

# Contributions to Agriculture, Forestry and Fisheries (AFF) Research of Non-AFF Undergraduate Researches: The Case of Bicol University Biology Department

Jonathan Jaime G. Guerrero<sup>1,\*</sup>, Mark Angelo O. Balendres<sup>2</sup>

Luis O. Amano<sup>3</sup>, Charmaine A. Malonzo<sup>1</sup>, and Amelia A. Dorosan<sup>4</sup>

<sup>1</sup>Department of Biology, College of Science, Bicol University, Legazpi City, Philippines

<sup>2</sup>Institute of Plant Breeding, College of Agriculture and Food Science,  
University of the Philippines Los Baños, Laguna, Philippines

<sup>3</sup>Office of the Vice President for Research, Development and Extension, Bicol University,  
Legazpi City, Philippines

<sup>4</sup>Office of the Vice President for Academic Affairs, Bicol University, Legazpi City, Philippines

\*Corresponding author: jjgguerrero@bicol-u.edu.ph

## Abstract

Agriculture, forestry and fisheries (AFF) researches' contribution to the economy is far-reaching. While there are a number of institutional researches produced, many AFF researches are lodged at the undergraduate level, many of which remain underutilized. The role of non-AFF undergraduate programs as a means to further research in AFF fields are highlighted in this study using the case of the BS Biology Program of Bicol University which may be reflective of other HEIs in the country. A total of 271 of the 865 undergraduate theses conducted in the Department of Biology from 1986 to 2019 were under AFF. Majority of the studies were on post-harvest and plant pathology of locally important commodities such as rice, coconut and pili. However, there were no records of publication. AFF - allied undergraduate programs like biology can be a source of valuable and valid research data to augment AFF researches in the region and in the country. Mechanisms to encourage publication of student outputs are also imperative for proper and wide dissemination of results. Inclusive undergraduate research agenda, co-mentoring and cohesive institutional academic policies are among the strategies to further strengthen the AFF contributions of allied undergraduate programs.

**Keywords:** *AFF, Biology, Bicol University, undergraduate research*

## Introduction

Philippine agriculture, forestry, and fisheries (AFF) collectively had contributed 13.2% to the country's gross domestic product (GDP) in 2019 (PSA 2019). This is a small share compared with the service and the industry sectors' contribution of 56.7% and 30.4%, respectively. Despite this, agriculture's role in the economy is crucial: providing food and raw materials, acting as a market for non-agricultural products, and providing employment and labor (Habito & Briones 2005). Low agricultural productivity and limited diversification are two of the most important challenges which are caused by a number of factors, including ageing farmers and fisherfolks and scant support for research and development (Brown *et al.*, 2018).

There is a waning interest and involvement of the youth in agriculture. As a career choice, it is laden with issues such as uncompetitive wages and the lack of awareness of the diverse career paths within the agricultural sector (Kruijssen, 2009). In the Philippines, enrolment in agriculture courses are in decline because of factors such as negative perception of agriculture as a profession and rapid urbanization of rural areas, among others (Zamora, 2014). Likewise, the Philippines lags behind neighboring countries in terms of agricultural research spending although there is some significant increase in the recent decade (Stads *et al.*, 2007).

Allied courses such as biology can provide the human and research complements to AFF growth and development. Biological concepts are integral parts of modernizing AFF in the country. Plant pathology,

aquaculture, wood technology, seed technology, entomology and biotechnology, among others, draw much of its technical resources from the life sciences. Biology is indispensable in our understanding of biological soil fertility (Abbott & Murphy 2007), microbial biofertilizers (Bhardwaj *et al.*, 2014), and the many ecological processes involving the crops (Shennan, 2008). The data from various biological researches open new opportunities for solutions to important AFF problems (Yarden *et al.*, 2003).

While government research institutions have vigorously studied agricultural, aquaculture and forestry systems, many universities also have massive archives of undergraduate researches with focus on AFF. Many of these theses or special problems are untapped, underutilized or not at all because they do not reach the points of presentation, publication or utilization. This may be the case with the Department of Biology of Bicol University in the Philippines and may mirror many higher education institutions worldwide.

Undergraduate researches are important in training students, especially those that will pursue research as a full-time profession. More so, undergraduate researches of local universities can be strong inputs to community programs because of their proximity to the region. In the Philippines, each region has at least one agricultural commodity that boosts regional economy, contribute to food security and essentially creates a sense of pride among people. Aside from the staples of rice and corn, the Bicol region for example is known for the focus on abaca (*Musa textilis*), sili (*Capsicum* sp.), pili (*Canarium ovatum* L.), and taro (*Colocasia esculenta* L.). These commodities are socio-economically important as they are also culturally ingrained in the region's rich folklores and legends.

There are 865 undergraduate researches conducted from 1986 to 2019 in the Biology Department of Bicol University. From this database, 271 are focused on agriculture, forestry and fisheries (AFF). Notwithstanding the results, they form a massive information reservoir which can be filtered and potentially start a cascade of solutions-based researches and technologies. An analysis of the more than three decades of undergraduate researches of the Biology Department of Bicol University can provide vital information that can help craft a more cohesive and responsive research agenda among biology undergraduate students supportive of the AFF thrusts of the institution, the region and the country. This analysis may present a compelling glimpse of the current status of undergraduate AFF researches in the country, especially

among non-agriculture majors.

This research, therefore, aimed to summarize the undergraduate AFF researches of Bicol University Department of Biology from 1986 to 2019 and provide insights on their focus, changing trends, opportunities and research gaps. Moreover, new researchable areas were recommended for a cohesive and responsive AFF research agenda at the undergraduate level. Finally, policy recommendations were outlined to sustain a vigorous research engagement among biology students which may also be useful in other allied courses and HEIs.

## Materials and Methods

### *Department of Biology of Bicol University*

Bicol University is a state-funded higher education institution (HEI) in the Bicol region. The main campus in the province of Albay houses the College of Science in which the Department of Biology is part of. The Department offers the Bachelor of Science in Biology since 1977 and the Master of Science in Biology since 2015. Undergraduate research is a requirement for graduation.

### *Selection of Undergraduate Researches*

A database of thesis titles is maintained at the department, college and university levels. Printed manuscripts are likewise available at the department and university libraries. All thesis titles were initially examined to filter out all researches with agriculture, fisheries and forestry (AFF) topics. A rigorous evaluation was conducted to assess the completeness of the database using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) procedure (McInnes *et al.*, 2018). Studies classified as AFF-related are those which dealt with the basic biology, product and process explorations of AFF commodities. Research titles that mention or include keywords such as "agriculture", "fisheries", "forestry", "pest", "fertilizer" and studies that mention specific species name, group, or AFF-related terms were filtered out into a separate database. Abstracts were consulted to provide details into the objectives and primary results of the researches.

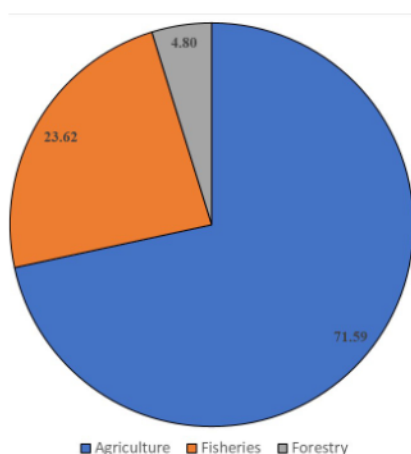
### *Analysis and Presentation of Results*

Analysis of thesis titles and abstract include clustering in terms of year, specialization and commodity studied. Important researches into regional crops and commodities were also highlighted. Data were presented

as percentages.

## Results

There are 271 AFF researches archived by the Biology Department from 1986 to 2019. Of these, 71.59% or 194 are agricultural (Figure 1). The first research on agriculture was on microorganisms found in leafy vegetables sold in local markets. This specific study was a post-harvest bacteriological research.

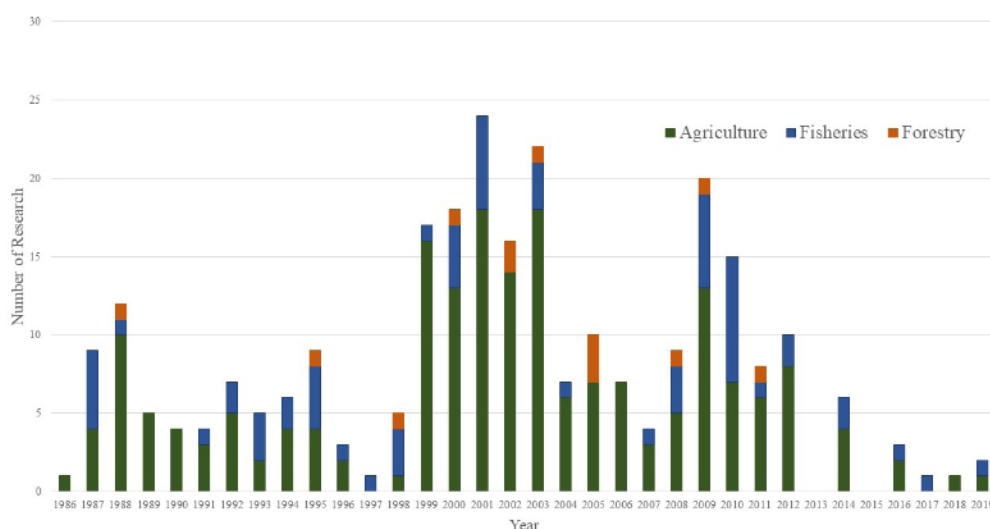


**Figure 1.** Distribution of AFF researches of the biology department from 1986 to 2019.

Fishery researches came in 1987 focused on edible seaweeds, edible gastropods and economically important finfishes. Fisheries studies account for a quarter of the total researches along AFF. Forestry comprise the least and were sparsely spaced throughout the three decades (Figure 2). The first forestry research was in 1988 on the improvement of *Canarium ovatum* germination.

The first few years of undergraduate research of the department manifested the weight given by the university to AFF researches. Expertise of regular and affiliate faculty members along agriculture, fisheries and forestry abound during the first decade (1986-1995). The percentage of thesis output along AFF were always above 50.00% as shown in Figure 3. The same figure will, however, show emphatically the decline in AFF researches in the succeeding years. AFF researches began to drop in the latter half of the second decade (1996-2000) and with least engagement at present. This is further punctuated by two years of zero outputs (2013 and 2015), years when the focus were on medicinal plants and biodiversity researches.

The decline in the number of AFF researches conducted by undergraduate biology students coincided with the strengthening of the AFF undergraduate programs in the agriculture and fisheries colleges of Bicol University. It was in 1993 when the BS Forestry was offered in Bicol University. Moreover, the full implementation of the university's Comprehensive Development Plan in 2004 restructured the faculty complement of the Department of Biology putting



**Figure 2.** Timeline and trends of AFNR-related undergraduate thesis of BS Biology students in Bicol University from 1986 to 2019.



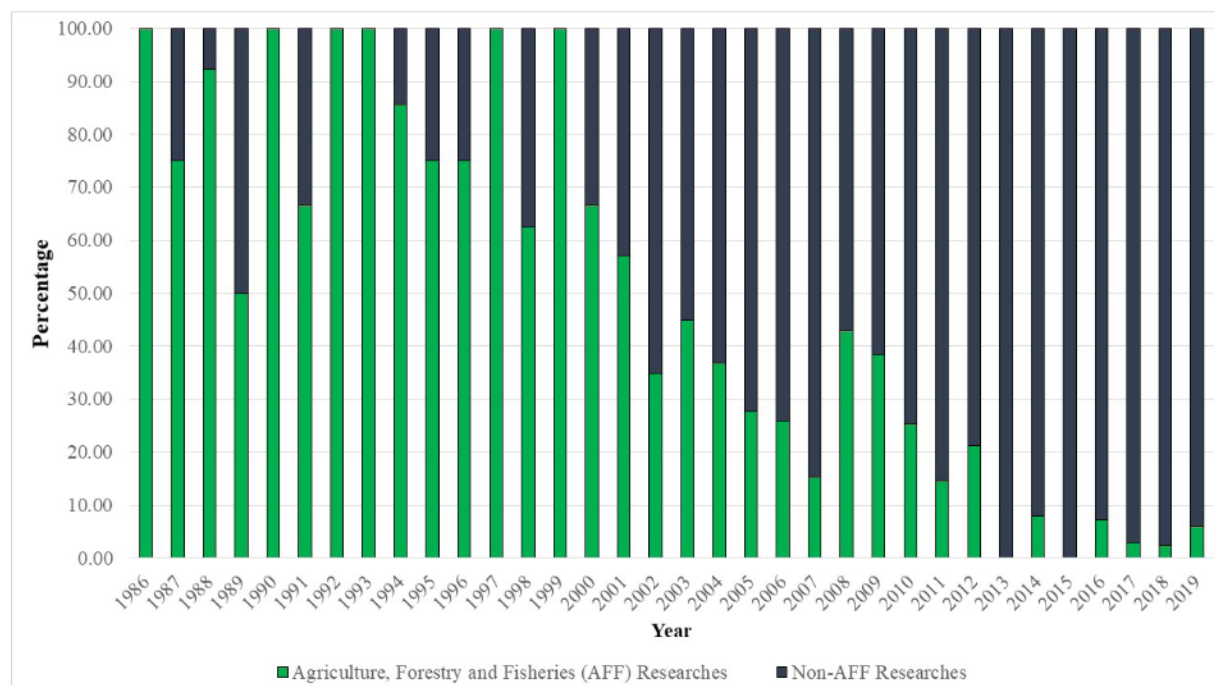


Figure 3. Proportion of AFF researches and non-AFF researches from 1986 to 2019.

weight on pure biological sciences rather than the allied fields such as agriculture and fisheries.

Much of the focus of agricultural researches of the department were on locally important commodities. There were at least forty-three plant species researched by the department. Rice (*Oryza sativa*), corn (*Zea mays*) and coconut (*Cocos nucifera*) were the most researched. Other locally important crops such as the abaca (*Musa textilis*) and sili (*Capsicum* sp.) were sparingly investigated. Aside from the food derived from the plants, a few were researched for ornamental purposes. These include species of orchids, hoyo, and ferns. Pili (*Canarium ovatum*) was also studied but all researches pertaining to this had entirely the same theme of controlling post-harvest fungal pathogens on stored pili kernels.

Majority of the researches conducted along agriculture were in entomology (22.16%) and animal sciences (20.10%). The least were on the control of snail pests (4.12%) and weed science (0.52%) (Figure 4). Entomological researches were on either of two major topics only: ecology and taxonomy or the control of insect pests using biological control agents. The coconut hispine beetle (*Brontispa longissima*) and the rice bug (*Leptocoris oratus*) were studied 4 and 2 times, respectively. This was during the time when these insects became a threat in the region (Navasero et al., 2008).

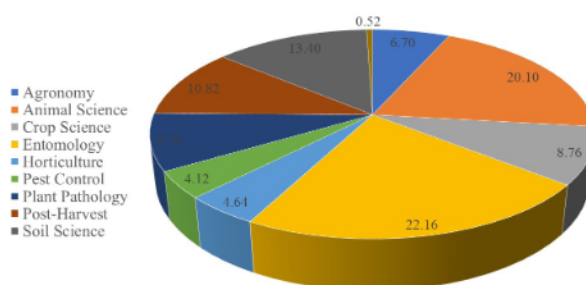


Figure 4. Percentage distribution of thesis topics across the agriculture subdisciplines investigated in the biology undergraduate program in Bicol University from 1986 to 2019.

Likewise, animal science researches were also on two topics only: improvement of animal products (20 researches) such as eggs and meat, and the parasitological assays on ticks and worms (19 researches). Interests on chicken (*Gallus domestica*) dominated the animal science researches.

Post-harvest and plant pathology studies combined comprise 19.59% of the total agricultural researches. Post-harvest researches can further be clustered into three: post-harvest pathology, entomology, and storage. Thirteen of the 16 post-harvest pathology studies were

mycological while the remaining were bacteriological.

Along fisheries, the tilapia (*Oreochromis nilotica*) was the most studied. During the 90s, studies on tilapia was mainly concerned on the tolerance of the fish to different environmental conditions such as salinity and addition of effluents to the water. This shifted from 2001 towards histological and parasitological studies of tilapia populations in freshwater lakes in the Bicol region. Studies on bangus (*Chanos chanos*), lawlaw (*Sardinella fimbriata*) and edible seaweeds were thinly spread throughout many years.

Studies on bivalves were limited to three scopes: gut analysis, depuration studies, and development of relaxants from plant extracts. Depuration and reduction of biotoxins in the short-necked clam (*Paphia amabilis*), locally known as punaw, and the green mussels (*Pernia viridis*), locally known as tahong, were carried out using plant extracts such as black pepper (*Piper nigrum*), langkuas (*Zingiber zerumbet*), ginger (*Zingiber officinales*) oregano (*Coleus aromaticus*), wild mangosteen (*Sandoricum koetjape*), tamarind (*Tamarindus indica*) and yerba buena (*Mentha corpiifolia*). The investigations on possible relaxants of the pearl oyster (*Pinctada maxima*) and freshwater mussels (*Cristaria plicata*), utilized plant extracts from talampunay (*Datura metel*), gatas-gatas (*Euphorbia piluifera*) and artemisa (*Artemisia vulgaris*).

Forestry is the least researched area and majority of these are focused on seedling growth and propagation. The locally important *Canarium ovatum* was saccharified with sulfuric acid (1988) and potassium nitrate (2000) and treated with cytokinin benzylaminopurine (2005) to improve seedling germination. Mahogany (*Swietenia mahogani*) was studied twice, both of which were on improvement of seedling growth. Other species of trees were studied only once: narra (*Pterocarpus indicus*), eucalyptus (*Eucalyptus camaldulensis*), mangium (*Acacia mangium*), golden shower (*Cassia fistula*), and pomegranate (*Punica granatum*). A single research on mycorrhizal inoculation for reforestation was conducted in 2011 and was the last forestry research on record.

## Discussion

Bicol region was the fastest growing economy in the Philippines in 2018 with a regional growth rate of 8.9%. Statistics from the National Economic Development Authority (NEDA) showed that despite the devastation from typhoons and volcanic eruptions, the region demonstrated sustained improvement in agriculture.

There were also significant increases in fish, hog, poultry and cattle production in the same year. AFF, however, mirrors the national statistics and lags behind the industry and service sectors.

Crucial to a sustained AFF development is a thriving research environment. It has been shown that agricultural research has contributed to productivity growth in many countries (Hu *et al.*, 2000; Alene, 2010). Public funding for AFF researches is correlated to output growth and crop yields (Piesse & Thirtle, 2010). More so, AFF has direct socio-economic implications. Adoptable technologies can lead to increased farm outputs, reduced forest denudation, and improve quality of aquatic resources. There is a clear correlation between AFF and poverty reduction (Hazell & Haddard 2001; Belcher, 2005; Bene *et al.*, 2016). Yet, less-developed countries such as the Philippines have more pronounced level of national underinvestment in agricultural R&D (Alston *et al.*, 2006).

It is to be understood that AFF researches should not be conducted in isolation with other sciences. Agriculture, fisheries, and forestry draw much of its data from both the basic and applied sciences (Pardey *et al.*, 2006), especially biology where the direct implications from plant physiology, soil ecology and genetics redefine the practices and technologies. It can be argued that the waning interest in AFF researches of the Biology Department potentially manifests the youth's perception of agriculture, most especially among non-agriculture majors. Government policies and directions could also be seen to influence the research trends among HEIs. The interest on providing scientific evidences on the efficacy of medicinal plants to cure various ailments was ignited when the Department of Health advocated in 1995 the use of ten herbs with reported medicinal properties. This was further strengthened by the enactment of the Traditional and Alternative Medicine Act of 1997 (Mendoza, 2009). While studies have drifted from the 10 recommended herbs, research interests have been sustained to include other flora with possible therapeutic values (Guerrero & Notarte, 2020).

The weight of AFF researches on government entities can be an opportunity for universities to invest in their own initiatives parallel and supportive of the national AFF agenda through guided undergraduate studies. The role of universities in AFF research does not necessarily require the increase in the number of studies. It will be good if it does. While the lack of qualified faculty mentors are now being addressed by HEIs through faculty development programs, the limitations in undergraduate

research is still largely set by monetary support (Petrella & Jung, 2008). HEIs can explore minimal funding strategies or placing related studies under a faculty grant. Undergraduate researches are, by analogy, small blocks on which full blown AFF researches can assimilate into stronger full-blown proposals. Aggressive scholarship and research grants through government agencies like the Department of Science and Technology can also fill in the funding needs. International linkages and scholarships are also available and needs only to be fully tapped by universities (Castillo, 2012).

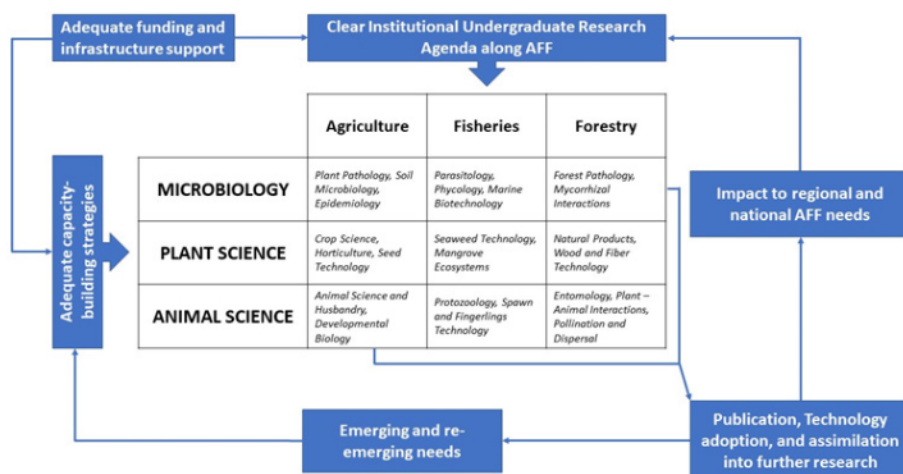
Agriculture, forestry and fisheries continue to be a thematic area under the Bicol University's research agenda, and among many state universities in the country. It is right to do so, both as a manifestation of its support to regional and national AFF thrusts and as a strong policy statement to improve the lives in the region. It remains unclear, however, how undergraduate researches fit into the narrative. For Bicol University, there is no clear policy that such research agenda trickles down to undergraduate researches. Crafting of a research agenda at the undergraduate level reflecting the local and national agenda can be a way forward.

The question of where undergraduate research fits into this context lies in the careful matching of what are expected from them and what can be delivered by them. This matching should be supported by an analysis of what resources are available such as infrastructure, mentorship, and time. While it is tempting to increase the number of AFF undergraduate researches in response to the data presented in this study, it is first logical for HEIs to assess the current infrastructure and human resource

capital of the university which can support this. While some HEIs offer both biology and agriculture courses, as in the case of Bicol University, AFF researches conducted in the biology program can be connected and interrelated to those performed in the agriculture programs and vice versa. Thus, a unified infrastructure, particularly research facilities, and human resource capital could benefit both programs. Further, undergraduate research is part of the academic curriculum, thus should be assessed so that deliverables integrate seamlessly into the learning process.

Literature is rich in documenting the role of faculty mentors in undergraduate researches. Choice of research topics should be deliberate and carefully discussed by the student and the mentor. This faculty-student interaction is critical and beneficial in improving quality of the research and providing a global perspective (Houser *et al.*, 2013; DeAngelo *et al.*, 2016). Mentoring in undergraduate researches leads to better student performance in research and research-related skills. Mentored students also gain more confidence in their overall research performance. Students who have none or little prior experience in conducting science-related researches benefit more from prolonged faculty-student interaction, with the faculty giving the right perspectives and motivation for the students (Haeger & Fresquez, 2016).

In the context of AFF, there is no need to completely redirect expertise of faculty members. Instead, institutions need to provide adequate areas for knowledge expansion so that the link between AFF and their current research niche is strengthened. In the case of the Biology Department, expertise lies along



**Figure 5.** Reintegration and strengthening of AFF studies in the undergraduate non-AFF curricula require adequate multifaceted institutional support from colleges and universities.



Microbiology, Plant Science and Animal Science. Such clustering can provide initial direction and cohesiveness of undergraduate researches (Figure 5). Co-mentoring among faculty across disciplines may also be a strategy to look into.

Despite the number of AFF researches presented in this study, there are no traceable records of any publications emanating from them. Because of the changing dynamics of AFF systems, researches require immediate publication or presentations especially when the data are responsive to a pressing need, or at least make them accessible to concerned agencies. Several professional organizations in the Philippines now encourage and accommodate student researches to be presented during their conferences and be published in their official publications for faster and wider dissemination of information from relevant and insightful student researches (Castillo, 2012).

Inaccessible and unpublished data has the tendency to be watered down or lost spatiotemporally, carrying with them their socio-economic impacts. Accessibility to these data can be achieved by maintaining an online open-access repository of researches, protected by applicable copyright policies of the university. Such move requires the strengthening of the institution's knowledge management division and library systems. More importantly, publication should be aggressively encouraged, with institutional policy support to both faculty adviser and student (Morales *et al.*, 2017). Undergraduates who publish are known to boost human research capital (Bozeman & Corley, 2004) who can eventually integrate into the AFF workforce. An initial move can be the creation of a peer-reviewed student journal so that undergraduates become aware and engaged in the research process (Stone *et al.*, 2016).

The pool of undergraduate non-AFF students is undeniably a formidable stronghold in filling in the gap in AFF researches and manpower. With the advent of genomic technologies as applied in the improvement of quality and yield of crops and livestock, AFF-related researches would provide more opportunities for non-AFF students to delve into relevant needs-based researches (Young, 2019). Along this line, the gap between basic and applied researches can be obscured emanating from, and leading to, a more integrative and multidisciplinary research approaches.

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