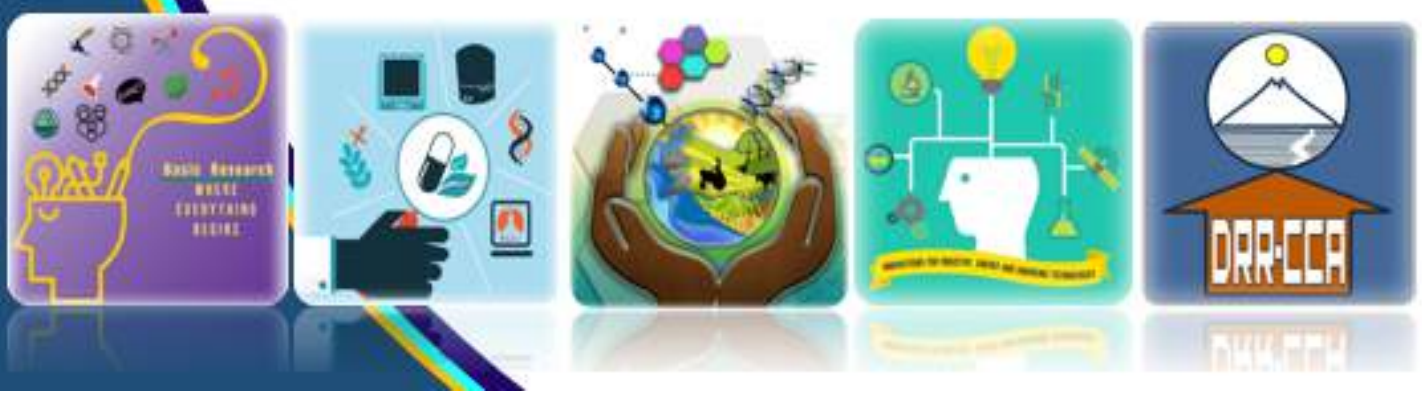
Department of Science and Technology

# HARMONIZED NATIONAL RESEARCH AND DEVELOPMENT AGENDA

## 2017-2022



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# Acronyms

| Acronym | Definition |
|---|---|
| AANR | Agriculture, Aquatic and Natural Resources |
| AIS | Automatic identification system |
| ALERT Program | Alternative Energy Research Trends Program |
| ATIN Program | Ang Tinig Natin Program |
| BMI | Body mass index |
| CCTV | Closed-circuit television |
| CHED | Commission on Higher Education |
| CVD | Cardiovascular disease |
| DNA | Deoxyribonucleic acid |
| DOH | Department of Health |
| DOST | Department of Science and Technology |
| DRR & CCA | Disaster Risk Reduction and Climate Change Adaptation |
| ENGP | Enhanced National Greening Program |
| FGD | Focused Group Discussion |
| GIT | Gastrointestinal tract |
| GNSS | Global navigation satellite system |
| GUT | Genitourinary tract |
| $H_2S$ | Hydrogen sulfide |
| HAB | Harmful algal bloom |
| HNRDA | Harmonized National Research and Development Agenda |
| HIV AIDS | Human immunodeficiency virus and acquired immunodeficiency syndrome |
| HIW | High-Impact Weather |
| HYV | High yielding variety |
| ICT | Information and Communication Technology |
| IEC | Information Education and Communication |
| ITS | Intelligent transportation system |
| IVM | Integrated vector management |
| LIKAS Program | Likas Yaman sa Kalusugan Program |
| MSME | Micro, small and medium enterprise |
| NGA | National Government Agency |

| | |
|---|---|
| NIBRA | National Integrated Basic Research Agenda |
| NIH-UPM | National Institutes of Health, University of the Philippines Manila |
| NRCP | National Research Council of the Philippines |
| NRDC | National Research and Development Conference |
| NUHRA | National Unified Health Research Agenda |
| PCAARRD | Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development |
| PAGASA | Philippine Atmospheric, Geophysical and Astronomical Services Administration |
| PCHRD | Philippine Council for Health Research and Development |
| PCIEERD | Philippine Council for Industry, Energy and Emerging Technology Research and Development |
| PES | Payment for Environmental Services |
| PHIVOLCS | Philippine Institute of Volcanology and Seismology |
| PNHRS | Philippine National Health Research System |
| PWD | Persons with disabilities |
| PTC | Positive Train Control |
| PUV | Public Utility Vehicle |
| QPF | Quantitative Precipitation Forecasting |
| R&D | Research and Development |
| RE | Renewable Energy |
| RFID | Radio Frequency Identification |
| RUTF | Ready to use therapeutic food |
| SAKLAW Program | Saklolo sa Lawa Program |
| SAPAT Program | Saganang Pagkain Para sa Lahat Program |
| SCP | Solar Power Concentrators |
| SDG | Sustainable Development Goal |
| SHC | Solar heating and cooling |
| STA | Space Technology Application |
| T2DM | Type 2 Diabetes Mellitus |
| TUBIG Program | Tubig ay Buhayin at Ingatan Program |
| UAV | Unmanned Aerial Vehicles |
| UN | United Nations |
| WSN | Wireless Sensor Network |
| XDP | X-linked Dystonia-Parkinsonism Syndrome |

# Introduction

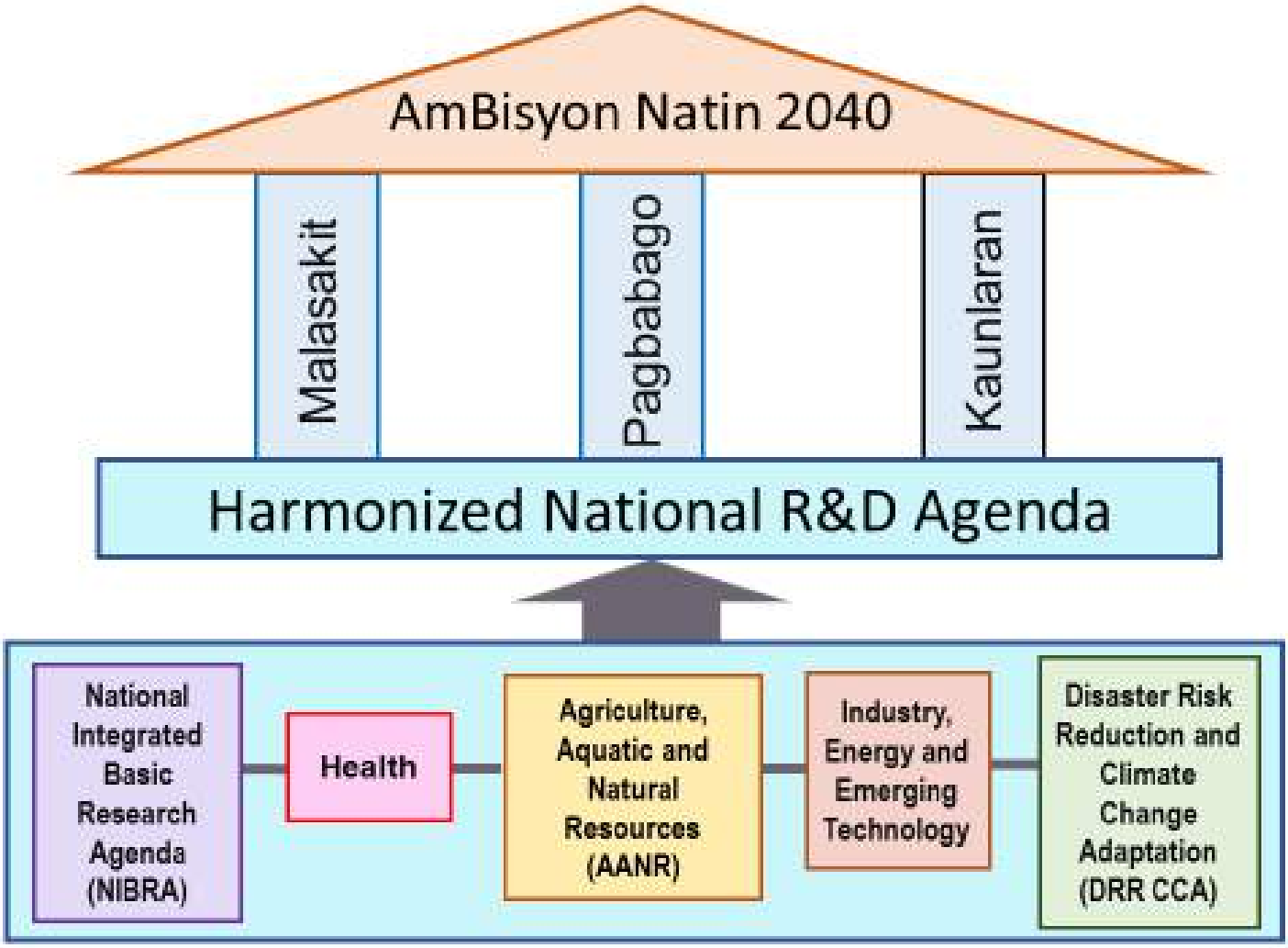
The DOST, in consultation with government and private research and development institutions, the academe, industry and other concerned agencies, prepared the Harmonized National R&D Agenda (HNRDA) 2017-2022 to ensure that results of S&T endeavors are geared towards and are utilized in areas of maximum 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 HNRDA, 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.*

# HARMONIZED NATIONAL R&D AGENDA (2017–2022)

## R&D Priority Areas and Programs

### National Integrated Basic Research Agenda (NIBRA)

- WATER SECURITY
  - Watershed studies, water quality, accessibility and availability
- FOOD AND NUTRITION SECURITY
  - Food safety, biodiversity studies
- HEALTH SUFFICIENCY
  - Fundamental studies on potential sources of natural products, basic veterinary studies, social dimensions on health
- CLEAN ENERGY
  - Alternative energy
- SUSTAINABLE COMMUNITIES
  - Vulnerable ecosystems, data analytics on natural phenomena, environmental and anthropogenic activities
- INCLUSIVE NATION-BUILDING
  - Documentation of indigenous knowledge, data collection on social phenomena, education, national security and sovereignty, arts, history and culture

### Health

- Drug Discovery and Development
- Diagnostics
- Functional Foods
- Hospital Equipment and Biomedical Devices
- Information and Communication Technology for Health
- Dengue
- Nutrition and Food Safety
- Disaster Risk Reduction - Health
- Climate Change Adaptation – Health
- Omic Technologies for Health

### Agriculture, Aquatic and Natural Resources Sector (AANR)

**AGRICULTURE**

Crops

- Germplasm research; Varietal improvement and selection; Good quality planting materials (QPMs); Cultural management and crop production systems; Postharvest processing and product development

Livestock

- Animal improvement; Improved reproduction, feeding and nutrition; Conservation and improvement of native animals; Vaccine, biologics and diagnostics; Detection of chemical residues and antimicrobial resistance; Decision support systems; Product development and processing

**FISHERIES AND AQUACULTURE**

- Applied genomics; Culture systems; Culture of new cultivable species; Fish health, disease diagnostics and management; Nutrition, feeds and feeding systems; Postharvest handling, processing and product development; Automation of feeding, water and culture management and post production; Fishkill warning and mitigation systems and environmental management; Management of fisheries

**FORESTRY**

- Development and sustainable management of tree plantations; HYV development of priority timber species; Production protocols for the production of QPM; Sustainable cultural management practices, harvesting and postharvest techniques and marketing strategies

**NATURAL RESOURCES AND ENVIRONMENT**

- Biodiversity; Watershed management and utilization; Soil management and rehabilitation; Agricultural and forest waste-based product development; Climate change strategies and decision support tools; Resource assessment and monitoring; Habitat management; Marine environmental management; Innovative systems for unique landscapes and ecosystems

**TECHNOLOGY TRANSFER**

- Upscaling of technology transfer and commercialization; New and innovative extension modalities; Technology business incubators

**SOCIO-ECONOMICS AND POLICY RESEARCH**

### Industry, Energy and Emerging Technology

- Food and Nutrition Security
- Countryside Development
- Competitive Industries
- Delivery of Social Services
- Intelligent Transportation Solutions
- Renewable Energy and Energy Storage Solutions
- Human Security

### Disaster Risk Reduction and Climate Change Adaptation (DRR CCA)

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

# 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 research 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 research 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)
b. Impact of various climate change scenarios on water supply

**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. Impact of various climate change scenarios on water supply

## 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 Sovereignty
   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 47-50.**
**For details, visit http://www.nrcp.dost.gov.ph/**

# SECTION II

# HEALTH
# Research and Development Agenda
# 2017 – 2022

**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. [1]

## RESEARCH PRIORITIES for HEALTH RESEARCH and DEVELOPMENT [2]

**A. Diagnostics**
**B. Drug discovery and development**
**C. Functional foods**

[1] Apart from the health S&T component of the NUHRA 2017-2022, the said document is also inclusive of other themes that cover diseases of globalization, urbanization, and industrialization, i.e., mental health, accidents and injuries, and substance abuse.
[2] Although not specifically reflected in this document, priority health research topics address the triple burden of disease, with diseases of globalization, urbanization, and industrialization covered in the management/ supportive care for such conditions under biomedical devices including some in the areas of diagnostics, omic technologies, and climate change adaptation.

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

2. Specific topics
   a. Characterization of food and food components
   b. Safety assessment
   c. Establishment of health benefits
   d. 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 research seeks 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 research on climate change adaptation, which have direct implications on public health

Specific topics

**Priorities for 2017-2022**

- Research 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. Omic 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

- Omic 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**

*Omic 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 omic 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.)

**For further details about the NUHRA, visit [www.pchrd.dost.gov.ph/](www.pchrd.dost.gov.ph/)**

# 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

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

## 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 53-75.**
**For details, visit http://www.pcaarrd.dost.gov.ph/home/portal/**

# 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
     - Hydrometallurgical
     - Pyrometallurgical
     - 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 $H_2S$ emission in the environmental and industrial sectors
        - Emission reduction focusing on efficient and clean technologies
        - $H_2S$ 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
  - Wastewater Management
- Air Quality R&D
  - Air Pollution Control and Management
- Solid Waste Management
- DRR/CCA Proofing Infrastructure Systems and Techniques
  - Urban infrastructure rainfall inflow-outflow modeling and early warning systems
- Hazards and Risk Assessment Tools and Systems Program
  - Liquefaction Hazard Assessment
- Instrumentation for early warning, monitoring and rapid assessment
  - 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
  - Vehicle-to-vehicle connectivity and information sharing
  - Road infrastructure-to-vehicle
  - Automated Parking Space Detection System
  - Harmonized radio frequency identification (RFID)/wireless sensor network (WSN) using multi-path transmission protocol & cognitive frequency
  - PUV tracking for fleet management & driving behavior
- Sea Transport Research on Marine Vessels
  - Standard sea-worthy hull design using alternative indigenous lightweight materials
  - Navigational Route Capacity Measurement & Analysis for inter-island connectivity
- Mass Transport Systems (Train, PUV)
  - Prototype double decker bus development and fuel efficiency analysis in compliance to Euro 4 Standards
  - 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
    - Efficient hydrokinetic energy harvesting systems
    - Sustainable urban waste to energy conversion
- Renewable Energy (RE) Systems
    - RE technologies and business models integration for sustainable off-grid power supply
    - Thermo/electro/biochemical hydrogen production
    - Solar power concentrators (SPC)
    - Solar heating and cooling (SHC)

## G. Human Security

1. Food Defense
2. Biosecurity
3. Cybersecurity

**Industry, Energy and Emergency Technology Roadmaps are on pages 76-87.**
**For details, visit http://pcieerd.dost.gov.ph/**

# SECTION V

# DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION (DRR & CCA) Research and Development Agenda 2017 – 2022

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

# SUSTAINABLE DEVELOPMENT GOALS

**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
4. Microbial Biotechnology for Sustainable Waste Management and Alternative Energy Source
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

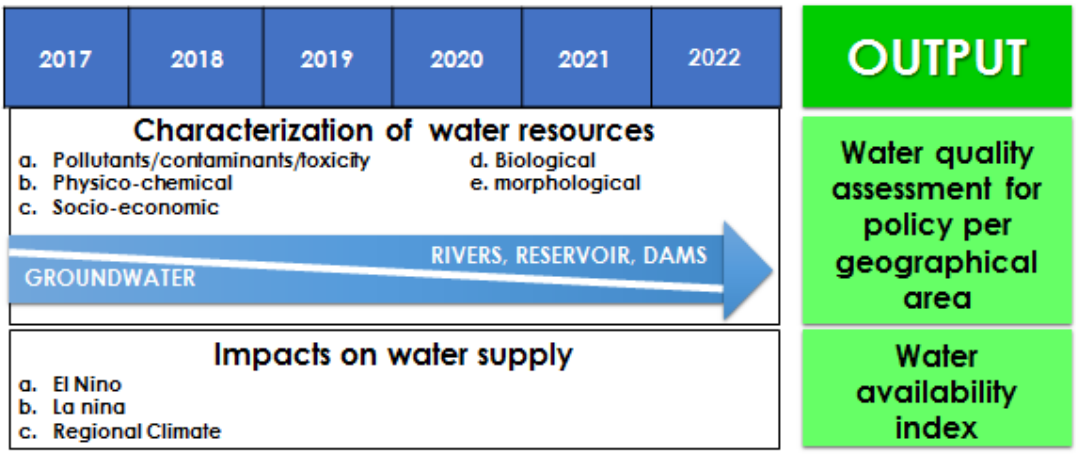
**For details, visit http://www.phivolcs.dost.gov.ph/**
**http://www.pagasa.dost.gov.ph/**

# ANNEXES: Roadmaps

**ANNEX 1**
**NIBRA Roadmaps**

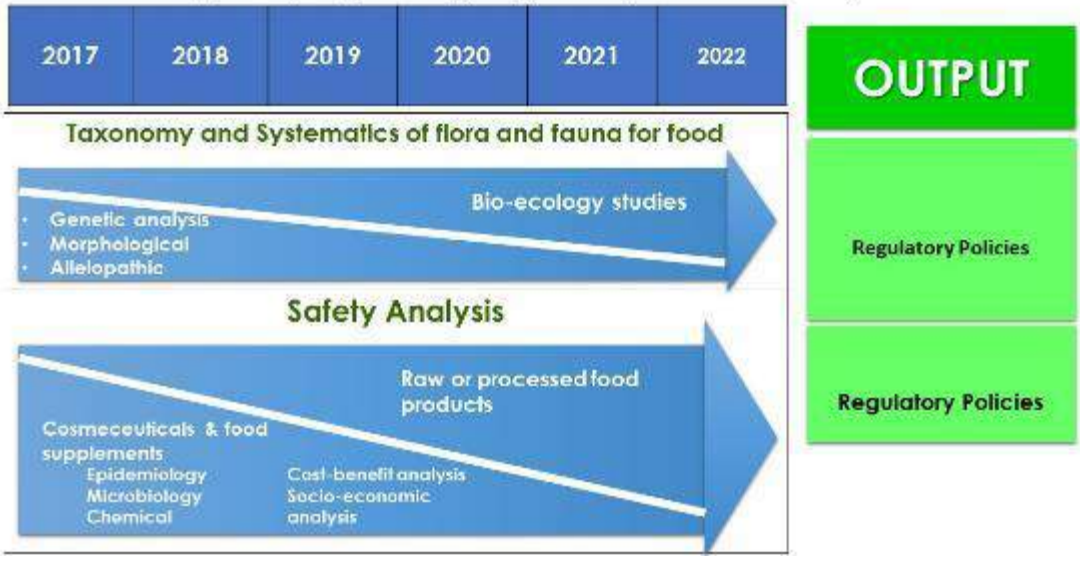
## 1. WATER SECURITY

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




## 2. FOOD and NUTRITION SECURITY

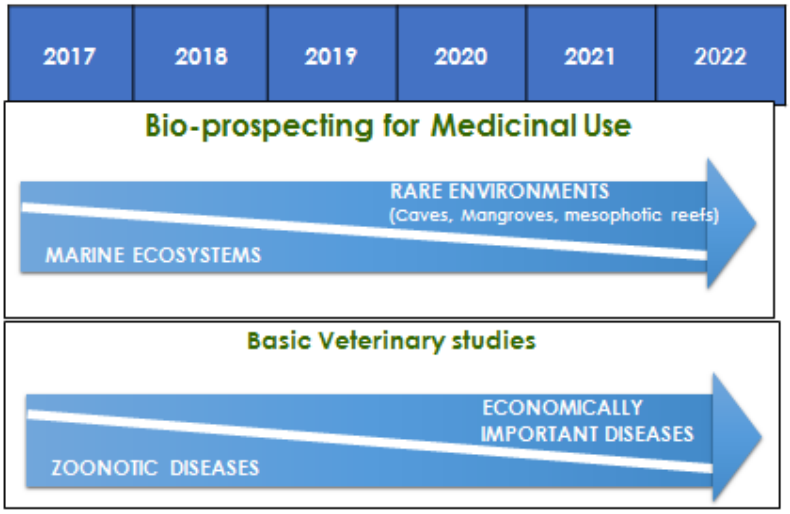
***SAPAT Program (Saganang Pagkain para sa Lahat)***



**ANNEX 2**
**NIBRA Roadmaps**

## 3. HEALTH SUFFICIENCY

***LiKas Program (Likas Yaman sa Kalusugan)***



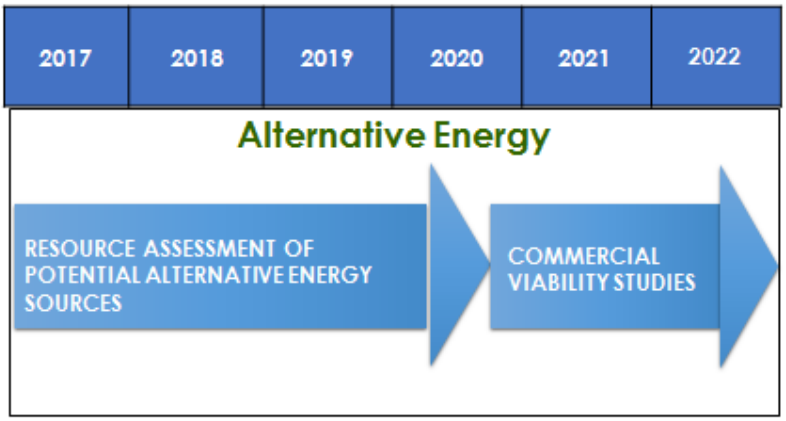

**OUTPUT**

- **Policy recommendation for Republic Acts**
- **Compounds for potential medicinal use**

**Herbal veterinary pharmacopoeia**

## 4. CLEAN ENERGY

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



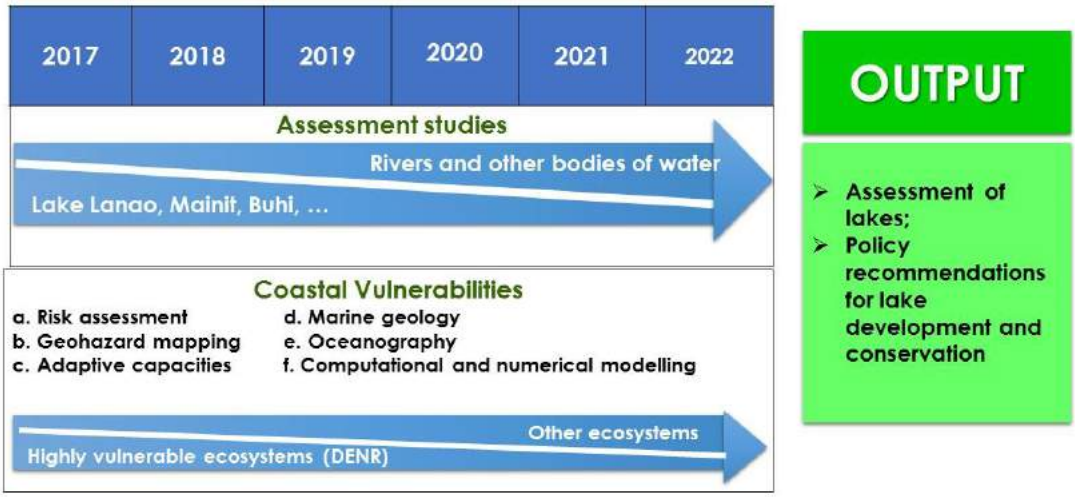

**OUTPUT**

**Inputs for RDIs, Councils and Industry**

**ANNEX 3**
**NIBRA Roadmaps**

## 5. SUSTAINABLE COMMUNITIES

***SAKLAW Program (Saklolo sa Lawa)***



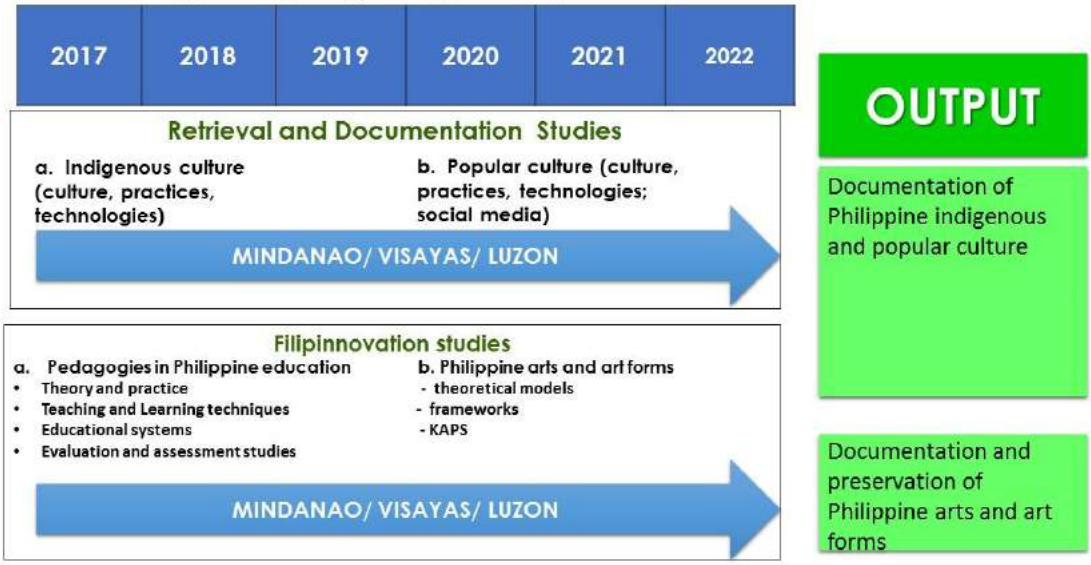

## 5. SUSTAINABLE COMMUNITIES

***SAKLAW Program (Saklolo sa Lawa)***

**ANNEX 4**
**NIBRA Roadmaps**

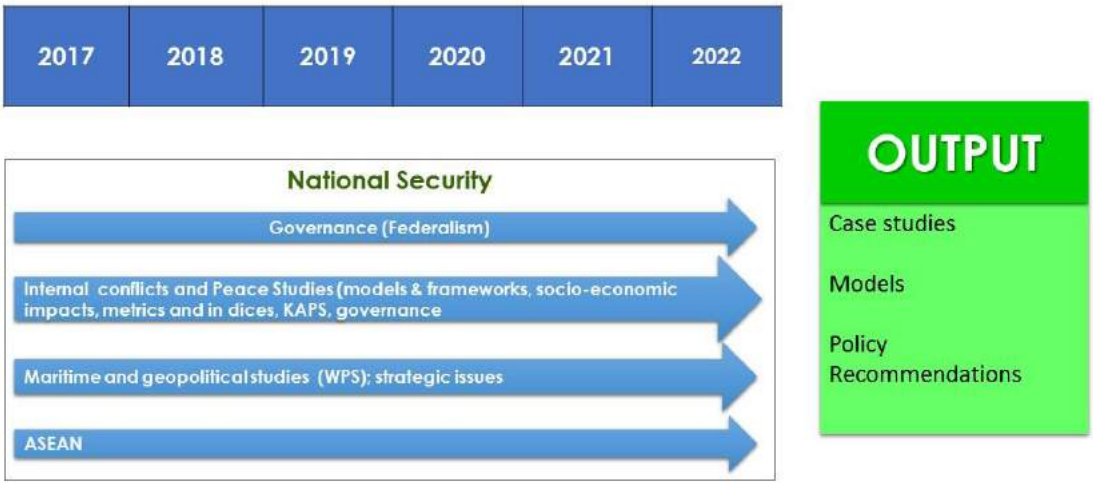
## 6. Re-engineering the Philippines towards inclusive Nation-Building

***ATIN Program (Ang Tinig Natin)***




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

***ATIN Program (Ang Tinig Natin)***



**ANNEX 5 - NUHRA**

**NATIONAL UNIFIED**
**HEALTH RESEARCH AGENDA 2017-2022**

The research priorities in the National Unified Health Research Agenda (NUHRA) 2017-2022 are subdivided into six themes with several areas as follows:

Theme 1. Responsive health systems

Health governance
Health financing
Access to essential medical products, vaccines and technologies
Health information systems
Health service delivery
Health human resource
Health economics
Health research management

Theme 2. Research to enhance and extend healthy lives

Adolescent health
Communicable diseases
Environmental health
Maternal, newborn and child health
Mental health
Non communicable diseases
Nutrition
Oral health
Reproductive health

Theme 3. Holistic approaches to health and wellness

Filipino traditional and complementary medicine
Determinants of health
Halal in health
Health behaviors

Theme 4. Health resiliency

Accidents and injuries
Climate change
Disaster risk reduction
Emerging and re-emerging diseases
Environmental threats
Migration and health
Occupational health

Theme 5. Global competitiveness and innovation in health

Diagnostics
Drug discovery and development
Functional foods
Information and Communication Technologies for Health
Biomedical products
Omic technologies for health

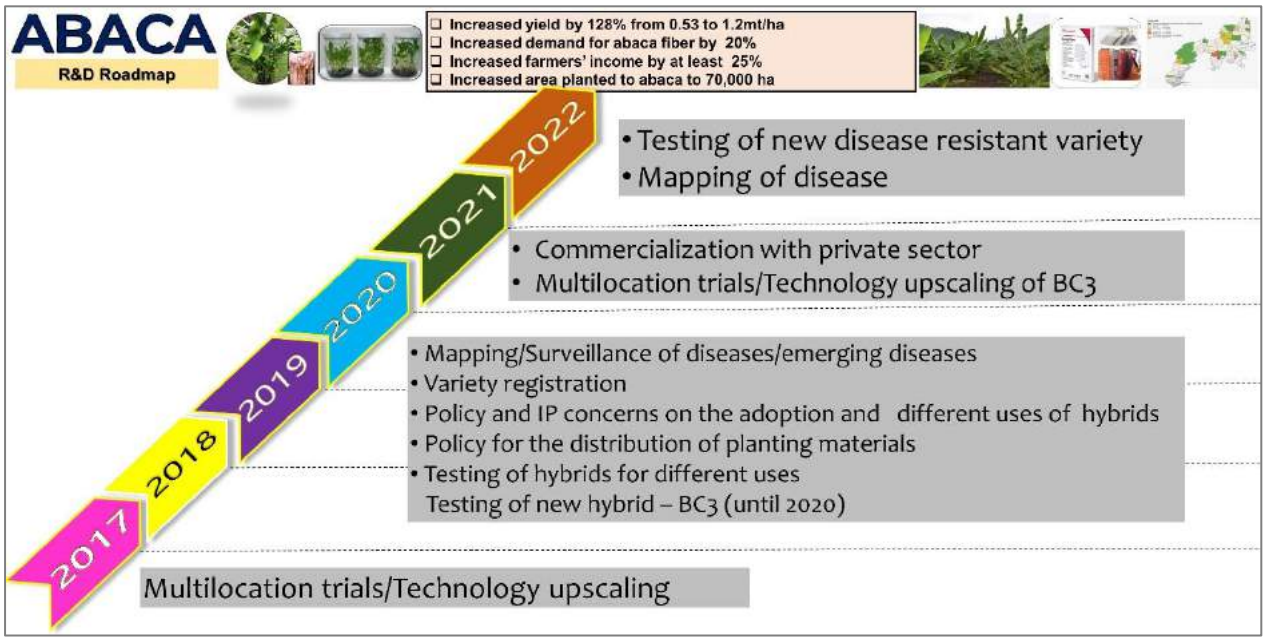
Theme 6. Equity in health research

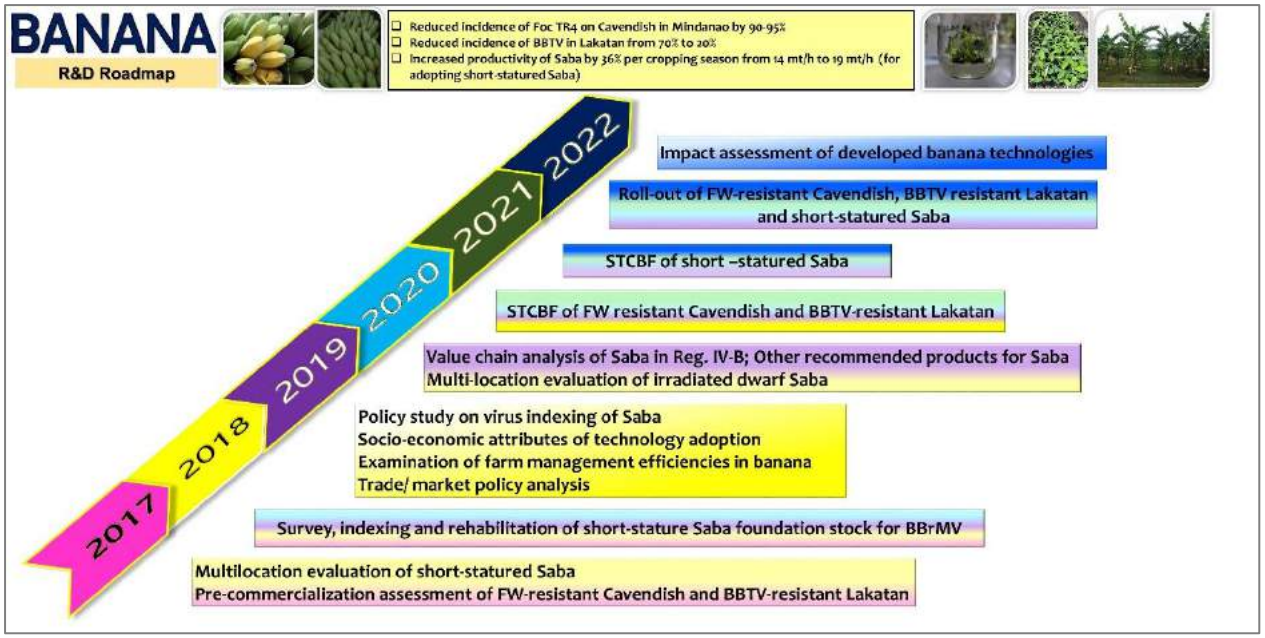
Disability
Gender
Geriatric care
Geographically isolated and disadvantaged areas
Indigenous peoples
Substance abuse
Violence

The new NUHRA document is being finalized and will be available in August 2017. It is planned to be launched during the PNHRS Week to be celebrated in the same month.

**ANNEX 6**
**AANR Programs/Projects Roadmaps**

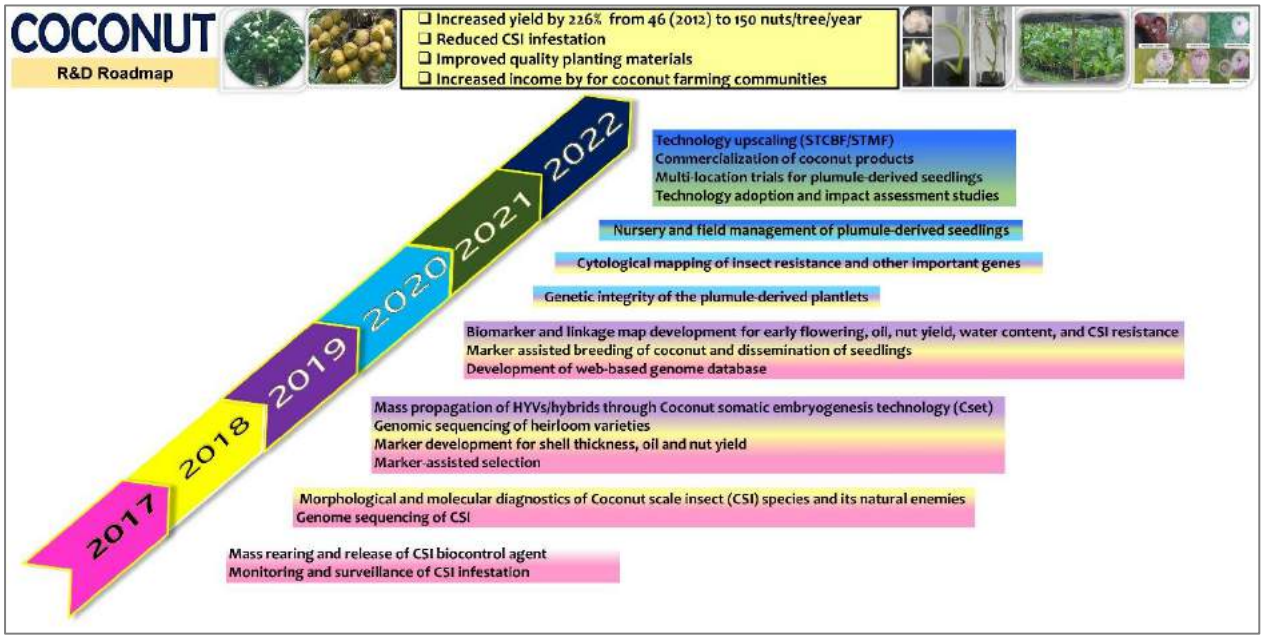
## CROPS

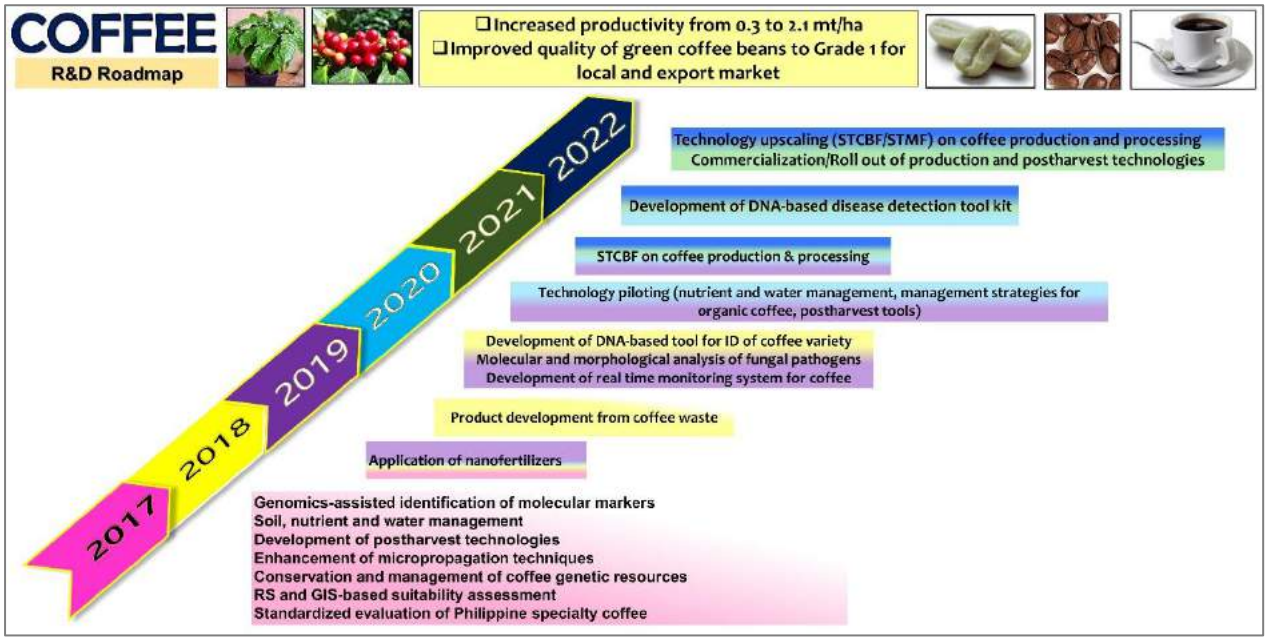


**ANNEX 7**
**AANR Programs/Projects**
**Roadmaps**

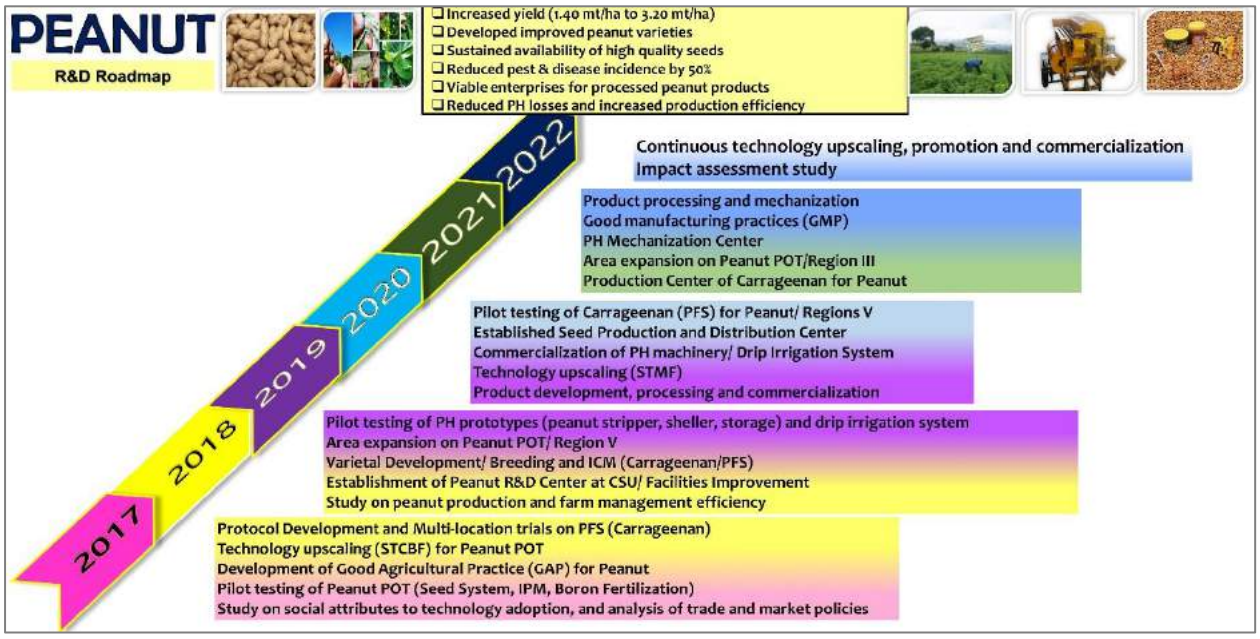
## CROPS



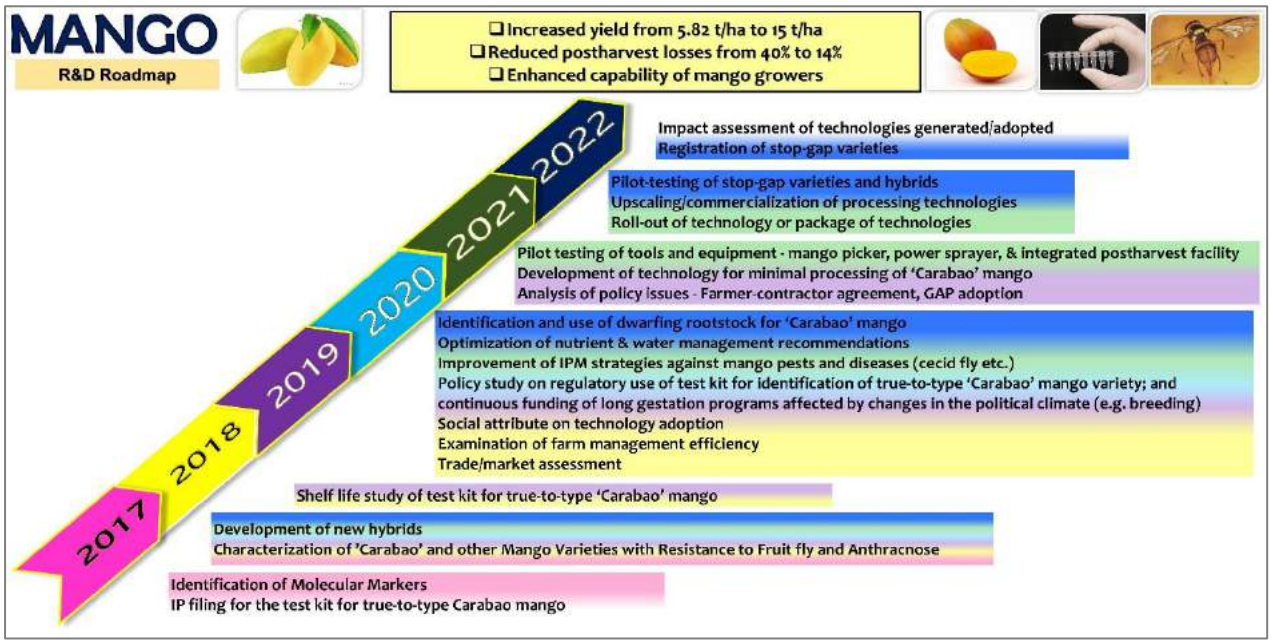
**ANNEX 8**
**AANR Programs/Projects**
**Roadmaps**

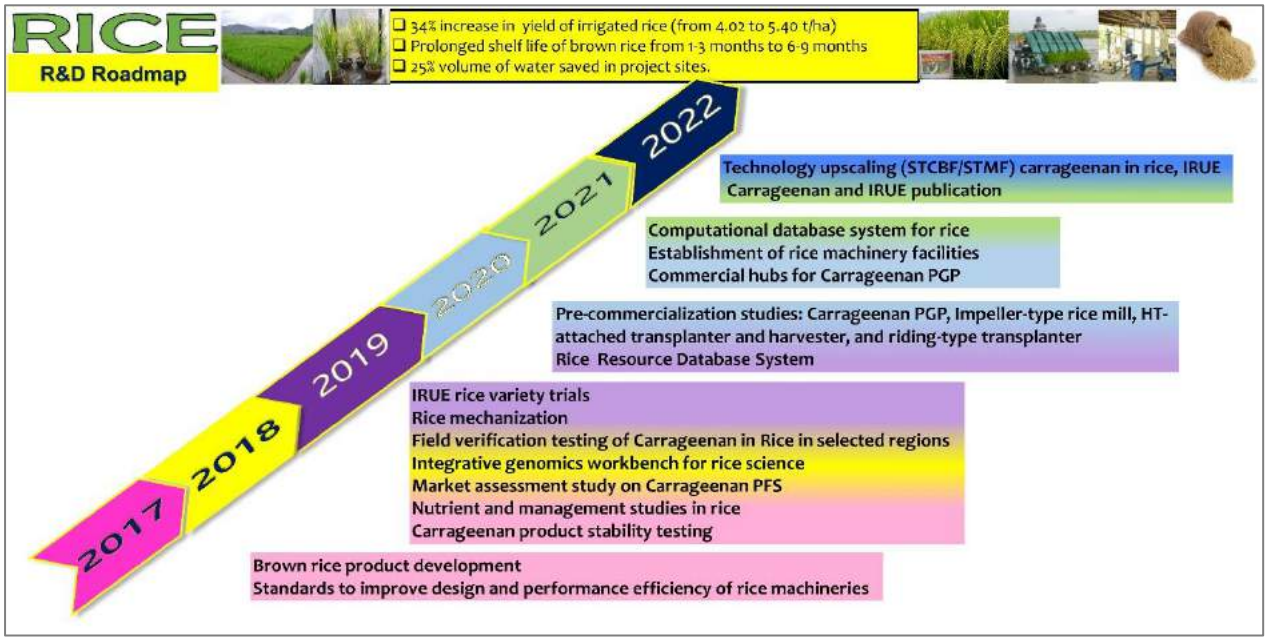
## CROPS: LEGUMES



**ANNEX 9**
**AANR Programs/Projects**
**Roadmaps**

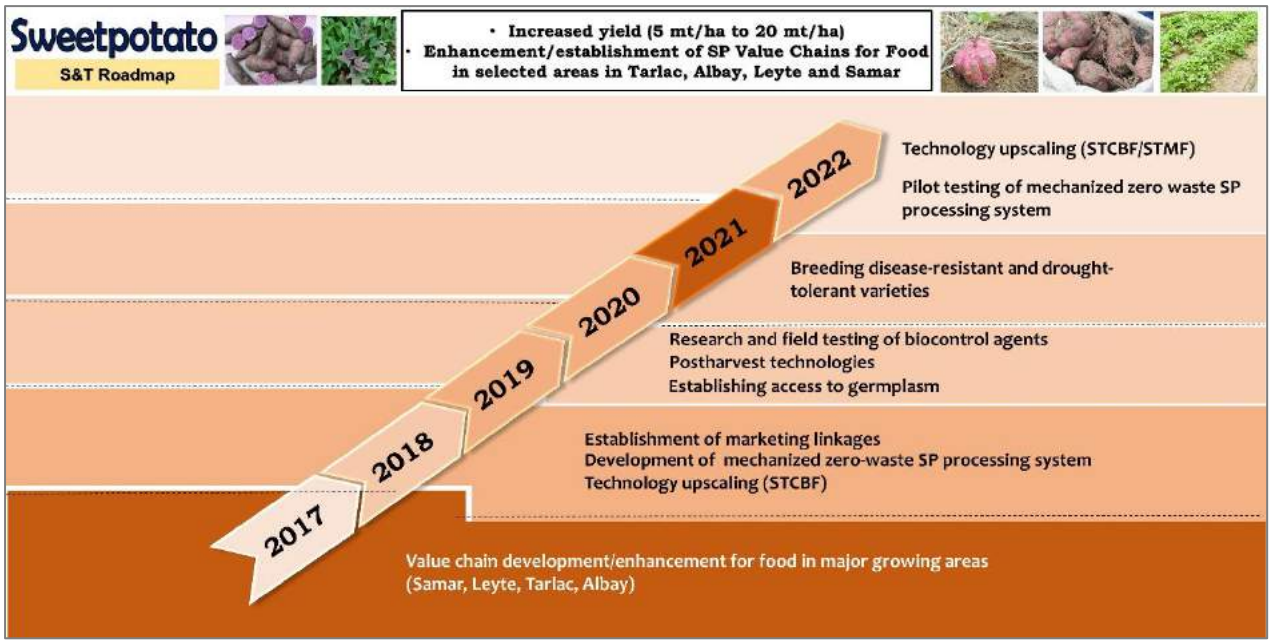
## CROPS



**ANNEX 10**
**AANR Programs/Projects**
**Roadmaps**

## CROPS: ROOTCROPS

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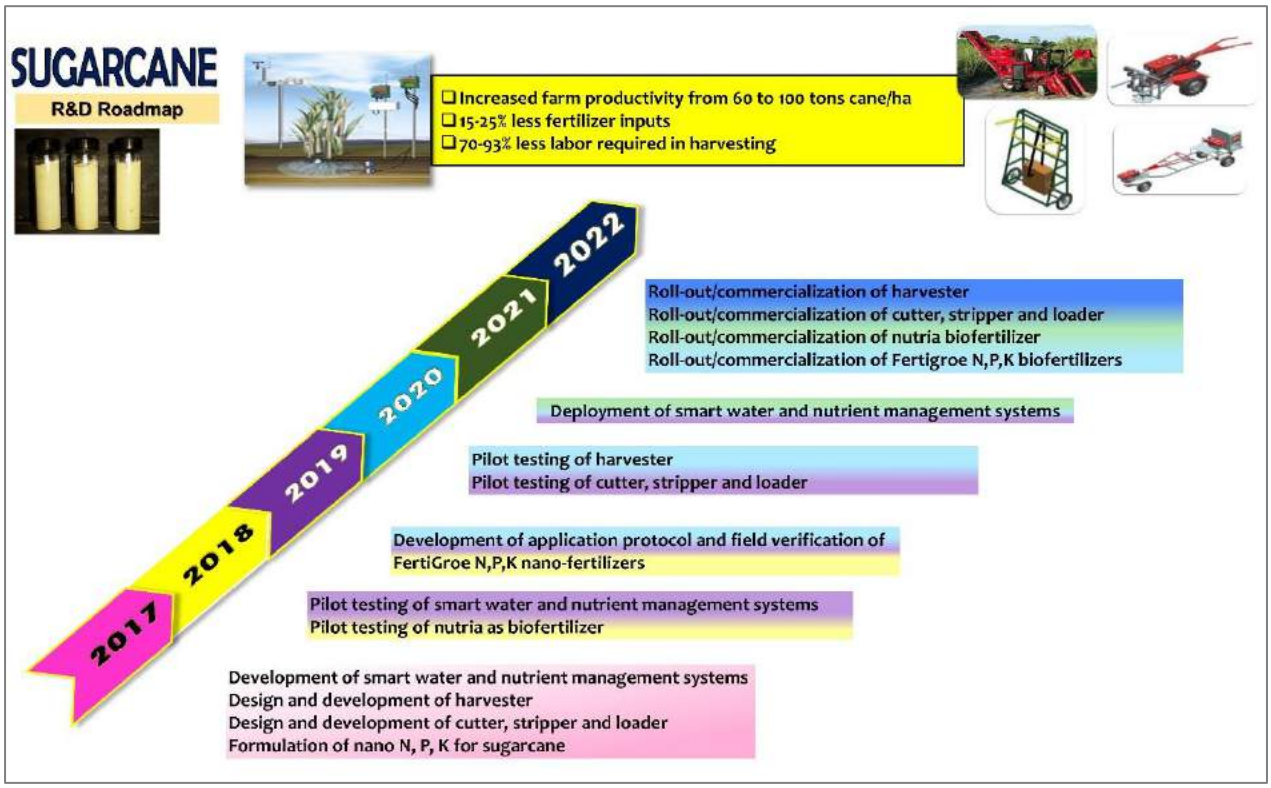
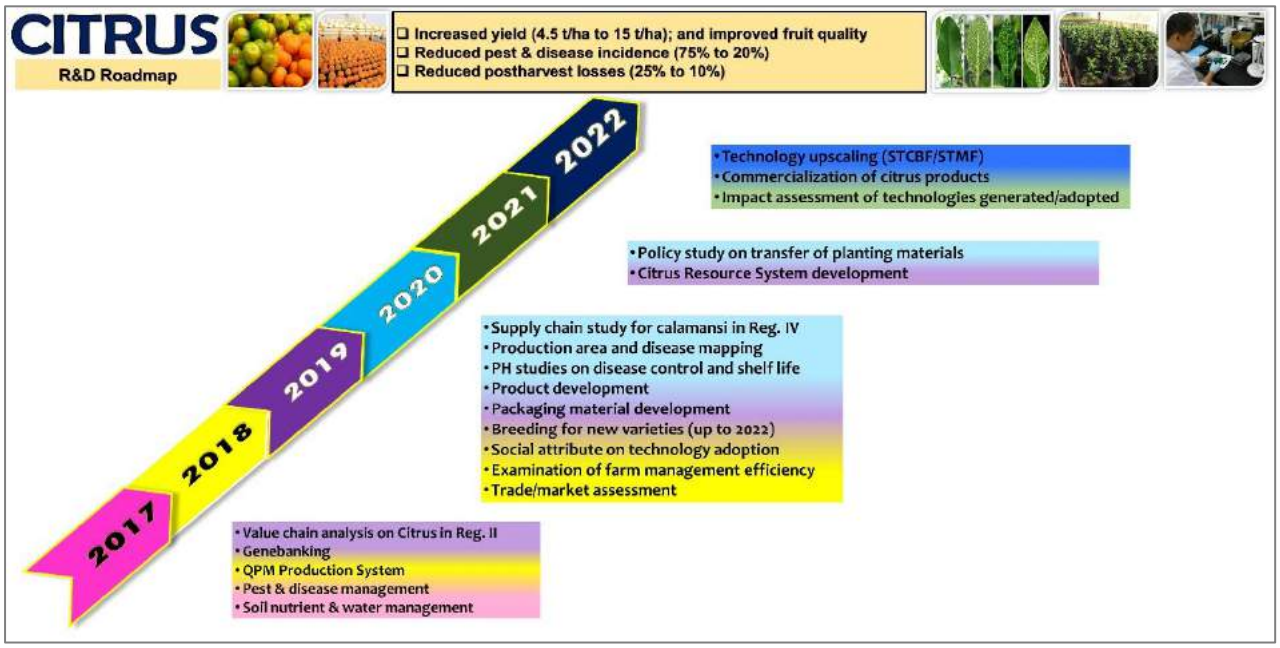
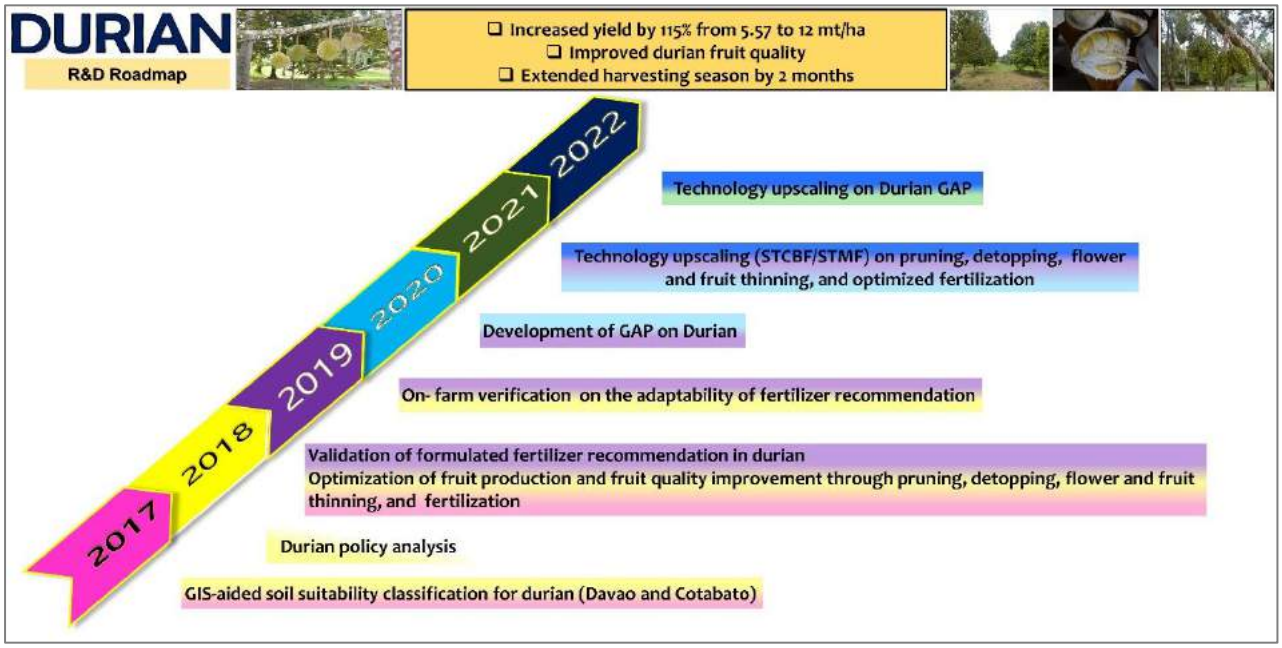


**ANNEX 11**
**AANR Programs/Projects**
**Roadmaps**

## CROPS: TROPICAL FRUITS

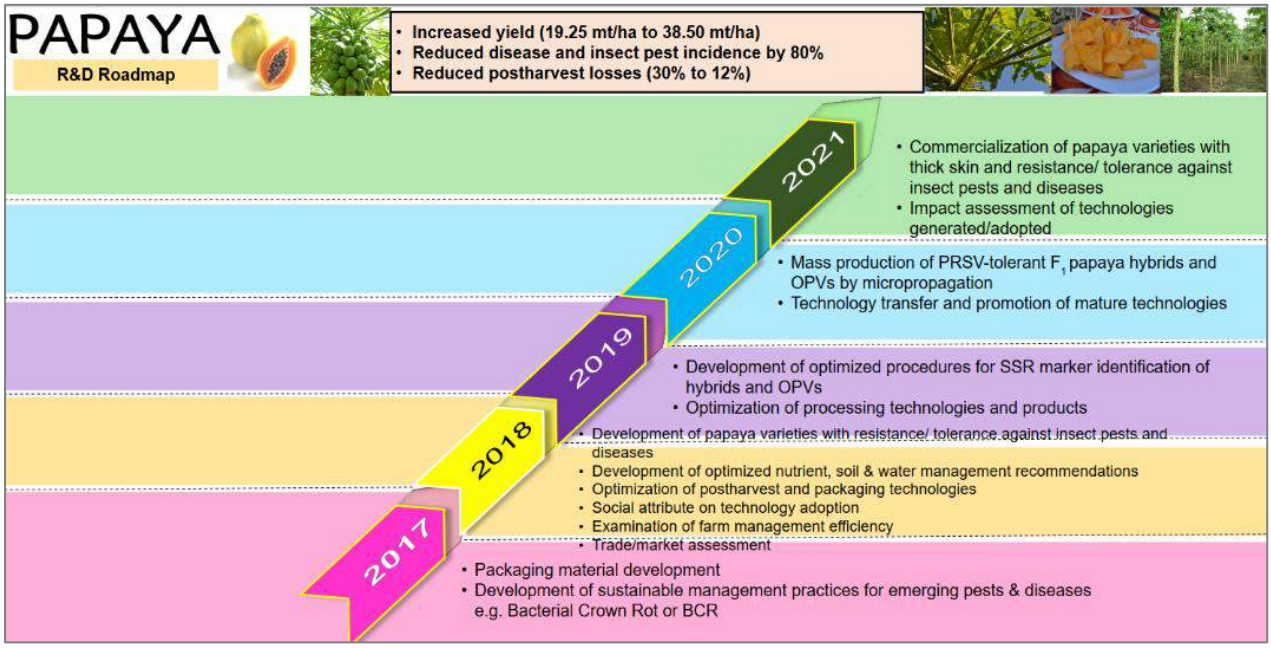


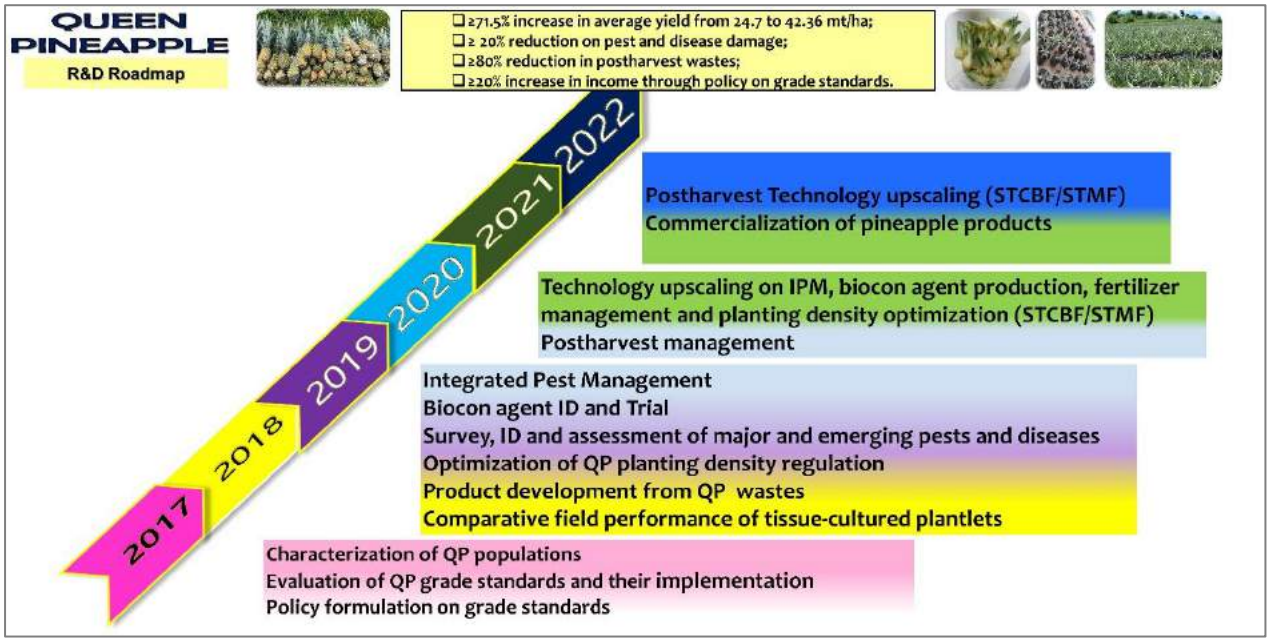



**ANNEX 12**
**AANR Programs/Projects**
**Roadmaps**

## CROPS: TROPICAL FRUITS

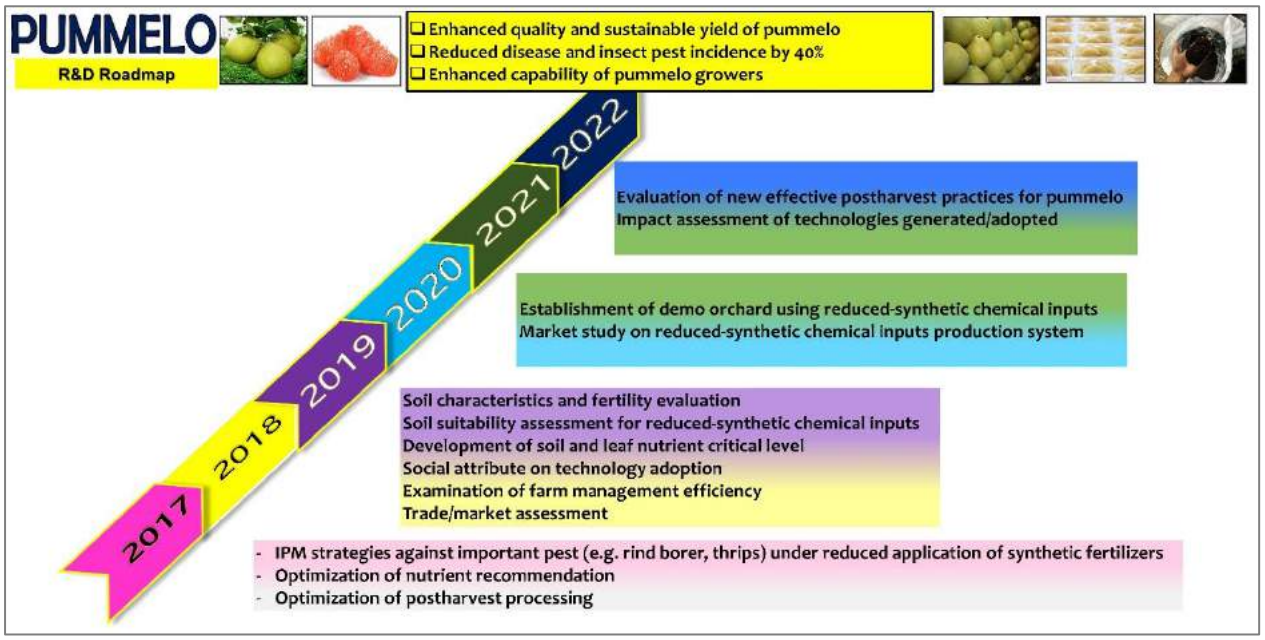
The R&D Roadmap for papaya covers the period 2017-2021. Stakeholders for this product will be consulted for the next initiatives/plans.



**ANNEX 13**
**AANR Programs/Projects**
**Roadmaps**

## CROPS: TROPICAL FRUITS

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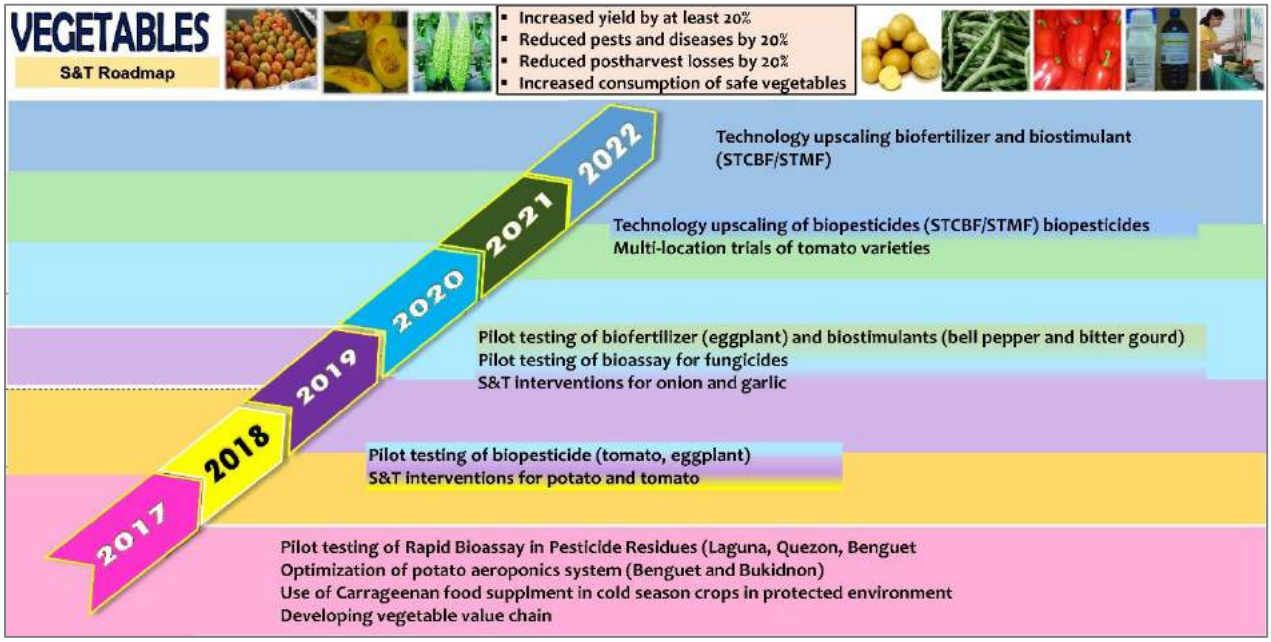
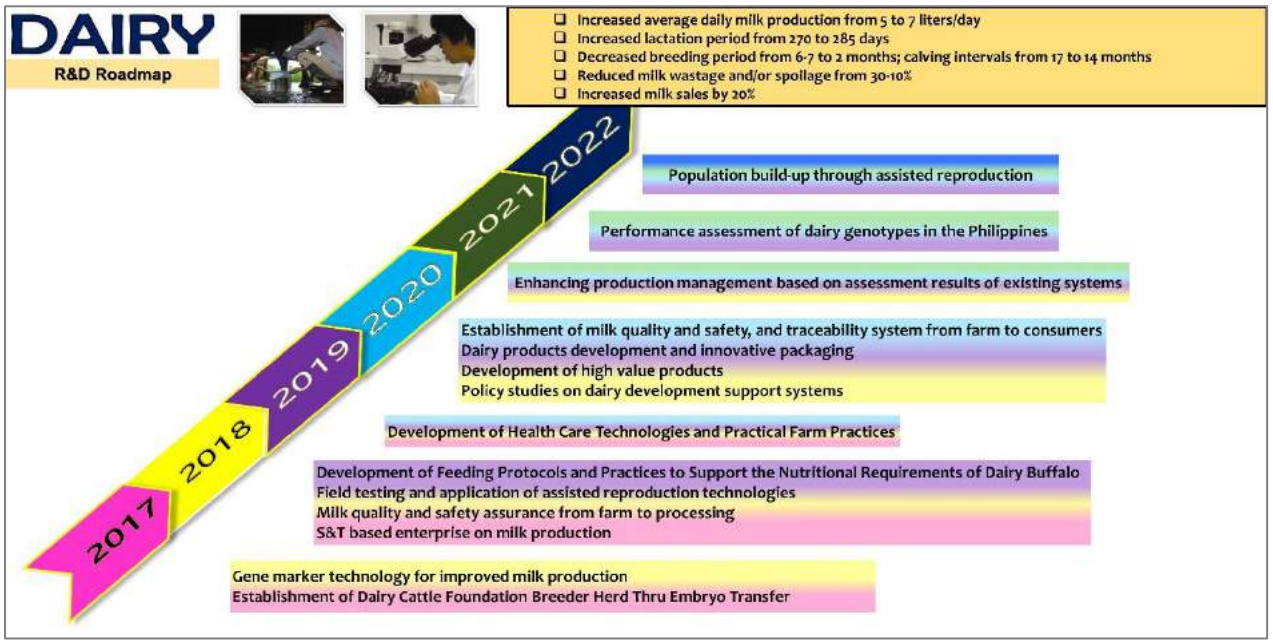
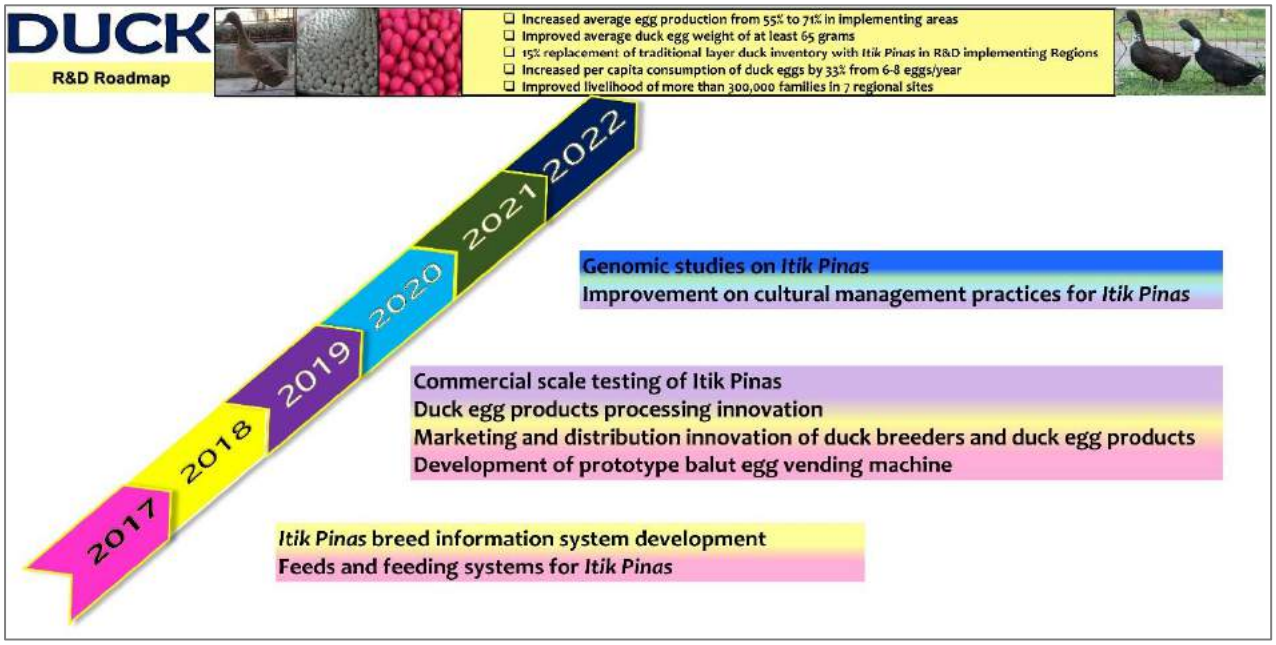


**ANNEX 14**
**AANR Programs/Projects**
**Roadmaps**

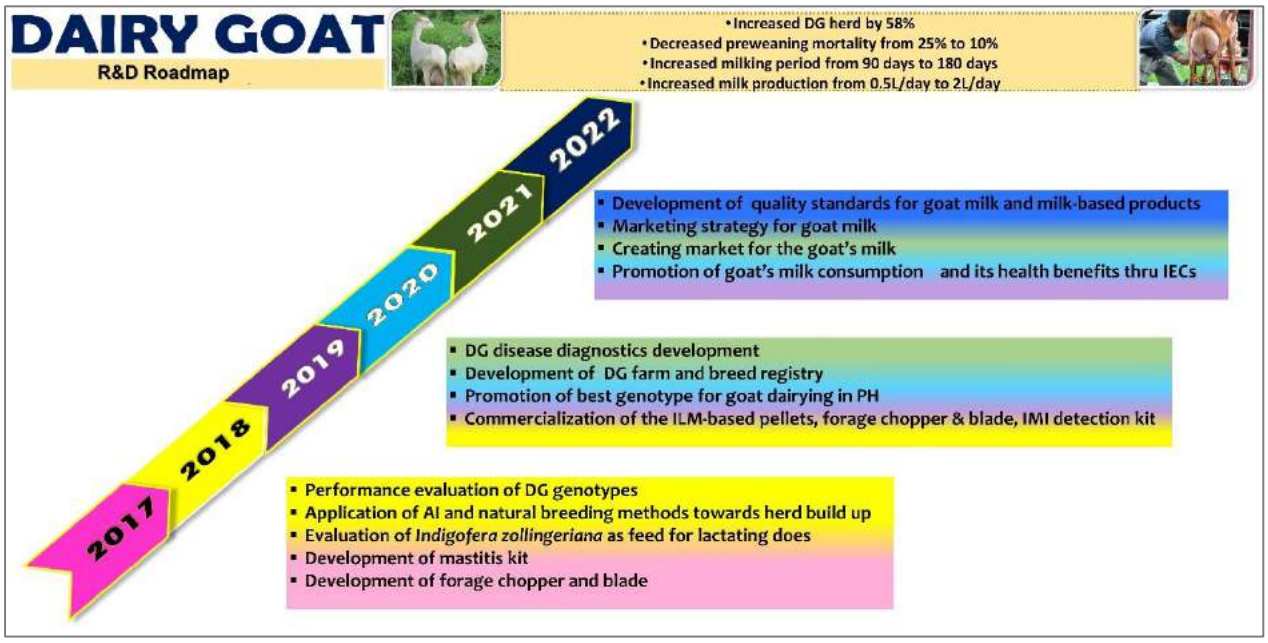
## LIVESTOCK

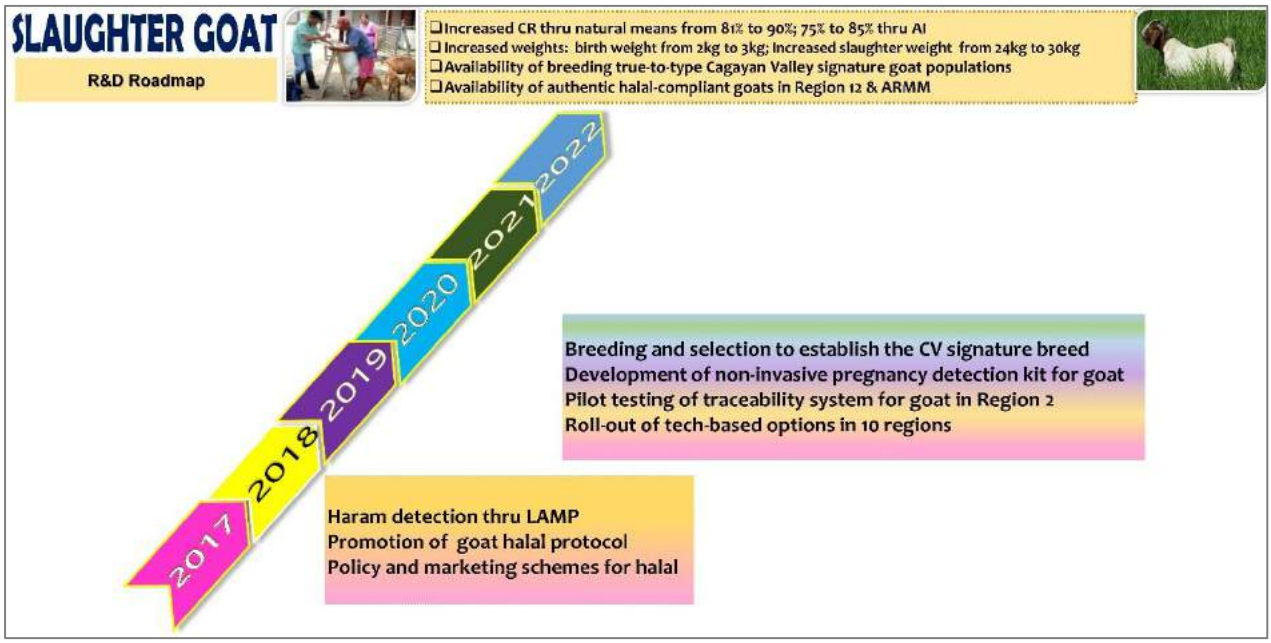


**ANNEX 15**
**AANR Programs/Projects**
**Roadmaps**

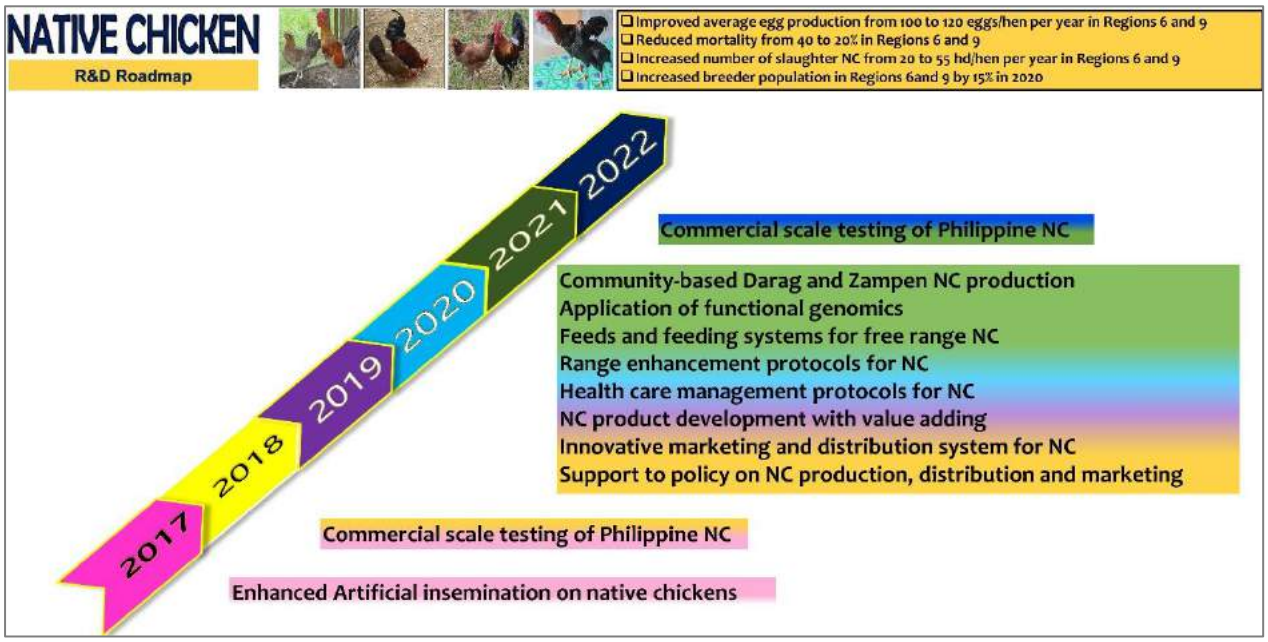
## LIVESTOCK

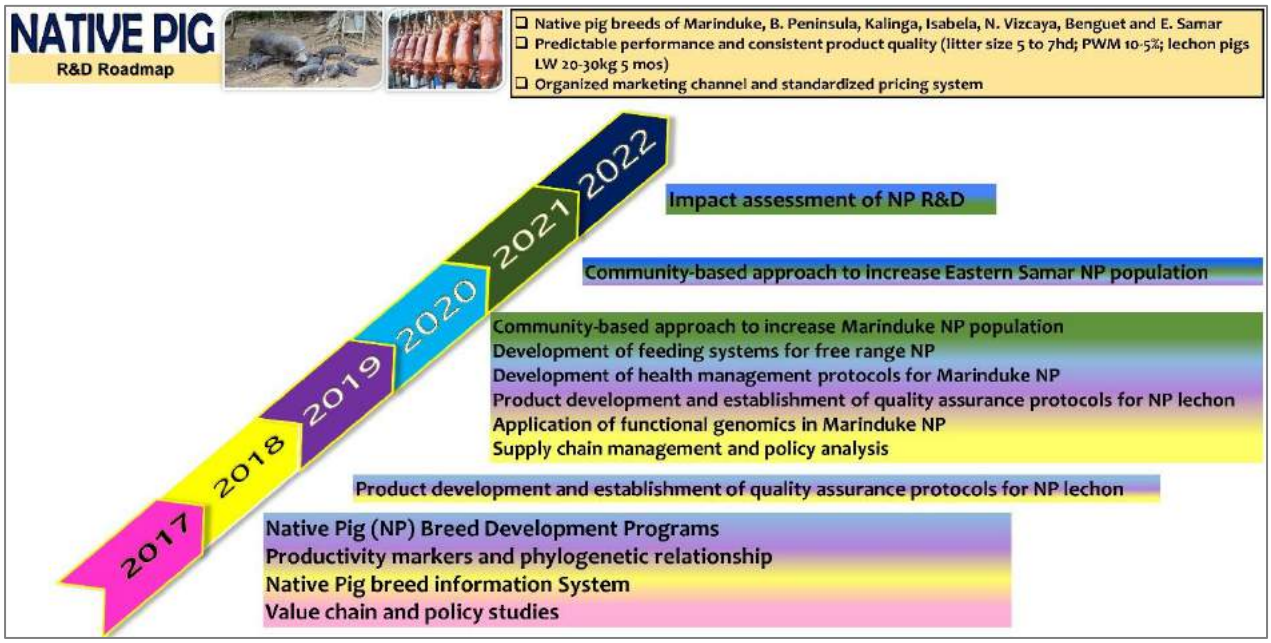


**ANNEX 16**
**AANR Programs/Projects**
**Roadmaps**

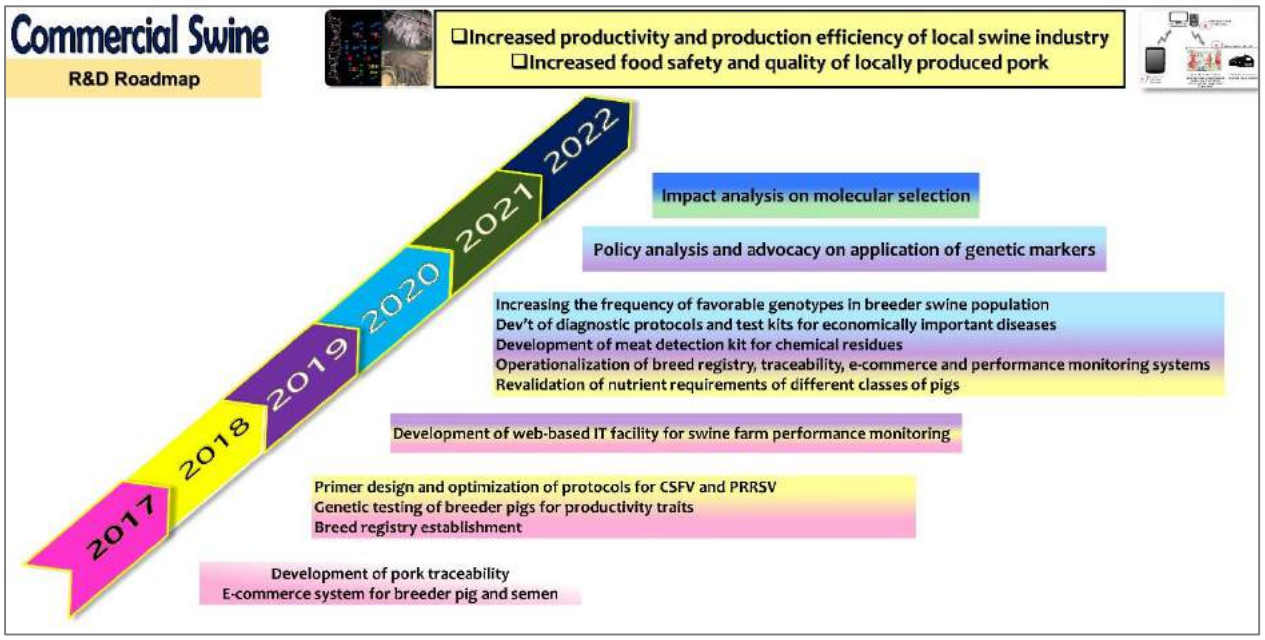
## LIVESTOCK

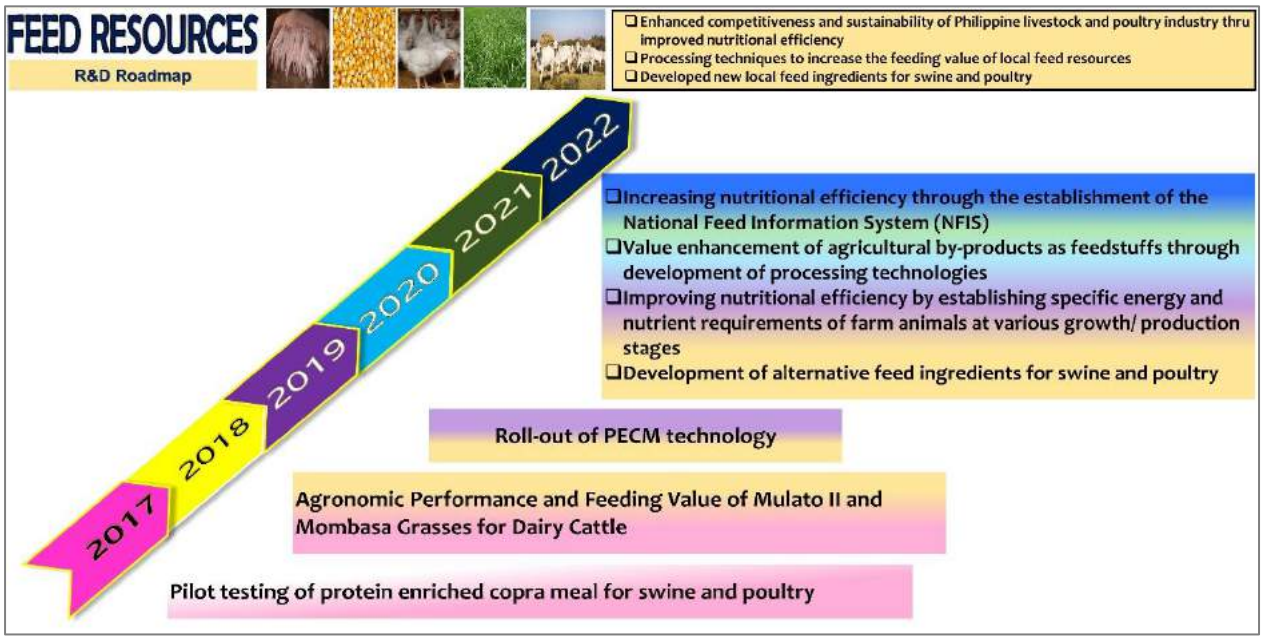


**ANNEX 17**
**AANR Programs/Projects**
**Roadmaps**

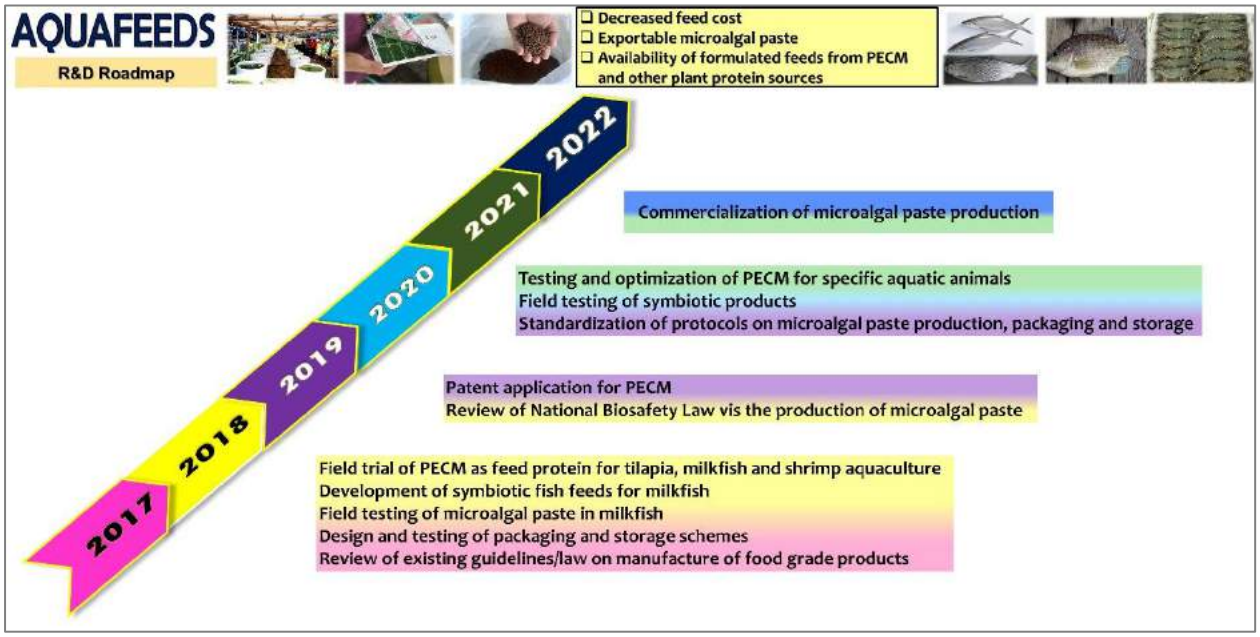
## LIVESTOCK

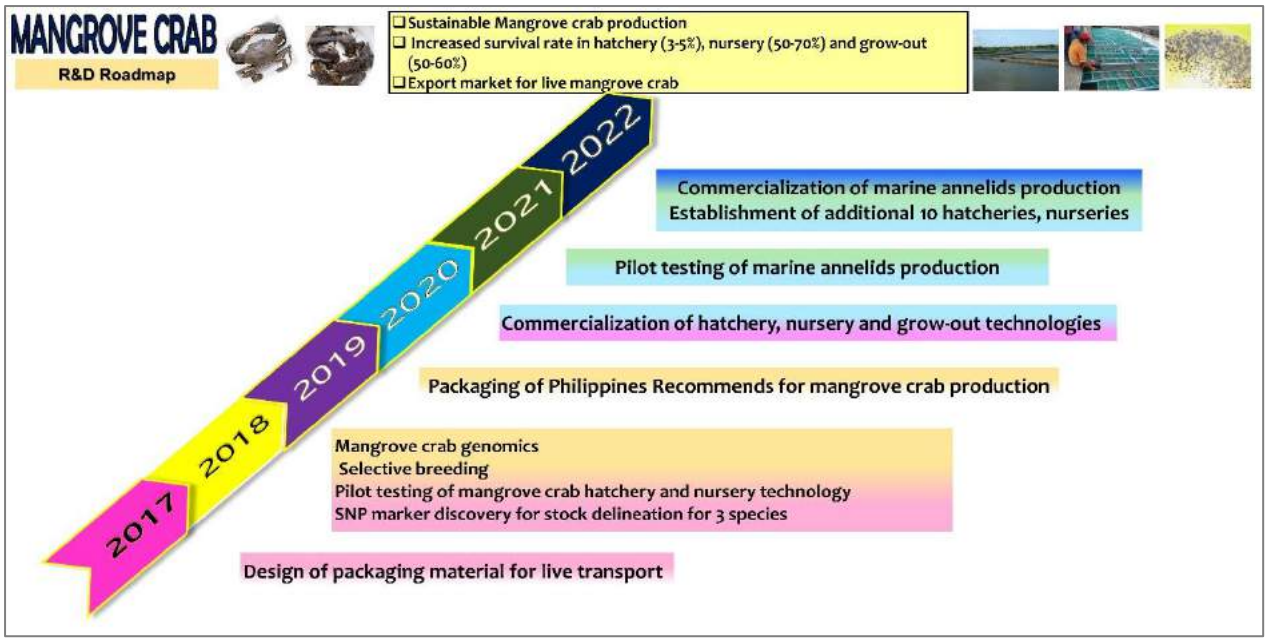


**ANNEX 18**
**AANR Programs/Projects**
**Roadmaps**

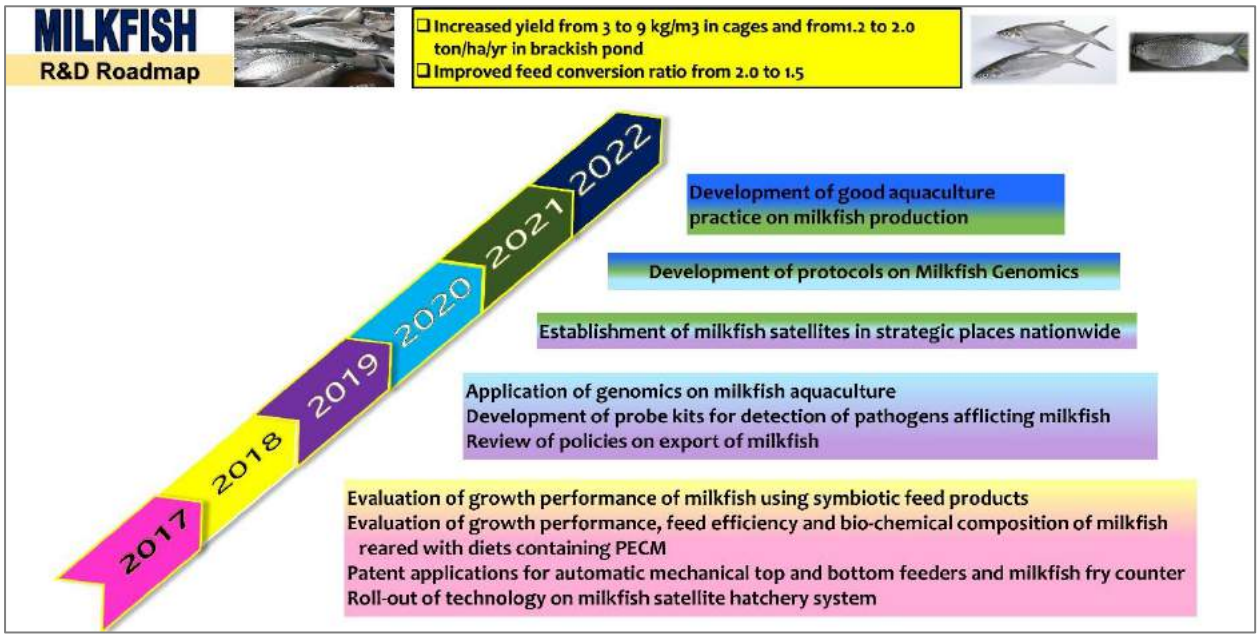
## AQUATIC: INLAND

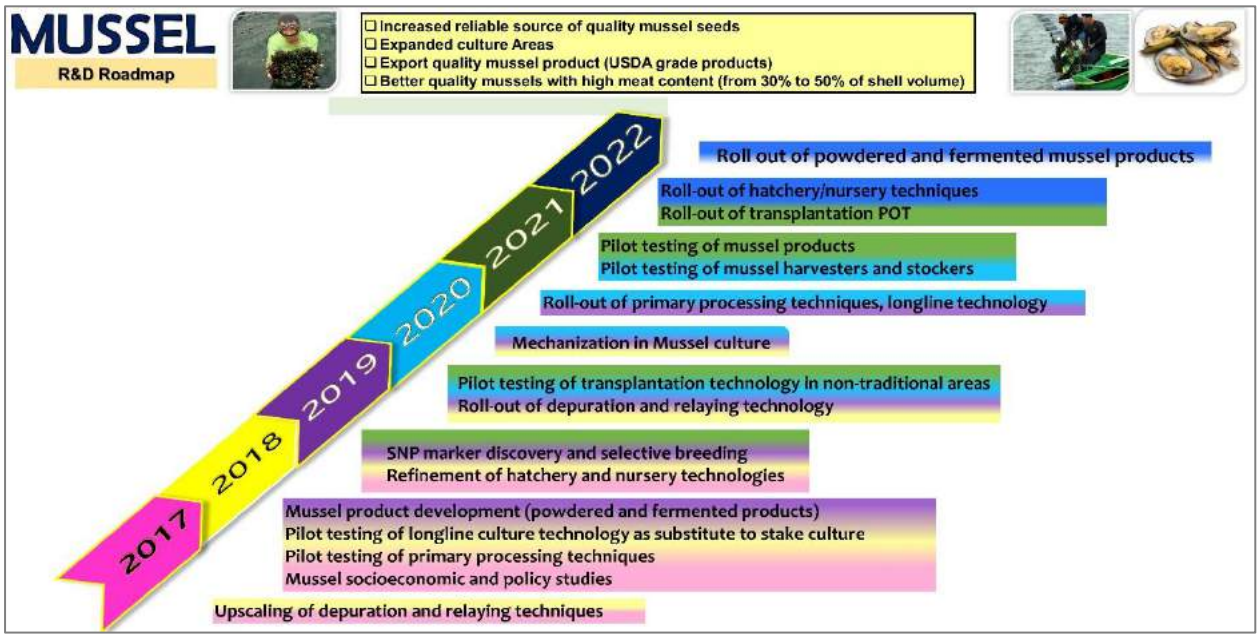


**ANNEX 19**
**AANR Programs/Projects**
**Roadmaps**

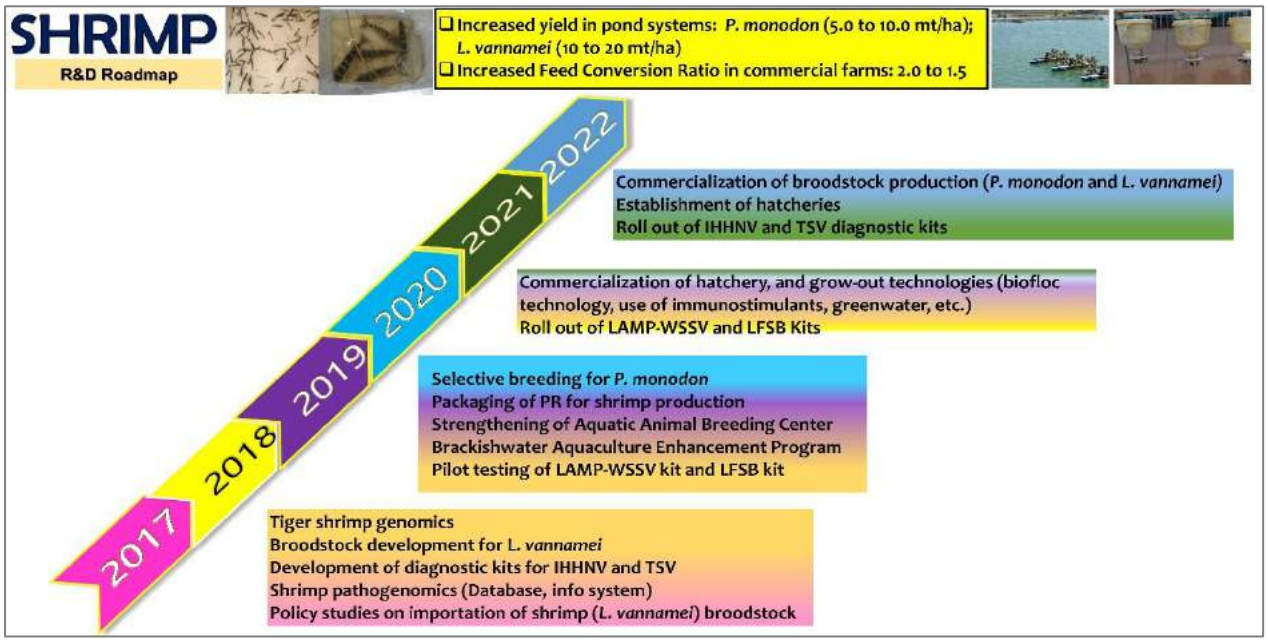
## AQUATIC: INLAND

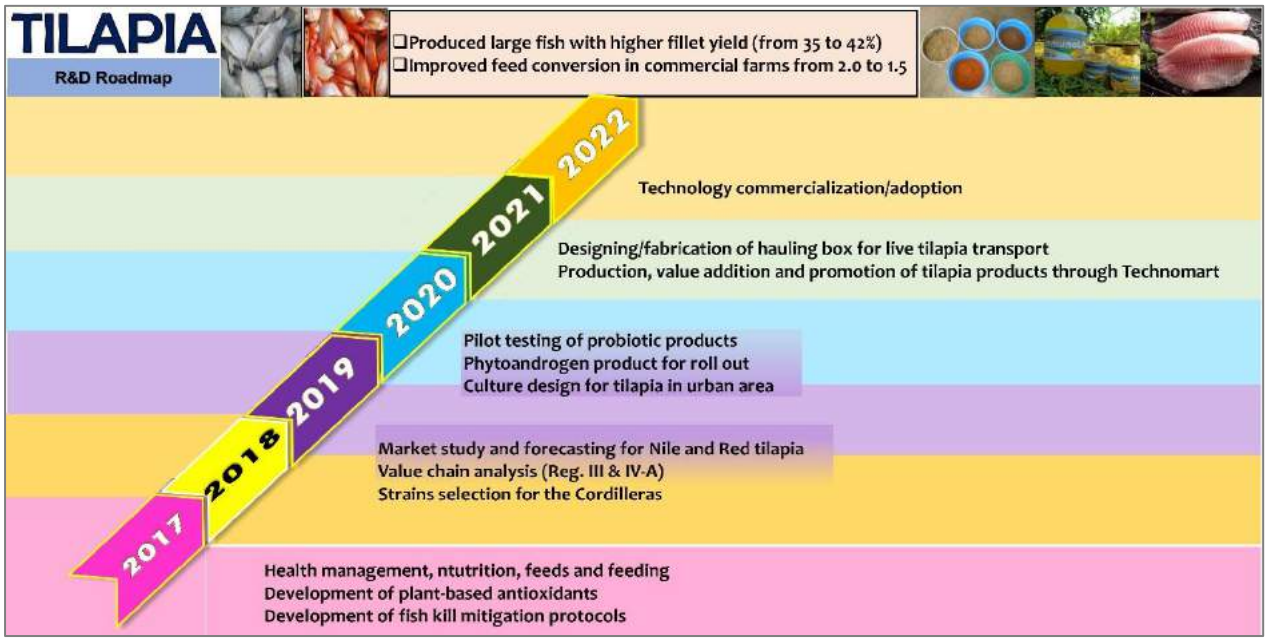


**ANNEX 20**
**AANR Programs/Projects**
**Roadmaps**

## AQUATIC: INLAND

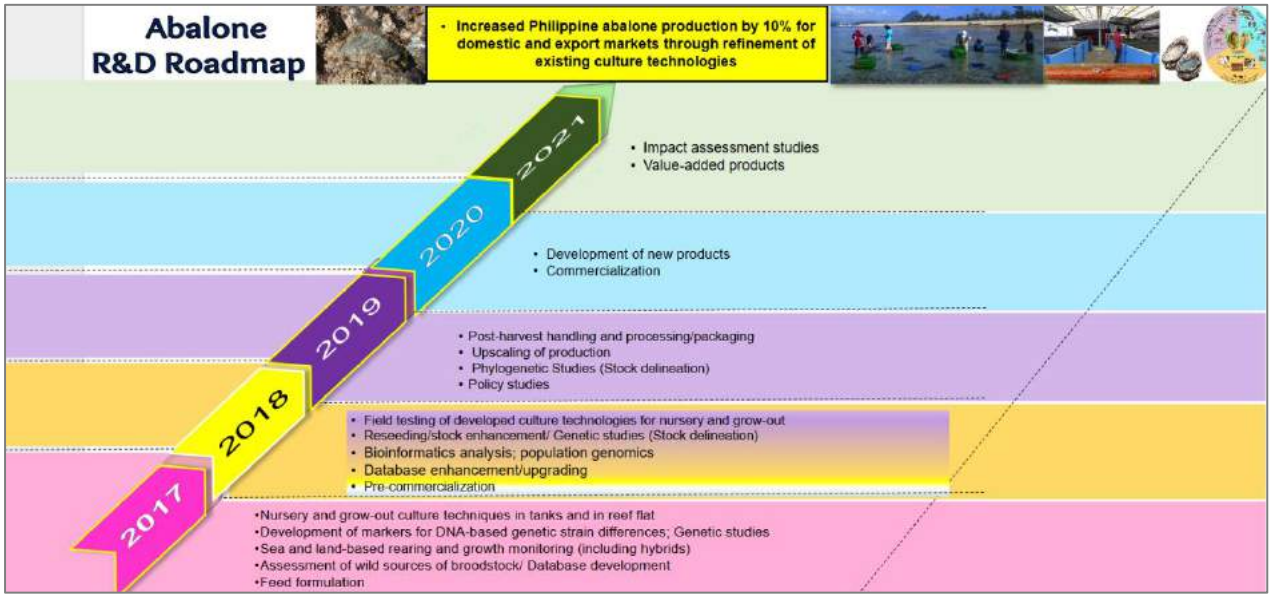


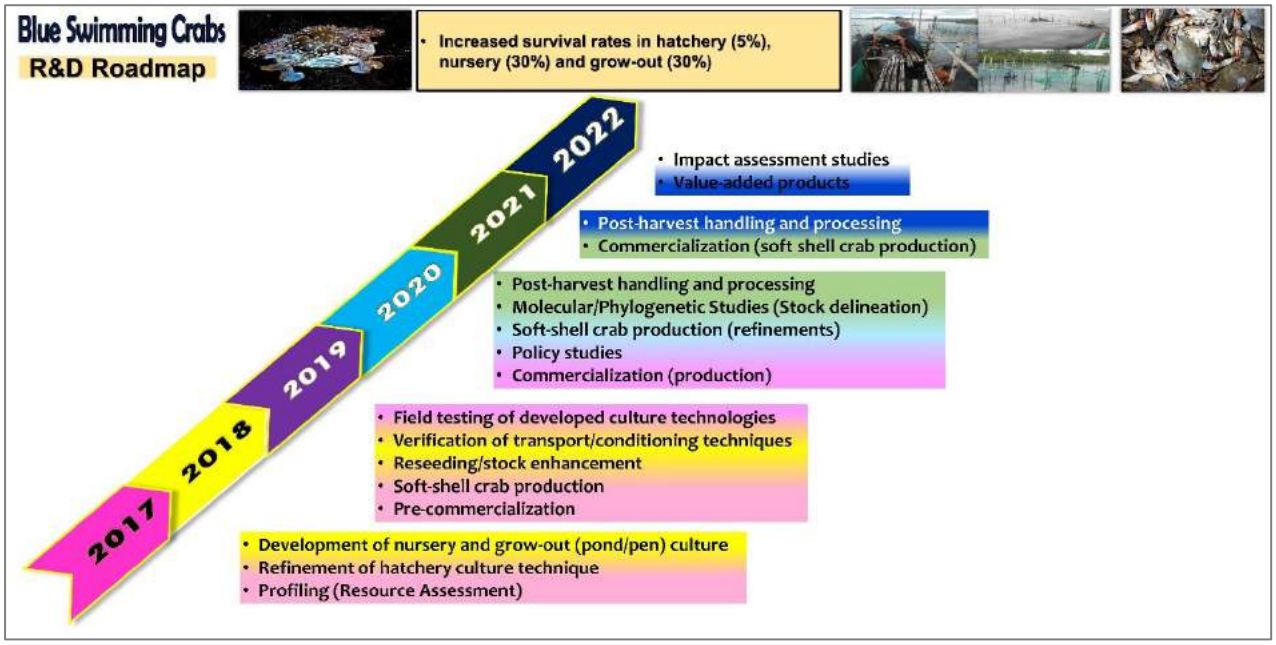



**ANNEX 21**
**AANR Programs/Projects**
**Roadmaps**

## AQUATIC: MARINE

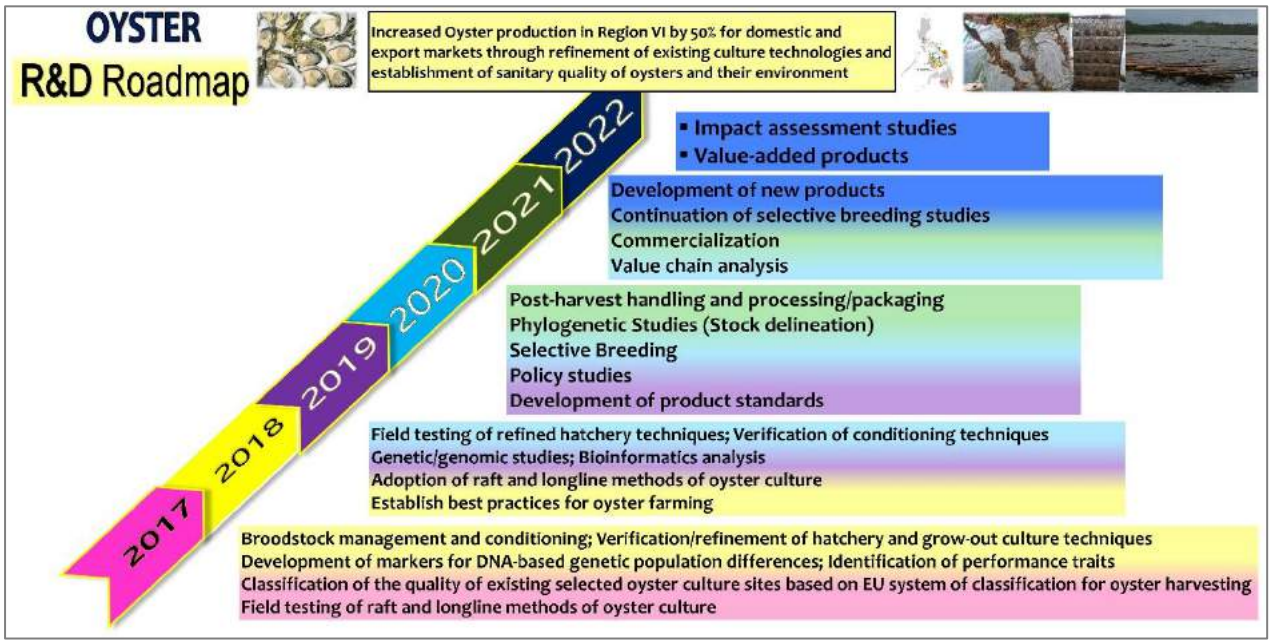
The R&D Roadmap for Abalone covers the period 2017-2021 only as the initiatives for abalone is already complete by 2021.

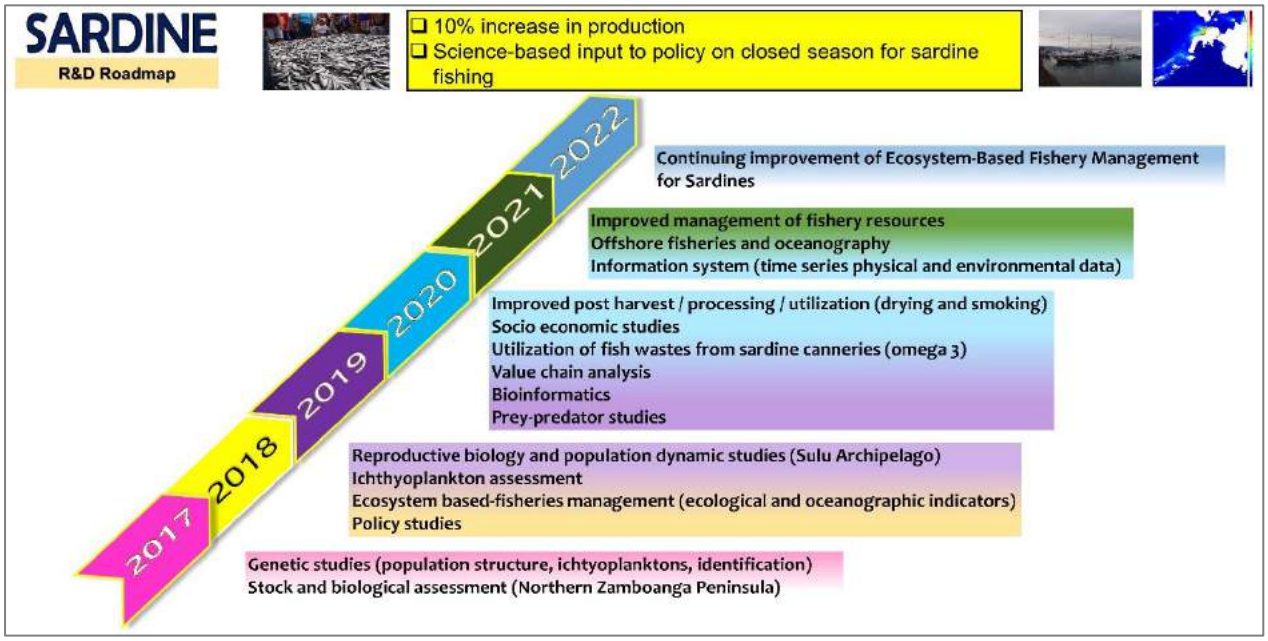


**ANNEX 22**
**AANR Programs/Projects**
**Roadmaps**

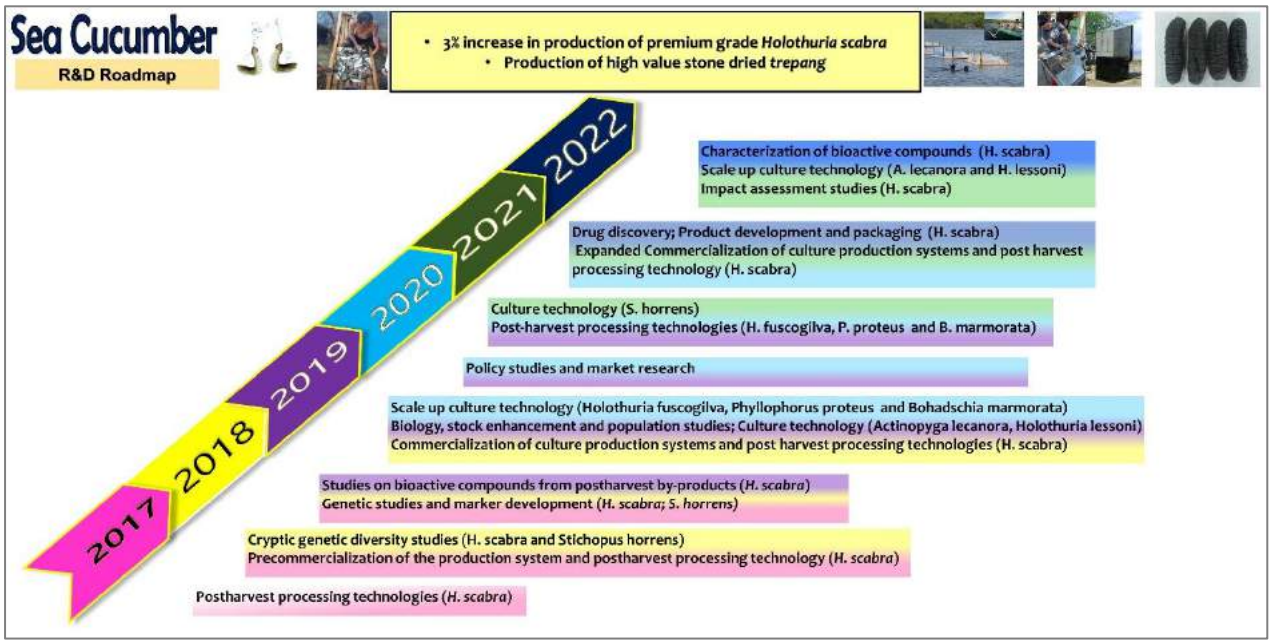
## AQUATIC: MARINE

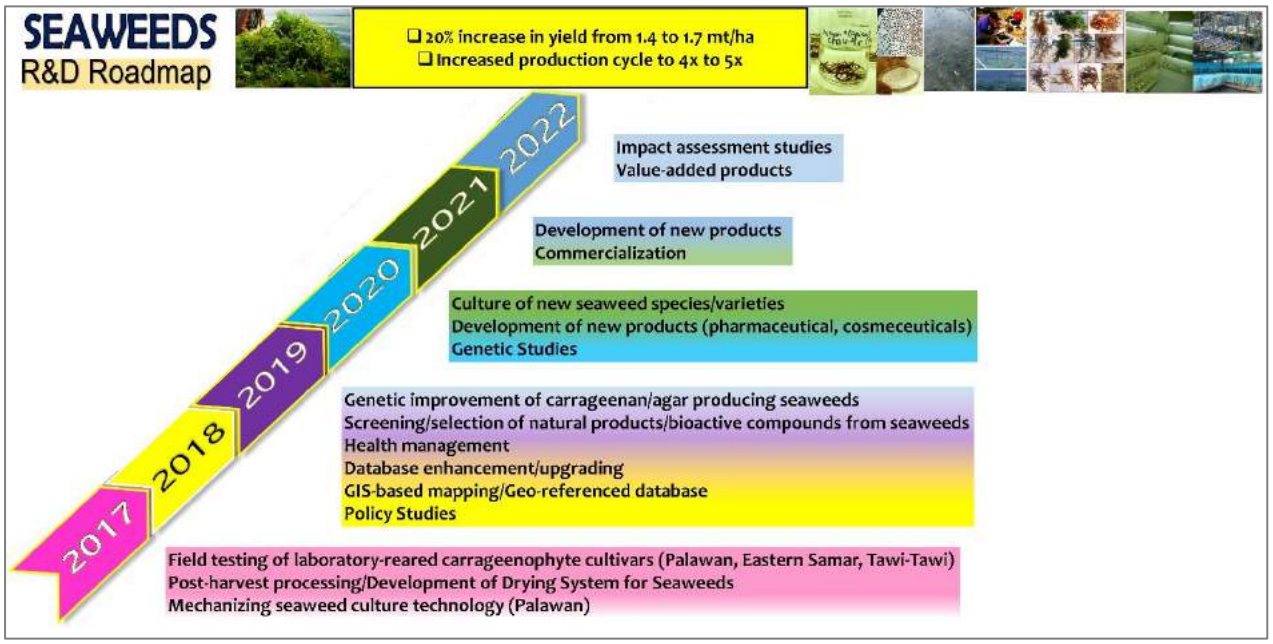


**ANNEX 23**
**AANR Programs/Projects**
**Roadmaps**

## AQUATIC: MARINE

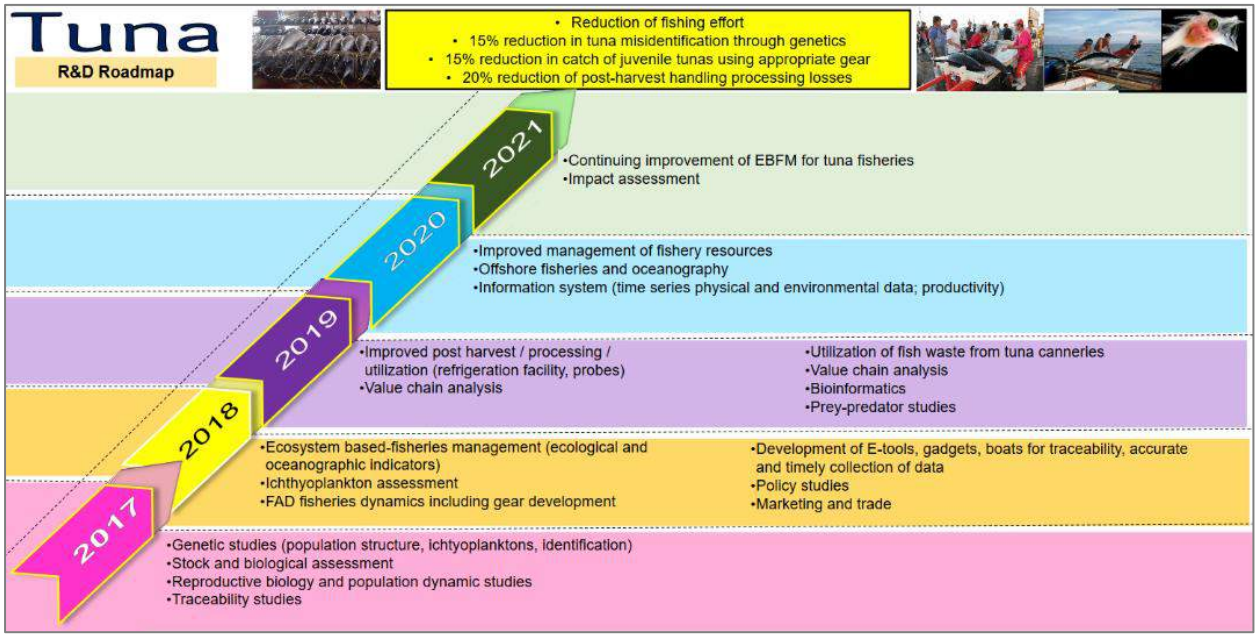


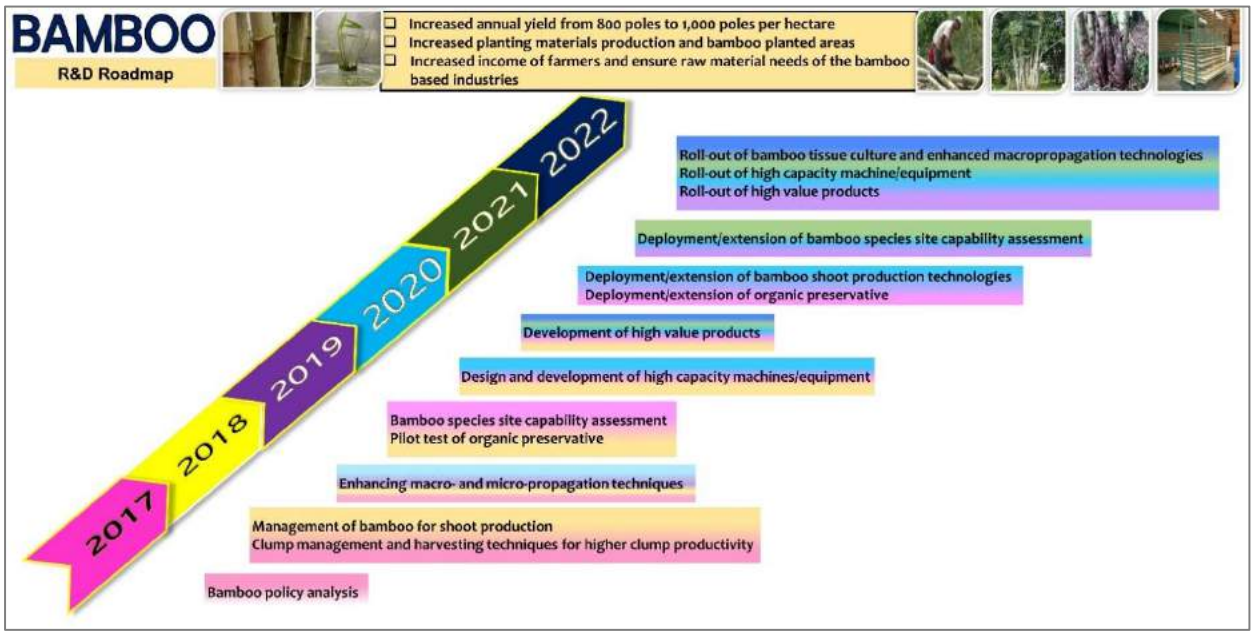
**ANNEX 24**
**AANR Programs/Projects**
**Roadmaps**

## AQUATIC: MARINE

The R&D Roadmap for tuna covers the period 2017-2021. Stakeholders for this product will be consulted for the next initiatives/plans.

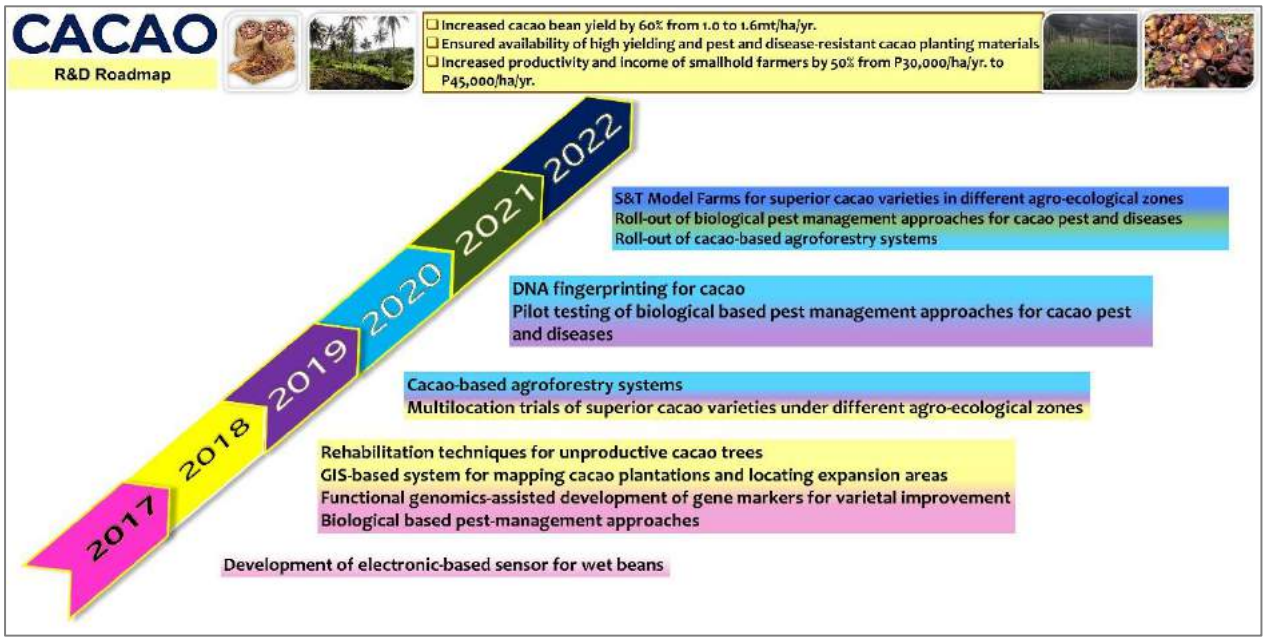


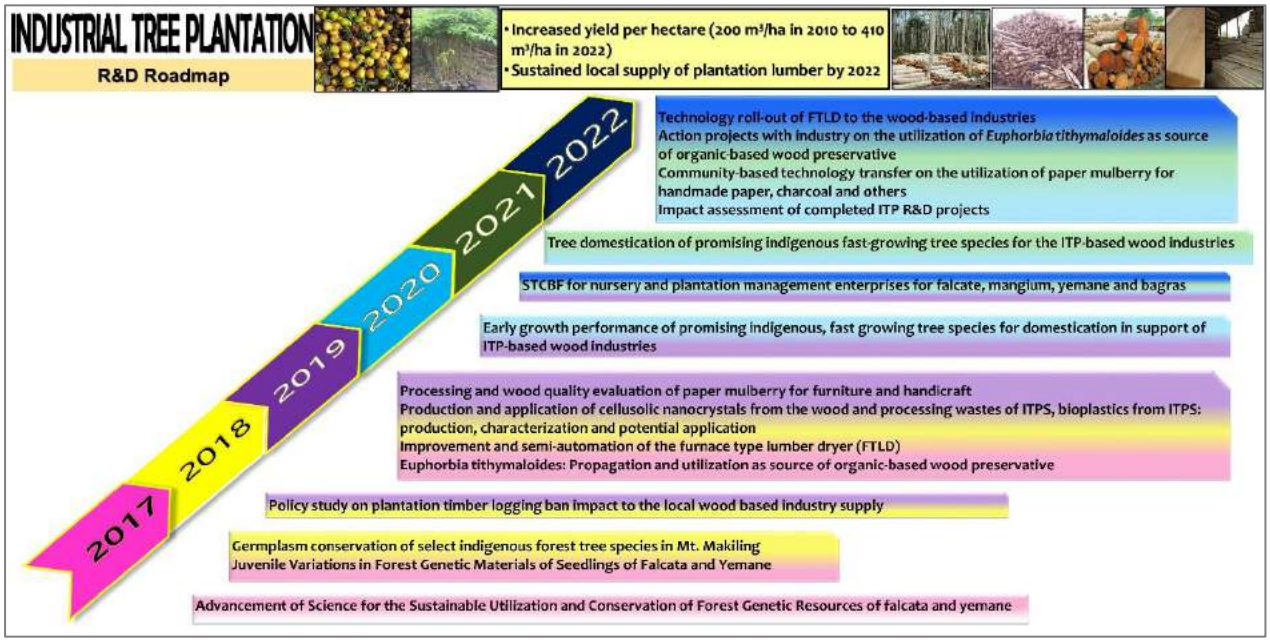

## FORESTRY AND NATURAL RESOURCES



**ANNEX 25**
**AANR Programs/Projects**
**Roadmaps**

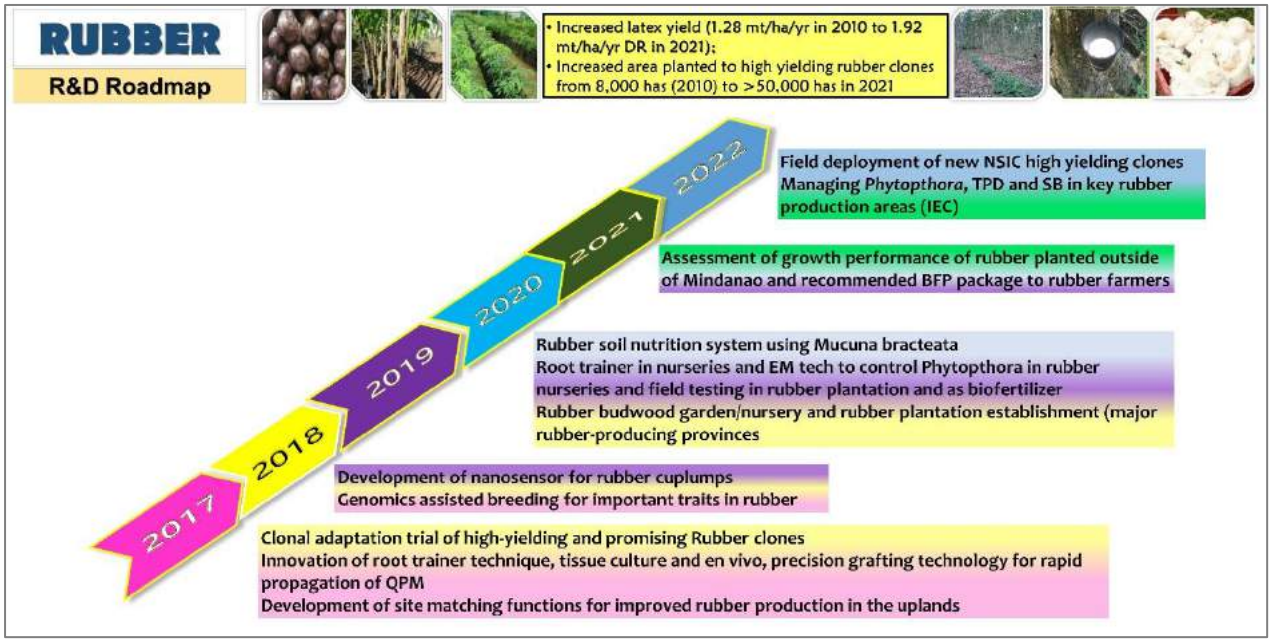
## FORESTRY AND NATURAL RESOURCES



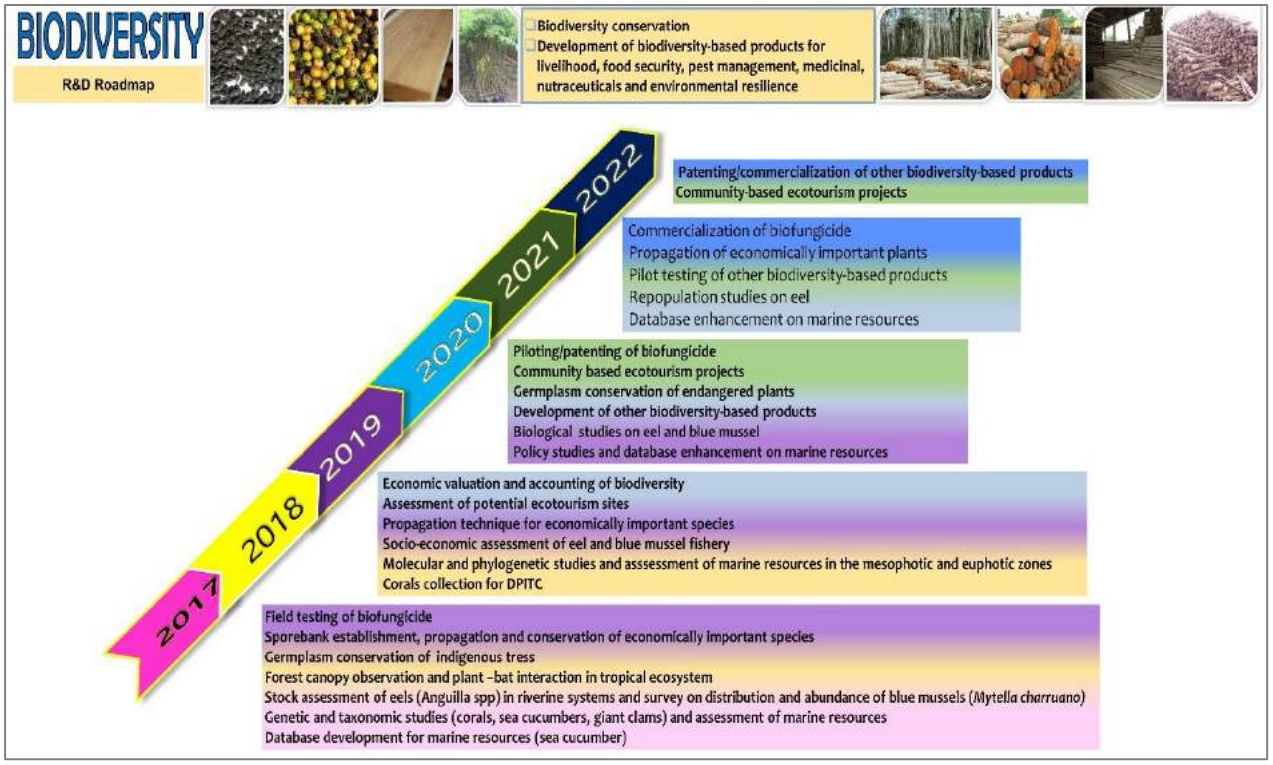



**ANNEX 26**
**AANR Programs/Projects Roadmaps**

## FORESTRY AND NATURAL RESOURCES

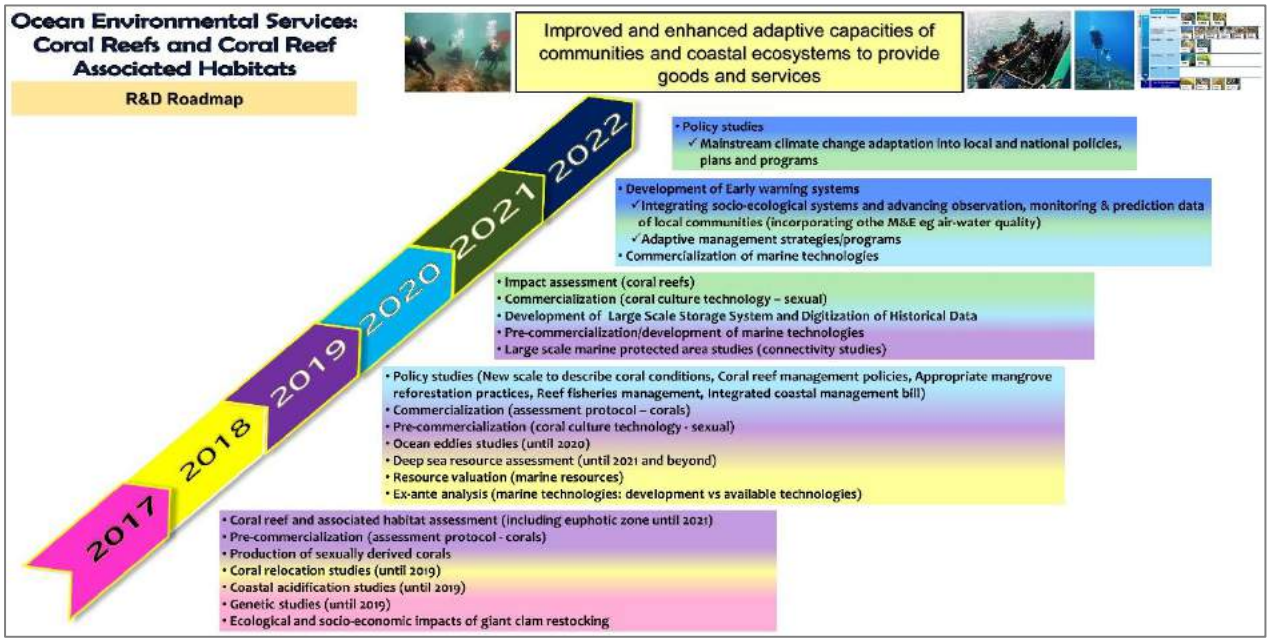


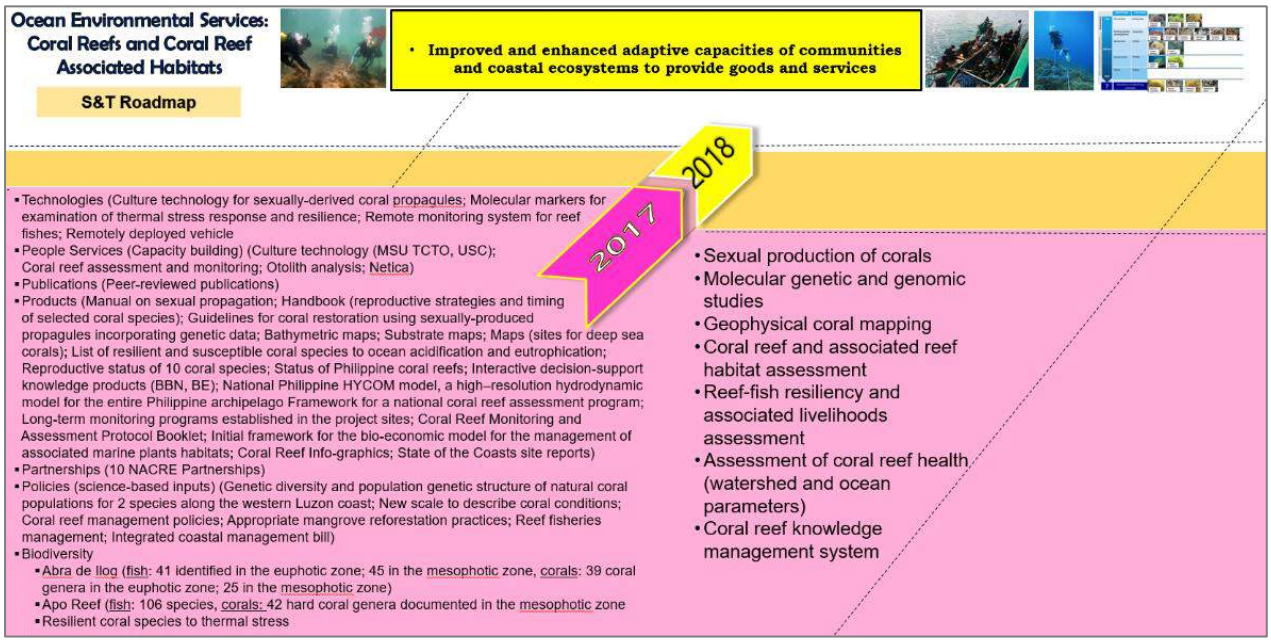

## ENVIRONMENTAL SERVICES



**ANNEX 27**
**AANR Programs/Projects**
**Roadmaps**

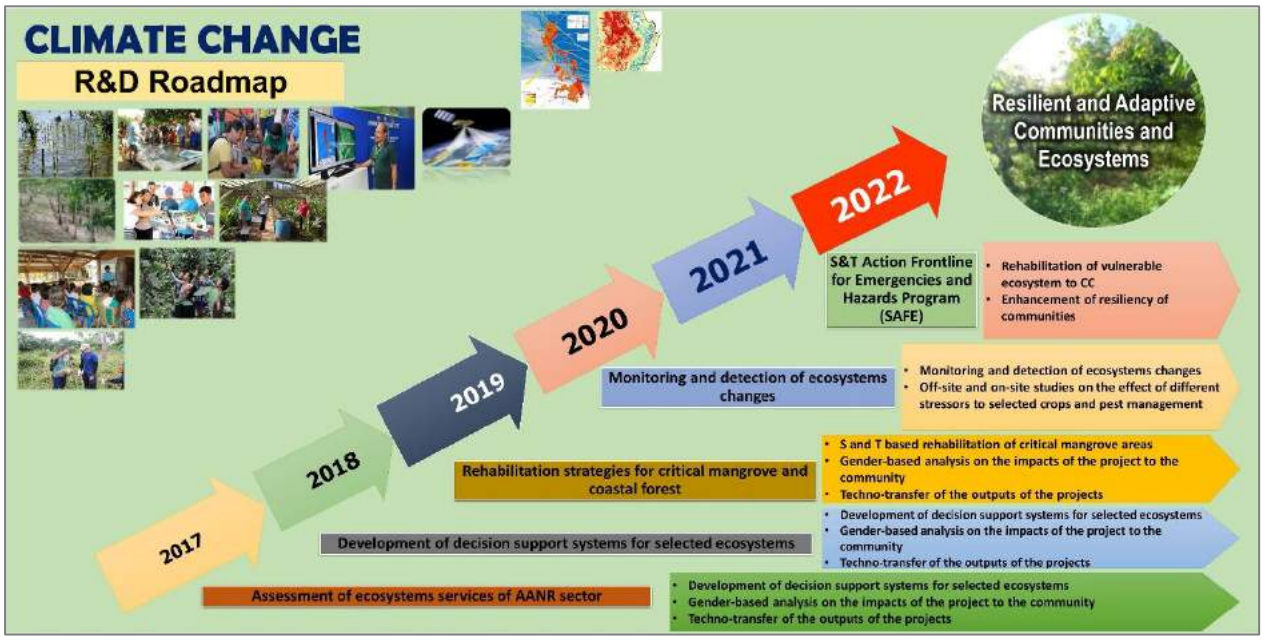
## ENVIRONMENTAL SERVICES

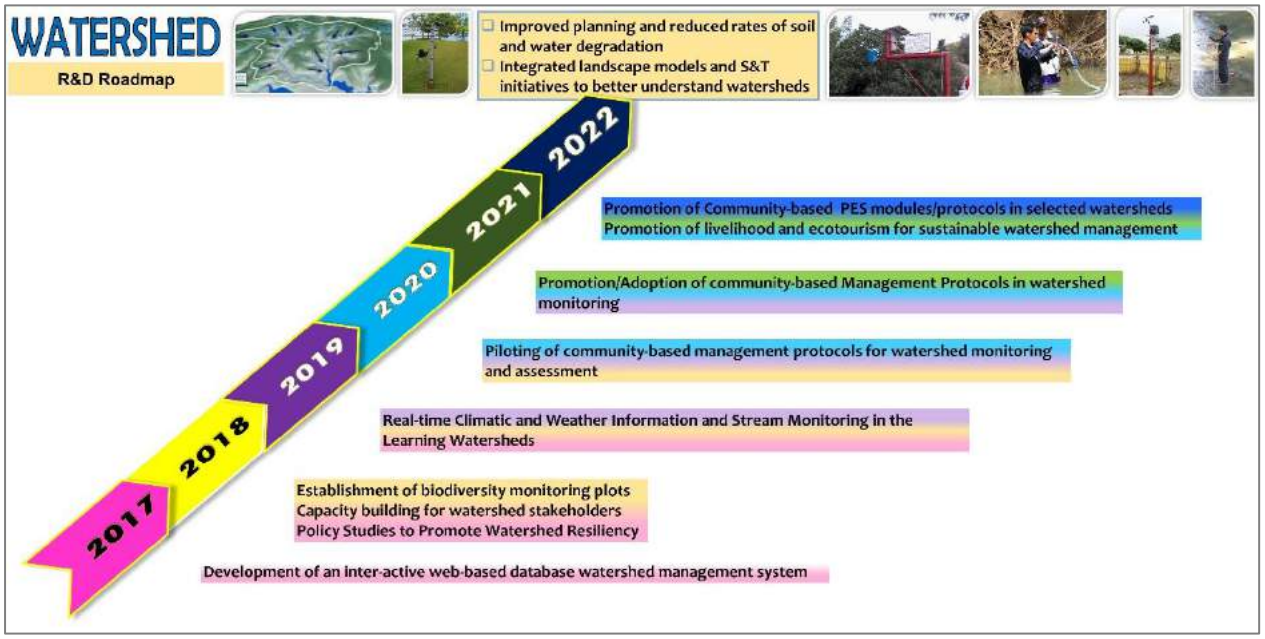


**ANNEX 28**
**AANR Programs/Projects Roadmaps**

## ENVIRONMENTAL SERVICES



**ANNEX 29 - Industry, Energy and Emerging Technology Roadmaps**

Most of the roadmaps of the industry, energy and emerging sectors cover the period 2013-2017. Since these are updated every 5 years, PCIEERD is currently updating its sectoral roadmaps for 2018-2022 through stakeholders' consultations and is expected to be completed before the end of 2017.

## COMPETITIVE INDUSTRIES:
## ICT, ELECTRONICS AND SEMICONDUCTOR

| Technology Cluster | Areas / Discipline | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Ubiquitous / Pervasive Computing | Sensors, Embedded Systems, Robotics, Security, Image/Video Retrieval, Next Generation Network | □ Empathic Space for Stroke Patients | □ Empathic Space v2.0 for Persons Afflicted with Autism | □ Security APIs for Mobile/Handheld Devices | | |
| | | Developing Technology-based Therapies for Stroke Patients (Dr. Suarez) | Developing Technology-based Support Tools for Children with Autism (Dr. Suarez) | Security Mechanisms for Mobile Devices (Dr. Festin) | | |
| | | □ Vision-Based Vehicle Counting System and Traffic Emissions Inventory | □ Security APIs for Mobile/Handheld Devices | □ Collaborative control systems for multiple UAVs surveying a geographical Area | | |
| | | Vision-based Vehicle Counter for Emissions Inventory and Traffic Monitoring (VIVEC-ET) (Dr. Suarez) | Security Mechanisms for Mobile Devices (Dr. Festin) | Aerial Dynamic Assessment Robot for National Advancement - phase III (Dr. Suarez) | | |
| | | | □ Unmanned Aerial Vehicle System (UAV) for Surveillance Operations | | | |
| | | | Aerial Dynamic Assessment Robot for National Advancement – phase II (Dr. Suarez) | | | |
| Human Machine Interaction | Empathic, Affective, NLP, Speech Recognition, Machine Vision, Machine Intelligence | □ Embodied Conversational Agents Teaching English | □ Embodied Conversational Agents Interacting with Persons Afflicted with Autism | □ Computer Storytellers in an ILE to Motivate Learners | | |
| | | Teaching English as a Second Language using ECAs (Dr. Suarez) | Developing Technology-based Support Tools for Children with Autism (Dr. Suarez) | □ Exploring Stories as Tools to Influence the Emotion of Learners (Dr. Suarez) | | |
| | | □ An Affect Model of Readers in an ILE for Reading | □ Software Tutors for Gifted Children | | | |
| | | Building an Affect Model of Student Readers as they Read Story Text (Dr. Suarez) | Developing Empathic Educational | | | |

# COMPETITIVE INDUSTRIES:
# ICT, ELECTRONICS AND SEMICONDUCTOR

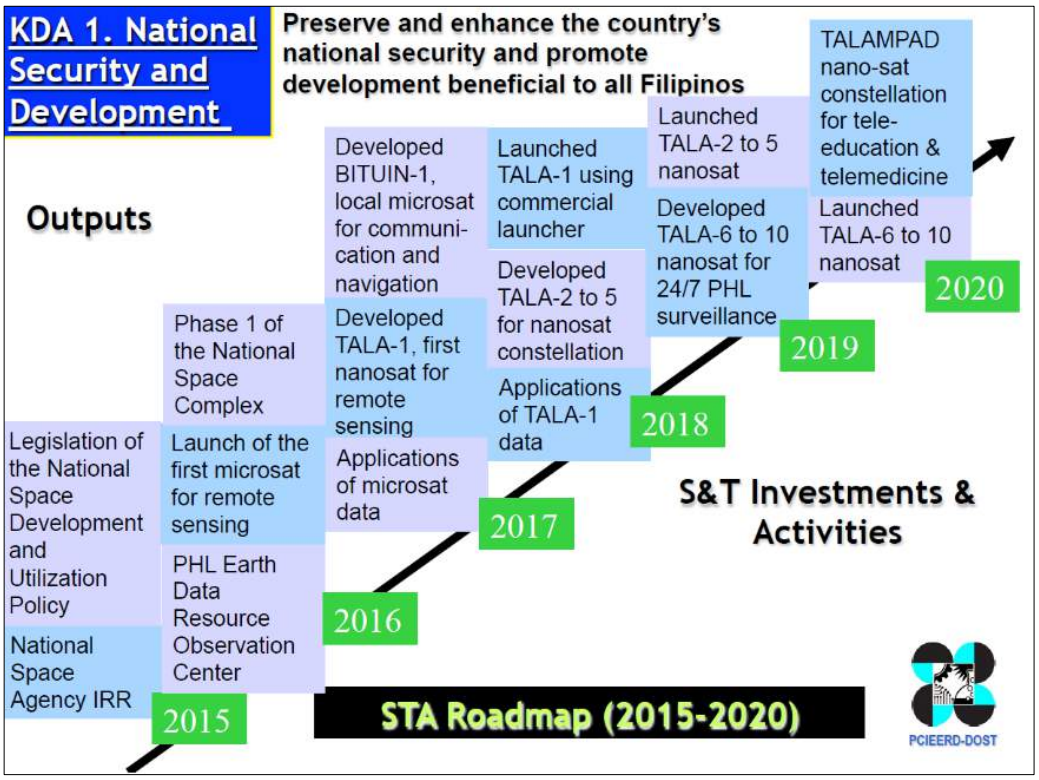
| Technology Cluster | Areas / Discipline | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| | | ☐ Alex: A Collaborative Peer in an Interactive Storytelling Environment for Disaster Preparedness | ☐ Interactive Storytelling Environment to promote Maternal Health Awareness | | | |
| | | Supporting Behavior Awareness through Interactive Social Stories (Dr. Suarez) | | | | |
| | | | ☐ Embodied Conversational Agent interacting with Readers in an ILE for Reading | | | |
| | | | Integrating an Embodied Conversational Agent into an ILE for Reading (Dr. Suarez) | | | |
| | | | ☐ Development of low cost research platforms that can assess user engagement, boredom, confusion based on posture, eye-gaze and biometrics | ☐ Data gathering in various contexts, e.g. film, advertising, driving, learning | ☐ Data analysis<br>☐ Report writing<br>☐ Publication | |
| | | | Development of low-cost research platforms for assessing user affect (Dr. Rodrigo) | | | |
| Computational Systems and Services | Grid, Cloud, Modeling & Simulation, Visualization, Datamining , Analytics | | ☐ Algorithms for Secure Data Mining | ☐ Algorithms for Secure Data Mining | | |
| | | | Algorithms for Secure Data Mining (Dr. Festin) | | | |
| Digital Media and Creative Content | Games, Animation, Digital Lib, E-learning/Instructional Systems, Entertainment Computing, Image/Video Processing | ☐ Mobile Picture Books | ☐ Animated Picture Books | ☐ Intelligent Tutoring Game System | | |
| | | Story Generation Systems as Support Tools for Literacy Development in Children (Dr. Suarez) | | Development of intelligent tutoring systems for Araling Panlipunan and Filipino for middle school (Dr. Rodrigo) | | |
| Web Science | Web Semantics, Q&A on the Web, Social Networking, Ontologies, Internet of Things | | | | | |
| Foundation of Computer Science | Algorithms, Systems Software, Languages, Basic Research on Computer Science Architecture | | ☐ Algorithms for Secure Data Mining v.1.0 | ☐ Algorithms for Secure Data Mining v.2.0 | | |
| | | | Algorithms for Secure Data Mining (Dr. Festin) | | | |
| ICT for Development (Government Thrusts – usage and applications) | GIS, Health Informatics, Instructional, Environment, Service Science (incl. Tele-health), Bio-informatics, E-governance | ☐ Pinoy SimCity v1.0 | ☐ Pinoy SimCity v2.0 | | | |
| | | Developing an Environment for Simulating City Planning through Community-Based Monitoring System Data (Dr. Suarez) | | | | |
| | | | ☐ Personal Health Records on Mobile Devices | ☐ Personal Health Records on Mobile Devices | | |
| | | | Personal Health Records on Mobile Devices (Dr. Festin) | | | |

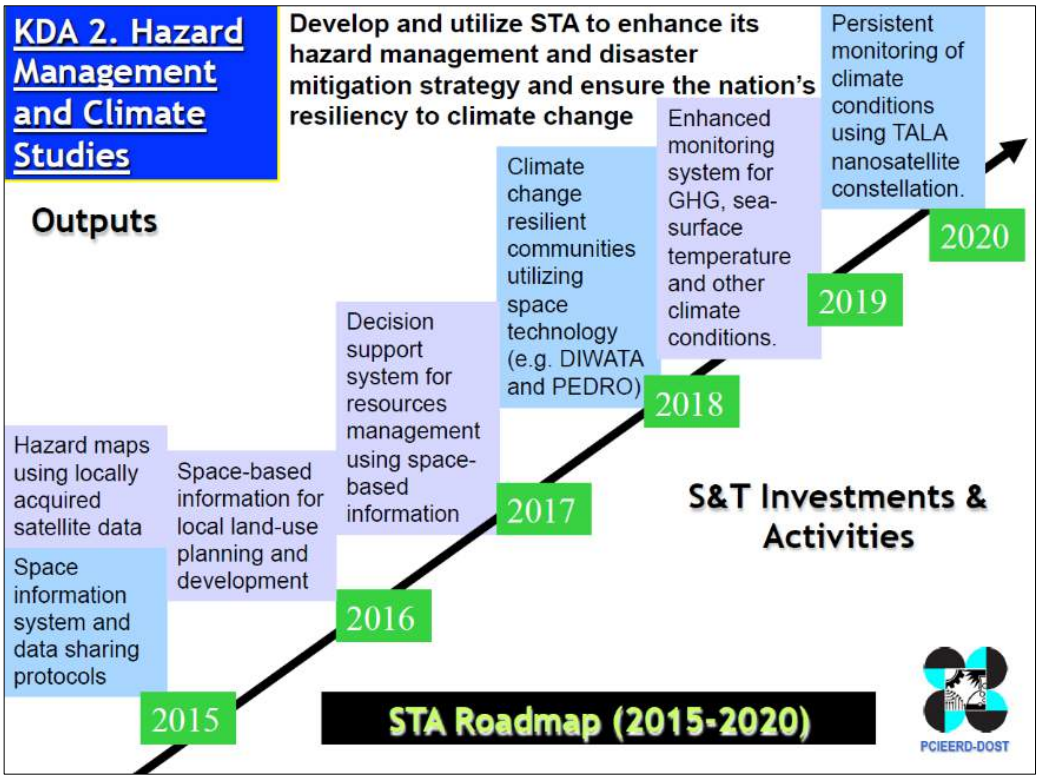
## DELIVERY OF SOCIAL SERVICES: DRR/CCA

DRRM ROADMAP

| PRIORITIES | RESEARCH DOMAIN | SPECIFIC ACTIVITIES | TIMEFRAME | | | | | | | | EXPECTED OUTPUT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Hazard and Risk Assessments | Hazard and risk assessment tools and systems | Assessment for multi- natural hazard exposure, vulnerability and capacity of different communities/LGUs | → | → | → | | | | | | Hazard and exposure database and determination of local capacities | |
| | | Multi-natural hazard mapping | → | → | → | | | | | | Multi-natural hazard mapping | |
| | | Capacity building of Regional SUCs in the use of hazard and risk assessment tools and systems to support LGUs | → | → | → | → | → | → | | | Capacity building of SUCs in hazard and risk assessment to support LGUs | Regional SUCs are able to provide R&D support for Hazard and Risk Assessment to LGUs |
| End-to-end Multi-Hazard, Multi-Platform Early Warning System | Localized decision support system | Development of hazard data, vulnerabilities and risk hazard measurement and logging system | → | → | → | | | | | | Technologies developed, pilot tested and rolled out Provincial-, municipal- and city-scale end to end early warning system | |
| | | Capacity building of Regional SUCs in development of exposure database and use of decision support systems to support LGUs and local communities | → | → | → | → | → | → | | | | SUCs operate and provide support to local decision support systems to LGUs and local commmunities |
| | Meso-scale hydro-meteorological hazard monitoring and early warning systems | Installation of community – based, near – real time multi – hazard monitoring system outside the scope of the 18 major river basins | → | → | → | | | | | | | |
| Disaster – ready Systems and Infrastructures | Cost-Effective Disaster Emergency and Rescue Utility Systems | Design and development of low-cost and locally-manufactured, easily deployable frontline command module system for disaster emergency and rescue utility | → | → | → | | | | | | Low-cost and locally-manufactured, rapid and easily deployable frontline mobile command module and system for disaster emergency and rescue utility for on site- incident command system which could provide high quality, real-time audio and video feed in disaster affected areas<br><br>Robust and smart infrastructure designs, building techniques and low-cost indigenous building materials<br><br>Deployment of low-cost and locally-manufactured, instrumentation systems for deployment and installation in disaster prone major urban centers | |
| | DRR/CCA Proofing Infrastructure Systems and Techniques | Development of multi-hazard – proof and climate smart infrastructure designs, building materials and construction techniques | → | → | → | → | | | | | | |
| | Instrumentation for early warning, monitoring and rapid assessment | Development and deployment of portable, on-line and telemetered system for data-gathering, natural hazard detection mechanisms/ systems for early warning in major urban centers | → | → | → | → | | | | | | |
| | | Strengthening partner's capability and transfer of technology in development and maintenance of early-warning instrumentation and rapid assessment | → | → | → | → | → | → | → | → | | SUCs and other partner organizations are fully capable of replicate, operate and provide technical support to LGUs |

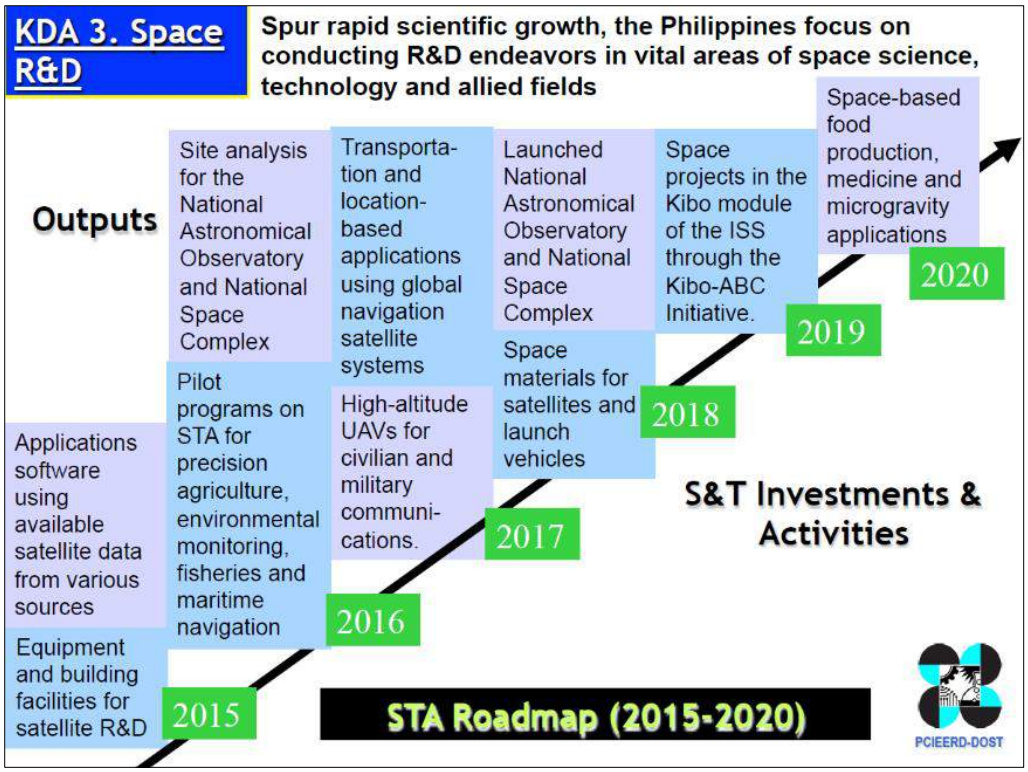
## DELIVERY OF SOCIAL SERVICES: SPACE TECHNOLOGY APPLICATION (STA)

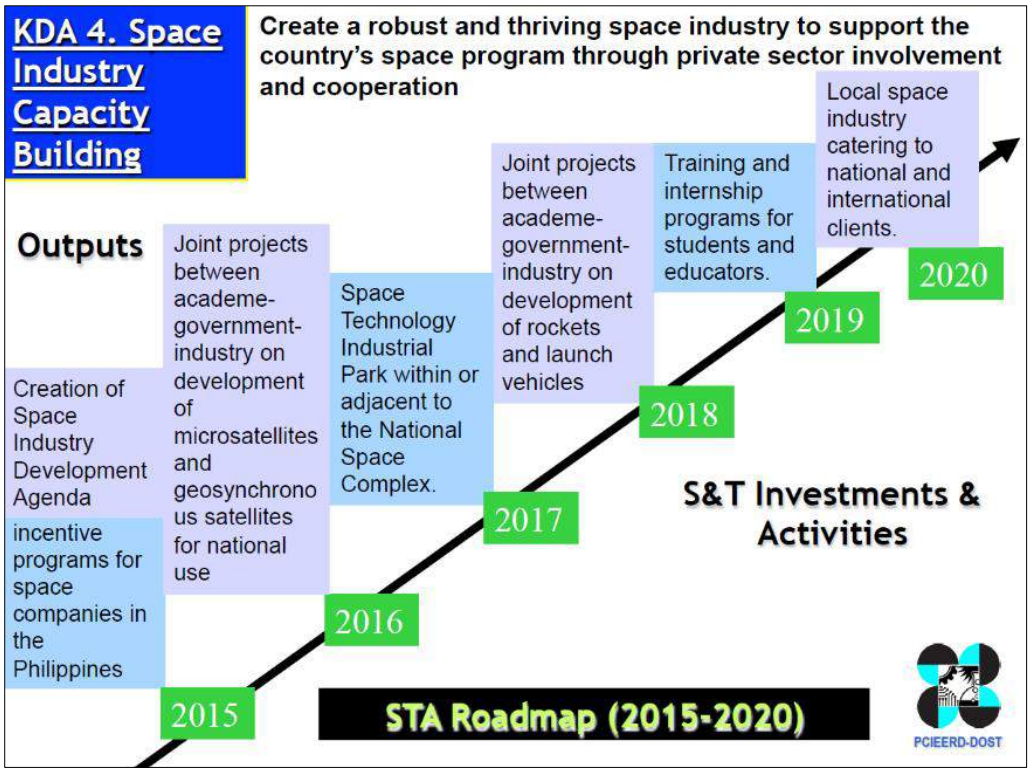



*KDA – Key Development Area

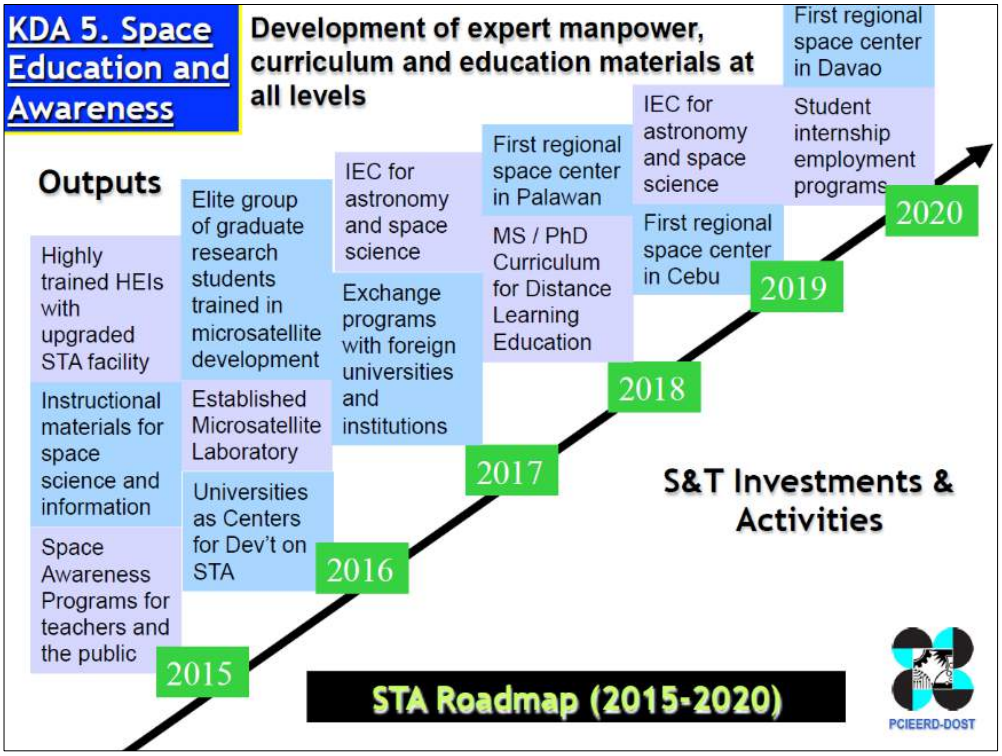
## DELIVERY OF SOCIAL SERVICES: SPACE TECHNOLOGY APPLICATION (STA)

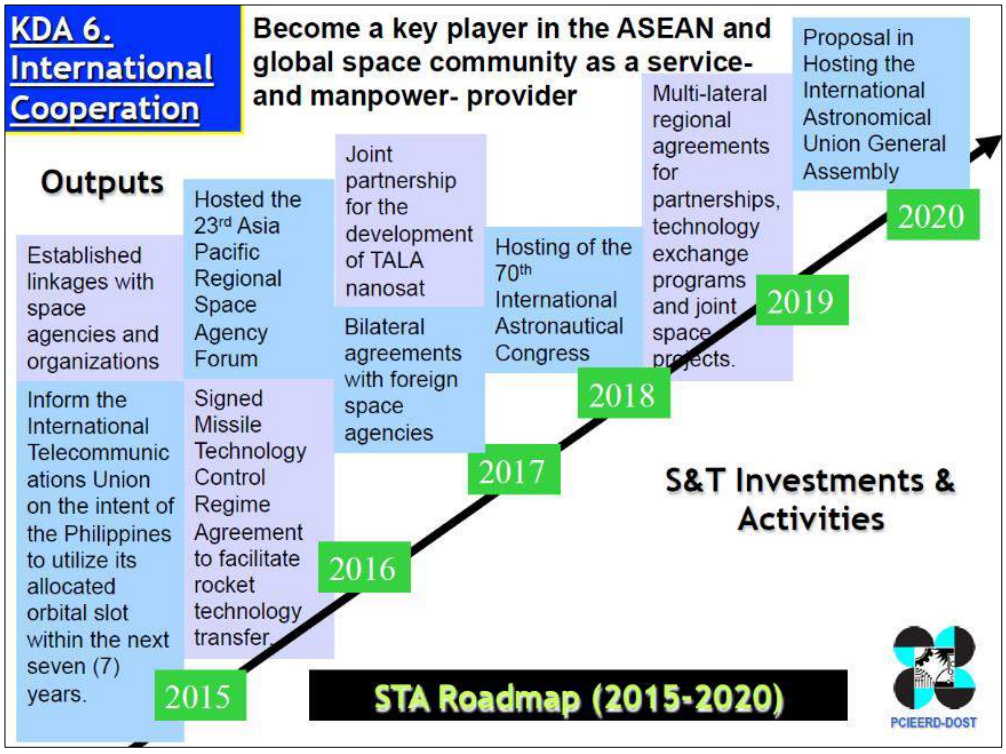



*KDA – Key Development Area

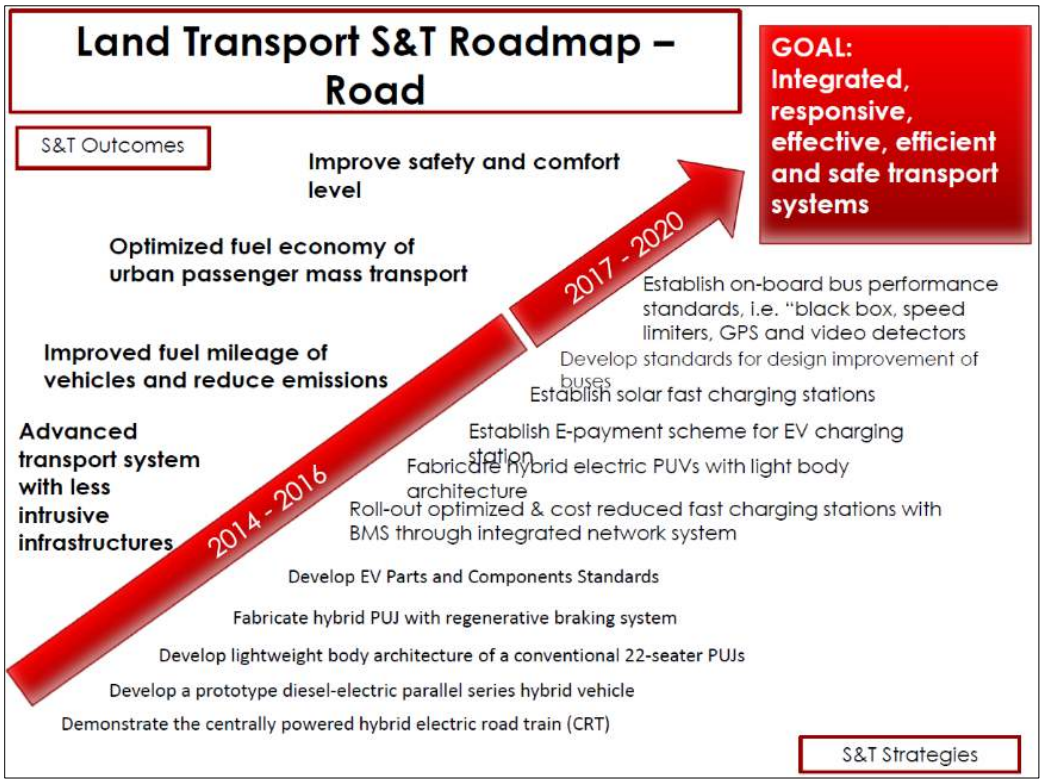
## DELIVERY OF SOCIAL SERVICES: SPACE TECHNOLOGY APPLICATION (STA)

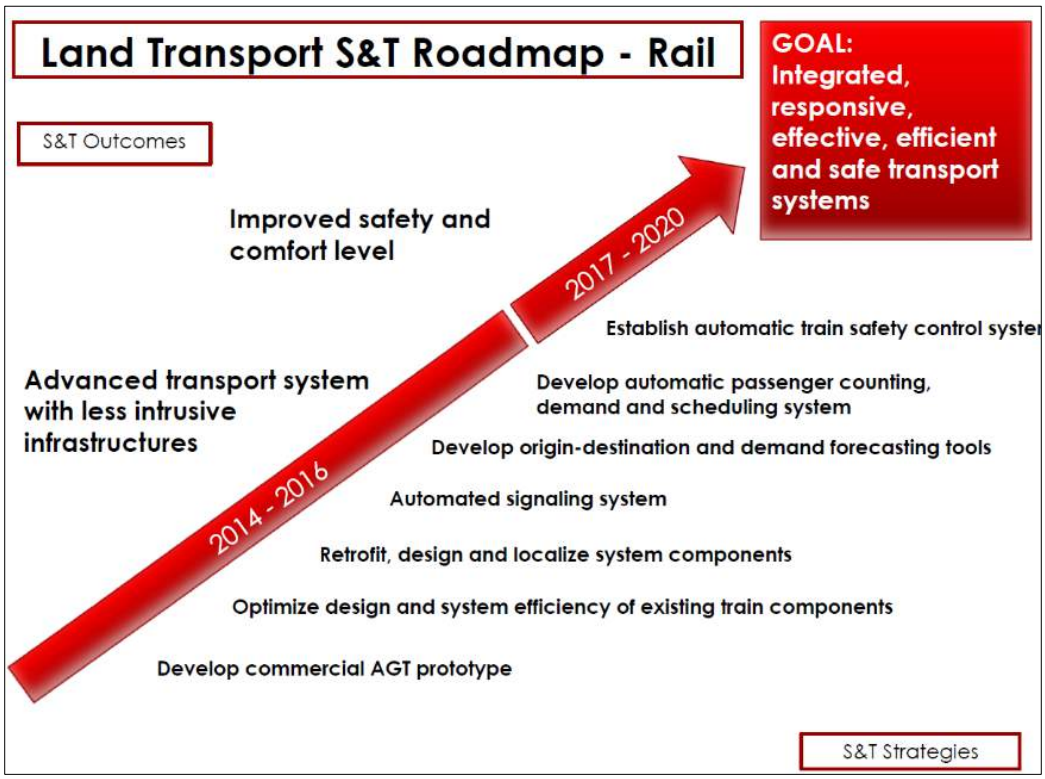


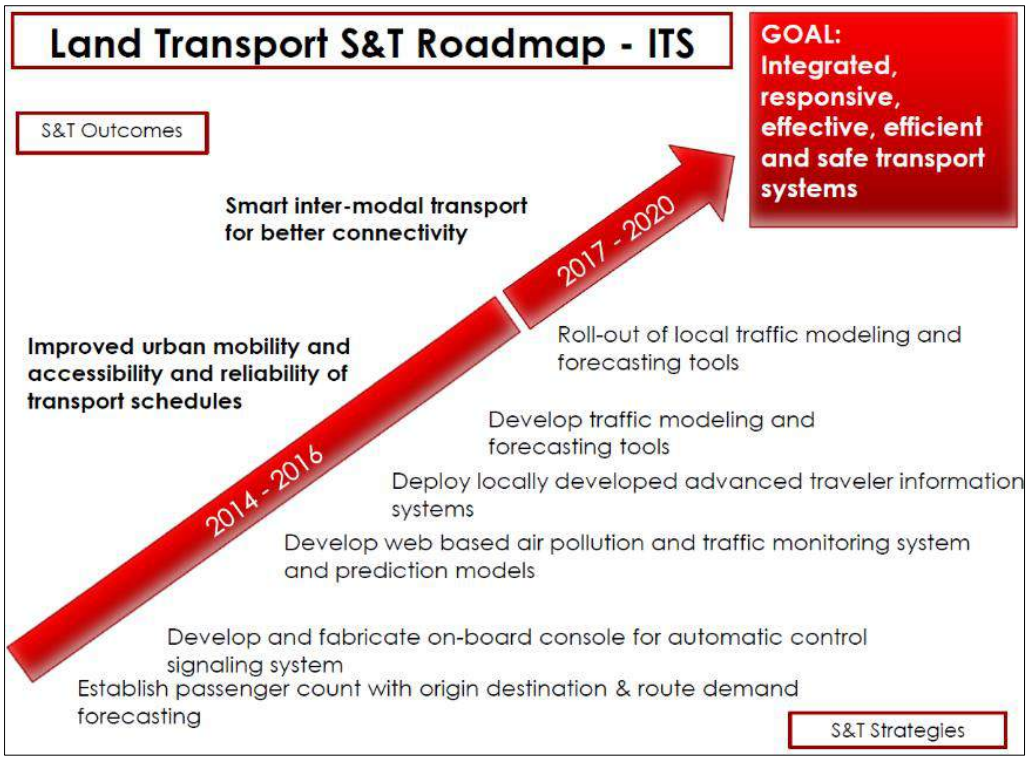

*KDA – Key Development Area

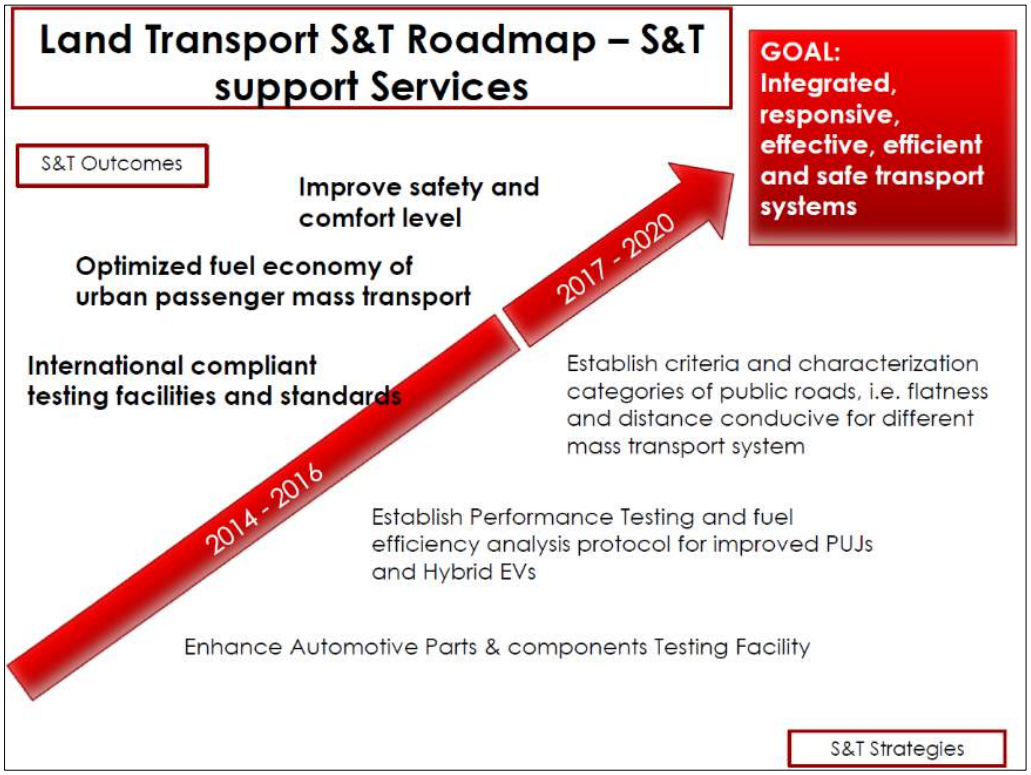
## INTELLIGENT TRANSPORTATION SOLUTIONS



## INTELLIGENT TRANSPORTATION SOLUTIONS



## INTELLIGENT TRANSPORTATION SOLUTIONS

# INTELLIGENT TRANSPORTATION SOLUTIONS

**LAND TRANSPORT R&D ROADMAP**

| PRIORITIES | RESEARCH DOMAIN | SPECIFIC ACTIVITIES | TIMEFRAME 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | EXPECTED OUTPUT 2013 - 2015 | 2016 - 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUSTAINABLE MASS TRANSPORT SYSTEM - **RAIL** | AGT | Optimize design and system efficiency | → | → | → | | | | | | Design and Efficiency Optimization Completed (30 – 120 seater)<br><br>New Design for commercializatio n ⇢ | Commercial Operation |
| | | Develop commercial prototype | → | → | → | | | | | | | |
| | | Automated signaling system | | → | → | | | | | | | |
| | | Develop safety standards and certification | | → | → | → | | | | | | |
| | Railway System | Retrofitting Design and Localization of System Components | → | → | → | | | | | | Selected Parts/component s Developed Locally<br><br>Local Design for PNR Completed | Local Capability for design and construction Developed<br><br>Local Parts/components Increased<br><br>Highspeed Railway System Study Completed |
| | | Develop commercial prototype | | | | → | → | | | | | |
| | | Automated Systems<br>- Develop origin-destination and demand forecasting tools<br>- Establish automatic passenger counting, demand and scheduling system<br>- Establish automatic train safety control system | → | → | → | | | | | | | |
| SUSTAINABLE MASS TRANSPORT SYSTEM - SUSTAINABLE MASS TRANSPORT SYSTEM – **Intelligent Transport System (ITS)** | Advance Traveller Information System(ATIS ) | Develop Advance Traveller Information System | → | → | | | | | | | PhilMATIS Platform Developed<br><br>ATMS and APS Prototype System Developed<br><br>Deployed locally developed ⇢ advanced traveler information systems | Developed Customized Local Traffic Simulator<br><br>Increased Societal Awareness on ITS<br><br>Pilot Smart Cities / Smart inter-modal transport for better connectivity |
| | | Roll-out Program for PhilMATIS | | | → | → | → | | | | | |
| | Advance Traffic Management System (ATMS) | Develop web based air pollution & traffic monitoring system and prediction models | | | → | → | → | | | | | |
| | | Establish passenger count with origin destination & route demand forecasting | | → | → | → | | | | | | |
| | | Develop traffic modeling and forecasting tools | | → | → | → | | | | | | |
| | | Roll-out Program for ATMS | | | | → | → | → | → | → | | |
| | | Transport Intermodal | | → | → | → | → | | | | | |
| | | Roll-out of local traffic modeling and forecasting tools | | | | → | → | → | → | | | |
| SUSTAINABLE MASS TRANSPORT SYSTEM - SUSTAINABLE MASS TRANSPO | Infra Support System | Establish Automotive Parts R&D and Testing Facility | → | → | → | | | | | | Automotive Parts R&D and Testing Center Established<br><br>Developed of a 12 hp single cylinder diesel engine | Enhanced Automotive Parts & components Testing Facility<br><br>Improved safety and |
| | | Establishment of international compliant testing facilities | → | → | → | | | | | | | |
| | | Localization of Parts and Components | | → | → | → | | | | | | |
| | | Gear Making and Assembly Facility | | → | → | → | | | | | | |
| RT SYSTEM – **R&D for Transportation parts and components** | | Establish Performance Testing and fuel efficiency analysis protocol for improved PUJs and Hybrid EVs | | | | | → | → | → | | prototype<br><br>Established Gear Making Facilty | comfort level<br><br>International compliant testing facilities and standards |
| | | Establish criteria and characterization categories of public roads, i.e. flatness and distance conducive for different mass transport system | | | | | → | → | → | | | |

# INTELLIGENT TRANSPORTATION SOLUTIONS

**Sea/Water Transport R&D Roadmap**

| PRIORITIES | RESEARCH DOMAIN | SPECIFIC ACTIVITIES | TIMEFRAME | | | | | | | | EXPECTED OUTPUT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2014 - 2016 | 2017 - 2020 |
| SUSTAINABLE MASS TRANSPORT SYSTEM - **Safer, cleaner and efficient maritime transport systems and services** | **Alternative material for fishing and passenger vessel** | Development of Design Guidelines (right sizing of hull, engine, propulsion & materials) for fishing and passenger vessel | → | → | → | | | | | | **Cost-effective sea-worthy hull design using alternative lightweight materials for passenger and fishing vessels**<br><br>**Cost-competitive amphibious rescue vessel for 10-12 passenger** | **IMO compliant sea crafts**<br><br>**Pilot Smart Cities / Smart inter-modal transport for better connectivity (sea, land and rail transport systems)** |
| | | Assess the local fiberglass industry and support industry for vessel construction using local alternative materials | → | → | → | | | | | | | |
| | | Assess the existing fishing and passenger vessel making sector | | → | → | | | | | | | |
| | | Prototype development of fishing and passenger vessels for bay/river and open sea | | → | → | → | | | | | | |
| | **Mulit-modal (sea, land, rail) transport systems** | Integrated ITS<br>- Navigational simulation tool<br>- Engine and machinery performance diagnostic tool<br>- Develop Local Maritime Transportation Simulation Models<br>- Develop Local Maritime Transportation Simulation Models | | | | → | → | → | → | | | |
| | | Assess inter-connectivity of freight and passenger multi-modal transport system | | | | → | → | → | → | | | |
| | | Develop integrated data recording and archiving system | | | → | → | → | → | → | | | |

## RENEWABLE ENERGY AND ENERGY STORAGE SOLUTIONS

### BIOMASS

| RESEARCH AREAS | TIMEFRAME | | | | | | | | S&T DELIVERABLES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Waste-to-energy for power from municipal solid waste | | | | | | | | | - Demonstration plant on waste-to-energy from MSW<br>- Resource assessment, database integration, policy study | - Cost-competitive hydrogen production<br>- Biofuel from alternative feedstock |
| Cost effective processes to produce bio-ethanol and biodiesel from agri-based resources<br>- By-product utilization | | | | | | | | | | |
| Biofuel Fuel analysis/characterization, stability and storage assessment as well as performance testing, durability, fuel systems and engine components impact assessment<br>- Higher blend, Combined feedstock | | | | | | | | | | |
| Production of hydrogen gas using environmentally sound technologies like the application of bioreactors and other processes | | | | | | | | | | |
| Biomass for export market assessment (local vs. export use) | | | | | | | | | | |
| Biomass resource assessment – integration of database | | | | | | | | | | |

### SOLAR

| RESEARCH AREAS | TIMEFRAME | | | | | | | | S&T DELIVERABLES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Modular stand-alone and mobile desalination system for brackish and sea water | | | | | | | | | Locally-developed solar desalination system for potable water | - Locally-developed solar cells<br>- Establishment of PV Laboratory |
| Localization of efficient solar thermal system i.e. concentrator, collectors, for drying and potable water production | | | | | | | | | | |
| Localization of solar cells (nanotech) | | | | | | | | | | |
| Establishment of PV Laboratory (for certification) | | | | | | | | | | |
| Support to PV standards development | | | | | | | | | | |

### MICRO-HYDRO

| RESEARCH AREAS | TIMEFRAME | | | | | | | | S&T DELIVERABLES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Local turbine inventory & assessment | | | | | | | | | - Locally-developed micro-hydro turbine<br>- Assessment of MH resource and market potential | Upgraded micro-hydro test facility |
| Localization of high-efficiency turbines | | | | | | | | | | |
| Upgrading of micro-hydro power performance test facility | | | | | | | | | | |
| Assessment of industry capability to manufacture (including logistics) | | | | | | | | | | |
| Assessment of MH resource and market potential | | | | | | | | | | |

### OCEAN

| RESEARCH AREAS | TIMEFRAME | | | | | | | | S&T DELIVERABLES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Ocean energy detailed resource assessment in remote/isolated communities (other market) and strategic areas (wave, tidal, OTEC) | | | | | | | | | Web-based GIS for ocean energy resource<br>- Mechanical harvesting device design modeling tools | Viability of ocean energy for power demonstrated |
| Ocean energy harvesting device design & development: Performance and modeling tools | | | | | | | | | | |
| Assessment of ocean energy harvesting device | | | | | | | | | | |
| Demonstration project on ocean energy for power | | | | | | | | | | |

### WIND

| RESEARCH AREAS | TIMEFRAME | | | | | | | | S&T DELIVERABLES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Localization and piloting of Small-Scale Wind Turbine Generator | | | | | | | | | - Localized and piloted 2 kW wind turbine generator | Wind energy testing lab established |
| Establishment of wind energy laboratory | | | | | | | | | | |
| Resource assessment in specific sites (remote island communities) | | | | | | | | | | |

## RENEWABLE ENERGY AND ENERGY STORAGE SOLUTIONS

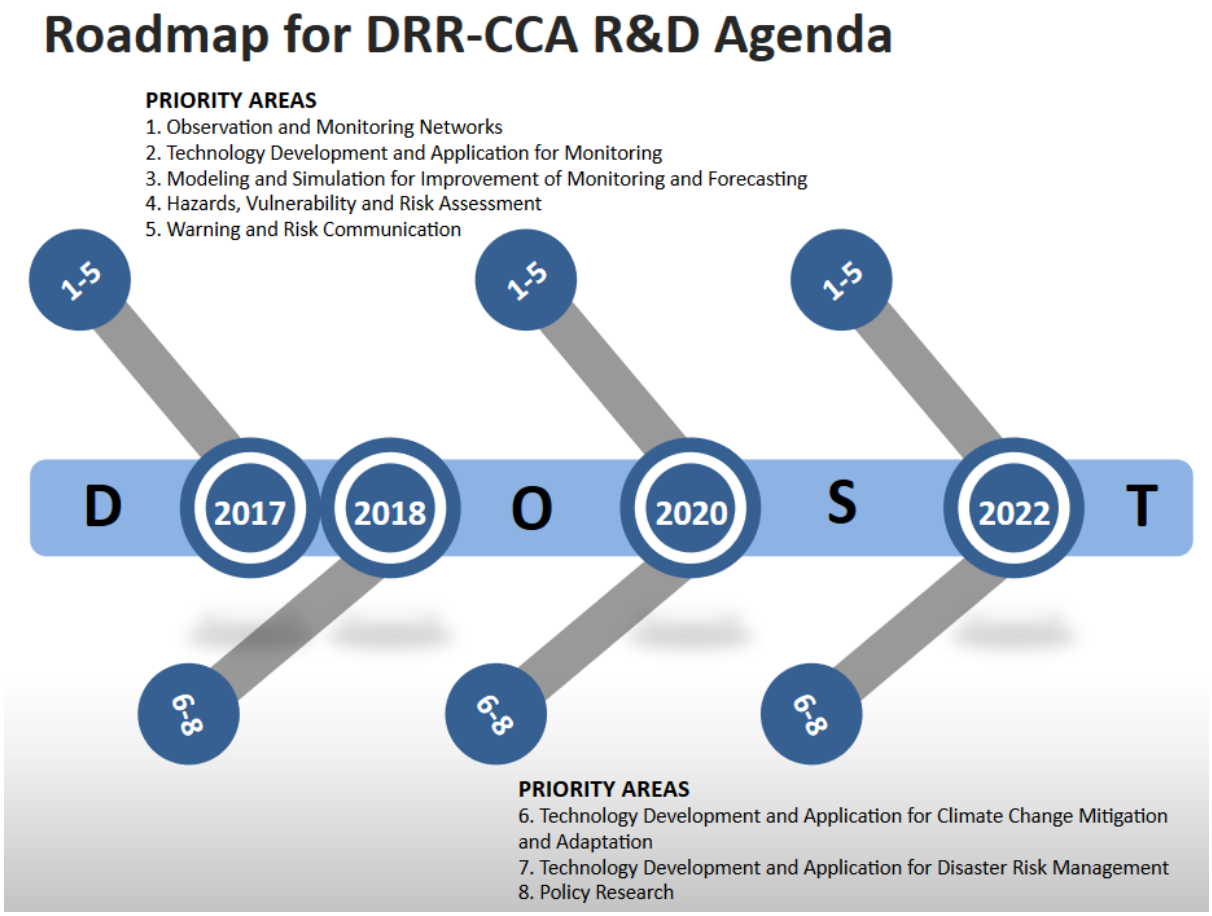
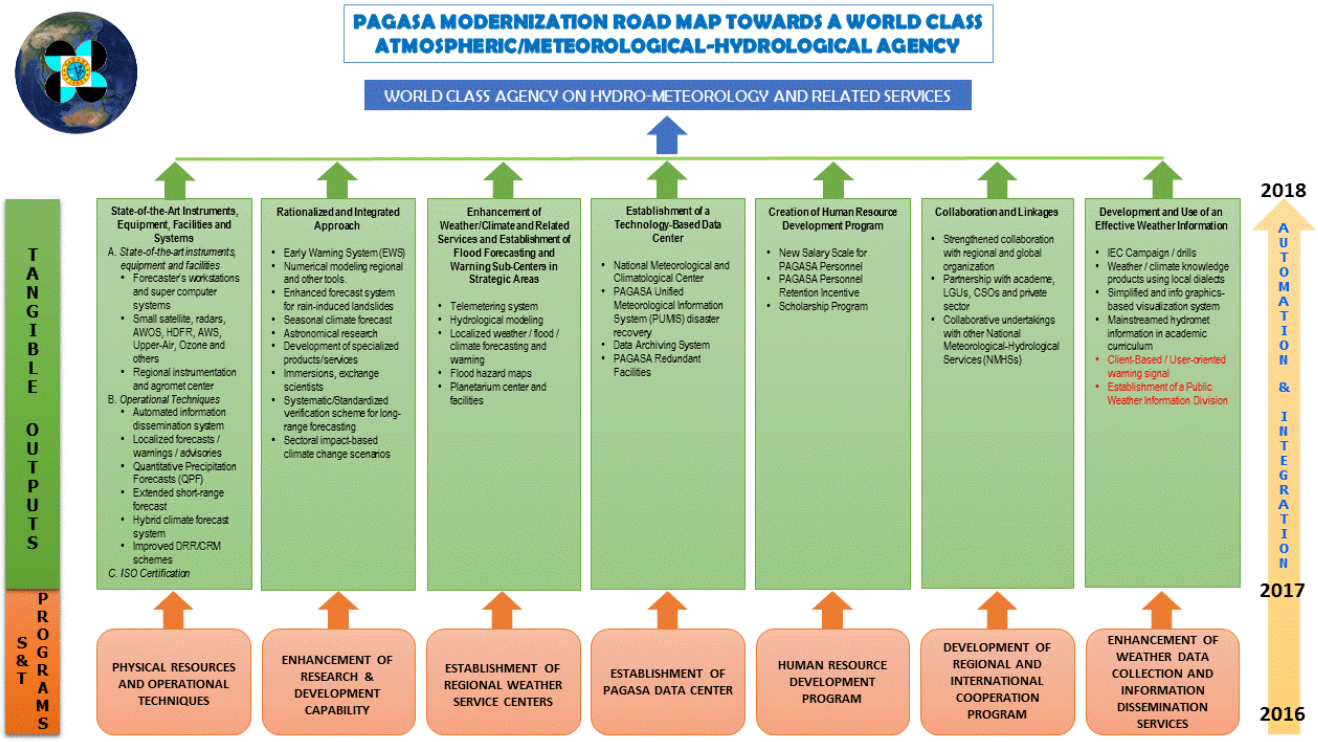
**ENERCON**

| RESEARCH AREAS | TIMEFRAME | | | | | | | | S&T DELIVERABLES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Integrated energy management system for household, industry and commercial buildings<br>- Smart and green DOST compound<br>- Smart grid technology program<br>• Smart home platform<br>• Advanced metering infrastructure<br>• Acceptability studies for pre-paid metering and smart home systems<br>• Rollout<br>- Design and implementation of Power Distribution Units for data centers | | | | | | | | | - Smart DOST building<br>- Smart grid technology--wireless and centralized integrated monitoring system | Locally-developed building energy management tool |
| Local Development of Building Management Systems<br>- Sensors, integration monitoring software, automation and control systems | | | | | | | | | | |
| Compendium of available energy efficiency devices and technologies<br>- Sensors, integration monitoring software, automation and control systems | | | | | | | | | | |

**LOW-ENTHALPY GEOTHERMAL**

| RESEARCH AREAS | TIMEFRAME | | | | | | | | S&T DELIVERABLES | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2013 - 2015 | 2016 – 2020 |
| Resource and market assessment of low-enthalpy geothermal | | | | | | | | | | - Resource and market assessment of low-enthalpy geothermal<br>- Heat pump technology development for low-enthalpy application |
| Heat pump technology development for low-enthalpy application | | | | | | | | | | |

**ANNEX 42**
**DRR-CCA R&D Roadmap**



**ANNEX 43**
**PAGASA Roadmap**