

# R4D *Highlights*



## DA-PCC In-House Review migrates to digital space

BY CHARLENE JOANINO

**F**or the first time, the Department of Agriculture-Philippine Carabao Center (DA-PCC) broadens reach in its R4D In-House Review through a combination of physical and online presentations that were broadcast via a web conferencing platform. It was held last December 3-4 at the DA-PCC National Headquarters and was joined in virtually by participants all over the Philippines.

“The In-House Review sums up the activities of the DA-PCC Research and Development Division (RDD) for the whole year,” underscored by DA-PCC RDD OIC-Head

Dr. Eufrocina Atabay in her message.

A total of 15 papers were evaluated by

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Rovelyn Jacang, Science Research Specialist I, presents the research titled "Extension Method for the Adoption of Dairy Buffalo Technologies in the Philippines" during the R&D Symposium held on December 3-4.

## DA-PCC migrates.. (From page 1)

Dr. Annabelle Sarabia, Former DA-PCC RDD chief; Dr. Ericson Dela Cruz, DA-PCC OIC-Chief of Planning and Information Management Division; and Dr. Virginia Venturina, Dean of Central Luzon State University (CLSU) College of Veterinary Science and Medicine.

The papers were categorized under four thematic areas namely Genetic Improvement-Animal Genomics or Genetic Diversity and Cryopreservation, Biosafety Production Systems and Nutrition, and Socio-Economic Dimensions of Carabao Development Program Implementation.

"Most number of papers presented" award was bagged by the DA-PCC at University of the Philippines-Los Baños and DA-PCC at Visayas State University.

The "Comparison of Progeny Testing and Genomic Selection Breeding Schemes in Dairy Buffalo" by Dr. Jesus Rommel Herrera, Dr. Ester Flores, and Dr. Julius van der Werf was hailed the "Best Paper" (average score of 92.67%). Dr. Herrera who presented the said paper also won as the "Best Presenter" (average score of 93.67%).

Criteria for judging for the "Best Paper"

include Title and Abstract (10%), Introduction (10%), Materials and Methods (25%), Results and Discussion (40%), and Summary and Conclusion (15%). While the "Best Presenter" was chosen based on Clear and Logical Presentation (25%), Comprehensive Knowledge on Subject Matter (30%), Answers to Questions (25%), and Clear and Relevant Visual Aids (20%).

Meanwhile, winners of DA-PCC Technology Pitch Day last November were once again recognized. The presenters on the agency's research and innovations webinar series namely Dr. Claro Mingala, DA-PCC OIC-Executive Director; Dr. Arnel Del Barrio, former DA-PCC Executive Director; Ms. Mina Abella, RDD CEDS Head; Dr. Annabelle Sarabia, former RDD head, Dr. Edwin Atabay, Scientist I, and Dr. Daniel Aquino, Former DA-PCC at CLSU center director, were also recognized.

Dr. Aquino was recognized for his study on the "Development of Feeding Protocols and Practices to Support the Nutritional Requirements of Dairy Buffaloes", which won "Best paper" award last August in an event facilitated by the CLSU.

Dr. Emerson Tapdasan of DA-PCC at

Ubay Stock Farm was also recognized for his paper entitled "Prevalence and Risk Factors of *Trypanosoma evansi* infection in Water Buffaloes (*Bubalus bubalis*) of Ubay, Bohol", which bagged the award during the Agriculture and Fisheries Cluster Development Symposium of Central Visayas, Agriculture, Aquatic and Natural Resources R&D Consortium held last October.

Other highlights of the event were the talks given by Dr. Diana Ignacio, Assistant Secretary for Human Resources, Management Services and Special Concerns, Department of Science and Technology (DOST) and Dr. Lily Ann Lando, motivational coach/Training and Facilitator, CORE Consulting and Development. The topics are on Guidelines in Certification of Eligibility of Non-DOST and S&T Personnel under RA 8439 as amended by RA 11312" and "Innovator Mindset: Changing mindsets from researchers to innovators", respectively.

Also in the event were DA-PCC OIC-Executive Director Dr. Mingala, DA-PCC Deputy Executive Director Dr. Caro Salces, and other DA-PCC RDD staff.



## DA-PCC gears up for techno commercialization

BY CHARLENE JOANINO

**Innovative technologies from the Department of Agriculture-Philippine Carabao Center (DA-PCC) are set to further the livestock industry as the said breakthroughs will be cascaded to broader masses.**

In a four-day seminar, the DA-PCC sharpened the ability of its researchers on translating "Research and Development (R&D) innovations to products and services for client and public good". The activity entitled "Virtual Technology Commercialization Seminar and Pitch Demo" was conducted last November 18-20 and 27.

"The pandemic may be tough but our goal to innovate and improve agriculture technology is tougher," said Dr. Claro Mingala, DA-PCC OIC Executive Director.

A highlight of the seminar was the awarding of best pitches. The "A2 Choice" presented by Pauleen Pineda won 1st place and "Prolipig" pitched by Sherwin Mathias bagged 2nd place. Both "Blockmate",

presented by Victorino Mayo, Jr. and "Nyogurt" by Teresita Baltazar tied at 3rd place. The "QuickCare" discussed by Dr. Gabriel Tubalinal took the "People's Choice Award".

All pitches were adjudged based on the Delivery of pitch (40%), Structure of pitch (30%), and Content of pitch (30%).

Three judges were invited, namely Dr. Annabelle Sarabia, former DA-PCC Research and Development Division (RDD) chief; Dr. Ester Flores, RDD ABGS head; and Jan Czarina Salas, Intellectual Property Specialist.

The other pitches and presenters were Buro Booster Silage Inoculant by Reynald Amido; e-RS (Enriched Rice Straw) by Charity Castillo; Milkybun by Joel Cabading; and Milkpops by Jennica Salazar.

There were three categories, namely, Molecular-based Technologies, Nutrition, and Product Development.

"This activity is very challenging, if not nerve breaking but very exciting," shared by Dr. Eufrocina Atabay, DA-PCC OIC RDD chief.

The resource speakers and facilitators were Dr. Flores; Abigail Gueco, Senior Science Research Specialist of Department of Science and Technology-Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD) Technology Transfer and Promotion Division (TTPD); and Dr. Lily Ann Lando, Motivational Coach/Mentor of Core Consulting and Development.

Also part of the event were Dr. Reynaldo Ebor, DOST-PCAARRD Executive Director; Engr. Grecelda Eusebio, Intellectual Property and Technology Business Management (IP-TBM) project leader; and select DA-PCC RDD staff.

In 2018, the DA-PCC started its IP-TBM efforts through a 2-year joint project between the agency and DOST-PCAARRD.

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# International experts agree: Livestock biotech is key to mitigate industry impact of COVID

By JUSTINE JOY SALVADOR

**T**he DA-PCC recently underscored research-driven innovations to address and mitigate the impact of the pandemic on livestock during an international symposium held last October 27-28.

The Department of Agriculture-Livestock Biotechnology Center (DA-LBC), in cooperation with the National Research Council of the Philippines (NRCP) - Division XIII has recently concluded the 5th International Livestock Biotechnology Symposium, which enables local and international researchers and scientists together with representatives from the government/public and private sector, non-government organizations, and academe to convene for the strengthening of agricultural outputs amidst pandemic. The ultimate goal is to foster a more competitive, profitable, and sustainable livestock industry.

With the recent outbreak of global pandemics such as COVID-19, African Swine Fever (ASF), and Avian Influenza, this year's symposium theme was "Research-Driven Innovations Addressing and Mitigating the Impacts of Global Pandemic on the Livestock Industry". It has brought together various

experts from the USA, Thailand, Japan, Australia, and Philippines. The two-day virtual symposium was attended by some 400 participants from different countries, mostly from the Philippines.

Dr. Claro N. Mingala, chief of the DA-LBC and OIC-Executive Director of the Department of Agriculture-Philippine Carabao Center (DA-PCC), said the emergence and resurgence of different global pandemic threatens biodiversity. He added that lives and livelihoods are harmed with the current pandemic impacting on global population in various levels. With globalization, he said, the persistence of animal diseases poses a serious risk to public health and causes damage to businesses and the economy at large.

Dr. Roger Merkel, an Associate Professor from Langston University, Oklahoma, USA shared that to replace antibiotics, one should promote growth of the animal, enhance its GI tract health, feed efficiency, and immune function, and reduce pathogenic bacteria found in animals.

Meanwhile, Dr. Sukolrat Boonyayatra of Chiang Mai University in Thailand

lectured on antimicrobial resistance of Bovine Mastitis pathogen while Dr. Rangsun Parnpai talked about the utilization of reproductive biotechnologies for production of genetically elite cattle and buffaloes.

Prof. Shin-Ichiro Kawazu of Obihiro University of Agriculture and Veterinary Medicine in Hokkaido, Japan, presented studies on the development of *Babesia* parasites using gene manipulation and bio-imaging analysis. The main goal of his *Plasmodium* and *Babesia* research is to understand the basic cellular mechanisms of these apicomplexan parasites.

Another speaker was Ms. Rowena Aguilar-Sino, a Fermentation Scientist from Australia, who talked about animal vaccine accessibility in the regional areas. Finally, Dr. Saturnina Halos from the University of the Philippines Diliman discussed the regulatory issues on animal biotechnology in the Philippine perspective.

Symposiasts raised questions during the last part of each session. Results of the feedback poll show that 83% of the participants believe that biotechnology is essential in mitigating the pandemic.

## Raw buffalo milk, is it safe for consumption?

By CHRISSALYN MARCELO, RANDOLPH TOLENTINO, MARVIN VILLANUEVA, LOINDA BALDRIAS, APRIL SHAYNE SULABO, AND THERESE MARIE COLLANTES

**F**ood is considered as one of the most traded commodities in the world. In fact, according to the reports of Food and Agriculture Organization of the United Nations (FAO), in 2020, global agri-food trade has more than doubled since 1995, amounting to \$1.5 trillion in 2018, with emerging and developing countries' exports on the rise and accounting for over one-third of the world's total.

Thus, this is the same reason why food safety is being implemented around the globe. With more and more food consumed and traded globally, food safety takes its role in protecting the people and consumers from physical, chemical, and microbiological hazards in the food that can cause foodborne illnesses after consumption.

In the Philippines, food safety is currently being strengthened and implemented through the Republic Act No. 10611 otherwise known as the "Food Safety Act of 2013". The act fortifies food safety regulatory system and provides protection to consumers so they will have access to local foods and food products that have undergone production and processing systems that comply to safety standards and have passed the tests on the allowed limits for hazards that may be present in the raw and processed food products.

Milk, which is one of the products that can be harnessed from buffalo production and management, is no exception. Thus, the Department of Agriculture-Philippine Carabao Center, an agency which is mandated to promote, propagate and conserve the carabao as a source of milk, meat, draft power, and hide, to benefit the rural farming families, is making an effort in order to abide by the Food Safety Act.

Among this effort was its recently conducted research study titled, "Antibiotic Residue Detection and Antimicrobial Resistance Profile of *Staphylococcus aureus* and *Escherichia coli* from Raw Milk of Water Buffaloes (*Bubalus bubalis*) in Nueva Ecija, Philippines".



The study was conducted to detect if raw buffalo milk is contaminated with antibiotic residues and if it is safe for consumption. The study also aimed at profiling the resistance of *S. aureus* and *E. coli* to antibiotics commonly used in dairy production for the treatment of common dairy buffalo diseases such as mastitis, pneumonia, and diarrhea.

In the study, the researchers, composed of Randolph Tolentino, Marvin Villanueva, Loinda Baldrias, April Shayne Sulabo, and Therese Marie Collantes, collected 208 raw buffalo milk samples that were randomly collected at five sampling sites consisting of three dairy collection centers and two dairy buffalo farms in Nueva Ecija.

The reserachers explained that raw buffalo milk samples were screened for residues of commonly used antibiotics in dairy production particularly the beta lactams, enrofloxacin, and oxytetracycline, using enzyme-linked immunosorbent assay (ELISA), which is commonly used to measure antibodies, antigens, proteins and glycoproteins in biological samples or compounds bound to biological samples.

The *S. aureus* and *E. coli* are common disease-causing bacteria that are present in the skin of healthy animals and

in the environment were recovered from milk samples. The phenotypic antimicrobial resistance profiles of these bacteria were determined using the Kirby-Bauer disk diffusion assay, which determines the sensitivity or resistance of certain pathogenic bacteria to various antimicrobial compounds.

**Based on the results, it was observed that the prevalence of antibiotic residues particularly beta lactams, enrofloxacin, and oxytetracycline in raw buffalo milk in Nueva Ecija was at 35.42%. And among these antibiotic residues, it was observed that beta lactam was the commonly found antibiotic residues in milk.**

(Continued on page 6)



PHOTO TAKEN PRIOR TO THE PANDEMIC

## Raw buffalo milk.. (From page 5)

Though the prevalence of antibiotic residues is found at 35.42%, it was noted in the study that the amount of residues was within the permissible level of the Maximum Residue Limit (MRL) of the Codex Alimentarius or the level that is legally tolerated in food.

Meanwhile, among the 208 raw buffalo milk samples collected in the study, 122 isolates of *S. aureus* from 30 raw milk samples and 233 isolates of *E.coli* from 78 raw milk samples were isolated. Isolates of *S. aureus* were found out to be resistant to penicillin G (85.71%), oxacillin (81.25%), cefoxitin (26.79%) and oxytetracycline (0.89%) while isolates of *E. coli* were found out to have resistance to oxytetracycline (16.31%), cefoxitin (1.29%) and enrofloxacin (0.43%).

The knowledge, attitude, practices and skills of farmers were also surveyed in the study to characterize the social aspects of dairy buffalo farmers. The survey showed

that the knowledge of majority of dairy buffalo farmers was high, their desirable attitude was favorable, their employ good dairy practices and their skills ranged from excellent to good concerning avoidance of antibiotic residue in milk in Nueva Ecija.

The dairy farmers were also able to prevent selling of milk from cows treated with antibiotics by discarding the contaminated milk. However, despite the prudent use of antibiotics in dairy buffalo production, presence of low levels antibiotic residues in raw buffalo milk was still observed. With this, the researchers recommend to detect presence of antibiotic residues in other farm inputs such as concentrates and water to determine whether direct or indirect contamination is occurring; and detect antibiotic residues in farm outputs such as in manure of treated buffaloes as this can cause contamination of the environment including water sources and forage areas.

In terms of the antibiotic resistant pathogenic bacteria present in raw milk, however, it's ubiquity necessitates that proper environmental sanitation and milking hygiene is imperative to prevent its transmission from the environment, humans, animals and its product. Avoiding consumption of raw milk and proper pasteurization, and storage are also important control measures to ensure that these pathogenic bacteria are not transmitted to the consumers.

**Overall, the study found out that raw milk is safe and fit for consumption with regard to antibiotic residue level and that the latter is not an alarming public health concern.**

## DA-PCC ushers strengthened CDP in VisMin

By CHARLENE JOANINO

**C**ommunication is vital in the provision of services by the Department of Agriculture-Philippine Carabao Center (DA-PCC) in its Carabao Development Program (CDP). It facilitates understanding and interaction among the people involved in CDP implementation.

In 2017, the DA-PCC's Knowledge Management Division (KMD), started the research and campaign entitled "Strengthening the CDP thru Communication for Development (ComDev) Campaign in Visayas and Mindanao". It was spearheaded by KMD chief Dr. Eric Palacpac with collaborators from DA-PCC regional centers hosted by West Visayas State University, University of Southern Mindanao, Central Mindanao University, and Mindanao Livestock Production Center.

The campaign, popularized as "Karbawan", a local term that implies "collective engagement in carabao keeping", 1) determined key priority issues and available communication channels in the target sites; 2) developed and implement communication strategies to address identified issues and; 3) monitored and evaluated the results of the communication campaign strategies. This was conducted based on the ComDev approach that includes four stages such as Participatory Communication Appraisal, Design of Strategy and Plan of Action, Implementation, and Result Assessment and Sustainability.

Participatory communication appraisals were held previously in the target areas of DA-PCC, namely, Sapian, Capiz; Leon, Iloilo; and Aklan (all in Panay Island); Sto. Niño, South Cotabato; Ipil, Zamboanga Sibugay; Polanco, Zamboanga del Norte;

and Don Carlos, Bukidnon, which helped derive key concerns that include improving stakeholders' awareness, knowledge, and practices on dairy buffalo production and management particularly on animal health and nutrition.

Appropriate communication strategies were developed following the appraisal. Key communication interventions of the campaign included radio plug and press release, school-on-the-air, farmer livestock school on dairy buffalo production, manual on proper management of dairy buffaloes, testimonial videos, jingle, advocacy kit, pastillas diplomacy, comics, billboard, and engagement flip chart.

These were tailor-fitted to respondents based on their socio-demographic profiles. In Visayas, Ilonggo was the

(Continued on page 11)

# Bakery waste concentrate mix can improve growth performance of buffalo yearlings

BY MA. CECILIA IRANG, LOWELL PARAGUAS, ELENA PARAGUAS, RAMON SOLIVEN, AND VICENTA CANATOY

**T**here's more to carabaos than just being a source of draft power. The DA-PCC's Carabao Development Program (CDP) continuously ushers the improvement of the genetic potentials of carabaos as a source of quality milk and meat to promote productive buffalo-based enterprises to farming communities.

Under the CDP, the potentials for meat production utilizing male animals produced from institutional herd and dairy cooperatives are continuously being explored.

Fattening and slaughtering of male buffaloes unfit for breeding purposes are not only meant to improve the economic condition of raisers, as it is a profitable business venture, but also to provide quality meat for domestic consumption at competitive prices.

However, due to high cost of feeding materials, farmers and feedlot operators are reluctant to adopt various feeding technologies for feedlot fattening of male buffaloes. One way to decrease feed cost is the utilization of industrial by-products and waste.

The use of bakery waste-based concentrate mix in the feeding system is seen as a factor for improved growth performance of Bulgarian Murrah buffalo yearlings.

This finding was based on an operations research carried out by the team from the DA-PCC at Central Mindanao University, which include Dr. Lowell Paraguas, Elena Paraguas, Vicenta Canatoy and Ramon Soliven.

Their study titled "Performance of Bulgarian Murrah Buffalo Calves Fed

with Mulato II Grass (*Brachiaria sp.*) and Napier Grass (*Pennisetum purpureum*) With or Without Bakery Waste-Based Concentrate Mix" was focused on further evaluating the nutritive value and effect of feeding bakery waste on Bulgarian Murrah buffalo yearlings' growth.

Specifically, it was aimed at determining the live weight gain, dry matter intake, and feed conversion ratio of Bulgarian Murrah Buffalo yearlings fed with Mulato II grass and Napier grass with varying levels of concentrate supplementation made from bakery waste.

It was also conducted to evaluate the apparent in vivo digestibility (IVD) of dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and ash content of the diets fed to Bulgarian Murrah Buffalo yearlings; and assess the economic benefit of using different levels of concentrate supplementation made from bakery waste in Bulgarian Murrah Buffalo yearlings.

In the study, 24 Bulgarian Murrah Buffalo yearlings were utilized and blocked according to their initial weights in a Randomized Complete Block Design (RCBD) in six replications per treatment.

Monthly weighing was done using

an electronic weighing scale. During the 120-day feeding trial period, the experimental animals were assigned to four dietary treatments. They were fed with varying levels of Mulato II grass, Napier and bakery waste-based concentrate mixture.

For Treatment 1, animals were fed with Mulato II grass without concentrate supplementation. For Treatment 2, they were fed with Napier grass without concentrate supplementation. Treatment 3 involved feeding of 80% Mulato II grass + 20% concentrate supplementation while Treatment 4 was composed of 70% Mulato II grass + 30% concentrate supplementation.

The addition of bakery waste-based concentrate to Mulato II grass resulted in increased in vivo CP digestibility in Bulgarian Murrah Buffalo yearlings. In vivo DM, NDF, ADF, and ash digestibilities of Mulato II and Napier grass were better than those with bakery waste concentrate in Bulgarian Murrah Buffalo yearlings.

The lesser the % of bakery waste-based concentrate mixed with Mulato II grass, the higher is the return above feed and supplement costs.

On the other hand, for better in vivo CP digestibility in Bulgarian Murrah buffalo yearlings, bakery waste-based



concentrate mix can be included in the diet. Basal ration with either Mulato II and Napier grass could however satisfy the nutrient requirements of the animals considering that these supply higher DM, NDF, ADF and ash.

Recommending for further research, the study initially concluded that in order to decrease the feed cost, the use of bakery waste-based concentrate mix at lower inclusion rates in a shorter period of time could be implemented for the improved growth performance of Bulgarian Murrah Buffalo yearlings.

Based on the findings and conclusions of the study, the researchers recommended the use of bakery waste concentrate mix in Bulgarian Murrah Buffalo yearlings for improved growth performance.

# DA-PCC Technologies

## A2Choice

**i** A genotyping test for A1 and A2 beta-casein (milk protein) variants for bovine and bubaline species developed by the DA-PCC to identify the type of milk that cow and carabaos have through their beta-casein gene.

## eRS

- i** Healthy feedstuff for carabaos, cows, and goats specially during summer when there is limited supply of fresh grasses.
- i** The ingredients of e-RS are urea, molasses, rice straw, and water.

## VERISIRE

- i** The first DNA-based parentage testing in the Philippines that uses Microsatellite-based Technology.
- i** Through VeriSire, proper pedigree information of animals, which is important in any breeding program, genetic evaluation system, and breed registry, can be determined.

## QuickCARE™

**i** A low cost, pen-side DNA-based test with high detection rate that can be performed in 4 easy steps and results can be obtained as early as 10 minutes without the use of any expensive equipment.

## BURO BOOSTER SILAGE INOCULANT

A silage additive for corn, sorghum, and grass

- i** An inoculant that helps in improving the quality of corn, sorghum, and grass silage.
- i** It has *Lactobacillus* species, which is good in the production of lactic acid and reduces possibility of spoilage of ensiled grasses.

## BM BLOCKMATE NUTRITION IN A BLOCK

- i** Supplement food for carabaos, cows, goats, and sheep.
- i** Rich in energy, minerals, and nitrogen, which is necessary in an animal's growth and milk production.

“Under the new normal and DA’s ‘new thinking’, various challenges and opportunities were experienced by the DA-PCC in implementing its RDD paradigms. I call it ‘research revolution’. Our new mindset is to translate research outputs to innovations to help boost the carabao sector and uplift the lives of Filipino farmers.”

**Dr. Eufrocina Atabay**  
Scientist I and OIC-Chief, Research and Development Division



For more information about DA-PCC technologies, please contact PCC Research and Development Division

Email: [rdd.pcc@gmail.com](mailto:rdd.pcc@gmail.com)  
Contact Number: **0936-8377797**  
Facebook Page: **PCC Research Trends and Innovations**



## DA-PCC ushers... (From page 7)

preferred language while in Mindanao, Cebuano was commonly used. Radio is the primary source of information by many of the respondents who are farmers.

Results of the strategies’ evaluation revealed that the respondents’ scores for Knowledge, Attitude, and Practices generally improved.

## OPINION



## Relentless resiliency in research for dev't

**EUFROCINA ATABAY, PhD**  
*PCC National R4D Coordinator*

We made it with Research and Development Division (RDD) ending 2020 on a high note! The year posed a lot of challenges brought about by the pandemic. Despite the condition, we never lost sight of our goal of helping our partner-farmers. When it seems like things are at the brink of being lost, we found ways to turn these problems into opportunities. That, I believe, is the beauty of research. You have the means to find the solutions.

At the onset of the COVID-19 pandemic, the research activities of Sections and Units of RDD were outrightly refocused to aptly address overwhelming concerns on food productivity, sustainability, and resiliency during the health crisis. Further, researchers went out of their way providing various services to the DA-PCC's assisted farmers.

During the lockdown, carabao raisers struggled in selling their milk produce. The Division came up with and volunteered in the Buffalo Milk on Wheels (BMW), which soon became part of the Department of Agriculture's Kadiwa initiative. It served as an alternative market channel of milk and dairy products processed from farmers' produce. More than just roving vehicles that went to communities, it provided easy access for consumers to healthy carabao's milk that can help boost immunity to combat COVID-19.

The RDD also pursued initiatives and adopted the use of the ICT tools as it migrates its activities to a digital platform. A webinar series on technologies featuring PCAARRD bundled S&T Projects constituted the first online attempt of the Division for information sharing and media boosting. Highlight was the technology pitch day for various innovations derived

from PCC R4D activities. The activity prepared the researchers in promoting and commercializing the outputs of their work or technologies for the benefit of the society.

This pioneering RDD activity intensified the cascading of these interesting innovations: VeriSire, Prolipig, e-RS (Enhanced Rice Straw), Blockmate, Buro Booster, and Quickcare. We also proudly introduced new products with carabao's milk namely the Milkybun, Milk pops, and Nyogurt.

The virtual holding of Annual In-house R&D Review and Research Symposium, where we showcased research works is a manifestation of our steadfast adherence and support to the Carabao Development Program. Likewise, these scientific activities are strategic venues to identify potential technologies for transfer and deployment to the farmers.

Essentially, this was my first year in leading the RDD and despite the tough beginning and rough sail, we managed it all in the end. I am profoundly grateful to the Division's team unwavering effort and other Division's support which made a big difference to be able to survive and operate through the challenges of the New Normal.

To the DA-PCC researchers, I hope we remain laser-focused on our aim for research excellence, aggressively pursuing research for development, translating them to innovative products and services for the farmers and general public. Lastly, as we brace ourselves for another year and far beyond R&D undertakings, let us be mindful and resolved of this new research paradigm: from Research to Innovations Mindset, which I believe, is a game changer for the betterment of the lives of our partner-farmers this pandemic and beyond.

## R4D Highlights<sup>®</sup>

R4D Highlights, an annual publication of the Philippine Carabao Center, publishes in popularized form the agency's completed researches presented in its annual R&D Review. This publication reaches out to a wide scope of readers both in the science and non-science profession as well as the interested public.

For comments and suggestions, please write to the Editor-in-Chief in this mailing address:

Philippine Carabao Center  
National Headquarters and Gene Pool  
Science City of Muñoz, Nueva Ecija, Philippines  
or email at [ilivestockbiotech@gmail.com](mailto:ilivestockbiotech@gmail.com).