESEARCH AGENDA
2011-2016

PURPOSE

- To provide focus and direction on health research and development efforts that will address the country’s health concerns for 2011-2016

- To serve as a guide where policy makers, funding and donor agencies and researchers from public and private sectors should invest to ensure the health and productivity of the country’s citizenry

- To assist in providing evidence based solutions to pressing national and local health problems

- To serve as basis to maximize resource utilization and minimize duplication of research efforts

FRAMEWORK

The formulation of the NUHRA 2011-2016 is anchored on the following national and international commitments:

The Millenium Development Goals (MDGs), which are eight international development goals adopted by countries to eradicate extreme poverty and hunger, reduce child mortality rates, improve maternal health, combat diseases, ensure environmental sustainability, achieve universal primary education, gender equality, and develop global partnership for development by the year 2015.

The Philippine Development Plan 2011-2016, the country’s development blueprint that intends to give the Filipino people a better chance of finding their way out of poverty, inequality, and the poor state of human development. Chapter 8 of the plan covers social development which translates inclusive growth by ensuring equitable access to adequate and quality basic social services and assets especially by the poor and vulnerable. The health strategies aim to provide full financial protection, improve access to quality health care facilities, and attain the MDGs by focusing on the following public health
programs: maternal and child health, TB, dengue, malaria, and HIV-AIDS in addition to emerging diseases, and non-communicable diseases such as cancer, diabetes mellitus, and end-stage renal disease.

The “Aquino Health Agenda: Achieving Universal Health Care for all Filipinos” provided for three strategic thrusts to achieve universal health care or “Kalusugan Pangkalahatan” (KP), i.e., 1) rapid expansion in the National Health Insurance Program (NHIP) enrollment and benefit delivery using national subsidies for the poorest families; 2) improved access to quality hospitals and health care facilities through accelerated upgrading of public health facilities; and 3) attainment of the health-related MDGs by applying additional effort and resources in localities with high concentration of families who are unable to receive critical public health services.

The Presidential Coordinating Council on Research and Development’s (PCCRD) National R&D Priorities Plan 2011-2016, which will serve as a guide in the allocation and utilization of government R&D funds and as a coordination tool to synchronize all R&D efforts in the government. The plan covers the development of priority products and technologies for 10 priority sectors including health.

The DOST Five-Point Priority Program for 2011-2016 supports the following: development of solutions to pressing national problems; development of appropriate technologies to create growth in the countryside; harnessing technology to improve competitiveness; using S&T to enhance delivery of government and social services; harnessing emerging technologies to boost national competitiveness; and other support programs.
METHODODOLOGY

The formulation of the core agencies’ research agenda is grounded on a consultation process. The Department of Health (DOH), Philippine Council for Health Research and Development – Department of Science and Technology (PCHRD-DOST), Commission on Higher Education (CHED), and the National Institutes of Health - University of the Philippines Manila (NIH - UPM) separately conducted several consultations as part of their research priority setting activities.

DOH

Mostly operational in nature, the DOH agenda underwent a process of consultation with all the concerned DOH offices including the Centers for Health Development and health partners. Health issues and concerns were also elicited from the existing documentation of management meetings and experts’ inputs through multisectoral multidisciplinary consultations. Values criteria were used to prioritize the agenda relative to its plan of implementation.

PCHRD-DOST

The PCHRD-DOST research priorities evolved from the PCCRD National R&D Priorities Plan (NRDPP) 2011-2016 and the DOST 5-point priority program for 2011-2016. The PCCRD NRDPP resulted from a series of consultation with stakeholders to include those from the regions.

The health research priorities in the NRDPP were presented to experts and stakeholders from the public and private sectors for validation and/or refinement. The consultation activities were guided by the criteria for technology identification and for priority setting.

CHED

The natural sciences research priorities which include the health related priorities were initially identified in a series of consultations with a group of technical experts. The output of the experts’ consultation was referred to the CHED Technical Panel for Natural Sciences for review and endorsement.
NIH - UPM

The research priorities were discussed and finalized in a management action planning workshop involving scientists and management of the NIH - UPM together with those from other units and colleges of UP Manila.

RESEARCH PRIORITIES

The research priorities are classified into four major areas, specifically health technology development, health financing, health service delivery, and socio-environmental health concerns. Specific priority research topics are listed for each major research area.

HEALTH TECHNOLOGY DEVELOPMENT

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
</table>
| Diagnostics   | Development of diagnostic kits for priority infectious diseases and non-communicable diseases for the early detection and/or prediction of disease and mortality, utilizing existing technologies that are off-patent or lapsed technology and/or novel technology. Such technology will also look at genetic or biological markers associated with DM, CVD, and cancer. | - Point of care
  - Latex agglutination
  - Lateral flow assay
  - Dipstick
  - Isothermal device
  - Biosensors |
| Priority diseases: | | |
| Infectious diseases | | |
| 1. Dengue and dengue-like illness | | |
| 2. Multidrug Resistant/Extensively Drug Resistant Tuberculosis (MDR/ XDR TB) | | |
| 3. Drug-Resistant Malaria | | |
| 4. Influenza-like illness | | |
| 5. Leptospirosis | | |
| 6. Sepsis | | |
| 7. Human immunodeficiency virus (HIV) | | |
| 8. Hepatitis | | |
| Screening/ Confirmatory/ Prognostic | | |
| - Latex agglutination | | |
| - Lateral flow assay | | |
| - Dipstick | | |
| - Isothermal device | | |
| - Biosensors | | |
| - Immunoassay | | |
| - Nucleic Acid Testing | | |
| - Immunochemistry | | |
### National Unified Health Research Agenda 2011-2016

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
</table>
| **Diagnostics** (cont’d) | Non-communicable diseases | - Omics technology  
- Biomarker identification via:  
  - Genomics  
  - Transcriptomics  
  - Proteomics  
  - Metabolomics  
- Host-pathogen omics  
  - Adult stem cells  
  - Mesenchymal/cord/ induced pluripotent stem cells |
  | 1. Myocardial infarction  
2. Colorectal cancer  
3. Stroke  
4. Diabetes Mellitus  
5. Breast Cancer  
6. Autoimmune/Immunologic diseases or deficiencies | **Genomics / Molecular technology** |
| **Molecular technology** | Molecular and genomics technologies use the information in the human genome in the design of vaccines, therapeutics, and diagnostic devices or products.  
Priority diseases:  
1. Cardiovascular Diseases (CVD)  
2. Infectious Diseases (TB, Dengue, and Influenza)  
3. Cancer  
4. Diabetes  
5. Neurodegenerative Diseases  
For cancer:  
1. Breast Cancer  
2. Lung Cancer  
3. Liver Cancer  
4. Cervical Cancer  
5. Colon Cancer | - Candidate biomarkers  
1. Cardiovascular disease: CYP3A4, CYP2C9, CYP2B6, P2Y12 (drug resistance markers applicable to other diseases)  
2. Infectious diseases: HLA-A, HLA-B, etc., dengue serotypes 1-4, pfmdr1  
3. Cancer: TAG72, EGFR, VEGF, ER1, caspase3, CD44, p53  
4. Diabetes: adiponectin, apolipoprotein B, C-reactive protein, ferritin  
5. Neurodegenerative disease: beta amyloid protein, total tau protein, phosphorylated tau |

---

HNRDA 2017-2022 | Page 53
### NATIONAL UNIFIED HEALTH RESEARCH AGENDA 2011-2016

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drug discovery and development</strong></td>
<td>Researches will aim to discover new drugs which can be developed up to the pre-clinical stage. It will involve the discovery of compounds or molecular drug targets (genomics) that can serve as candidates for drug development. Drugs will be developed for common infectious diseases and lifestyle related disorders.</td>
<td>• Pre clinical drug development from natural substances (herbal and marine sources)</td>
</tr>
<tr>
<td><strong>Functional foods</strong></td>
<td>Researches will involve the determination of health benefits and safety assessment of food or food components in reducing risk for disease occurrence, specifically lifestyle related diseases such as CVD, diabetes, and cancer.</td>
<td>• Malunggay</td>
</tr>
<tr>
<td><strong>Hospital Equipment and Biomedical Devices</strong></td>
<td>Development of affordable, safe and reliable hospital equipment and biomedical devices.</td>
<td>• Yacon</td>
</tr>
<tr>
<td><strong>Information and Communication Technology (ICT) for Health</strong></td>
<td>Development of user-friendly ICT solutions to accelerate the gathering and processing of health and related information for policymaking, and to deliver quality healthcare services</td>
<td>• Coconut products (coconut flour, coco sap sugar)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ginger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Brown rice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Probiotics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sago palm tree</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ventilator (Adult / Neonatal)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Prosthesis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Minimally invasive surgical and rehabilitation equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• LED Operating Room lights</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Anaesthesia machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Public Health Surveillance/Health Intelligence Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Telehealth services and systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Interface for ICT-enabled medical devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ICT-enabled health services</td>
</tr>
</tbody>
</table>
HEALTH FINANCING

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
</table>
| Financial Risk Protection     | Financial risk reduction means eliminating, if not greatly reducing the amount patients must pay out of pocket to avail health services. The Benefit Delivery Review jointly conducted by DOH and PhilHealth in 2008 highlighted the need to increase enrollment coverage, improve availing of benefits and increase support value in order for the NHIP to provide Filipinos substantial financial risk protection. | • Health Budget Expenditure Studies (Regular and Special Budgets)  
  Evaluation and assessment of existing health budget and expenditures; National vs. Local, and Government of the Philippines (GOP) vs. external budget allocations  
  Analysis of the DOH budget and Health Sector Expenditure using Expenditure Tracking System (ETS) and System of Health Accounts (SHA)  
  • Sub-Accounts for Non-Communicable Diseases including trauma  
  Determine the cost of preventive interventions versus cost of care for non-communicable diseases including trauma  
  • Assessment and impact studies in enhancing Payment Provider Mechanisms  
  Application of Benefit Delivery Reviews to increase/improve support value, benefits and coverage  
  No Balance Billing Policy: Assessment / evaluation of implementing No Balance Billing in DOH Hospitals  
  Case Mix Implementation: Initial evaluation of 23 case payments in hospitals  
  Out patient benefit mechanisms and monitoring and evaluation systems  
  Effects of increased Sponsored Program (SP) enrollment on the income of private hospitals  
  • Assessment of PhilHealth Benefits  
  Assess outpatient benefit package for regular and sponsored programs to support program scale-up or expansion |

8
## Financial Risk Protection

### (cont'd)

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Legal research to review the NHIP Law</em></td>
<td><em>Legal research to review the NHIP Law and its Implementing Rules and Regulations</em></td>
<td><em>Entitlements of all Filipinos under Kalusugan Pangkalahanan (KP)</em></td>
</tr>
<tr>
<td><em>Studies related to catastrophic</em></td>
<td><em>Studies related to catastrophic coverage</em></td>
<td><em>Studies on catastrophic illnesses, prioritization of illnesses, extent of the coverage, and the needed premiums</em></td>
</tr>
<tr>
<td><em>Engaging the private sector</em></td>
<td><em>Engaging the private sector for provision of supplemental benefits</em></td>
<td><em>Role of HMOs and other private insurance in the social health insurance schemes, e.g. role of private sector in providing supplemental package</em></td>
</tr>
<tr>
<td><em>Validating case rates and mechanisms</em></td>
<td><em>Validating case rates and mechanisms for price setting</em></td>
<td><em>Validating case rates and mechanisms for price setting</em></td>
</tr>
<tr>
<td><em>Studies related to premiums paid for</em></td>
<td><em>Studies related to premiums paid for health coverage</em></td>
<td><em>Effect of increased SP premium of national government on the local government unit's (LGU) enrollment of informal poor</em></td>
</tr>
<tr>
<td><em>Effect of increasing the premium for</em></td>
<td><em>Effect of increasing the premium for overseas Filipino workers (OFW)</em></td>
<td><em>Effect of increasing the premium for overseas Filipino workers (OFW)</em></td>
</tr>
<tr>
<td><em>Implication of increasing the premium of</em></td>
<td><em>Implication of increasing the premium of the poorest sector on the contribution of other PhilHealth Members</em></td>
<td><em>Implication of increasing the premium of the poorest sector on the contribution of other PhilHealth Members</em></td>
</tr>
<tr>
<td><em>Capitation estimates of outpatient and</em></td>
<td><em>Capitation estimates of outpatient and inpatient services</em></td>
<td><em>Capitation estimates of outpatient and inpatient services</em></td>
</tr>
<tr>
<td><em>Studies on improving the NHIP</em></td>
<td><em>Studies on improving the NHIP coverage, availability, and support value</em></td>
<td><em>Studies on improving the NHIP coverage, availability, and support value</em></td>
</tr>
<tr>
<td><em>Investments and resources to</em></td>
<td><em>Investments and resources to implement KP</em></td>
<td><em>Investments and resources to implement KP</em></td>
</tr>
</tbody>
</table>
## NATIONAL UNIFIED HEALTH RESEARCH AGENDA 2011-2016

### HEALTH SERVICE DELIVERY

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
</table>
| Improving access to quality hospitals and health care facilities | To improve access to quality hospitals and health facilities, government-owned and operated hospitals and health facilities will be upgraded to expand capacity and provide quality services. The capacity to attend to traumatic injuries and other type of emergencies and manage common causes of morbidity and mortality especially non-communicable diseases and their complications will be enhanced. | • Responsiveness of health system  
  Determine access and satisfaction levels of clients, especially the poor on health services, facilities, human resource and other resources  
  • Public-Private Partnership  
  Determine potential resource, capacities, gaps of private sector to beef-up support for universal health care (UHC) implementation according to strategic instruments or goals (e.g., human resource, technology, health facility enhancement)  
  • Review and analyze the existing Basic Emergency Obstetric and Newborn Care (BEmONC) and Comprehensive Emergency Obstetric and Newborn Care (CEmONC) system in terms of facilities, human resource expertise, usage and usefulness  
  • Evaluate functionality of each Rural Health Unit (RHU) and Barangay Health Station (BHS) in relation to district hospitals |
<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
</table>
| Improving access to quality hospitals and health care facilities (cont’d) | Determine voice of customer  
What are the actual health needs of patients suffering from chronic illnesses such as dialysis?  
How can patients at risk of nutritional deficiencies be cared for?  
New and alternative ways of health care delivery  
How health care can be extended to the settings of home and community particularly for chronic diseases  
Human resources and capacities needed | |
| Improving provision of public health services | Although the overall health status of Filipinos has improved, the Philippines is lagging behind in reducing maternal and infant mortality. Disparities in health outcomes are evident across income levels and geographic areas. KP aims to improve provision of public health services to achieve the MDGs. | Improve design and implementation of public health surveys  
Establish national demographic health survey (NDHS) with provincial level disaggregation to provide data for managing performance of Province-wide Health System (PVHS)  
Local Health Governance  
Optimal level of devolution to establish effective local health governance  
Data on geographically isolated disadvantaged area (GIDA)  
Establish data on GIDA and their performance to provide data for managing inequities  
Data on urban health  
Establish data on wealth classification of barangays in cities and their performance to provide data for managing inequities in urban slums (possibly, using the DSWD method) |
<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving provision of public health services</td>
<td>- Health Needs and Services for Special Population Groups</td>
<td>• Occupational Health Services for the Informal Sector</td>
</tr>
<tr>
<td>(cont’d)</td>
<td></td>
<td>Determine appropriate occupational health services for the Informal Sector through the Rural Health Units or Mobile Clinics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Overseas Filipino Workers (OFWs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide in-depth data and analysis on the desired and required health services for OFWs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Elderly/Seniors/Garantisadong Pangmatanda</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide in-depth data and analysis on the desired and required health services for OFWs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Health Promotion for High Risk Individuals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Health Promotion for High Risk Individuals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Determine impact of health promotion activities for high risks individuals (e.g., smoking, non communicable diseases, etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Models for access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Determine models that will increase and sustain access to health services by the urban poor, people living in GIDAs, indigenous peoples, persons with disabilities, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enhancement of service delivery and referral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Problems and successes on the use of sea ambulances and mobile bus clinics in the delivery of health services</td>
</tr>
<tr>
<td>Research Area</td>
<td>Description</td>
<td>Specific technologies/topics</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------</td>
<td>-----------------------------</td>
</tr>
</tbody>
</table>
| Improving provision of public health services (cont’d) | - Capacitating Human Resources for Health Human Resources for Health (HRH) Master Plan Reformulation  
  - Inventory of staff complement and capacities and technology support to implement UHC programs and thrusts. Funding and technical assistance implications  
  - Evaluation of service provision programs e.g., Nurses Assigned in Rural Services (NARS) project, RNHeals (Registered Nurses for Health Enhancement and Local Service)  
  - Strengthen HR commitment to physical therapy (PT) care through annual credentialing and privileging, both permanent and temporary  
  - Need to regulate Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) providers and standardize their training |  
|                                  | - Efficient approach/model for scale up of deployment of community health teams (CHT)  
  Time motion study for CHT to produce output  
  Evaluation of CHT performance and impact on access to health care (safety, accessibility, and affordability)  
  Sustaining CHT mobilization (logistics)  
|                                  | - Contracting and Procurement  
  Review/assess the implementation of the Procurement Law in DOH. Identify bottlenecks and challenges |
### NATIONAL UNIFIED HEALTH RESEARCH AGENDA 2011-2016

#### Research Area | Description | Specific technologies/topics
---|---|---
Improving provision of public health services (cont’d) |  | • Performance and Budget Utilization Reviews
Comprehensive report and profile of DOH-Central Office, LGU, CHD, hospital and donor performance
Integrated reports on Monitoring and Evaluation for Effectiveness and Equity (ME3) and Performance Governance System (PGS) budget (regular, sub-allotment, grants) reviews and reports

#### SOCI-OENVIRONMENTAL HEALTH CONCERNS

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Description</th>
<th>Specific technologies/topics</th>
</tr>
</thead>
</table>
Environmental and climate change | Disease transmission is affected by environmental health which refers to the control of physical, biological, chemical and socio-cultural factors. Climate change is one of the components of environmental change. In reality, it is just one dimension of change brought by the environment. | • Studies to develop cost-effective technologies to prevent / control / monitor environmental pollution
• Development of integrated interventional models to reduce prevalence of infectious diseases affected by changes in the environment (e.g., malaria, dengue, leptospirosis, cholera and typhoid, tuberculosis MDR and XDR)
• Correlation of climate sensitive diseases to increased temperature, rainfall, and humidity
• Reduction of prevalence of water and sanitation related diseases |
Health social sciences (including community development) | Diseases are not merely products of pathological processes due to infection, stress, etc., but they are also products of the interaction of bio- psychosocial and cultural milieu. Political and policy decisions of the state impact on health of the people. An understanding of the non-biological character of health would deepen the understanding of health and disease, and dynamics of disease. | • Health social science approach in health research and community development to address emerging concerns/issues on sexual and reproductive health, childhood illnesses, chronic illnesses, and mental health. |
ANNEX 6
AANR Programs/Projects
Roadmaps

CROPS

ABACA
R&D Roadmap
- Testing of new disease resistant variety
- MAPPING OF DISEASE
- Commercialization with private sector
- Multilocation trials/Technology upscaling of BC3
- Mapping/ surveillance of diseases/emerging diseases
- Variety registration
- Policy and IP concerns on the adoption and different uses of hybrids
- Policy for the distribution of planting materials
- Testing of hybrids for different uses
- Testing of new hybrid – BC3 (until 2020)

Multilocation trials/Technology upscaling

BANANA
R&D Roadmap
- Impact assessment of developed banana technologies
- STCBF of short-statured Saba
- Variety testing for banana
- Multilocation evaluation of short-statured Saba
- STCBF of short-statured Saba, FW resistant Cavendish and BBTV-resistant Lakanan
- SCBF of short-statured Saba, FW resistant Cavendish and BBTV-resistant Lakanan
- Policy advocacy on virus indexing of Saba for BBTV
- Social attributes to technology adoption in banana
- Examination of farm management efficiencies in banana
- Trade market policy analysis
- Value chain analysis of Saba in Reg. IV-A
- Multilocation evaluation of short-statured Saba
- Survey, indexing, and rehabilitation of short-stature Saba foundation stock for BBTV
- Pre-commercialization assessment of FW-resistant Cavendish and BBTV-resistant Lakanan
ANNEX 7

AANR Programs/Projects
Roadmaps

CROPS

### COCONUT

**R&D Roadmap**

- Increased yield by 228% from 46 (2012) to 150 nuts/tree/year (2021)
- Reduced CSI infestation (2017)
- Improved quality planting materials (2020)
- Increased income by for coconut farming communities (2021)

- Technology upscaling (STCBF/STMF)
- Commercialization of coconut products
- Multi-location trials for pummelo-derived seedlings
- Impact assessment

- Nursery and field management of pummelo-derived seedlings
- Social attributes to technology adoption

- Ex-vivo establishment of pummelo-derived plants
- Biomarker and linkage map development for early flowering, oil, nut yield, water content, and CSI resistance
- Marker-assisted breeding of coconut and dissemination of seedlings
- Development of web-based genome database
- NGS Eco-TILLING for insect resistance

### COFFEE

**R&D Roadmap**

- Increase in productivity from 0.3 to 2.1 m/ha
- Improved quality of green coffee beans to Grade 1 for local and export market

- Technology upscaling (STCBF/STMF)
- Commercialization/Roll out of production and postharvest technologies

- Technology piloting (soil, nutrient, tools and machinery)
- Development of DNA-based disease detection tool kit

- Pilot (nutrient and water mgmt, mg strategies for organic coffee, postharvest tools)
- STCBF on coffee production & processing
- Development of DNA-based tool for ID of coffee variety
- Molecular and morphological analysis of fungal pathogens
- Development of real time monitoring system for coffee

- Application of nano-fertilizers
- Product development from coffee waste
- Genomics-assisted identification of molecular markers
- Soil, nutrient and water management
- Postharvest technologies
- Enhancement of micropropagation techniques
- Conservation and management of coffee genetic resources
- RS and GIS-based suitability assessment
- Standardized evaluation of Philippine specialty coffee
CROPS: LEGUMES

MUNGBEAN R&D Roadmap

- Increased yield (0.86 m/ha to 1.2 m/ha)
- Developed varieties for adverse conditions
- Sustained availability of high-quality seeds
- Reduced pest & disease incidence by 30%
- Viable enterprises for mungbean-based nutri products

PEANUT R&D Roadmap

- Increased yield (1.40 m/ha to 3.20 m/ha)
- Developed improved peanut varieties
- Sustained availability of high-quality seeds
- Reduced pest & disease incidence by 56%
- Viable enterprises for processed peanut products
- Reduced PH losses and increased production efficiency

ANNEX 8
AANR Programs/Projects Roadmaps
ANNEX 9
AANR Programs/Projects Roadmaps

CROPS

<table>
<thead>
<tr>
<th>Year</th>
<th>Roadmap</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>Mango</td>
<td>Registration of stop-gap varieties and hybrids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pilot-testing of stop-gap varieties and hybrids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upscaling/commercialization of processing technologies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impact assessment of technologies generated/adopted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pilot testing of tools and equipment (mango picker, power sprayer, and integrated postharvest facility)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development of technology for minimal processing of ‘Carabao’ mango</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analysis of policy issues - Farmer-contractor agreement, GAP adoption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shell life study of seed lot for true-to-type ‘Carabao’ mango</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optimization of nutrient &amp; water management recommendations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improvement of IPM strategies against mango pests and diseases (pest fly etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policy study on regulatory use of seed lot for identification of true-to-type ‘Carabao’ mango variety and continuous funding of long gestation programs affected by changes in the political climate (e.g. breeding)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social attitude on technology adoption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examination of farm management efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transformation assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IP filing for the last lot for true-to-type ‘Carabao’ mango</td>
</tr>
<tr>
<td>2018</td>
<td>Mango</td>
<td>Development of new hybrids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Characterization of ‘Carabao’ and other Mango Varieties with Resistance to Fruit fly and Anthracnose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identification of Molecular Markers</td>
</tr>
<tr>
<td>2019</td>
<td>Mango</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>Mango</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>Mango</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mango</td>
<td></td>
</tr>
</tbody>
</table>

RICE

<table>
<thead>
<tr>
<th>Year</th>
<th>Roadmap</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>RICE</td>
<td>34% increase in rice production (from 4.02 to 5.40 t/ha in irrigated areas)</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Prolonged shelf life of brown rice from 1-3 months to 6-8 months</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>25% volume of water saved in project sites</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Technology upsizing (STCBP/STMF) carrageenan in rice, IRUE</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Carrageenan and IRUE publication</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Computational database system for rice</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Establishment of rice machinery facilities</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Commercial hubs for Carrageenan PGP</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Pre-commercialization studies: Carrageenan PGP, Impeller-type rice mill, HT-attached transplanter and harvester, and riding-type transplanter</td>
</tr>
<tr>
<td></td>
<td>RICE</td>
<td>Rice Resource Database System</td>
</tr>
<tr>
<td>2018</td>
<td>RICE</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>RICE</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>RICE</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>RICE</td>
<td></td>
</tr>
</tbody>
</table>

IRUE rice variety trials |
Rice mechanization |
Field verification testing of Carrageenan in Rice in selected regions |
Integrative genomics workbench for rice science |
Manifold assessment study on Carrageenan PFS |
Nutritional and management studies in rice |
Carrageenan product stability testing |
Brown rice product development |
Standards to improve design and performance efficiency of rice machines.
ANNEX 10
AANR Programs/Projects
Roadmaps

CROPS: ROOTCROPS

Sweetpotato

R&D Roadmap

- Identification of natural enemies and strategies for biological control of insect pests (UPLB, BFAR)
- Development strategies for biological control of major diseases (UPLB, BFAR)
- Pilot testing of cutter, stripper and loader (MIHRC, BFAR)
- Commercialization of harvester (PHI-Mech, BFAR)
- Commercialization of narrow N, P, K fertilizer (UPLB)
- Promotion of water and nutrient management systems

- Identified yield (5 mt/ha to 20 mt/ha)
- Enhancement/establishment of SP value chains for Food in selected areas in Tafael, Albay, Leyte and Samar

- Pilot testing of cutter, stripper and loader (MIHRC, BFAR)
- Commercialization of harvester (PHI-Mech, BFAR)
- Commercialization of narrow N, P, K fertilizer (UPLB)
- Promotion of water and nutrient management systems
- Development of smart water and nutrient management systems (CSU, PIHAR, BFAR)
- Design and development of harvesters (PHI-Mech, BFAR)
- Design and development of cutter, stripper and loader (MIHRC)

- Increased yield (5 mt/ha to 20 mt/ha)
- Enhancement/establishment of SP value chains for Food in selected areas in Tafael, Albay, Leyte and Samar

- Technology upscaling (STCBP/STMF)
- Development of value chain for food in Leyte and Samar
- Enhanced value chain analysis for food in Taffael
- Enhanced value chain analysis for food in Albay
- Develop mechanized zero waste 5P processing system
- Technology upscaling (STCBP)

CROPS

SUGARCANE

R&D Roadmap

- Increased sugar productivity from 60 tons cane/ha to 100 tons cane/ha
- 15-25% less fertilizer inputs
- 50-75% less labor required in harvesting

- Identification of natural enemies and strategies for biological control of insect pests (UPLB, BFAR)
- Development strategies for biological control of major diseases (UPLB, BFAR)
- Pilot testing of cutter, stripper and loader (MIHRC, BFAR)
- Commercialization of harvester (PHI-Mech, BFAR)
- Commercialization of narrow N, P, K fertilizer (UPLB)
- Promotion of water and nutrient management systems
- Development of smart water and nutrient management systems (CSU, PIHAR, BFAR)
- Design and development of harvesters (PHI-Mech, BFAR)
- Design and development of cutter, stripper and loader (MIHRC)
ANNEX 11
AANR Programs/Projects
Roadmaps

CROPS: TROPICAL FRUITS

CITRUS
Roadmap
- Increased yield (4.5 t/ha to 15 t/ha); and improved fruit quality
- Reduced pest & disease incidence (75% to 20%)
- Reduced postharvest losses (25% to 10%)
- Technology upscaling (STCBF/STMF)
- Commercialization of citrus products
- Impact assessment of technologies generated/adopted
- Policy study on transfer of planting materials
- Citrus Resource System development
- Supply chain study for calamansi in Reg. IV
- Production area and disease mapping
- PH studies on disease control and shelf life
- Product development
- Packaging material development
- Breeding for new varieties
- Social attribute on technology adoption
- Examination of farm management efficiency
- Trade/Market assessment
- Value chain analysis on Citrus in Reg. II
- Genebanking
- QPM Production System
- Pest & disease management
- Soil nutrient & water management

DURIAN
R&D Roadmap
- Increased yield by 115.44% from 5.57 to 12 mt/ha
- Improved durian fruit quality
- Extended harvesting season by 2 months
- Technology upscaling on Durian GAP
- Development of GAP on Durian
- On-farm verification on the adaptability of fertilizer recommendation
- Validation of formulated fertilizer recommendation in durian
- GIS-aided soil suitability classification for durian in Davao and Cotabato
- Optimization of fruit production and fruit quality improvement through pruning, detopping, flower and fruit thinning, and fertilization
ANNEX 12
AANR Programs/Projects
Roadmaps

CROPS: TROPICAL FRUITS

**PAPAYA**
R&D Roadmap
- Increased yield (19.25 mt/ha to 38.50 mt/ha)
- Reduced disease and insect pest incidence by 80%
- Reduced postharvest losses (30% to 12%)
- Commercialization of papaya varieties with thick skin and resistance/tolerance against insect pests and diseases
- Impact assessment of technologies generated/adopted
- Mass production of PRSV-tolerant F, papaya hybrids and OPVs by micropropagation
- Technology transfer and promotion of mature technologies
- Development of optimized procedures for SSR marker identification of hybrids and OPVs
- Optimization of processing technologies and products
- Development of papaya varieties with resistance/tolerance against insect pests and diseases
- Development of optimized nutrient, soil & water management recommendations
- Optimization of postharvest and packaging technologies
- Social attribute on technology adoption
- Examination of farm management efficiency
- Trademark assessment
- Packaging material development
- Development of sustainable management practices for emerging pests & diseases e.g. Bacterial Crown Rot or BCR

**QUEEN PINEAPPLE**
R&D Roadmap
- 274.5% increase in average yield from 34.7 mt/ha to 42.36 mt/ha;
- 20% reduction in pest and disease damage;
- 380% reduction in postharvest wastes;
- 200% increase income through policy on grade standards
- Postharvest Technology upscaling (STCBF/STMF)
- Commercialization of pineapple products
- Technology upscaling on IPM, biocon agent production, fertilizer management and planting density optimization (STCBF/STMF)
- Postharvest management
- Integrated Pest Management
- Biocon agent ID and Trial
- Survey, ID and assessment of major and emerging pests and diseases
- Optimization of GP planting density regulation
- Product development from GP, wastes
- Comparative field performance of tissue-cultured plantlets
- Characterization of GP populations
- Evaluation of GP grade standards and their implementation
- Policy formulation on grade standards
CROPS: TROPICAL FRUITS

**PUMMELO**

- Enhanced quality and sustainable yield of pummelo
- Reduced disease and insect pest incidence by 40%
- Enhanced capability of pummelo growers

**R&D Roadmap**

- Evaluation of new effective postharvest practices for pummelo
- Impact assessment of technologies generated/adopted
- Establishment of demo orchard using reduced-synthetic chemical inputs
- Market study on reduced-synthetic chemical inputs production system
- Soil characteristics and fertility evaluation
- Soil suitability assessment for reduced-synthetic chemical inputs
- Development of soil and leaf nutrient critical level
- Social attitude on technology adoption
- Examination of farm management efficiency
- Trademark assessment

**Pummelo Program**
- Development of IPM strategies against important pest (e.g. rind borer, thrips) under reduced application of synthetic fertilizers
- Optimization of nutrient recommendation
- Optimization of postharvest processing

CROPS

**VEGETABLES**

- Increased yield by at least 20%
- Reduced pests and diseases by 20%
- Reduced postharvest losses by 20%
- Increased consumption of safe vegetables

**R&D Roadmap**

- Technology upscaling (STC/FSTMF) biocontrol, bioinsectant, biocon
- Impact assessment of technologies generated

- Technology upscaling (STC/FSTMF) biopesticides
- Whole season trials of tomato varieties

- Pilot testing of biopesticides (tomato, eggplant)
- RIDT interventions for potato and tomato
- Social attributes to technology adoption
- Examination of farm management efficiency
- Trademark policy analyses

- Pilot testing of RapsBioassay for Pesticide Residues in Laguna, Quezon, and Bicol
- Optimization of potato aeroponics system in Iloilo and Bislig
- Monitoring of EUs materials on vegetable pests and diseases in Eastern Visayas
- Pilot trials and technology demonstrations
- Development of technology management approach for soft rot diseases
- Drop irrigation system for garlic/onion
- Branding for produced vegetables
Annex 14
AANR Programs/Projects
Roadmaps

Livestock

Dairy R&D Roadmap

- Increase average daily milk production from 5 to 7 liters/day
- Increase lactation period from 270 to 285 days
- Decrease breeding period from 6-7 to 2 months; calving intervals from 17 to 14 months
- Reduce milk wastage and/or spoilage from 26-10%
- Increase milk sales by 26%

- Establishment of milk quality and safety, and traceability system from farm to consumers
- Dairy products development and innovative packaging
- Economic and socio-cultural assessment of dairy production and consumption patterns in the Philippines
- Policy studies on dairy development support systems

- Performance assessment of dairy genotypes in the Philippines
- Population build-up through assisted reproduction
- Enhancing production management based on assessment results of existing systems
- Development of health care technologies and practical farm practices in support of increasing milk production

- Gene marker technology for improved milk production
- Development of Feeding Protocols and Practices to Support the Nutritional Requirements of DB
- Field testing and application of assisted reproduction technologies
- Development of Health Care Technologies and Practical Farm Practices
- Development of community milk collection system
- Establishment of milk cold storage & quality testing facilities
- B&T based enterprise on milk production
- Establishment of Dairy Cattle Foundation Breeder Herd Thru Embryo Transfer

Duck R&D Roadmap

- Increase average duck egg weight of at least 68 grams
- 18% replacement of traditional layer duck inventory with Itik Pinsas in R&D implementing Regions
- Increased per capita consumption of duck eggs by 22% from 4.8-eggs/year in 2021
- Improved livelihood of more than 200,000 families in 7 regions

- Genomics study of Itik Pinsas
- Improvement on cultural management practices for Itik Pinsas

- Commercial scale testing of Itik Pinsas
- Itik Pinsas breed information system development
- Duck egg products processing innovation
- Marketing and distribution innovation of duck breeders and duck egg products
- Development of prototype balut egg vending machine

HNRDA 2017-2022 | Page 70
ANNEX 15
AANR Programs/Projects
Roadmaps

LIVESTOCK

**DAIRY GOAT**

- Increased DG herd by 54%
- Decreased preweaning mortality from 25% to 10%
- Increased milking period from 90 days to 180 days
- Increased milk production from 0.5L/day to 3L/day

**R&D Roadmap**

2017

- Development of quality standards for goat milk and milk-based products
- Marketing strategy for goat milk
- Creating market for the goat’s milk
- Promotion of goat’s milk consumption and its health benefits thru IECs

2018-2019

- DG disease diagnostics development
- Development of DG farm and breed registry
- Promotion of best genotype for goat dairying in PH
- Commercialization of the ILM-based pellets, forage chopper & blade, IML detection kit

2020

- Performance evaluation of DG genotypes
- Application of AI and natural breeding methods towards herd build up
- Evaluation of Indigofera zollingeriana as feed for lactating does

2021

**SLAUGHTER GOAT**

- Increased CR thru natural means from 81% to 90%, 75% to 95% thru AI
- Increased weights: birth weight from 2kg to 3kg, increased slaughter weight from 24kg to 33kg
- Availability of breeding true to type Cagayan Valley signature goal populations
- Availability of authentic halal compliant goats in Region 12 & ARMM

**R&D Roadmap**

2017

- 2017-2020
  - Breeding and selection to establish the CV signature breed
  - Dev’t of non-invasive pregnancy detection kit for goat
  - Pilot testing of traceability system for goat in Region 2
  - Roll-out of tech-based options in 10 regions

2018

- 2017-2018
  - Halal detection thru LAMP
  - Promotion of goat halal protocol
  - Policy and marketing schemes for halal
ANNEX 16
AANR Programs/Projects
Roadmaps

LIVESTOCK

Native Chicken
R&D Roadmap

- Improved average egg production performance from 100 to 120 eggs/ hen per year in Regions 6 and 9
- Reduced mortality from 40 to 20% in Regions 6 and 9
- Increased number of slaughter native chickens produced from 20 to 50 hens/ per year in Regions 6 and 9
- Increased breeder population in Regions Sand 9 by 15% in 2020
- Established native chicken conservation farms and R&D centers in Regions 6 and 9

- Community-based Darag and Zampen NC production
- Application on functional genomics
- Feeds and Feeding systems for free range NC
- Range enhancement protocols for NC
- Health care Mgt protocols for NC
- NC product Devl. With value adding
- Innovative Mktg and Distribution System for NC
- Support to policy on NC production, distribution and marketing

- Commercial scale testing of Phil NC
- Enhanced Artificial insemination on native chickens

Native Pig
R&D Roadmap

- Ensuring stable supply of Lechon pigs
- Promotion, marketing and policy studies
- Ensuring stable supply of Lechon pigs
- Devl of NP A I protocols
- Application of DNA markers in breeding and selection

- Devl of feeding systems
- Ensuring stable supply of lechon pigs
- Product devl., processing packaging & organoleptic studies

- Native Pig Breed Development Programs
- Productivity markers and phylogenetic relationship
- Native Pig breed Information System
ANNEX 17
AANR Programs/Projects
Roadmaps

LIVESTOCK

**Commercial Swine**

- Increase productivity and production efficiency of local swine industry
- Increase food safety and quality of locally produced pork

- Impact analysis on molecular selection
- Revalidation of nutrient requirements of different classes of pigs
- Dev’t meat detection kit for chemical residues
- Increasing the frequency of favorable genotypes in breeder swine population
- Dev’t of diagnostic protocols and test kits for economically important diseases
- Operationalization of the pork traceability
- P&A on application of genetic markers
- Development of pork traceability
- E-commerce system for breeder pig and semen
- Primer design and optimization of protocols for CSFV and PRRSV
- Genetic testing of breeder pigs for productivity traits
- Breed registry establishment
- Dev’t of web-based IT facility for swine farm performance monitoring

**Feed Resources**

- Enhanced competitiveness and sustainability of Philippine livestock and poultry industry
- Processing techniques to increase the feeding value of local feed resources
- Developed new local feed ingredients for swine and poultry

- Increasing nutritional efficiency through the establishment of the National Feed Information System (NFIS)
- Value enhancement of agricultural by-products as feedstuffs through development of processing technologies
- Improving nutritional efficiency by establishing specific energy and nutrient requirements of farm animals at various growth/production stages
- Development of alternative feed ingredients for swine and poultry

- Agronomic Performance and Feeding Value of Mulato II and Mombasa Grasses for Dairy Cattle
- Pilot testing of protein enriched copra meal for swine and poultry
ANNEX 18
AANR Programs/Projects
Roadmaps

AQUATIC: INLAND

**AQUAFEEDS**
R&D Roadmap

- Export of microalgal paste
- Nationwide sale of formulated feeds from PECM and other plant protein sources
- Commercialization of microalgal paste production
- Production in commercial scale of different formulated aquaculture feeds
- Improvement of protocols on microalgal paste production and storage and packaging system
- Testing and optimization of feed formulation for specific aquatic animals of PECM and other plant protein sources
- Evaluation of aquatic plants (Gracilaria sp., Sargassum sp., and Lemna sp.) as diets for tilapia
- Field testing of microalgal paste production and testing of packaging schemes
- Field trial of PECM as feed protein for tilapia, milkfish and shrimp aquaculture
- Development of probiotic/prebiotic fish feeds for improved production performance of milkfish

**MANGROVE CRAB**
R&D Roadmap

- Sustainable Mangrove crab production
- Increased survival rate in hatchery (3-5%), nursery (50-70%), and grow-out (50-60%)
- Export market for live mangrove crab
- Commercialization of marine anelids production
- Establishment of additional 10 hatcheries, nurseries
- Pilot testing of marine anelids production
- Commercialization of hatchery, nursery and grow-out technologies
- Selective breeding
- SNP marker discovery for stock definition for 3 species
- Packaging material (Container Box) development
- Packaging of PR for mangrove crab production
- Mangrove crab genomics
  - Selective breeding
  - Pilot testing of mangrove crab hatchery and nursery technology
  - Policy studies on conservation and management of mangrove crabs
ANNEX 19
AANR Programs/Projects
Roadmaps

AQUATIC: INLAND

MILKFISH
R&D Roadmap

- Increase yield from 3 to 9 kg/ha (oocytes) and from 1.2 to 2.0 ton/ha/yr (bran. prod.)
- improve FCR from 2.0 to 1.5

2017
- Development and application of probiotic enriched fish feeds for improved production performance of milkfish
- Development of probe kits for detection of pathogens affecting milkfish
- Evaluation of the growth performance, feed efficiency and biochemical composition of milkfish reared with diets containing PECM
- Roll out of technology on milkfish satellite hatchery system

2018
- Development of protocols on Milkfish Genomics Program
- Application of genomics on milkfish aquaculture
- Development of probe kits for detection of pathogens affecting milkfish

2019
- Export of milkfish and other by-products
- Development of good aquaculture practice on milkfish production

2020

2021

Mussel
R&D Roadmap

- Roll out of hatchery and nursery technologies (STMF)
- Roll out of processed mussel products

2017
- Mussel Socioeconomic/Marketing/Supply chain study
- Pilot testing of primary processing techniques: Post harvest technology (depuration and relaying techniques)
- Refinement of culture (hatchery, nursery and grow out) technology
- Product development (powdered and fermented products)
- Impact of invasive mussel species to the Philippine Green Mussel Industry

2018
- Roll out of primary processing technology
- Roll out of transplantation technology (STBF/STMF)
- SNP marker discovery and selective breeding

2019
- Roll out of depuration and relaying
- Promotion of longline technology
- Technology in non-traditional areas and transplantation technology

2020

2021
- Roll out of quality mussel seeds
- Expanded culture areas
- Export quality mussel product (USDA grade products)
- Better quality mussels with high meat content (from 30% to 50% of shell volume)
ANNEX 20
AANR Programs/Projects
Roadmaps

AQUATIC: INLAND

SHRIMP

R&D Roadmap

- Increased yield in pond systems:
  - P. monodon (5.0 to 10.0 mt/ha)
  - L. vannamei (10 to 20 mt/ha)
- FCR in commercial farms: 2.0 to 1.5
- Commercialization of broodstock production for P. monodon and L. vannamei
- Establishment of hatcheries
- Roll out of IHNV and TSV diagnostic kits
- Pilot testing of IHNV and TSV diagnostic kits
- Commercialization of hatchery, and grow-out technologies (biofloc technology, use of Immunostimulants, greenwater, etc.)
- Roll out of LAMP-WSSV and LFSS Kits

- Selective breeding for P. monodon
- Packaging of PR for shrimp production
- Strengthening of Aquatic Animal Breeding Center
- Brooksh satu et Water Aquaculture Enhancement Program
- Pilot testing of LAMP-WSSV kit and LFSSB kit

TILAPIA

R&D Roadmap

- Produced large fish with higher fillet yield (from 35 to 42%)
- Improved feed conversion in commercial farms from 2.0 to 1.5
- Technology commercialization/adoption
- Pre-Com Phytoandrogen product development
- Design for tilapia culture in urban area
- Pre-Com/Patentable aquashade design
- Development of fish koi mitigation protocols
- Market study and forecasting for red tilapia
- Development of plant-based antioxidants
- Multi-freshwater fish breeding program
- Pilot testing of probiotics products
- Nutrition, feeds and feeding
- Strains selection for the Cordilleras
ANNEX 21
AANR Programs/Projects
Roadmaps

AQUATIC: MARINE

**Abalone R&D Roadmap**
- Increased Philippine abalone production by 10% for domestic and export markets through refinement of existing culture technologies
- Impact assessment studies
- Value-added products
- Development of new products
- Commercialization
- Post-harvest handling and processing
- Upgrading of production
- Phytogeographic Studies (stock delineation)
- Policy studies
- Field testing of developed culture technologies for nursery and grow-out
- Rearing/stock enhancement Genetic studies (stock delineation)
- Biometrics analysis; population genomics
- Database enhancement/upgrading
- Pre-commercialization
- Nursery and grow-out culture techniques in tanks and in reef flat
- Development of markers for DNA-based genetic strain differences; Genetic studies
- Sea and land-based rearing and growth monitoring (including hybrids)
- Assessment of wild sources of broodstock; Database development
- Feed formulation

**Blue Swimming Crabs R&D Roadmap**
- Increased survival rates in hatchery (5%), nursery (30%) and grow-out (30%)
- Impact assessment studies
- Value-added products
- Post-harvest handling and processing
- Commercialization (soft shell crab production)
- Post-harvest handling and processing
- Molecular/Phytogeographic Studies (stock delineation)
- Soft-shell crab production (refinements)
- Policy studies
- Commercialization (production)
- Field testing of developed culture technologies
- Verification of transport/conditioning techniques
- Rearing/stock enhancement
- Soft-shell crab production
- Pre-commercialization
- Development of nursery and grow-out (pond/pen) culture
- Refinement of hatchery culture technique
- Profiling (Resource Assessment)
ANNEX 22
AANR Programs/Projects
Roadmaps

AQUATIC: MARINE

**OYSTER R&D Roadmap**

- Increased Philippine oyster production in Region VI by 50% for domestic and export markets through refinement of existing culture technologies and establishment of sanitary quality of oysters and their environment

- Impact assessment studies
- Value-added products
- Development of new products
- Continuation of selective breeding studies
- Commercialization
- Value chain analysis

- Post-harvest handling and processing/packaging
- Phylogenetic Studies (Stock delineation)
- Selective Breeding
- Policy studies
- Development of product standards

- Field testing of refined hatchery techniques; Verification of conditioning techniques
- Genetic/genomic studies, Bioinformatics analysis
- Adoption of raft and longline methods of oyster culture
- Establish best practices for oyster farming

- Broodstock management and conditioning; Verification/refinement of hatchery and grow-out culture techniques
- Development of markers for DNA-based genetic population differences; Identification of performance traits
- Classification of the quality of existing selected oyster culture sites based on EU system of classification for oyster harvesting
- Field testing of raft and longline methods of oyster culture

**Sardine R&D Roadmap**

- 10% increase in production by 2017
- Science-based input to policy on closed season for sardine fishing

- Continuing improvement of EBFM for sardines

- Improved management of fishery resources
- Offshore fisheries and oceanography
- Information system (time series physical and environmental data)

- Improved post harvest / processing / utilization (drying and smoking)
- Socio economic studies
- Utilization of fish wastes from sardine canneries (Omega 3)

- Value chain analysis
- Bioinformatics
- Prey-predator studies

- Ecosystem based-fisheries management (ecological and oceanographic indicators)
- Policy studies

- Reproductive biology and population dynamic studies (Sulu Archipelago)
- Ichthyoplankton assessment

- Genetic studies (population structure, ichthyoplanktons, identification)
- Stock and biological assessment (Northern Zamboanga Peninsula)
ANNEX 23
AANR Programs/Projects
Roadmaps

AQUATIC: MARINE

Sea Cucumber
R&D Roadmap

- 3% increase in production of premium grade Holothuria scabra
  - Production of high value stone dried trepang

- Continuous technology upscaling and commercialization

- 2021
- Post and diseases (H. scabra, H. fascogutta, P. proteus & E. manamita)
- Impact assessment studies
- Market research and value chain analysis
- Product development and packaging
- Culture technology for other economically important species like A. antennata, N. luteum
- Drug discovery

- 2020
- Policy studies (culture and capture sea cucumber fisheries)
- Post harvest processing (Economically important species like S. ornata and H. fascogutta)
- Drug discovery from sandfish
- Value added products

- 2019
- Hatchery/seed production on economically important species like A. antennata and H. fascogutta
- Genetic studies and marker development
- Culture technology on economically important species like H. fascogutta, P. proteus and B. mauritiana

- 2018
- Studies on bioactive compounds from post-harvest by-products
- Commercialization (H. scabra)
- Biology, ecology, stock enhancement and population studies on economically important species like A. antennata, N. luteum

- 2017
- Genetic diversity studies
- Pre-commercialization (H. scabra)
- Post harvest processing
- Database development

Seaweeds
R&D Roadmap

Increase in production (20% increase in yield/ha, 1.4 to 1.7 mt/ha; Increase production cycle from 4 to 5x; 10% increase in farm areas)

- 2021
- Impact assessment studies
- Value-added products

- 2020
- Development of new products
- Commercialization

- 2019
- Culture of new seaweed species/varieties
- Development of new products (pharmaceutical, cosmeceuticals)
- Genetic studies

- 2018
- Genetic improvement of carrageenan/agar producing seaweeds
- Screening/selection of natural products/bioactive compounds from seaweeds
- Health Management
- Database enhancement/upgrading
- Policy Studies

- 2017
- Field testing of laboratory-bred carrageenophytes cultivars (Palawan, Eastern Samar, Tawi-Tawi)
- Post-harvest processing/Development of Drying System for Seaweeds
- Mechanizing seaweed culture technology (Palawan)
- GIS-based mapping/geo-referenced database

HNRDA 2017-2022 | Page 79
ANNEX 24
AANR Programs/Projects
Roadmaps

AQUATIC: MARINE

Tuna R&D Roadmap

- Reduction of fishing effort
  - 15% reduction in tuna re władz through genetics
  - 15% reduction in catch of juvenile tunas using appropriate gear
  - 20% reduction of post-harvest handling processing losses

2017
- Genetic studies (population structure, ichthyoplankton, identification)
- Stock and biological assessment
- Reproductive biology and population dynamic studies
- Traceability studies

2018
- Ecosystem based fisheries management (ecological and oceanographic indicators)
- Ichthyoplankton assessment
- FAD fisheries dynamics including gear development

2019
- Improved post harvest / processing / utilization (refrigeration facility, probes)
- Value chain analysis
- Utilization of fish waste from tuna canneries
- Value chain analysis
- Informatics
- Prey-predator studies

2020
- Continuing improvement of EBFM for tuna fisheries
- Impact assessment
- Development of E-tools, gadgets, boats for traceability, accurate and timely collection of data
- Policy studies
- Marketing and trade

2021
- Improved management of fishery resources
- Offshore fisheries and oceanography
- Information system (time series physical and environmental data, productivity)

FORESTRY AND NATURAL RESOURCES

BAMBOO S&T Roadmap

- Increased annual yield from 800 poles to 1,000 poles per hectare
- Increased planting materials production and bamboo planted areas
- Increased income of farmers and ensure raw material needs of the bamboo based industries

2017
- Orienting policies in support of bamboo industries
  - (Bamboo policy analysis (2017))
  - Enhanced macroprop. (cut/branch cutting) & microprop. (tissue culture techniques) (2017-2019)

2018
- Pilot test and Roll out of organic preservative (2018-2019)
- Clump mgmt. & harvesting techniques for higher clump productivity (2017-2019)

2019
- Development of high value bamboo products (engineered bamboo, textile etc.) (2016-2021)
- Design and Devt. of high capacity machines/equipment (2018-2020)
- Bamboo specie-site compatibility assessment (2017-2019)
- Management of bamboo for shoot production (2017-2019)

2020
- Roll out of bamboo tissue culture, bamboo shoot production & engineered bamboo prod. (2020-2021)
- Roll out of production of new products (engineered bamboo products) (2019-2021)

2021
- Increased planting materials production and bamboo planted areas
ANNEX 25
AANR Programs/Projects
Roadmaps

FORESTRY AND NATURAL RESOURCES

Cacao

- Development of S&T model farms and postharvest processing for superior cacao variety/clones adaptable to different agro-ecological locations
- Promotion of commercial application of biological-based pest & disease approaches in cacao farming
- Development of improved cacao varieties/clones under different agro-ecological locations
- Cacao-based agro-forestry systems
- Pilot testing of biological-based approaches for cacao pest & disease (pheromone lures/traps, BCAs, biopesticides, nano biosensor system, particle film technology
- Cacao pod husk fuel briquettes
- Genes phenotype lures/traps of cacao mirid bug
- BCAs for cacao pod borers & cacao mirid bug; Rearing protocols for the BCAs
- Nano-biosensor system for cacao fungal diseases; Biopesticides (mycoparasites) for VSD & BPR
- Biosediments using mycoparasites for VSD & BPR
- Particle film technology using local clay materials
- ID gene specific molecular markers and primers for important traits in cacao for varietal improvement
- Policy advocacy: Use of biologically-based approaches in pest management/establishment of Philippine Biological Control Center
- Nursery/Batchwood for HYVs
- Rehabilitation techniques for unproductive cacao trees
- GIS-based system in mapping cacao plantations and locating expansion areas
- Electronic based sensor device for wet beans

Industrial Tree Plantation

- Increased yield per hectare (200 m³/ha in 2019 to 410 m³/ha in 2021)
- Sustained local supply of plantation lumber by 2021
- Domesticated promising Indigenous fast-growing tree species for the ITP-based wood industries
- Upgraded the Forest Products and Paper Science (FPPS) Laboratory
- Technology roll-out on the improved semi automated furnace type lumber dryer (FTLD)
- Genomics Assisted Development of Gene Marker for Important Traits in Falcata and Yemane Production and Clone Improvement
- Documented, assessed and established the germplasm conservation and management of select indigenous forest tree species in Mt. Makiling
- Assessed the juvenile variations in forest genetic materials of Falcata and Yemane seedlings
- Assessed the promising Indigenous fast-growing tree species for domestication to support the ITP-based wood industries
- Collected, field tested and selected superior genetic germplasm of Falcata and Yemane
- Identified superior mother trees from seedlots/provenances of Falcata and Yemane as source of quality planting materials
ANNEX 26
AANR Programs/Projects
Roadmaps

FORESTRY AND NATURAL RESOURCES

RUBBER
R&D Roadmap

- Increased latex yield (1.28 mth/ha/yr in 2010 to 1.92 mth/ha/yr in 2021);
- Increased area planted to high yielding rubber clones from 8,000 has (2010) to >30,000 has in 2021

- Field deployment tech transfer of new NSIC high yielding clones in the Phils.
- IEC/Awareness campaign in managing Phytophthora, TPD and SB in key rubber production areas

- Assessment of growth performance of rubber planted outside of Mindanao and recommended BFP package to rubber farmers in Luzon and Visayas
- Genomics assisted breeding for important traits in rubber
- Establishment of rubber berwood garden/nursery facility and model rubber plantation in Bukidnon

- Rubber soil nutrition system using Mucuna bracteata
- Root trainer (RSM) in nurseries and EM tech to control Phytophthora in rubber nurseries and field testing in rubber plantation and as biofertilizer
- Enhancement of R&D Center for Rubber & Cacao Germplasm Conservation and Management
- Establishment of Center for Biopesticides/Biocontrol & Biofertilizer R&D for Rubber and Various Crops

- Tech transfer of technology on rubber berwood garden/nursery establishment and rubber plantations establishment in Basilan, North Cotabato and Laguna and rubber tapping trainings in major rubber-producing provinces; Development of nanosensor for rubber clumps
- Clonal Adaptation Trial of Newly Introduced High-Yielding and Promising Rubber Clones; Innovation of root trainer technique, tissue culture and in vivo, precision grafting technology for rapid propagation of quality planting materials of rubber; Development of site matching functions for improved rubber production in the uplands

ENVIRONMENTAL SERVICES

BIODIVERSITY
R&D Roadmap

- Patenting/commercialization of other biodiversity-based products
- Community-based ecotourism projects

- Commercialization of biolnguide
- Propagation of economically important plants
- Pilot testing of other biodiversity-based products
- Repopulation studies on eel
- Database enhancement on marine resources

- Pilot testing of biolnguide
- Community-based ecotourism projects
- Germplasm conservation of endangered plants
- Development of other biodiversity-based products
- Biological studies on eel and blue mussel
- Policy studies and database enhancement on marine resources

- Economic valuation and accounting of biodiversity
- Assessment of potential ecotourism sites
- Propagation techniques for economically important species
- Socio-economic assessment of eel and blue mussel fishery
- Molecular and phylogenetic studies and assessment of marine resources in the mesophotic and euphotic zones
- Corals collection for DPITC

- Field testing of biolnguide
- Biopark establishment, propagation and conservation of economically important species
- Germplasm conservation of indigenous trees
- Forest canopy observation and plant–bat interaction in tropical ecosystem
- Stock assessment of eel (Anguilla spp) in marine systems and survey on distribution and abundance of blue mussels (Mytilus charltonii)
- Genetic and taxonomic studies (corals, sea cucumbers, giant clams) and assessment of marine resources in the mesophotic and euphotic zones
- Database development for marine resources (sea cucumber)
ENVIROMENTAL SERVICES

Ocean Environmental Services:
Coral Reefs and Coral Reef Associated Habitats

R&D Roadmap

• Improved and enhanced adaptive capacities of communities and coastal ecosystems to provide goods and services

• Policy studies
  ✓ Mainstream climate change adaptation into local and national policies, plans and programs

  ✓ Development of Early warning systems
  ✓ Integrating socio-ecological systems and advancing observation, monitoring & prediction data of local communities (incorporating other M&E e.g. air-water quality)
  ✓ Adaptive management strategies/programs
  ✓ Commercialization of marine technologies

  ✓ Impact assessment (coral reefs)
  ✓ Commercialization (coral culture technology – sexual)
  ✓ Development of Large Scale Storage System and Digitalization of Historical Data
  ✓ Pre-commercialization/development of marine technologies
  ✓ Large scale marine protected area studies (connectivity studies)

  ✓ Policy studies (New scale to describe coral conditions
  ✓ Coral reef management policies, Appropriate mangrove reforestation practices, Reef fisheries management;
  ✓ Commercialization (assessment protocol – corals)
  ✓ Pre-commercialization (coral culture technology – sexual)

  ✓ Coral reef and associated habitat assessment (including euryhaline zone until 2021)
  ✓ Pre-commercialization (assessment protocol – corals)
  ✓ Production of sexually derived corals

Ocean Environmental Services:
Coral Reefs and Coral Reef Associated Habitats

S&T Roadmap

• Improved and enhanced adaptive capacities of communities and coastal ecosystems to provide goods and services

• Technologies (Culture technology for sexually-derived coral propagules; Molecular markers for examination of thermal stress response and resilience; Remote monitoring system for reef fishes; Remotely deployed vehicle)
• People Services (Capacity building) (Culture technology (MSU TCTO, USC); Coral reef assessment and monitoring; Ocean analysis; Helias)
• Publications (Peer-reviewed publications)
• Products (Manual on sexual propagation; Handbook (reproductive strategies and timing of selected coral species); Guidelines for coral restoration using sexually-produced propagules incorporating genetic data; Bathymetric maps; Substrate maps; Maps (sites for deep sea corals); List of resilient and susceptible coral species to ocean acidification and eutrophication; Reproductive status of 16 coral species; Status of Philippine coral reefs; Interactive decision-support knowledge products (BBN, E); National Philippine HYCOM model; A high-resolution hydrodynamic model for the entire Philippine archipelago; Framework for a national coral reef assessment program; Long-term monitoring programs established in the project sites; Coral Reef Monitoring and Assessment Protocol Booklet; Initial framework for the bio-economic model for the management of associated marine plants habitats; Coral Reef Info-graphics; State of the Coasts site report)
• Partnerships (to MCORE Partnerships)
• Policies (science-based inputs) (Genetic diversity and population genetic structure of natural coral populations for 2 species along the western Luzon coast; New scale to describe coral conditions; Coral reef management policies; Appropriate mangrove reforestation practices; Reef fisheries management; Integrated coastal management bill)
• Biodiversity
  ✓ Abo de llo (88): 41 identified in the euryhaline zone; 45 in the mesohaline zone, corals: 39 coral genera in the euryhaline zone; 25 in the mesohaline zone
  ✓ Abo Reef (Bo): 198 species, corals: 42 hard coral genera documented in the mesohaline zone
  ✓ Resilient coral species to thermal stress

2017
2018
2019
2020
2021
2022

ANNEX 27
AANR Programs/Projects
Roadmaps

HNRDA 2017-2022 | Page 83
ENVIRONMENTAL SERVICES

ANNEX 28
AANR Programs/Projects
Roadmaps

CLIMATE CHANGE
R&D ROADMAP

Resilient and Adaptive Communities and Ecosystems

- Rehabilitation of vulnerable ecosystem to CC
- Enhancement of resiliency of communities

2017
Development of decision support systems for selected ecosystems
Assessment of ecosystems services of AANR sector

2018
Rehabilitation strategies for critical mangrove and coastal forest

2019
Monitoring and detection of ecosystems changes

2020
S&T Action Priorities for Emergencies and Hazards Program (SAFE)

2021
- Monitoring and detection of ecosystems changes
- Off-site and on-site studies on the effect of different stressors to selected crops and pest management

WATERSHED
R&D Roadmap

- Improved planning and reduced rates of soil and water degradation
- Integrated landscape models and S&T initiatives to better understand watersheds

- Promotion of livelihood and ecotourism for sustainable watershed management
- Promotion of Community-based PES modules/protocols in selected watersheds

- Adoption of community-based Management Protocols in watershed monitoring and assessment in the six (6) Learning watersheds
- Formation of multisectoral watershed council

- Capacity building on community-based PES modules for upstream communities in the Learning Watersheds
- Real-time Climatic and Weather Information; Stream Monitoring in the Learning Watersheds
- Establishment of Biodiversity Monitoring plots
- Develop an inter-active web-based database watershed management system
- Capacity building for watershed stakeholders
- Policy Studies to Promote Watershed Resiliency
## ANNEX 29 - Industry, Energy and Emerging Technology Roadmaps

### COMPETITIVE INDUSTRIES:

#### ICT, ELECTRONICS AND SEMICONDUCTOR

<table>
<thead>
<tr>
<th>Technology Cluster</th>
<th>Areas / Discipline</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Developing Technology-based Therapies for Stroke Patients (Dr. Suarez)</td>
<td>Developing Technology-based Support Tools for Children with Autism (Dr. Suarez)</td>
<td>Security Mechanisms for Mobile Devices (Dr. Festin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vision-Based Vehicle Counting System and Traffic Emissions Inventory</td>
<td>□ Security APIs for Mobile/Handheld Devices</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vision-based Vehicle Counter for Emissions Inventory and Traffic Monitoring (VIVEC-ET) (Dr. Suarez)</td>
<td>Security Mechanisms for Mobile Devices (Dr. Festin)</td>
<td>Aerial Dynamic Assessment Robot for National Advancement - phase III (Dr. Suarez)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Unmanned Aerial Vehicle System (UAV) for Surveillance Operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Machine Interaction</td>
<td>Empathic, Affective, NLP, Speech Recognition, Machine Vision, Machine Intelligence</td>
<td>□ Embedded Conversational Agents Teaching English</td>
<td>□ Embedded Conversational Agents Interacting with Persons Afflicted with Autism</td>
<td>□ Computer Storytellers in an ILE to Motivate Learners</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching English as a Second Language using EDAs (Dr. Suarez)</td>
<td>Developing Technology-based Support Tools for Children with Autism (Dr. Suarez)</td>
<td>Exploring Stories as Tools to Influence the Emotion of Learners (Dr. Suarez)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ An Affect Model of Readers in an ILE for Reading</td>
<td>□ Software Tutors for Gifted Children</td>
<td>Building an Affect Model of Student Readers as they Read Story Text (Dr. Suarez)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Anx: A Collaborative Peer in an Interactive Storytelling Environment for Disaster Preparedness (Dr. Suarez)</td>
<td>Developing Empathic Educational</td>
<td>□ Interactive Storytelling Environment to promote Maternal Health Awareness (Dr. Suarez)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Supporting Behavior Awareness through Interactive Social Stories (Dr. Suarez)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Embodied Conversational Agent interacting with Readers in an ILE for Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrating an Embodied Conversational Agent into an ILE for Reading (Dr. Suarez)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Development of low cost research platforms that can assess user engagement, boredom, confusion based on posture, eye-gaze and biometrics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development of low-cost research platforms for assessing user affect (Dr. Rodrigo)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Algorithms for Secure Data Mining</td>
<td>□ Algorithms for Secure Data Mining (Dr. Festin)</td>
<td>□ Algorithms for Secure Data Mining (Dr. Festin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grid, Cloud, Modeling &amp; Simulation, Visualization, Datamining, Analytics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Mobile Picture Books</td>
<td>□ Animated Picture Books</td>
<td>□ Intelligent Tutoring Game System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digital Media and Creative Content</td>
<td>Story Generation Systems as Support Tools for Literacy Development in Children (Dr. Suarez)</td>
<td>Development of intelligent tutoring systems for Araling Panlipunan and Filipino for middle school (Dr. Rodrigo)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Web Semantics, Q&amp;A on the Web, Social Networking, Ontologies, Internet of Things</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Web Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Algorithms for Secure Data Mining</td>
<td>□ Algorithms for Secure Data Mining v.1.0</td>
<td>□ Algorithms for Secure Data Mining v.2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Algorithms, Systems Software, Languages, Basic Research on Computer Science Architecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foundation of Computer Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Pinoy SimCity v1.0</td>
<td>□ Pinoy SimCity v2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICT for Development (Government Trusts – usage and applications)</td>
<td>Developing an Environment for Simulating City Planning through Community-Based Monitoring System Data (Dr. Suarez)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GIS, Health Informatics, Instructional, Environment, Service Science (incl. Tele-health), Bio-informatics, E-governance</td>
<td>□ Personal Health Records on Mobile Devices</td>
<td>□ Personal Health Records on Mobile Devices (Dr. Festin)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### HNRDA 2017-2022 | Page 85
# ANNEX 30 - Industry, Energy and Emerging Technology Roadmaps

## DELIVERY OF SOCIAL SERVICES: DRR/CCA

<table>
<thead>
<tr>
<th>PRIORITIES</th>
<th>RESEARCH DOMAIN</th>
<th>SPECIFIC ACTIVITIES</th>
<th>TIMELINE</th>
<th>EXPECTED OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRR/CCA</td>
<td></td>
<td></td>
<td>2013-2020</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development of multi-hazard proof and climate smart infrastructure designs, building materials and construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instrumentation for early warning, monitoring and rapid assessment</td>
<td>Development and deployment of portable, on-line and telemeasured systems for data-gathering, natural hazard detection mechanisms/s systems for early warning in major urban centers</td>
<td>SUCs and other partner organizations are fully capable of replicating, operate and provide technical support to LGUs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DRR/CCA Proofing Infrastructure Systems and Techniques</td>
<td>Development of multi-hazard proof and climate smart infrastructure designs, building materials and construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2013-2020</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hazard and Risk Assessments</td>
<td>Assessment for multi-natural hazard exposure, vulnerability and capacity of different communities/LGUs</td>
<td>Hazard and exposure database and information of local copetencies</td>
<td>Multi-natural hazard mapping</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2013-2015</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capacity building of Regional SUCs in the use of hazard and risk assessment tools and systems to support LGUs</td>
<td>Capacity building of SUCs in hazard and risk assessment to support LGUs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meso-scale hydro-meteorological hazard monitoring and early warning systems</td>
<td>Installation of community-based, near real-time multi-hazard monitoring systems outside the scope of the 18 critical river basins</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost-Effective Disaster Emergency and Rescue Utility Systems</td>
<td>Design and development of low-cost and locally-manufactured, easily-deployable mobile command module and technology for disaster emergency and rescue utility for on-site incident command which could provide high quality, real-time audio and video feed in disaster affected areas</td>
<td>Robust and smart infrastructure designs, building techniques and low-cost indigenous building materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2013-2015</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-to-end Multi-Hazard, Multi-Platform Early Warning System</td>
<td>Development of hazard data, vulnerabilities and risk hazard measurement and logging system</td>
<td>Technologies developed, piloted and rolled out Provincial, municipal and city-scale end to end early warning system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2013-2016</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Localized decision support system</td>
<td>Capacity building of Regional SUCs in development of exposure database and use of decision support systems to support LGUs and local communities</td>
<td>SUCs operate and provide support to local decision support systems to LGUs and local communities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2013-2018</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2013-2020</td>
<td></td>
</tr>
</tbody>
</table>

HNRDA 2017-2022 | Page 86
DELIVERY OF SOCIAL SERVICES: SPACE TECHNOLOGY APPLICATION (STA)

**KDA 1. National Security and Development**

**Preserve and enhance the country’s national security and promote development beneficial to all Filipinos**

- Developed BITUIN-1, local microsat for communication and navigation
- Launched TALA-1 using commercial launcher
- Developed TALA-2 to 5 nanosat for remote sensing
- Developed TALA-1, first nanosat for remote sensing
- Launched TALA-2 to 5 nanosat for 24/7 PHL surveillance
- Applied TALA-3 to 5 nanosat for telecommunication
- Launch of first microsat for remote sensing
- PHIL Earth Data Resource Observation Center

**S&T Investments & Activities**

- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

**KDA 2. Hazard Management and Climate Studies**

**Develop and utilize STA to enhance its hazard management and disaster mitigation strategy and ensure the nation’s resiliency to climate change**

- Climate change resilient communities utilizing space technology (e.g. DIWATA and PEDRO)
- Persistent monitoring of climate conditions using TALA nanosatellite constellation
- Decision support system for resources management using space-based information
- Enhanced monitoring system for GHG, sea-surface temperature and other climate conditions
- Hazard maps using locally acquired satellite data
- Space information system and data sharing protocols

**S&T Investments & Activities**

- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

*KDA – Key Development Area*
DELIVERY OF SOCIAL SERVICES: SPACE TECHNOLOGY APPLICATION (STA)

**KDA 3. Space R&D**

Spur rapid scientific growth, the Philippines focus on conducting R&D endeavors in vital areas of space science, technology and allied fields.

**Outputs**
- Site analysis for the National Astronomical Observatory and National Space Complex.
- Pilot programs on STA for precision agriculture, environmental monitoring, fisheries and maritime navigation.
- Transportation and location-based applications using global navigation satellite systems.
- Launched National Astronomical Observatory and National Space Complex.
- Space projects in the Kibo module of the ISS through the Kibo-ABC Initiative.
- Space-based food production, medicine and microgravity applications.

**S&T Investments & Activities**
- 2019
- 2018
- 2017
- 2016
- 2015

**STA Roadmap (2015-2020)**

---

**KDA 4. Space Industry Capacity Building**

Create a robust and thriving space industry to support the country’s space program through private sector involvement and cooperation.

**Outputs**
- Joint projects between academe-government-industry on development of microsatellites and geosynchronous satellites for national use.
- Joint projects between academe-government-industry on development of rockets and launch vehicles.
- Space Technology Industrial Park within or adjacent to the National Space Complex.
- Training and internship programs for students and educators.
- Local space industry catering to national and international clients.

**S&T Investments & Activities**
- 2019
- 2018
- 2017
- 2016
- 2015

**STA Roadmap (2015-2020)**

---

*KDA – Key Development Area*
DELIVERY OF SOCIAL SERVICES: SPACE TECHNOLOGY APPLICATION (STA)

*KDA – Key Development Area
INTELLIGENT TRANSPORTATION SOLUTIONS

Land Transport S&T Roadmap – Road

**S&T Outcomes**

**2014-2016**

- Improve safety and comfort level
- Optimized fuel economy of urban passenger mass transport
- Improved fuel mileage of vehicles and reduce emissions
- Advanced transport system with less intrusive infrastructures

**2017-2020**

- Establish on-board bus performance standards, i.e. “black box, speed limiters, GPS and video detectors
- Develop standards for design improvement of buses
- Establish solar fast charging stations
- Establish E-payment scheme for EV charging
- Fabricate Hybrid PUH with lightweight body architecture
- Roll-out optimized & cost reduced fast charging stations with BMS through integrated network system
- Develop EV Parts and Components Standards
- Fabricate hybrid PUH with regenerative braking system
- Develop lightweight body architecture of a conventional 22-seater PUHs
- Develop a prototype diesel-electric parallel series hybrid vehicle
- Demonstrate the centrally powered hybrid electric road train (CRT)

**S&T Strategies**

**GOAL:** Integrated, responsive, effective, efficient and safe transport systems

Land Transport S&T Roadmap – Rail

**S&T Outcomes**

**2014-2016**

- Improved safety and comfort level
- Advanced transport system with less intrusive infrastructures

**2017-2020**

- Establish automatic train safety control system
- Develop automatic passenger counting, demand and scheduling system
- Develop origin-destination and demand forecasting tools
- Automated signaling system
- Retrofit, design and localize system components
- Optimize design and system efficiency of existing train components
- Develop commercial AGT prototype

**S&T Strategies**

**GOAL:** Integrated, responsive, effective, efficient and safe transport systems
INTELLIGENT TRANSPORTATION SOLUTIONS

**Land Transport S&T Roadmap - ITS**

**GOAL:** Integrated, responsive, effective, efficient and safe transport systems

<table>
<thead>
<tr>
<th>S&amp;T Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart inter-modal transport for better connectivity</td>
</tr>
<tr>
<td>Improved urban mobility and accessibility and reliability of transport schedules</td>
</tr>
<tr>
<td>Roll-out of local traffic modeling and forecasting tools</td>
</tr>
<tr>
<td>Develop traffic modeling and forecasting tools</td>
</tr>
<tr>
<td>Deploy locally developed advanced traveler information systems</td>
</tr>
<tr>
<td>Develop web based air pollution and traffic monitoring system and prediction models</td>
</tr>
<tr>
<td>Develop and fabricate on-board console for automatic control signaling system</td>
</tr>
<tr>
<td>Establish passenger count with origin destination &amp; route demand forecasting</td>
</tr>
</tbody>
</table>

*S&T Strategies*

**Land Transport S&T Roadmap – S&T support Services**

**GOAL:** Integrated, responsive, effective, efficient and safe transport systems

<table>
<thead>
<tr>
<th>S&amp;T Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve safety and comfort level</td>
</tr>
<tr>
<td>Optimized fuel economy of urban passenger mass transport</td>
</tr>
<tr>
<td>International compliant testing facilities and standards</td>
</tr>
<tr>
<td>Establish criteria and characterization categories of public roads, i.e. flatness and distance conducive for different mass transport system</td>
</tr>
<tr>
<td>Establish Performance Testing and fuel efficiency analysis protocol for improved PUJs and Hybrid EVs</td>
</tr>
<tr>
<td>Enhance Automotive Parts &amp; components Testing Facility</td>
</tr>
</tbody>
</table>

*S&T Strategies*
INTELLIGENT TRANSPORTATION SOLUTIONS

Sea/Water Transport S&T Roadmap

S&T Outcomes

Multi-modal (sea, land, rail) transport systems

2014 - 2016

Alternative material for fishing and passenger vessel

IMO compliant sea crafts

2017 - 2019

Develop integrated data recording and archiving system

Assess inter-connectivity of freight and passenger multi-modal transport systems

Develop Local Maritime Transportation Simulation Models

Develop Local Maritime Transportation Simulation Models

Engine and machinery performance diagnostic tool

Navigational simulation tool

Develop appraisal system tool for sea worthy compliant per IMO standards

Prototype development of fishing and passenger vessels for bay/river and open sea

Assess the existing fishing and passenger vessel making sector

Assess the local fiberglass industry and support Industry for vessel construction using local alternative materials

Development of Design Guidelines (right sizing of hull, engine, propulsion & materials) for fishing and passenger vessel

GOAL: Safer, cleaner and efficient maritime transport systems and
## INTELLIGENT TRANSPORTATION SOLUTIONS

### LAND TRANSPORT R&D ROADMAP

<table>
<thead>
<tr>
<th>PRIORITIES</th>
<th>RESEARCH DOMAIN</th>
<th>SPECIFIC ACTIVITIES</th>
<th>TIMEFRAME</th>
<th>EXPECTED OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Develop commercial prototype</td>
<td>2013 - 2015</td>
<td>Commercial Operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automated signaling system</td>
<td>2013 - 2015</td>
<td>Local Capability for design and construction Developed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop safety standards and certification</td>
<td>2013 - 2015</td>
<td>Local Parts/components Increased</td>
</tr>
<tr>
<td>SUSTAINABLE MASS TRANSPORT SYSTEM - RAIL</td>
<td>Retrofitting Design and Localization of System Components</td>
<td>Selected Parts/components Developed Locally</td>
<td>2013 - 2015</td>
<td>Local Design for PNR Completed</td>
</tr>
<tr>
<td>Railway System</td>
<td>Develop commercial prototype</td>
<td>Local Design for Rail System</td>
<td>2013 - 2015</td>
<td>Highspeed Railway System Study Completed</td>
</tr>
<tr>
<td></td>
<td>Automated System</td>
<td>- Develop origin-destination and demand forecasting tools</td>
<td>2013 - 2015</td>
<td>- Establish automatic passenger counting, demand and scheduling system</td>
</tr>
<tr>
<td></td>
<td>- Establish automatic train safety control system</td>
<td>2013 - 2015</td>
<td>- Establish automatic train safety control system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advance Traffic Management System (ATMS)</td>
<td>Roll-out Program for PhilMATIS</td>
<td>2013 - 2015</td>
<td>ATMS and APS Prototype System Developed</td>
</tr>
<tr>
<td></td>
<td>- Develop web based air solution &amp; traffic monitoring system and prediction models</td>
<td>- Establish passenger count with origin, destination &amp; route demand forecasting</td>
<td>2013 - 2015</td>
<td>- Deploy locally developed advanced traveler information systems</td>
</tr>
<tr>
<td></td>
<td>- Develop traffic modeling and forecasting tools</td>
<td>- Roll-out Program for ATMS</td>
<td>2013 - 2015</td>
<td>Pilot Smart Cities / Smart inter-modal transport for better connectivity</td>
</tr>
<tr>
<td></td>
<td>- Transport Intermodal</td>
<td>- Roll-out of local traffic modeling and forecasting tools</td>
<td>2013 - 2015</td>
<td>- Enhanced Automotive Parts &amp; components Testing Facility</td>
</tr>
<tr>
<td></td>
<td>Establishment of international compliant testing facilities</td>
<td>Localization of Parts and Components</td>
<td>2013 - 2015</td>
<td>Improved safety and comfort level</td>
</tr>
<tr>
<td></td>
<td>Localization of Parts and Components</td>
<td>Gear Making and Assembly Facility</td>
<td>2013 - 2015</td>
<td>International compliant testing facilities and standards</td>
</tr>
<tr>
<td></td>
<td>Gear Making and Assembly Facility</td>
<td>Establish Performance Testing for improved PUJs and Hybrid EVs</td>
<td>2013 - 2015</td>
<td>Established Gear Making Facility</td>
</tr>
</tbody>
</table>
## INTELLIGENT TRANSPORTATION SOLUTIONS

### Sea/Water Transport R&D Roadmap

<table>
<thead>
<tr>
<th>Priorities</th>
<th>Research Domain</th>
<th>Specific Activities</th>
<th>Timeframe</th>
<th>Expected Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sustainable mass transport system</td>
<td>Development of Design Guidelines (right sizing of hull, engine, propulsion &amp; materials) for fishing and passenger vessel</td>
<td>2014</td>
<td>Cost-effective seaworthy hull design using alternative lightweight materials for passenger and fishing vessels</td>
</tr>
<tr>
<td></td>
<td>Safer, cleaner and efficient maritime transport systems and services</td>
<td>Assess the local fiberglass industry and support industry for vessel construction using local alternative materials</td>
<td>2015</td>
<td>Pilot Smart Cities / Smart inter-modal transport for better connectivity (sea, land and rail transport systems)</td>
</tr>
<tr>
<td></td>
<td>Alternative material for fishing and passenger vessel</td>
<td>Assess the existing fishing and passenger vessel making sector</td>
<td>2016</td>
<td>Cost-competitive amphibious rescue vessel for 10-12 passenger</td>
</tr>
<tr>
<td></td>
<td>Multi-modal (sea, land, rail) transport systems</td>
<td>Prototype development of fishing and passenger vessels for bay/river and open sea</td>
<td>2017</td>
<td>IMO compliant sea crafts</td>
</tr>
<tr>
<td></td>
<td>Integrated ITS</td>
<td>Integrated ITS - Navigational simulation tool - Engine and machinery performance diagnostic tool - Develop Local Maritime Transportation Simulation Models - Develop Local Maritime Transportation Simulation Models</td>
<td>2018</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assess inter-connectivity of freight and passenger multi-modal transport system</td>
<td>2019</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop integrated data recording and archiving system</td>
<td>2020</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cost-effective seaworthy hull design using alternative lightweight materials for passenger and fishing vessels</td>
<td>2022</td>
</tr>
</tbody>
</table>
## RENEWABLE ENERGY AND ENERGY STORAGE SOLUTIONS

### BIOMASS

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>TIMEFRAME</th>
<th>S&amp;T DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste-to-energy for power from municipal solid waste</td>
<td>2013-2015</td>
<td>- Demonstration plant on waste-to-energy from MSW</td>
</tr>
<tr>
<td>Cost effective processes to produce bio-ethanol and biodiesel from agri-based resources</td>
<td>2016-2017</td>
<td>- Resource assessment, database integration, policy study</td>
</tr>
<tr>
<td>Biofuel analysis characterization, stability and storage assessment as well as performance testing, durability, fuel systems and engine components impact assessment</td>
<td>2018-2019</td>
<td>- Cost-competitive hydrogen production</td>
</tr>
<tr>
<td>Higher blend, Combined feedstock</td>
<td>2020-2022</td>
<td>- Biofuel from alternative feedstock</td>
</tr>
<tr>
<td>Production of hydrogen gas using environmentally sound technologies like the application of bioeaters and other processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass for export market assessment (local vs. export use)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass resource assessment - integration of database</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SOLAR

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>TIMEFRAME</th>
<th>S&amp;T DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular stand-alone and mobile desalination system for brackish and sea water</td>
<td>2013-2015</td>
<td>Locally-developed solar desalination system for potable water</td>
</tr>
<tr>
<td>Localization of efficient solar thermal system i.e. concentrator, collectors, for drying and potable water production</td>
<td>2016-2017</td>
<td>- Locally-developed solar cells</td>
</tr>
<tr>
<td>Localization of solar cells (nanotech)</td>
<td>2018-2019</td>
<td>- Establishment of PV Laboratory</td>
</tr>
<tr>
<td>Establishment of PV laboratory (for certification)</td>
<td>2020</td>
<td></td>
</tr>
<tr>
<td>Support to PV standards development</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MICRO-HYDRO

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>TIMEFRAME</th>
<th>S&amp;T DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local turbine inventory &amp; assessment</td>
<td>2013-2015</td>
<td>- Locally-developed micro-hydro turbine</td>
</tr>
<tr>
<td>Localization of high-efficiency turbines</td>
<td>2016-2017</td>
<td>- Assessment of MH resource and market potential</td>
</tr>
<tr>
<td>Upgrading of micro-hydro power performance test facility</td>
<td>2018-2019</td>
<td>Upgraded micro-hydro test facility</td>
</tr>
<tr>
<td>Assessment of industry capability to manufacture (including logistics)</td>
<td>2020-2022</td>
<td></td>
</tr>
<tr>
<td>Assessment of MH resource and market potential</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### OCEAN

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>TIMEFRAME</th>
<th>S&amp;T DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean energy detailed resource assessment in remote/isolated communities (other market and strategic areas i.e. wave, tidal OTEC)</td>
<td>2013-2015</td>
<td>Web-based GIS for ocean energy resource</td>
</tr>
<tr>
<td>Ocean energy harvesting device design &amp; development; Performance and modeling tools</td>
<td>2016-2017</td>
<td>- Mechanical harvesting device design modeling tools</td>
</tr>
<tr>
<td>Assessment of ocean energy harvesting device</td>
<td>2018-2019</td>
<td></td>
</tr>
<tr>
<td>Demonstration project on ocean energy for power</td>
<td>2020-2022</td>
<td>Viability of ocean energy for power demonstrated</td>
</tr>
</tbody>
</table>

### WIND

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>TIMEFRAME</th>
<th>S&amp;T DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Localization and piloting of Small-Scale Wind Turbine Generator</td>
<td>2013-2015</td>
<td>Localized and piloted 2 kW wind turbine generator</td>
</tr>
<tr>
<td>Establishment of wind energy laboratory</td>
<td>2016-2017</td>
<td>Wind energy testing lab established</td>
</tr>
<tr>
<td>Resource assessment in specific sites (remote island communities)</td>
<td>2018-2019</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2020-2022</td>
<td></td>
</tr>
</tbody>
</table>
### RENEWABLE ENERGY AND ENERGY STORAGE SOLUTIONS

#### ENERCON

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>TIMEFRAME</th>
<th>SAT DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated energy management system for household, industry and commercial buildings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Smart and green DOST compound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Smart grid technology program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Smart home platform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Advanced metering infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Acceptability studies for pre-paid metering and smart home systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Rollout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Design and implementation of Power Distribution Units for data centers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Development of Building Management Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sensors, integration monitoring software, automation and control systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compendium of available energy efficiency devices and technologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sensors, integration monitoring software, automation and control systems</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### LOW-ENTHALPY GEOTHERMAL

<table>
<thead>
<tr>
<th>RESEARCH AREAS</th>
<th>TIMEFRAME</th>
<th>SAT DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource and market assessment of low-enthalpy geothermal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat pump technology development for low-enthalpy application</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Smart DOST building
- Smart grid technology—wireless and centralized integrated monitoring system
- Locally-developed building energy management tool
- Resource and market assessment of low-enthalpy geothermal
- Heat pump technology development for low-enthalpy application
ANNEX 41
DRR-CCA R&D Roadmap

Roadmap for DRR-CCA R&D Agenda

PRIORITY AREAS
1. Observation and Monitoring Networks
2. Technology Development and Application for Monitoring
3. Modeling and Simulation for Improvement of Monitoring and Forecasting
4. Hazards, Vulnerability and Risk Assessment
5. Warning and Risk Communication

PRIORITY AREAS
6. Technology Development and Application for Climate Change Mitigation and Adaptation
7. Technology Development and Application for Disaster Risk Management
8. Policy Research